

J. S. FORBES.

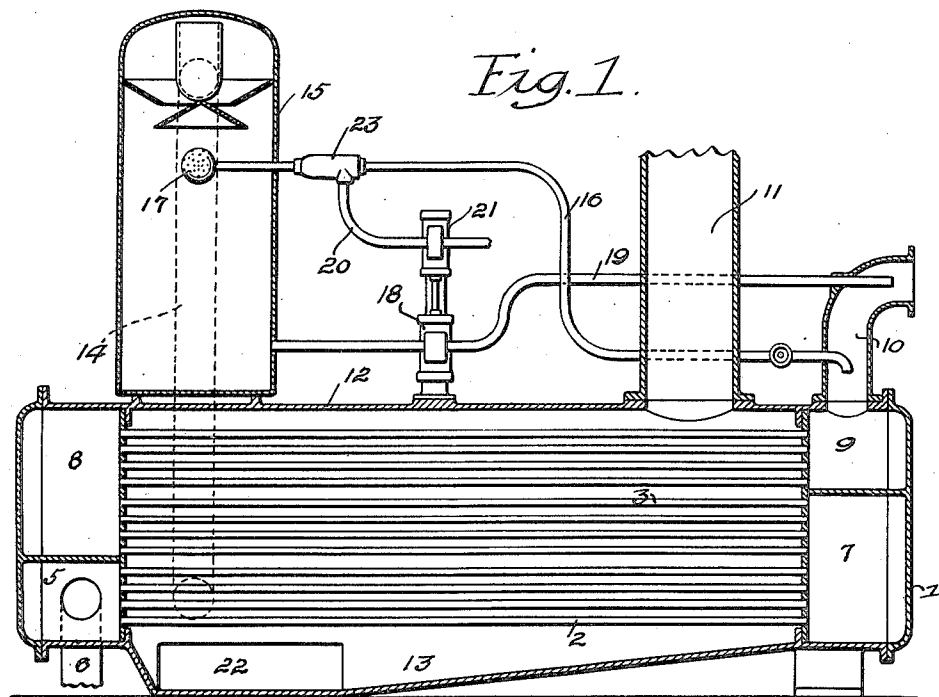
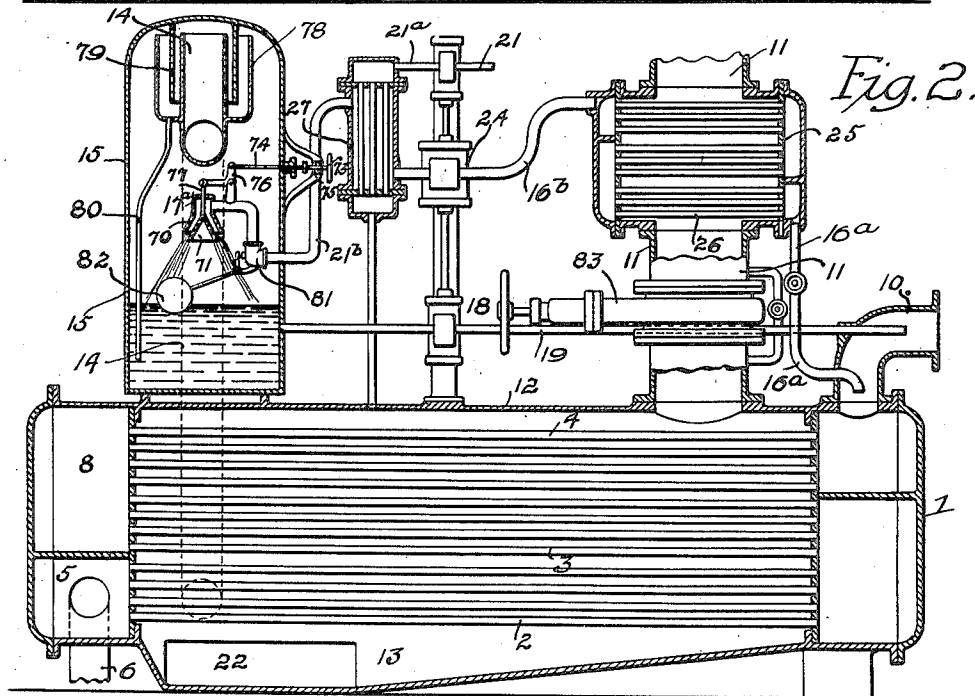
METHOD OF AND APPARATUS FOR DISTILLING AND EVAPORATING.

APPLICATION FILED OCT. 10, 1913,

Patented July 3, 1917.

4 SHEETS—SHEET 1.

1,232,269.



Witnesses—
Walter Blum
William F. Naser

Inventor—
John S. Forbes.
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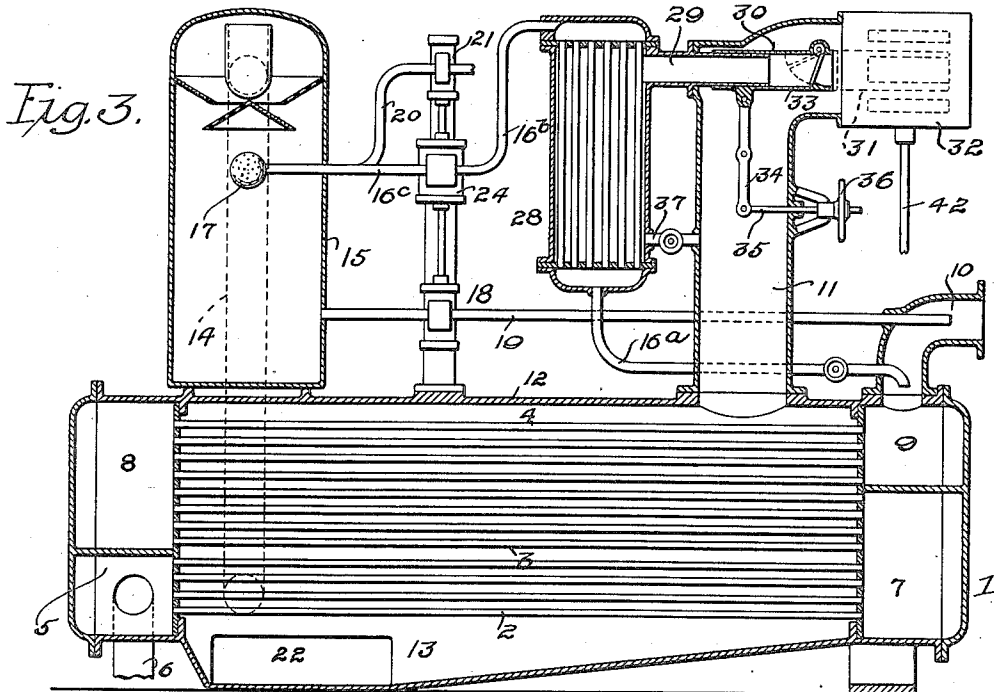
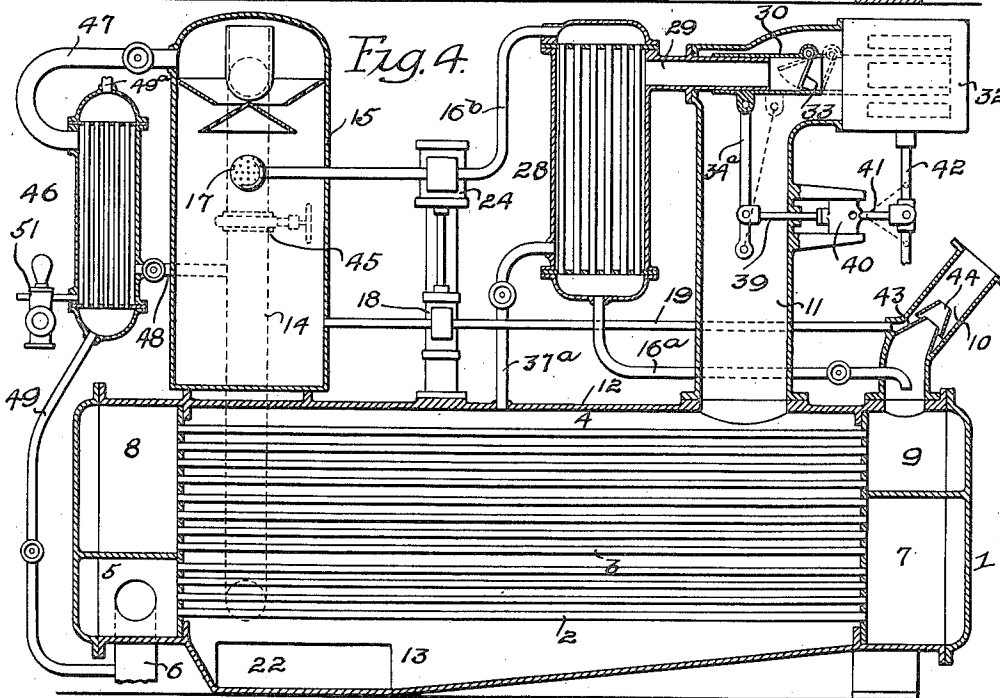
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Witnesses—
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William F. Has.

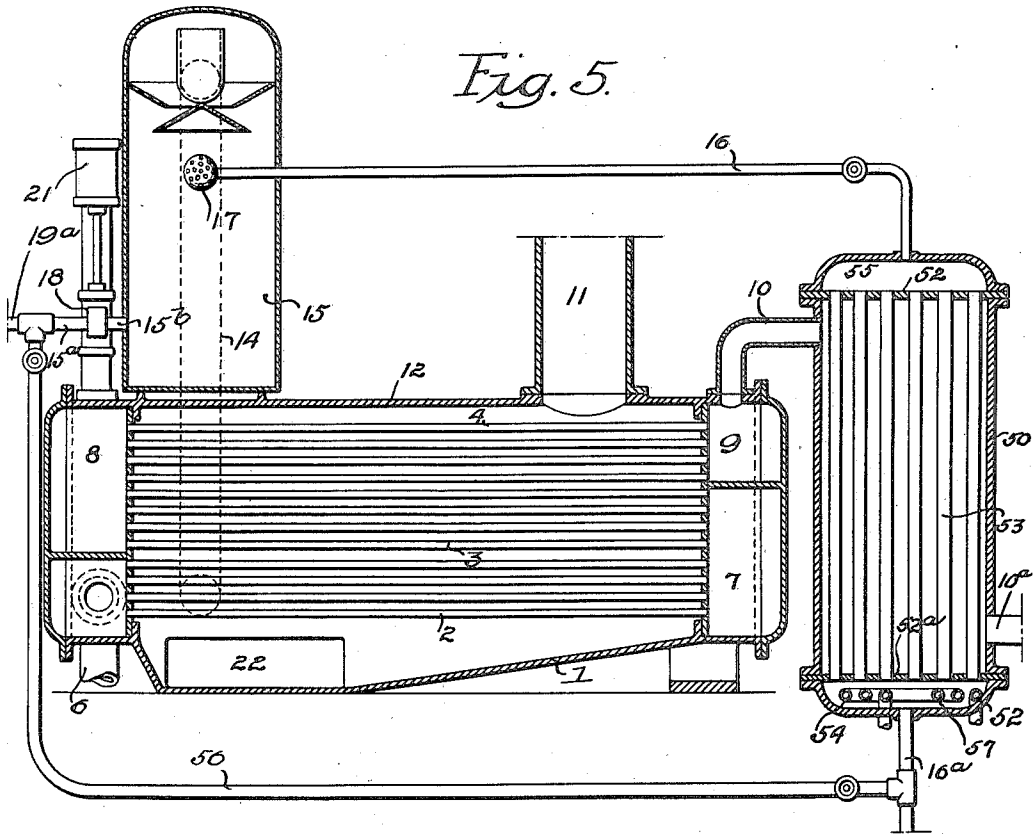
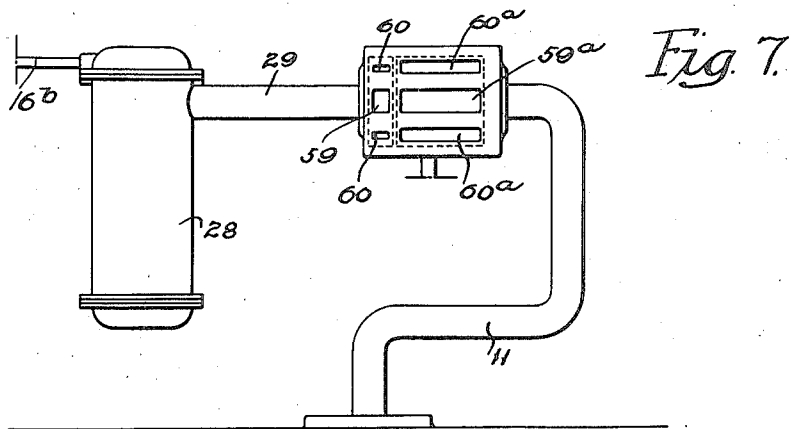
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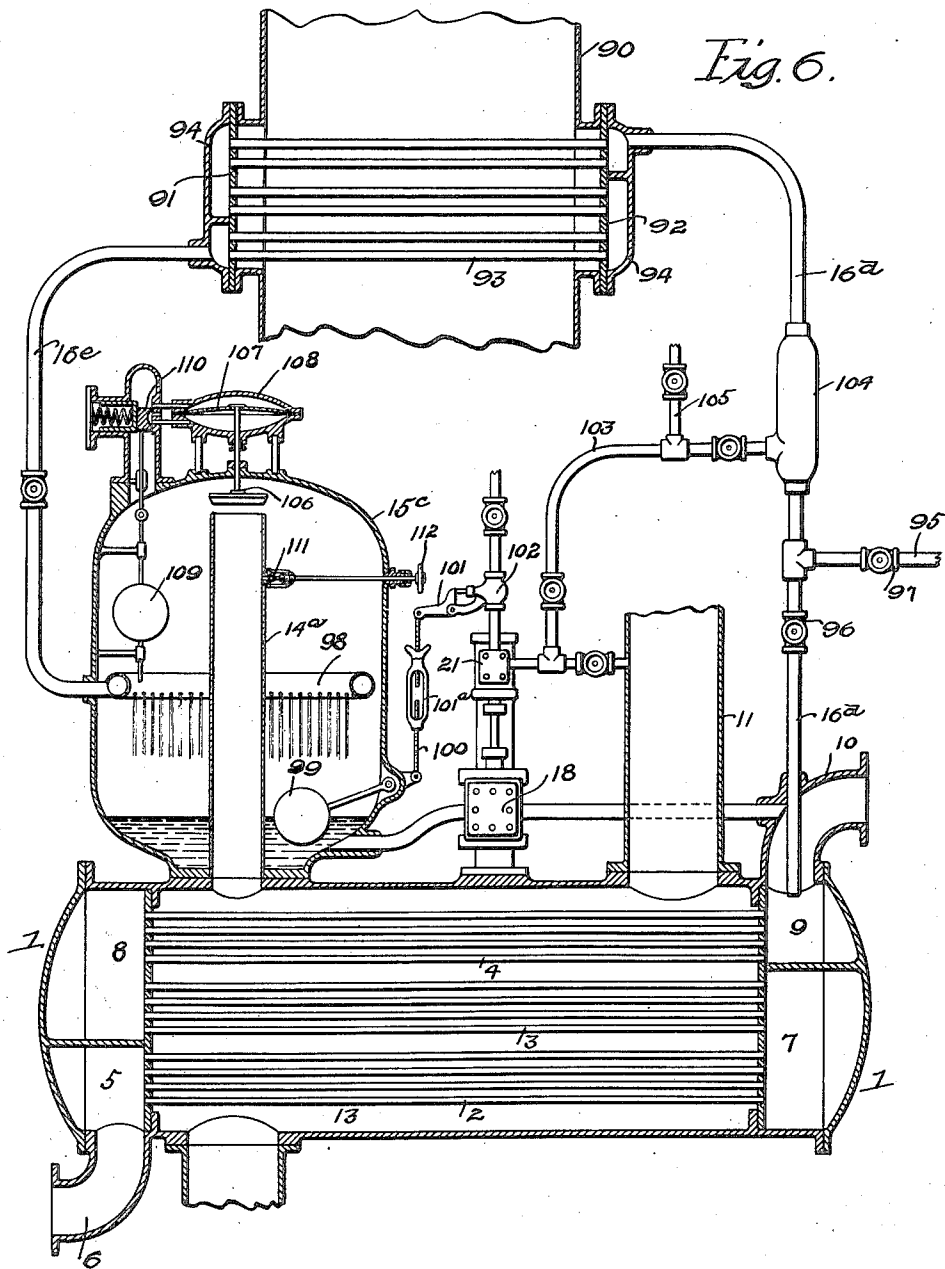
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UNITED STATES PATENT OFFICE.

JOHN S. FORBES, OF PHILADELPHIA, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR DISTILLING AND EVAPORATING.

1,232,269.

Specification of Letters Patent.

Patented July 3, 1917.

Application filed October 10, 1913. Serial No. 794,509.

To all whom it may concern:

Be it known that I, JOHN S. FORBES, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented a Method of and Apparatus for Distilling and Evaporating, of which the following is a specification.

One object of my invention is to provide a novel method for securing distilled water in addition to that ordinarily obtained from the surface condenser used in connection with a condensing engine or other steam or heat source, it being particularly desired that the method shall be such as to supply distilled water in amounts equal to or greater than that lost by leakage or other causes from the engines, boilers, condensers, etc., comprising a steam plant such as that on board a ship.

I further desire to provide a novel method for utilizing what would ordinarily be the waste heat of flue gases or of steam from any source, such as the exhaust of a condensing or other engine, for the purpose of obtaining greater or less quantities of distilled water in addition to that ordinarily obtained from a condenser, or for the purpose of concentrating liquids; the method being of such a nature as to be easily and economically carried out at an expense that is practically negligible as compared with that of the distilling apparatus otherwise employed.

Another object of my invention is to provide a novel apparatus for carrying out the method of distilling above referred to, which shall occupy but relatively little space, shall be compact and substantial in construction, and shall not require any but a minimum of attention or repairs for prolonged periods of time.

These objects and other advantageous ends I attain as hereinafter set forth, reference being had to the accompanying drawings, in which;

Figure 1 is a vertical section, to a certain extent diagrammatic, illustrating a simple form of apparatus for carrying out my improved method;

Figs. 2, 3 and 4, are diagrammatic vertical sections illustrating modified forms of the apparatus shown in Fig. 1;

Figs. 5 and 6 are diagrammatic vertical

sections of other modifications of my invention, and

Fig. 7 is a diagrammatic view of a modification of a detail of my invention.

Referring to Fig. 1 of the above drawings, 1 represents a surface condenser having three sets of tubes 2, 3 and 4, of which those of the first set communicate at one end with a chamber 5 supplied with cold condensing water through the pipe 6 and at the other end connect with a chamber 7. The tubes 3 also connect with this latter chamber and with the chamber 8, while the tubes 4 connect the chamber 8 with another chamber 9 which is in turn connected to the water discharge pipe 10. Steam from the exhaust of an engine is discharged from a pipe 11 into a casing 12 inclosing the tubes 2, 3 and 4, and the bottom of said casing is so formed as to constitute a hot well 13 though it may be connected to any desired container serving the same function. Mounted on or adjacent the condenser casing 12 is a casing 15 forming a flash or vaporizing chamber whose upper portion is connected, preferably by a relatively large pipe 14, with some point of the vacuum compartment of the condenser casing 12 which is relatively distant from the exhaust steam pipe 11.

A pipe 16 is connected to receive heated water from the water discharge pipe 10 and deliver the same to a vaporizing or atomizing nozzle or head 17 within the vaporizing chamber 15, and a pump 18 is provided to withdraw water from the bottom of said chamber and discharge it through a pipe 19 into the water discharge conduit 10 or any other desired waste pipe, the flow of water through said pipe 16 being due partly to the fact the hot water is under pressure and partly because of the vacuum in the vaporizing chamber 15. That part of the pipe 16 entering the hot water conduit 10 preferably opens so as to directly receive the water flowing through said conduit and if desired it may have connected to it the exhaust steam pipe 20 as clearly shown in Fig. 1 so that the water flowing through it may be heated thereby.

As is understood by those skilled in the art, a condenser such as that shown, under

operating conditions is supplied with cold water from the pipe 6 and said water flows successively through the series of tubes 2, 3 and 4, finally reaching the chamber 9 and the discharge pipe 10 in a more or less heated condition, since the heat of the exhaust steam discharged from the engine through the pipe 11 is imparted to such water and said steam is condensed in the casing 12; the condensed water collecting in the hot well 13, which in this instance is shown as having an opening 22 adjacent the bottom of the condenser, in connection with an air pump.

If now some of the more or less heated water from the pipe 10 be delivered through the pipe 16 into the head 17 so as to be either atomized or given a film form, or be otherwise finely subdivided, a greater or less quantity of it will flash into vapor owing to the vacuum in said casing by reason of its connection through the pipe 14 with the interior of the condenser casing 12. Such vapor passing through this pipe 14 is condensed within the casing 12 and is added to the water provided by the condensed steam exhausted by the engine. A certain part of the water passing into the casing 15 through the pipe 16 is not vaporized but after collecting in the lower part of said casing is drawn off by the pump 18 through the pipe 19 which discharges it into the condenser outlet pipe 10. In order to add to the heat of the water flowing through the pipe 16, the exhaust steam from the steam cylinder 21 of the pump may be directed into it by any suitable means such as the injector 23, with the result that a greater quantity of it is vaporized when it is discharged into the casing 15.

With the above described method of operation, there is obtained an ample supply of distilled water in addition to that which would have otherwise been provided by the condenser, at a cost which is relatively small since there is but a slight additional load put on the air pump and but a very small amount of steam used to operate the pump 18.

Inasmuch as the vacuum in the casing 15 as well as the velocity head of the water in the discharge pipe 10 tends to cause a flow of water through the pipe 16, I may if desired utilize such water to operate a motor 24 which in turn actuates the pump 18 as shown in Fig. 2 to draw the water from the casing 15 and discharge it into the waste pipe 10.

With such an arrangement of parts, I preferably also combine a small steam engine 21, which may assist the water motor 24 when necessary or advisable.

In order to bring the temperature of the water discharged into the casing 15 to as high a point as possible, I may lead the heated water from the condenser discharge

pipe 10 through a pipe 16^a, shown in Fig. 2, to a small heater 25 mounted in the exhaust pipe 11 between the engine and the condenser 1, with the result that the exhaust steam flowing around the tubes 26 of said heater very materially raises the temperature of the water therein. The hot water from the heater is then delivered through a pipe 16^b to the water motor 24 and before being delivered to the spray head 17^a in the casing 15 may be passed through a second heater 27 whereby its temperature is still further raised by the exhaust steam delivered through pipe 21^a from steam engine 21. The water then passes through the pipe 21^b to the spray head 17^a, which in this case is shown as consisting of a downwardly opening conical shell 70 carried on the end of said pipe and having mounted within it a second but smaller conical shell 71. The thin conical sheet of water delivered between the two shells may be regulated or cut off by means of a handle 73 fixed to a rod 74 which is threaded through a bracket 75 and within the casing 15 is connected through a bell crank lever 76 to a vertically guided rod 77 carrying the inner shell 71.

As is obvious, by the above method of treatment, a relatively greater quantity of the water delivered through the pipe 21^b to the casing 15 is vaporized and a correspondingly increased amount thereof is condensed within the casing 12 of the main condenser, while a correspondingly less amount of water has to be removed from the casing 15.

In this case, as well as in others illustrated, I provide suitable means for separating liquid particles from the vapor passing from the vaporizing chamber 15 to the pipe 14, so designing said chamber that the velocity of the vapor flow is slow enough to accomplish this end and if desirable providing a device in the form of an annular structure 78 closed at the bottom and mounted concentrically with the end of the pipe 14 in the upper portion of said casing. An annular partition 79 extends from the top of the casing downwardly between the annular structure 78 and the end of the pipe 14, thus forming a tortuous passage-way for the vapor passing out of the chamber 15. Any liquid collecting in the lower part of the annular structure 78 is delivered through a pipe 80 into the lower part of the chamber 15 below the normal water level.

In order to prevent the continued admission of water through the pipe 21^b in case the pump 18 fails to operate, I connect a valve 81 in this pipe and control it by means of a float 82 within the chamber 15, so that when the water rises to a predetermined height, said valve is automatically closed by the float until the liquid level is lowered. Under certain conditions as for example when my invention is used in connection

with a condenser receiving steam from a turbine which naturally does not deliver steam in separate bodies like a reciprocating engine, I may increase the capacity of the heater 25 by retarding or cutting off the flow of steam through the pipe 11 leading to the condenser, and for this purpose connect in said pipe a suitable valve 83. By closing this to a limited extent so as to slightly retard the flow of steam from the engine to the condenser, the temperature of said steam in the heater is materially raised without unduly increasing the back pressure of the engine, which may be of any type, *i. e.*, either reciprocating or rotary. As a result, the water delivered from the heater is raised to a considerably higher temperature than would otherwise be the case and greater quantities thereof are consequently vaporized in the chamber 15 to be thereafter liquefied in the condenser.

As will be understood by those skilled in the art, the temperature of the steam exhausted from an engine cylinder is at a maximum immediately after the exhaust valve has opened, and inasmuch as my novel method of securing distilled water requires or utilizes but relatively little of the total amount of heat energy actually present in the exhaust steam when it is released from the engine cylinder, I may as shown in Fig. 3, provide a heater 28 for the water taken to be vaporized, whose casing is connected so that it will periodically receive steam from the engine exhaust and that for a limited time only immediately after the exhaust valve has opened. With this idea in view I provide the steam intake pipe 29 of the heater 28 with an extension 30 in the form of a sleeve longitudinally slidable on said pipe 29 and so mounted within the exhaust pipe 11 as to extend immediately adjacent the exhaust port 31 of the engine cylinder, a portion of which is diagrammatically illustrated at 32. The pipe extension of sleeve 30 has mounted within it, immediately adjacent the exhaust port an inwardly opening check valve 33 and I preferably provide some mechanism whereby it may be adjusted toward or from the exhaust port of the engine cylinder in order to vary the amounts of steam delivered to the pipe 29 and to the heater 28 under operating conditions.

In Fig. 3 I have shown a manually operated form of adjusting device consisting of a lever 34 pivoted at one end to said sleeve 30 and at its opposite end connected to a rod 35 threaded at one end for the reception of a hand wheel 36, so that by turning said wheel the lever 34 may be turned on its pivot or fulcrum and the pipe extension 30 slid on the pipe 29 toward or from the exhaust port 31.

The heater casing is connected through a

valved pipe 37 with the exhaust pipe 11 so that there may be more or less of a vacuum in the heater and under operating conditions each body of exhaust steam delivered from the engine at the moment of release swings the check valve 33 into the position shown in dotted lines and a portion of such steam enters the heater casing. Thereafter the check valve closes so that the steam at the lower temperatures is not admitted to the heater, which thus utilizes steam at a relatively high temperature and consequently raises the temperature of the water delivered to it through the pipe 16^a to a higher temperature than would otherwise be possible.

As before, the water from the heater may be passed through a water motor 24 so as to wholly or in part serve as the means for actuating the pump 18 which withdraws the water from the casing 15. In this instance, I have shown the exhaust pipe 20 of the auxiliary steam engine 21 as connected to discharge into the pipe 16^c leading from the water motor 24 to the spray head or nozzle 17, so as to still further increase the temperature of the water finally delivered into the vaporizing chamber.

As shown in Fig. 4, I may provide an automatically acting device whereby the extension 30 of the heater intake pipe 29 is moved alternately toward and from the exhaust port of the engine for the purpose of insuring that it receives exhaust steam or a heat impulse only at the relatively high temperature existing at the beginning of the exhaust, and with this idea in view the lever 34^a while being connected to the sleeve 30 at one end, has its opposite end fulcrumed, in the case shown, within the exhaust pipe 11, and at a suitable point of its body is connected through a rod 39 with a suitably guided cross head 40. This latter, through a second rod 41 is connected to a valve rod or other movable part of the engine, so that at the desired point of each inward and each outward movement of said rod the sleeve 30 is so moved that its open end is brought immediately adjacent or in some cases caused to engage or enter the exhaust port of the engine for a short period of time, and is thereafter removed some distance away from said port; the path of movement of the said sleeve being determined by the adjustment of the rod 39, or other suitable part.

As a result, a relatively small amount of exhaust steam at the highest possible temperature—depending on the engine cutoff and sleeve adjustment, is delivered to the heater 28 whose casing in this instance is connected through a valved pipe 37^a to the condenser casing 12. In this particular case, the water from the heater 28 actuates the water motor 24 to operate the pump 18 and is assisted in such action by special suction-producing nozzles 43 and 44 mounted within

the condenser discharge pipe 10 so as to tend at all times to draw water through the pipe 19.

In the cases hitherto illustrated, I have shown the apparatus as so arranged that the distilled water obtained by my invention was delivered directly to the hot well of the condenser, but in case it should be desired to obtain distilled water not contaminated by the lubricant used in the engine and fit for drinking purposes, I provide an arrangement of apparatus such as shown in Fig. 4. While the vaporizing casing 15 is as before connected through a pipe 14 with the condenser casing 12, I mount in said pipe a valve 45, and provide an auxiliary condenser 46 of relatively small capacity, whose casing is connected through a valved pipe 47 to the upper part of said casing 15 as well as through a valved pipe 48 with the condenser casing 12, in this instance, by way of the pipe 14. Said condenser 46 is supplied with cooling water through a pipe 49 connected to the cold water supply pipe 6 and is also connected to any suitable waste pipe by a discharge pipe 49^a.

With this arrangement of parts, when it is desired to obtain pure distilled water for drinking purposes, the valve 45 would be closed and the valves in pipes 47 and 48 opened and with the parts operating as above described, the steam or water vapor generated in the casing 15 by reason of the vacuum produced therein, would pass through the pipe 47 and be condensed in the auxiliary condenser 46 from which the water could be withdrawn by a pump 51.

Whenever it is not desired to use the condenser 46, the valves in the pipes 47 and 48 may be closed and the valve 45 in the pipe 14 may be opened, whereupon the system operates as previously described, to deliver distilled water to the hot well of the condenser in addition to that formed from the exhaust steam of the engine.

It is obvious that in utilizing my invention, it is by no means necessary that the liquid itself which comes from the condenser be directly utilized as in the cases shown in Figs. 1 to 4, where a greater or less quantity is actually delivered into the casing 15 to be atomized or vaporized, for if desired, liquid coming from the condenser may be passed through any suitable form of heat exchange and thereby caused to transfer its heat to another body of liquid which is then delivered to the atomizing or vaporizing head 17 in the casing 15 as previously described.

An arrangement of apparatus for accomplishing this method of operation is shown in Fig. 5, where 50 represents a heat exchange in the form of a casing having tube sheets 52 and 52^a connected by tubes 53. The outlet pipe 10 of the condenser is

then connected to one of the compartments of this heat exchange,—in the case shown, to the space surrounding the tubes 53, and an outlet pipe 10^a is provided for carrying off the liquid from said compartment. The chamber 54 into which opens one end of each of the tubes, is provided with an inlet conduit 16^a while the chamber 55 at the opposite ends of the tubes connects through the pipe 16 with the atomizing or vaporizing head 17 in the casing 15. In this case, said casing 15 has its outlet conduit 15^b connected to the pump 18 which delivers into a discharge pipe 19^a and a pipe 56 connects the inlet pipe 16^a with the same discharge pipe.

For purposes of starting or assisting the operation of the device some source of heat such as the steam coil 57 may be placed in the chamber 54 and with this arrangement of parts the apparatus may be utilized to concentrate some liquid, such for example as a sugar solution, and at the same time provide a supply of distilled water in addition to that customarily delivered by the condenser. With this idea in view the liquid to be concentrated would be delivered through the pipe 16^a at the same time that the exhaust steam from an engine or any other suitable source was supplied to the condenser through the pipe 11.

The cooling water delivered from the pipe 6 would as before be heated in the condenser, while the steam from the pipe 11 would be condensed, and the heated water flowing from the discharge pipe 10 into the casing of the heat exchange 50 would raise the temperature of the sugar solution flowing through the tubes 53, being finally discharged through the pipe 10^a under the action of a circulating pump usually connected to said pipe 6. As before the heated liquid passing from the pipe 16 to the vaporizing or atomizing head 17 would have a greater or less amount vaporized in the casing 15 and the vapor so formed would be liquefied within the condenser casing 12.

As a consequence of the evaporation of some of the water in said casing 15, the liquid finally removed therefrom by the pump 18 would be to some degree concentrated and could either be discharged through the pipe 19^a or through the pipe 56 be returned to the heat exchange 50. By supplying steam to the coil 57, greater or less amounts of heat in addition to that received from the water discharged from the condenser, may be imparted to the liquid to be concentrated.

As a still further refinement of the apparatus shown in Fig. 3, I may so construct the valve of the engine used in connection with the other features of my invention as to insure a maximum heat impulse being delivered to my system of apparatus at each exhaust of the engine and with this idea in

view the portion of the valve chest with which the engine valve coacts would be provided with an auxiliary exhaust port 59 and auxiliary steam ports 60 as shown in Fig. 7, the exhaust port being directly connected to the inlet pipe 29 of the heater 28. The steam valve would be provided with a supplementary cavity independent of its main cavity which would coact with the main exhaust and steam ports 59^a and 60^a, so that at each stroke, there would be delivered to the heater 28 a body of exhaust steam which would be permitted to flow from the valve chest only at the beginning of the engine exhaust and would be immediately thereafter cut off in order to prevent exhaust steam at lower temperature flowing to the heater and also to prevent the latter being connected to the condenser through the main exhaust port 59^a. With such an arrangement of parts or with an equivalent device, the heat impulses received are a maximum for any given cut off of the engine and consequently the liquid finally delivered to the vaporizing or atomizing head 17 is heated to the highest possible temperature obtainable from the exhaust of a given engine.

While in all of the above described forms of my invention the water which it is desired to distil has been taken from the condenser cooling water, and the heat for raising the temperature of this water has been obtained from the exhaust steam of the engine which is connected to said condenser, I may, without departing from my invention, use water from an outside source and heat the same prior to its vaporization by heat from any suitable source, preferably one whose heat is not otherwise utilized. For example, in the case of Fig. 6, the main heater for raising the temperature of the water to be distilled may be placed in the stack 90 of the boilers supplying steam for the engine employing the condenser 1, and one form of such a heater as shown in Fig. 6 consists of a pair of tube sheets 91 and 92 mounted over flanged openings in opposite sides of the stack and connected by tubes 93. Suitable heads 94 are provided to coact with the tube sheets to cause the water to take a tortuous course through the heater, and to one of said heads is connected a water supply pipe 16^a leading from the discharge pipe of the main condenser 1. To this pipe 16^a is connected a branch pipe 95 leading from any suitable source of cold or hot water, and valves 96 and 97 are provided whereby the supply of water for the heater may be taken from either source at will. The hot water from the heater is delivered through a pipe 16^b to an annular perforated spray pipe 98 within the casing 15^c.

With this arrangement of apparatus I provide a float 99 connected through a link

100, turn buckle 101^a and a lever 101 to the throttle valve 102 in the steam supply pipe of the engine 21, so that when the water in the casing 15^c rises to a predetermined height said engine is speeded up and caused to operate the pump 24 at an increased speed until said float 99 is caused to drop by the withdrawal of the water whereupon the engine 21 slows down or stops until the water again rises in the tank. The exhaust of this engine may be utilized to heat the incoming water in the pipe 16^a by delivering it through a pipe 103 to a suitable heater 104 connected in said supply pipe. A branch 105 is provided in the exhaust pipe 103 so that the exhaust from the engine 21 may be permitted to escape independently of the heater 104, if this should be desirable.

In order to avoid the possibility of the water rising in the vaporizing chamber 15^c to such an extent as to flow into the pipe 14^a and thence to condenser, in case the engine 21 or pump 24 should break down or be accidentally stopped, I provide a valve 106 designed to close the inlet of said pipe 14^a when the water level has reached a predetermined abnormal level. For this purpose said valve 106 is connected to a diaphragm 107 within a suitable casing 108 mounted outside of the vaporizing chamber 15^c and the action of said diaphragm is controlled by a float 109 which actuates a slide or other suitable form of valve 110. This latter in one position connects the under side of the diaphragm 107 with the atmosphere and at the same time permits communication between the upper side of the diaphragm and the interior of the casing 15^c. Under these conditions the float 109 is at its lowest point and the diaphragm is in such a position that the valve 106 is open. When, however, the float is raised by an abnormal quantity of water in the chamber 15^c, the space in the casing 108 under the diaphragm is connected to the interior of said casing 15^c, while the upper side of the diaphragm is acted on by the atmosphere, thus causing the valve 106 to be moved to and held in its closed position.

Should the vacuum in the casing 15^c be destroyed after the closing of the valve 106, there would as a consequence be no means for causing the operation of the diaphragm 107, and I, therefore, provide the valve 111, whereby communication may be established under such conditions between the steam receiving compartment of the condenser through the pipe 14^a with the interior of the casing 15^c. By opening this valve, therefore, the diaphragm 107 is caused to act after the water has been withdrawn from said casing sufficiently to allow the float 109 to drop and the valve 110 to occupy the position shown in Fig. 6.

It is to be understood that in carrying out

my invention the exhaust steam delivered to the condenser or to the heaters may be received from a reciprocating engine, turbine or other form of rotary engine, and under certain circumstances the exhaust from the auxiliary engines may be used to heat the water, the vapor from which is to be condensed to provide boiler feed make-up or for any other purpose. Obviously such condensation may be accomplished either in the condenser belonging to the engine whose exhaust is used for heating, or in the condenser of another engine, or in a special condenser without departing from my invention.

It is to be noted that in large power turbine engine plants where the highest possible vacuum is required to be produced by the condenser in order that the plant shall operate with the highest efficiency, there will not exist a sufficient heat gradient between such a turbine and its condenser to effect the suitable operation of my invention. In such cases I employ the heat from the waste flue gases, as shown in Fig. 6, for heating the water to be vaporized; or employ the exhaust steam from some or all of the auxiliary engines employed in connection with such a plant.

It is noted that if, as previously stated, the valve 83, in that form of my invention shown in Fig. 2, be wholly or partially closed, a greater or less amount of water will collect in the heater 25, or in that part of the pipe 11 below the same. Such water would be discharged to any desired point of use or waste, and in the present case I have shown a valved pipe connected around the stop valve 83 in such manner as to deliver the water to the condenser casing.

I claim:

1. The method of obtaining distilled water which consists in heating a body of water by that portion of the exhaust steam of an engine delivered at the beginning of the exhaust thereof; vaporizing a portion of the water so heated; and condensing the vapor so secured.

2. The method of obtaining distilled water which consists in heating a body of water by that portion of the exhaust steam of an engine delivered at the beginning of the exhaust thereof; obtaining vapor from the water so heated; and condensing said vapor.

3. The method of obtaining distilled water which consists in heating a body of water by that portion of the exhaust steam of an engine delivered at the beginning of the exhaust thereof; vaporizing a portion of the water so heated; utilizing the energy of subsequent incoming bodies of water to remove the unvaporized water and condensing the vapor obtained.

4. The method which consists in trans-

ferring the heat of a body of exhaust steam to a body of liquid; vaporizing a portion of the liquid so heated; separating the remaining liquid from the vapor so formed; and condensing the vapor.

5. The method which consists in taking heated water from the discharge pipe of a condenser; subjecting said water in finely divided form to a vacuum to vaporize a portion thereof; separating the vapor from the unevaporated water; and condensing said vapor.

6. The method which consists in subjecting a body of steam to the cooling action of a body of water to condense said steam; separating a portion of said water heated by the steam from the main body thereof; subjecting said separated water in finely divided form to a vacuum to vaporize the same; and condensing said vapor.

7. The method which consists in subjecting a body of steam to the cooling action of a body of water to condense said steam; separating a portion of said water heated by the steam from the main body thereof; heating said separated water; subjecting the separated water in finely divided form to a vacuum; and condensing the vapor so formed.

8. The method which consists in subjecting a body of exhaust steam to the cooling action of a body of water to condense said steam; separating a portion of said water heated by the steam from the main body thereof; heating said separated water by imparting to it the heat of a further body of exhaust steam; vaporizing a portion of the heated water by subjecting the same to a vacuum after the heating has been completed; and condensing the vapor so formed.

9. The method which consists in subjecting a body of exhaust steam to the cooling action of a body of water to condense said steam; separating a portion of said water heated by the steam from the main body thereof; heating said separated water by imparting to it the heat of a body of exhaust steam delivered at the beginning of the exhaust of an engine; vaporizing a portion of the heated water by subjecting it to a vacuum; and condensing the vapor so formed.

10. The method which consists in subjecting a body of steam to the cooling action of a body of water to condense said steam; separating a portion of said water heated by the steam from the main body thereof; vaporizing a portion of said separated water by subjecting the same to a vacuum; utilizing the force of subsequent bodies of the separated heated water to remove the unvaporized portion of said water; and condensing the water vapor formed.

11. The method of supplying distilled water in addition to that provided by a condenser which consists in vaporizing a por-

tion of the heated cooling water discharged after its passage through the condenser; and delivering the vapor so formed to the steam receiving compartment of said condenser.

tor connected to be actuated by water flowing through said pipe, for actuating the pump; and an auxiliary motor for assisting said water motor.

5 12. The method which consists in separating a body of heated condensing water discharged from a condenser, from the main portion thereof; finely dividing and vaporizing a portion of the water so separated; removing the unvaporized water from the vapor so formed; and condensing the vapor.

13. The combination with a condenser of a vaporizing chamber connected to the vacuum compartment thereof; and a conduit connected to deliver heated cooling water from the discharge pipe of the condenser to said vaporizing chamber.

14. The combination with a condenser of a vaporizing chamber connected to the vacuum compartment thereof; and a conduit connected to deliver heated cooling water from the discharge pipe of the condenser to said vaporizing chamber; with means for discharging unvaporized water from said chamber.

15. The combination with a condenser of a vaporizing chamber; a conduit connected to deliver heated cooling water from the discharge pipe of the condenser to said chamber; and means for heating the water during its passage through said conduit.

16. The combination with a condenser of a vaporizing chamber; a conduit connected to deliver heated cooling water from the discharge pipe of the condenser to said chamber; means for delivering such water in finely divided form within the chamber; means for causing condensation of the vapor generated in said chamber; and means for withdrawing unvaporized water from the chamber.

17. The combination with a condenser of a vaporizing chamber connected to the condenser; a pipe connected to deliver heated cooling water from the condenser to said chamber; a pump for withdrawing unvaporized water from the vaporizing chamber; and a water motor connected to be actuated by water flowing through said pipe, for actuating the pump.

18. The combination with a condenser of a vaporizing chamber connected thereto; a pipe connected to deliver heated cooling water from the condenser to said chamber; a pump for withdrawing unvaporized water from the vaporizing chamber; a water mo-

19. The combination with a condenser of a vaporizing chamber connected thereto; a pipe connected to deliver heated cooling water from the condenser to said chamber; a pump for withdrawing unvaporized water from the vaporizing chamber; a water motor connected to be actuated by water flowing through said pipe, for actuating the pump; a steam engine for assisting said water motor; and means for imparting the heat of the exhaust steam from said engine to the water in the said pipe.

20. The combination of a condenser connected to the exhaust pipe of an engine; a vaporizing chamber connected to the vacuum compartment of the condenser; a pipe for delivering water to said vaporizing chamber; a heater for raising the temperature of the water delivered by said pipe; and means for delivering the exhaust steam from the engine to said heater.

21. The combination of a condenser connected to the exhaust pipe of an engine; a vaporizing chamber connected to the vacuum compartment of the condenser; a pipe for delivering water to the vaporizing chamber; a heater for raising the temperature of the water delivered by said pipe; and a device for delivering to the heater only that portion of the exhaust steam of the engine which is discharged at the beginning of each exhaust stroke.

22. The combination of a condenser connected to the exhaust pipe of an engine; a vaporizing chamber connected to the vacuum compartment of the condenser; a pipe for delivering water to the vaporizing chamber; a heater for raising the temperature of the water delivered by said pipe; and an automatically acting device for delivering to the heater only that portion of the exhaust steam of the engine which is discharged at the beginning of each exhaust stroke.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JOHN S. FORBES.

Witnesses:

WILLIAM E. BRADLEY,
JOS. H. KLEIN.