

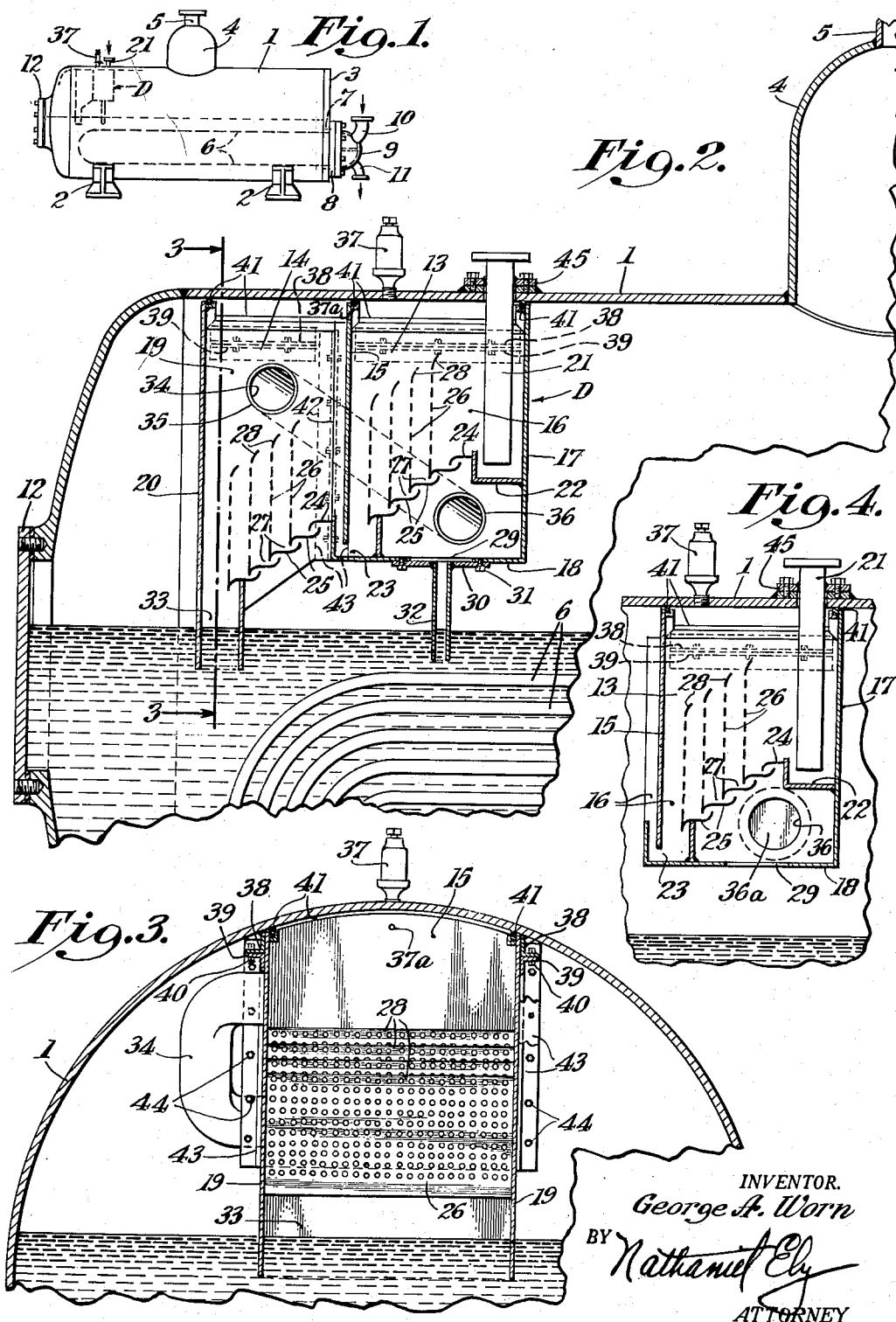
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DEAERATING AND EVAPORATING UNIT

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DEAERATING AND EVAPORATING UNIT

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This invention relates to improved apparatus for preheating deaerating and evaporating a liquid such as water for example, and, in particular, boiler feed water.

A steam generating plant commonly includes an evaporator for removing impurities from raw feed water and also a separate deaerator unit for preheating the feed water and removing air therefrom. Such a unit is usually a large and expensive item of the plant equipment and it imposes spaced requirements, a foundation for supporting it separately from the evaporator and heat insulated piping connecting it with the evaporator.

An important object of the present invention is to provide for satisfactory embodiment of deaerating apparatus and evaporating apparatus in a single unit and thereby reduce space requirements, eliminate the need for a separate foundation for the deaerating apparatus, eliminate outside piping and substantially reduce the cost of the deaerating equipment.

A further object of the invention is to provide an improved unit including an evaporator and deaerator equipment mounted in an advantageous position within the vapor space of the shell of the evaporator.

A still further object of the invention is to provide deaerating apparatus of improved design for embodiment in an evaporator unit.

Further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is a side elevation of an evaporator unit embodying the invention;

Fig. 2 is an enlarged vertical longitudinal sectional view of the unit including the deaerating apparatus designed for two-stage operation;

Fig. 3 is a vertical cross section on the line 3-3 of Fig. 2; and

Fig. 4 is a vertical longitudinal sectional view of a portion of the evaporator shell and deaerating apparatus designed for single-stage operation.

Referring to Figs. 1, 2 and 3, 1 designates an evaporator body, or shell, of cylindrical form supported in a horizontal position by cradles 2. One end of the shell is shown as convex and the opposite end as formed by a flat welded-on plate 3. The shell ends may be otherwise formed, however. At its upper side, the shell has a vapor dome 4 with a vapor outlet nozzle 5. The lower portion of the shell provides a liquid space and the upper portion provides a vapor space open-

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ing into the dome. Within said liquid space there is heating means for vaporizing the liquid. In the present disclosure said heating means comprises a bundle of U-tubes 6 extending longitudinally of the shell and through an opening 7 in the shell end plate 3. The outer ends of said tubes are secured to a tube sheet 8 bearing against the outer side of the plate 3, around the hole 7. A channel or header 9 bears against the tube sheet and has a steam inlet nozzle 10, a condensate outlet nozzle 11 and a pass partition between said nozzles. The channel and the tube sheet are bolted or otherwise detachably secured to the plate 3 so that the tube bundle may be withdrawn from the shell, through the opening 7, when the tube sheet and channel are released from plate 3. The shell may have one or more manholes, one being shown at 12 in the convex end of the shell, to give access to the bundle and to the deaerator device which will be described hereinafter.

Within the vapor space of the shell, at a position substantially spaced from the vapor dome and its outlet, there is mounted a deaerator device D. In the present disclosure, said device is located near the convex end of the shell and its manhole 12. The device comprises a metal casing defining two side-by-side chambers 13 and 14 separated by a vertical wall 15. In the present disclosure said casing is open at the top to the upper side of the shell. However, the casing may be formed with a top wall, if desired. Chamber 13 is defined by opposite side walls 16, an end wall 17, the dividing wall 15, a bottom wall 18 and the upper side of the shell 1. Chamber 14 is defined by opposite side walls 19, an end wall 20, the dividing wall 15 and the upper side of the shell 1. A feed water supply pipe 21 extends downwardly through an opening in the shell and dips into a trough 22 within the chamber 13 and at the wall 17 thereof. At the opposite side of said chamber and at a level below that of the trough 22 there is a trough 23 into which the partition wall 15 dips. Between said troughs there are baffle means to cause cascade flow of the water from the trough 22 to the trough 23 and to admit vapor to the water at points along its course. Said baffle means, as shown, is of the type disclosed in U. S. Patent No. 2,401,569 to Koch.

The baffle means includes a strip 24 extending from the overflow side of the trough 22 and a series of strips 25 in transversely overlapping stepped relation descending from the trough 22 to the trough 24. Each strip 25, together with a

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tall upstanding baffle plate 26 at the forward edge thereof, forms a shallow trough 27, the rear edge of each strip being bent upward to form the rear side of the trough, and the forward edge dipping into the trough 27 therebelow. The baffles 26 have numerous small perforations distributed over their area with the exception of the lower margin, and the upper margins of the baffles are all curved in the same direction, as shown at 28. The bottom 18 of the chamber 13 has an opening 29 normally closed by a cover 30 detachably secured to the bottom, as at 31, and bearing a depending drain pipe 32.

Chamber 14 has a down spout 33 at the under side thereof and located at the wall 20. Within the lower portion of said chamber there is a baffle assembly precisely like that within the chamber 13 and descending from the overflow side of the trough 23 to the down spout 33. In the drawing, corresponding elements of said two baffle assemblies are correspondingly numbered. The baffle assembly within the chamber 14 forms, in effect, the lower side of the chamber and also defines the inlet for flow of vapor from the vapor space of the shell into the chamber 14. A vapor transfer pipe 34 of elbow form leads from an outlet orifice 35 of the chamber 14 to an inlet orifice 36 of the chamber 13. The orifice 35 is spaced above the baffles 26 in chamber 14, and orifice 36 is spaced below the baffle strips 25 in chamber 13. Chamber 13 has at its upper side, an air vent through the shell 1 provided with a valve 37. A small bleed hole 37a may also be provided in the upper portion of the partition 15 to vent the upper portion of the chamber 14 to the chamber 13 and thereby prevent air trapping in chamber 14, above the orifice 35.

The deaerator device is detachably mounted within the shell 1. Angle-irons 38 are welded to the under side of the top of the shell and angle-irons 39 welded on the outer side walls of the chambers 13 and 14 are bolted, as at 40, to the angle-irons 38. Gaskets 41 are fitted within grooves at the upper edges of the vertical walls of the casing and are adapted to be pressed against the shell 1 when the bolts connecting said angle-irons are tightened. Of course, the casing may be otherwise mounted and sealed. The chambers 13 and 14 are also detachably connected to each other to part in a plane indicated by the line 42 of Fig. 2. The side walls 16 and 19 of said chambers have opposed vertical angle-irons 43 welded thereto and abutting in said plane. Bolts 44 releasably connect said abutting flanges. The various troughs and baffle elements within each chamber are preferably welded to the adjacent walls of the chamber. In order to enable withdrawal of the feed water supply pipe from the chamber 13 said pipe may be provided with a welded-on collar 45 releasably secured to a seat on the shell, with an interposed gasket.

In the operation of the unit the shell 1 is kept charged with water to a level sufficiently high to submerge the tube bundle and also the lower end of the down-spout 33 and the drain pipe 32. Steam is charged to the tubes of the bundle through the channel nozzle 10 and condensate is discharged from the tubes through the nozzle 11. The raw feed water enters the water space of the shell through the pipe 21, the chamber 13, the chamber 14 and the down-spout 33. Most of the steam or vapor generated within the shell flows through the dome and is discharged through the outlet 5. Some of the steam however, enters the deaerator device and contacts the water cascad-

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ing therethrough to the down-spout to preheat the water and release the air therefrom.

All of the feed water charge to the evaporator is delivered through the pipe 21 which first delivers into the trough 22 in the chamber 13. The water overflows from said trough and descends over the baffle element 24 and the baffle elements 25 in succession to the trough 23 where it forms a seal between the chambers 13 and 14. The overflow from trough 23 descends over the baffle elements 24 and 25 of chamber 14 and passes to the down-spout 33 for delivery to the liquid space within the shell. In both chambers there is a slot-like space between the upturned rear edge of each baffle element 25 and the element overlying it. The vapor flows through said spaces and casts the water descending over the elements 25 upwardly over the rear face of the upstanding baffles 26 in succession. Through the perforations of the baffles 26 the water flows forward toward the down-spout. Thereby, a desired turbulence and spreading of the water is obtained for efficient transfer of heat from the vapor to the water to effect release of air from the water.

Chamber 13 may be considered the first-stage deaerating chamber for the reason that the feed water flows first through this chamber and is there first preheated and deaerated. The vapor first enters the chamber 14 which is in direct communication with the vapor space of the shell, through the space between the baffle elements 25. Vapor which has not been condensed in chamber 14, together with released air, flows through the transfer pipe 35 to the chamber 13 for contact with the water flowing therethrough. The air escapes from chamber 13 through the vent valve 37.

When two-stage operation is not required the chamber 13 alone may be employed, as shown in Fig. 4. The said chamber may be readily adapted for single-stage service by omitting the transfer pipe 34, blanking the orifice 36 with a cover 36a and omitting the cover 30. Then, vapor may enter directly from the vapor space of the shell through the opening 29, and the water overflow from the trough 23 may fall directly to the water space of the shell.

In both single-stage and double-stage employment of the deaerator the chamber-forming casing thereof is surrounded by hot vapor within the shell. Thereby, substantial additional heat input may be obtained by conduction of heat through the metal walls of the casing to the deaerating zone. Preheating and deaerating are thereby substantially assisted. They are further assisted by the highly efficient baffle arrangement for obtaining contact of the vapor with the water. The efficiency of the baffle arrangement also enables very compact construction of the deaerator so that it may not objectionably reduce the vapor space within the shell 1. It may be conveniently mounted near one end of the shell out of the way of the main course of the vapor to the dome or shell outlet. The compactness of the deaerator also facilitates its installation and removal. A single-stage deaerator may be inserted or removed through a manhole, such as the one shown at 12, and the two-stage deaerator may be inserted or removed through the tube bundle opening 7.

The embodiment of the deaerator and the evaporator in a unit also eliminates outside space requirements, eliminates the need of a separate mounting or foundation for the deaerator and eliminates all outside vapor piping between the

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evaporator and the deaerator. The design of the deaerator is also such as to render its cost of construction comparatively low.

It is to be understood that the present disclosure of the invention is merely illustrative and in nowise limited and that the invention comprehends such modifications as will fall within the scope of the appended claims.

I claim:

1. A self-contained evaporator and deaerator unit comprising a shell forming the evaporator body and affording a space for charge liquid within the lower portion thereof and an overlying vapor space, heating means within the said liquid space to vaporize the liquid therein by indirect heat exchange comprising a bundle of tubing and connections for circulating a heating fluid there-through, the shell having a vapor outlet leading from said vapor space; and deaerating apparatus within said vapor space and comprising casing means offset from said vapor outlet of the shell and forming a first-stage deaerating chamber and a subsequent-stage deaerating chamber, said first-stage chamber having an inlet for the charge liquid and a gas outlet, said subsequent-stage chamber having an outlet for said liquid in delivery communication with said liquid space within the shell, said subsequent-stage chamber having also a vapor inlet open to said vapor space of the shell and a vapor outlet in delivery communication with said first-stage chamber, a vapor-excluding connection for delivery of said liquid from the first-stage chamber to the subsequent-stage chamber and forming the liquid outlet for the former chamber and the liquid inlet for the latter chamber, and baffle means in the path of flow of said liquid from the liquid inlet to the liquid outlet of each chamber, said baffle means being correlated with the vapor inlets of the chambers to effect deaerating contact of the admitted vapor with the liquid.

2. A self-contained evaporator and deaerator unit comprising a shell forming the evaporator body and affording a space for charge liquid within the lower portion thereof and an overlying vapor space, heating means within said liquid space to vaporize the liquid therein by indirect heat exchange comprising a bundle of tubing and

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connections for circulating a heating fluid there-through, the shell having a vapor outlet leading from said vapor space; and deaerating apparatus within said vapor space and comprising casing means offset from said vapor outlet of the shell and forming a deaerating chamber, said chamber having an inlet for said charge liquid, a vapor-excluding outlet for said liquid from the chamber in delivery communication with said liquid space within the shell and a vapor inlet for the chamber in delivery communication with said vapor space within the shell, and baffle means in the path of flow of the liquid from said liquid inlet to said outlet of the chamber and including portions spaced along said path and extending cross-wise thereof and having numerous perforations to cause divided flow of the liquid, said baffle means being correlated with the vapor inlet of said chamber to effect deaerating contact of the admitted vapor with the liquid in said divided flow thereof, said baffle means being spaced above the bottom of said chamber, said vapor inlet being located to admit vapor into the space beneath the baffle means, and an air outlet from said chamber above the baffle means.

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