

Sept. 13, 1932.

P. S. LYON

1,877,412

DEAERATING WATER HEATER

Filed Oct. 20, 1928

2 Sheets-Sheet 1

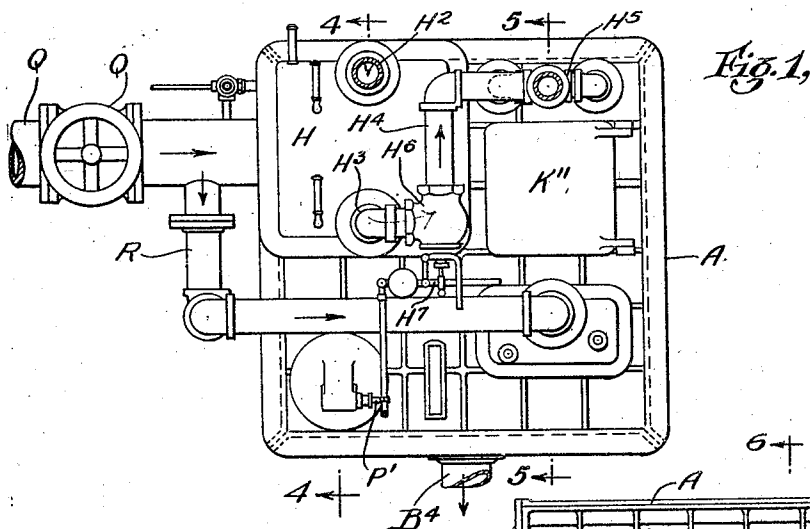


Fig. 2,

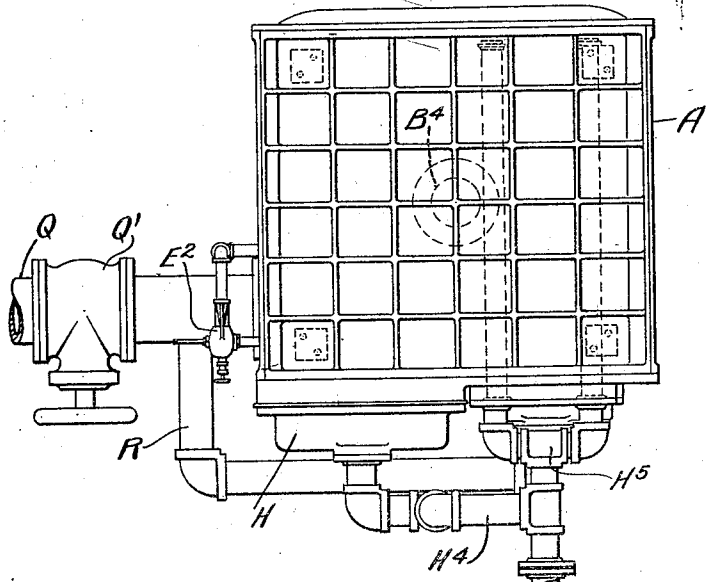
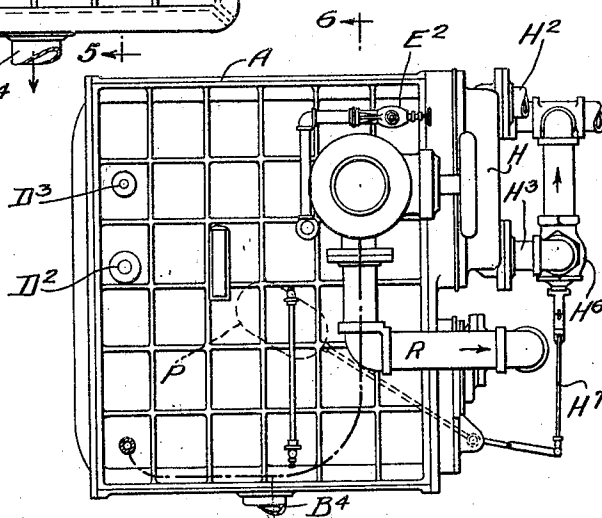


Fig. 3,

INVENTOR
PERCY S. LYON
BY
John E. Hubbell
ATTORNEY

Sept. 13, 1932.

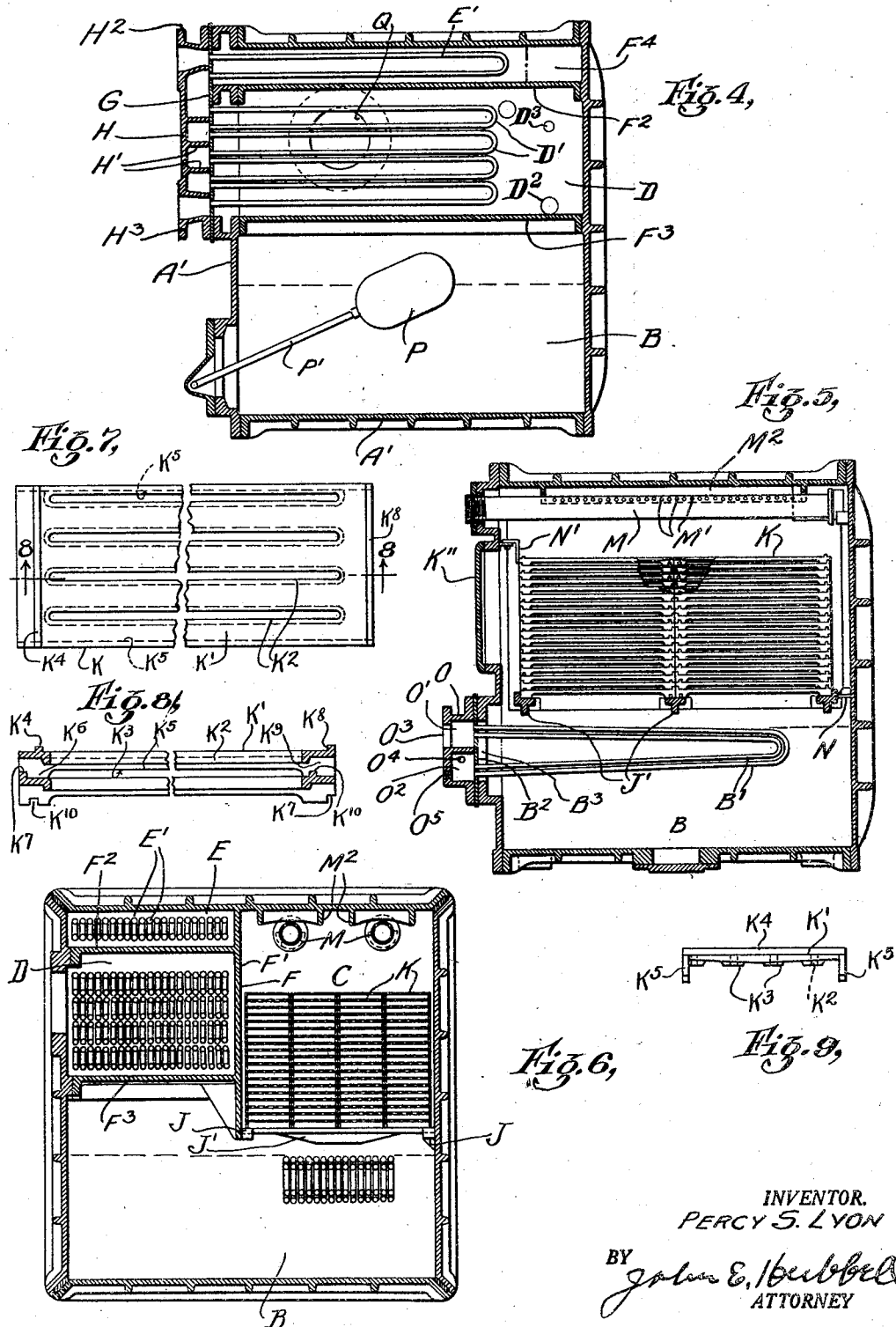
P. S. LYON

1,877,412

DEAERATING WATER HEATER

Filed Oct. 20, 1928

2 Sheets-Sheet 2



INVENTOR.
PERCY S. LYON

BY *John E. Hubble*
ATTORNEY

UNITED STATES PATENT OFFICE

PERCY S. LYON, OF FORT WAYNE, INDIANA, ASSIGNOR TO COCHRANE CORPORATION,
OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

DEAERATING WATER HEATER

Application filed October 20, 1928. Serial No. 313,716.

The present invention relates to apparatus for heating and deaerating water of the type in which raw water previously heated in a heat exchanger to a predetermined temperature is sprayed downwardly onto a bank of trays in which the descending water contacts with and is scrubbed by steam passing upwardly through said tray bank to liberate air and other corrosive gases contained therein, and the invention is devised especially for use in deaerating apparatus of the surface heater type i. e. apparatus in which the steam used for scrubbing the water is generated from the water being deaerated by contact with a heat exchanger comprising steam filled tubes into contact with which the water passes after leaving said tray bank. In deaerating apparatus of the character described the steam not condensed during its upward passage through the tray bank and the air and other gases liberated are passed into a second heat exchanger or vent condenser which may comprise one or two stages in which the major portion of the steam is condensed and from which the uncondensed gases and vapors are vented or discharged by an ejector.

In installations heretofore made of apparatus of the type described the heat exchanger, vent condenser and deaerating heater have usually been separate pieces of apparatus, and usually the vent condenser has been mounted on the top of the deaerating heater. Installations of this type occupy considerable floor space and require a considerable amount of interconnecting piping between the various pieces of apparatus.

Economy in floor space and headroom is especially desirable with deaerating apparatus of the type described because that apparatus is particularly adapted for domestic service use in hotels, apartments and buildings presenting space restrictions and where it is not desirable to permit the heating steam to contact with the deaerated water to be used for domestic purposes and where it is advantageous to utilize the condensate recovered from the heat exchangers of the apparatus as boiler feed water, rather than to mix it with the hot treated water.

Such apparatus is usually installed in the basement of the building wherein floor space and headroom are usually very limited. Deaerating heaters in present use are of sufficient height to cause great difficulty in installing them in basements of normal height. In installations where the vent condenser is mounted on the top of the heater, the required amount of headroom is greatly increased. A further disadvantage of the separate arrangement is that the standard pumps available for pumping the water from the water storage compartment of the heater to a point of use require a head of water from 6 to 10 feet above the inlet of the pump for efficient use. In many instances such a water head was impossible of attainment and it has been necessary to use special and more expensive pumps which can operate with approximately a three foot head above the suction inlet.

The object of my invention is to provide an improved arrangement and construction of apparatus for heating and deaerating water which is characterized by the consolidation of the preheater, vent condenser and deaerating heater in a single piece of apparatus having considerably less over-all height and requiring less piping and floor space than the apparatus heretofore in use. A further object of my invention is to provide an improved form of deaerating tray.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, and the advantages possessed by it reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

Fig. 1 is a front elevation of my improved apparatus;

Fig. 2 is a side elevation;

Fig. 3 is a plan view;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a section on the line 5—5 of Fig. 1;

Fig. 6 is a section on the line 6—6 of Fig. 2;

Fig. 7 is a plan view of the deaerating tray; Fig. 8 is a section on the line 8—8 of Fig. 7; and

Fig. 9 is an end elevation of one of the deaerating trays.

In the drawings I have illustrated a preferred form of my apparatus in which A represents the shell of the self-contained deaerating heater. In the preferred form shown the shell is preferably rectangular in horizontal and vertical cross sections and includes a water storage compartment or chamber B in the lower portion of the shell, a deaerating compartment C above one side of the storage compartment, a preheater compartment D above the other side of the storage compartment and alongside the deaerating compartment and separated from said compartments, and a vent condenser compartment E above the preheater compartment and at one side of and connected to the deaerating compartment. As shown the shell is composed of metallic plates A' shaped and connected as is usual in such rectangular shells.

The vent condenser and preheater chambers or compartments are formed by partitions mounted in one of the upper corners of the container and secured to the front, rear, a side and top wall plates of the container. The partitions comprise a vertical partition F' extending longitudinally of the heater and separating the chamber formed from the deaerating compartment. A pair of vertically spaced horizontal partitions F² and F³ extend laterally from the partition F' and are integrally connected to the adjacent side wall to form an upper vent condenser compartment and a lower preheater compartment. A port F⁴ is formed in the rear portion of the partition F' above the partition F².

A horizontal row of U-shaped tubes E' are positioned in the vent condenser compartment with the open ends of the tubes secured in a tube sheet G closing the front end of the compartments D and E. A steam ejector E² is connected to the compartment E and serves to withdraw air and small amounts of vapor therefrom. The preheater compartment D is occupied by a plurality of horizontal rows of U-shaped tubes D', each of said tubes having its outer ends secured to the tube sheet G. As shown in Fig. 4 the elements D' and E' extend longitudinally of and throughout the major portion of the corresponding compartment. A header H having a substantially smooth outer face and an inner face formed with a plurality of inwardly projecting transverse ribs H' is secured to and covers the tube sheet G. The header is provided with flanged inlet and outlet openings H² and H³, respectively. Each rib is arranged to contact with the tube sheet at a level between the upper and lower

legs of one of the rows of heating elements. This arrangement provides a continuous closed path of flow for the water passing in at H², through the tubular elements in each compartment to the outlet opening H³. A drain opening D² is located adjacent the bottom of the preheater compartment and an air outlet opening D³ adjacent the upper end of the compartment.

The lower edge of the plate F' and the opposite wall of the container are provided with brackets J at horizontally spaced points thereon and in which transverse members J' are supported. As shown there are three of such transverse members. A plurality of stacks of trays K are mounted on and extend from one to the other of the transverse members J'. The front of the deaerating chamber is closed by a tray door K¹¹, through which the trays may be inserted or removed.

As shown in Figs 7-9, each of the trays K is formed with a flat body portion K' in which a plurality of longitudinally extending transversely spaced slots K² are arranged. The portions of the tray body adjacent the slots K² are formed with bosses K³ on the underside. As shown in Fig. 7 the slots are symmetrically arranged relative to a line laterally displaced from the longitudinal center line of the tray. Each tray is provided at one end with a transverse lug K⁴ at its upper side intermediate the ends of the slots and adjacent end of the tray. A flange K⁵ depends from the underside of the tray at each side edge thereof and has a depending portion K⁶, which is cut away at its outer end below the lug K⁴ to form a notch K⁷. The opposite end of the tray has an upper transverse lug K⁸ at its outer end and each marginal flange K⁵ is formed with a depending portion K⁹ having a notch K¹⁰ therein inwardly spaced from the lug K⁸. With each of the trays constructed as described, the trays are necessarily stacked with alternate trays in the reverse position and the lugs K⁴ and K⁸ of each tray fitting into the notches K¹⁰ and K⁷, respectively, of the superposed tray. The slots K² of each tray of the stack are thus staggered relative to the slots of the adjacent upper and lower trays without requiring more than one form of baffle.

A pair of brass pipes M, each having one end open and threaded in the front wall of the shell and the opposite end closed and supported by the rear wall of the shell, are mounted above the tray stacks. Each pipe is provided with a multiplicity of perforations M' in its upper side. Ribs M² are formed on the underside of the top wall of the shell and extend longitudinally of the deaerating compartment on each side of each of the perforated pipes M.

A horizontal baffle N extends transversely of the deaerating compartment closing the space between the rear transverse member J' and

and the rear wall of the compartment. A second transverse baffle N' closes the space between the upper end of the tray stacks and the front wall of the compartment for a purpose hereinafter described.

The water storage compartment B contains an inner and outer row of U-tube elements B' arranged with the legs of each element in the outer row parallel with and surrounding the legs of the corresponding element in the inner row. The corresponding legs of the elements in each of the rows are mounted in a tube sheet B² covering an opening B³ in the front wall of the shell. A steam chest O having an upper inlet chamber O' and a lower outlet chamber O² covers and is secured to the tube sheet B² with the upper legs of the elements B' opening to the chamber O' and the lower legs opening to the chamber O². The upper chamber has a steam inlet opening O³ and the lower chamber is provided with a vent opening O⁴ and a drain opening O⁵. The tubular elements may be above the water level in the compartment or wholly or partially submerged. In the construction shown, the elements are substantially submerged. The elements are positioned below the center stacks of trays and extend longitudinally of the compartment to a point adjacent the rear wall.

A float P mounted on a lever arm P' pivoted in the front wall of the shell is positioned in the storage compartment at one side of the tubular elements B' and controls the amount of water sprayed onto the deaerating trays K. The water outlet H³ is connected by piping H⁴ to a common inlet H⁵ connected to the water distributing pipes M. A regulating valve H⁶ is positioned in the piping H⁴ adjacent the outlet. The valve H⁶ is operated by a lever system H⁷ connected to the lever arm P' of the float valve to increase and decrease the supply of water as the water level in the storage compartment decreases and increases, respectively. A water outlet pipe B⁴ is connected to the bottom of the storage compartment and leads to the inlet of a pump (not shown).

A steam inlet pipe Q having a thermostatically controlled valve Q' mounted therein is connected to one side of the preheater compartment D for passing steam into that compartment in contact with the preheater tubes. The thermostatic element controlling the operation of the valve is located in the storage compartment below the level of the water. A branch steam pipe R extends externally of the shell from a point in the steam inlet pipe Q between the valve Q' and heater to the upper chamber of the steam chest.

The general operation of the apparatus disclosed is as follows:

Raw water is passed into the heater through the inlet H² to the tubes forming the vent condenser and through which it passes dis-

charging into the header common to the vent condenser elements and first pass of the preheater elements. During its passage through the vent condenser, the water absorbs heat from the steam and air therein. The water then passes through the eight passes shown of the preheater elements where it is heated by the steam passing into that compartment through the inlet pipe Q. The apparatus is designed and the supply of heating steam and water so regulated that the water is heated in the preheater D to a temperature approximately that of the temperature of the water leaving the heater at B⁴, before it passes to the deaerating compartment. The heated water passes out through the valve H⁶ and piping H⁴ to the water distributing pipes M extending above the tray elements.

The water being under pressure is sprayed upwardly from the perforated distributing pipes against the top wall of the container and the spray is deflected by the longitudinal ribs M² downwardly onto the tray stacks. In normal operation the water in the storage compartment is at the outlet temperature desired and the heat supplied thereto by the evaporator elements B' is sufficient to convert a portion of the water in the compartment into steam which passes upwardly through and longitudinally between the tray stacks wherein it contacts with and scrubs the water passing downwardly therethrough. The scrubbing action taking place on the finely divided water assists in removing the air. By the term "air" as used herein, I mean to include not only the constituents of atmospheric air dissolved in the water and liberated from the latter in the apparatus, but also carbon dioxide and other gases liberated from the water in its treatment. Any steam not condensed during its passage through the tray stacks passes upwardly with the separated air through the port F⁴ into the vent condenser compartment and after contacting with the water tubes therein is exhausted by the steam ejector connected thereto. The deaerated water is withdrawn from the water storage compartment as needed by a suitable pump.

The apparatus of my invention is characterized by its simplicity, effectiveness and low cost of manufacture and installation. Only a small amount of floor space and a single foundation is required for the self-contained unit. The apparatus may be installed in locations having very limited headroom as the overall height of the unit is approximately four feet. This feature is also advantageous in that special pumps are not required and standard pumps of lower cost can be used. All openings and accessories are confined to the front, one of the side walls and bottom of the unit, whereby the unit may be installed in a corner having limited headroom. The

unitary construction results in a large saving in cost of material and a material decrease in the amount of heat insulation necessary. The large amount of interconnecting piping formerly necessary has been almost completely eliminated, thereby improving the appearance and lowering the cost of the equipment. The rectangular form of shell is considered advantageous over the cylindrical form and all the space therein is economically used and in all, the construction is unusually compact and effective.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

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

1. A self-contained water heating and deaerating unit comprising a casing having a deaerating space in the upper portion thereof, a tray stack in said space, water distributing means in said space above said tray stack, a water storage compartment below and open to said deaerating space, means for passing heating steam into said storage compartment, a plurality of water tubes in said casing at one side of said deaerating space and above said storage compartment, a closed vent condensing chamber in said casing at one side of said deaerating space and adjacent said water tubes, and a port connecting said condensing chamber with the upper portion of said deaerating space.

2. A self-contained water heating and deaerating unit comprising a casing of simple and compact form having a deaerating compartment in the upper portion thereof, a tray stack in said compartment, water distributing means above said tray stack, a water storage compartment below and connected to said deaerating compartment, means for passing heating steam into said storage compartment, a plurality of water tubes at one side of said deaerating compartment and above said storage compartment, said tube space being separated from said compartments by partitions, means for passing heating steam into contact with said tubes, a vent condensing space at one side of said deaerating compartment and above said water tubes, a port connecting said condensing space with the upper portion of said deaerating compartment, and means connected to said condensing space for withdrawing air passing thereto from said deaerating compartment.

3. A self-contained water heating and deaerating unit comprising a shell or casing of simple and compact form and partitions therein dividing the shell interior into superposed upper water preheating and vent condensing chambers, the latter having an air outlet, a deaerating space alongside said chambers and a water storage space beneath the deaerating and preheating chambers, one of said partitions being ported to permit the passage of air and vapor into said condensing chamber from said deaerating space, a steam heated water heater for evaporating a portion of the water entering said storage space from said deaerating space, water supply connections comprising tubes in the vent condensing and preheating chambers through which the water is passed in series into the upper end of the deaerating space, and means for supplying heating steam to said preheating chamber to heat the water passing through the tubes therein.

4. A self-contained water heating and deaerating unit comprising a casing having a deaerating space in the upper portion thereof, a tray stack in said space, water distributing means above said tray stack, a water storage compartment below and open to said deaerating space, means for passing steam into said storage compartment, a plurality of U-shaped preheating tubes at one side of said deaerating space and above said storage compartment, a closed vent condensing chamber at one side of and connected to said deaerating space and above said preheating tubes and containing a plurality of U-shaped water tubes, a water supply connection to said condensing tubes at the front of said casing, and water conduit means for connecting said condensing tubes, preheating tubes and said water distributing means in series arranged at and confined to the front end of said casing.

5. A self-contained water heating and deaerating unit comprising a casing having a deaerating space in the upper portion thereof, a tray stack in said space, water distributing means above said tray stack, a water storage compartment below and open to said deaerating space, means for passing steam into said storage compartment, a plurality of U-shaped preheating tubes at one side of said deaerating space and above said storage compartment, a closed vent condensing chamber at one side of and connected to said deaerating space and above said preheating tubes and containing a plurality of U-shaped water tubes, a water supply connection to said condensing tubes at the front of said casing, means at the front of said casing for connecting said condensing tubes and preheating tubes in series, and a conduit arranged at the front end of said casing connecting the discharge end of said preheating tubes to said water distributing means.

6. A self-contained water heating and de-

aerating unit comprising a casing rectangular in horizontal and vertical cross section and having a deaerating space in the upper portion thereof, a tray stack in said space, water distributing means above said tray stack, a water storage compartment below and open to said deaerating space, means at the front of said casing for passing steam into said storage compartment, a preheating compartment having a plurality of water tubes at one side of said deaerating space and above said storage compartment, a closed vent condensing chamber at one side of and connected to said deaerating space and above said preheating compartment and containing a plurality of water tubes, a water supply connection to said condensing tubes at the front of said casing, conduit means confined to the front of said casing and connecting said condensing tubes, preheating tubes and water distributing means in series, and steam conduit means connected to one side of said preheating compartment, whereby the rear, top, and one side of said casing are free from external connections.

7. A self-contained water heating and deaerating unit comprising a substantially rectangular casing having a deaerating space in the upper portion thereof, a tray stack in said space, water distributing means in said space above said tray stack and arranged to spray water onto said tray stack, a water storage compartment below and open to said deaerating space, a control float in said storage compartment, a plurality of steam tubes in said storage compartment, a vent condensing chamber in said casing at one side of said deaerating space and separated therefrom, a port connecting said condensing chamber with the upper portion of said deaerating space, and door means in the front wall of said casing providing access to said tray stack and float and through which the trays and float can be removed.

8. A tray stack adapted for use in liquid degasifying apparatus and formed by a plurality of superposed shallow trays of rectangular form and wholly similar in construction, each of said trays having a plurality of transversely spaced slots extending longitudinally thereof and symmetrically arranged relative to a line parallel to the longitudinal center line thereof, and means insuring a staggering of the slots in superposed adjacent trays when said trays are arranged horizontally and stacked consisting of lugs on one side of each tray adjacent the ends thereof, said lugs being spaced differently from the corresponding tray ends, flanges projecting from the opposite side of each tray adjacent the ends thereof, and notches formed in said flanges for receiving said lugs therein, each of said notches being positioned relative to the adjacent tray end a distance corresponding to the spacing of the lug at

the opposite end of the tray, whereby in stacking said trays alternate trays must be reversed to permit the lugs thereon to be positioned in the proper notches in an adjacent tray.

9. A tray stack adapted for use in liquid treating apparatus and consisting of a plurality of superposed trays wholly similar in form, each of said trays having one or more slotted overflow openings formed therein, and means insuring a stable stack formation of the trays and a vertical staggering of the overflow openings in superposed adjacent trays when said trays are arranged horizontally and stacked, comprising a plurality of vertically projecting lugs formed on each tray adjacent opposite peripheral portions thereof, a lug adjacent one of said peripheral portions being differently positioned relative to the corresponding portion of said periphery from a lug adjacent the opposite peripheral portion, and each of said trays having a plurality of recesses formed therein adjacent said opposite peripheral portions for receiving the lugs of an adjacent tray of said stack, each of said recesses being located at a point relative to one of said peripheral portions corresponding to the location of a lug on the opposite side of said tray relative to said opposite peripheral portion, whereby in stacking said trays alternate trays must be reversed in position to permit each lug thereon to be properly positioned in a corresponding recess in an adjacent tray of the stack.

Signed at Fort Wayne, in the county of Allen and State of Indiana this 9th day of October, A. D. 1928.

PERCY S. LYON.