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STRAIGHT TUBES IN A VERTICAL SHELL STEAM GENERATOR

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2 Sheets-Sheet 1

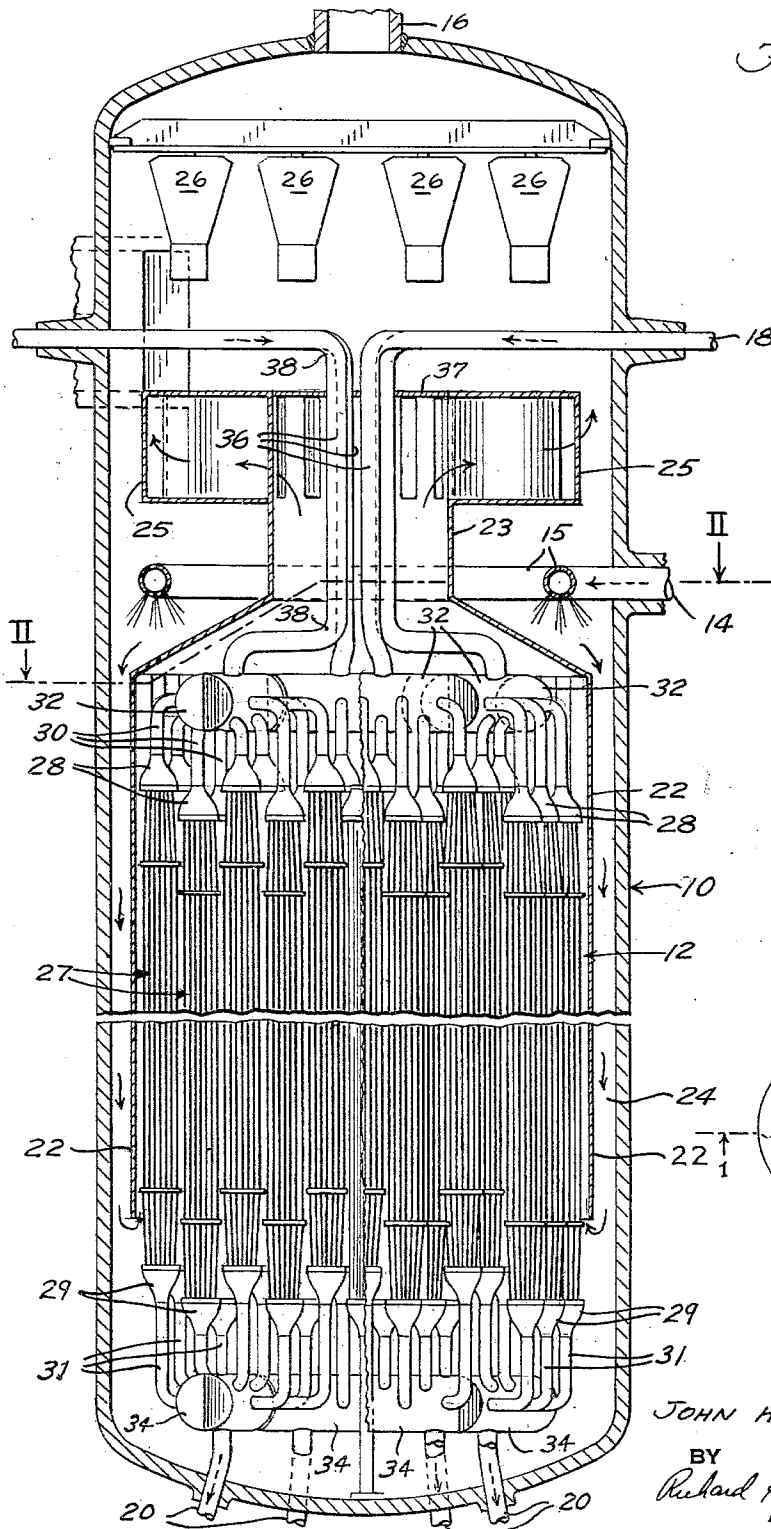
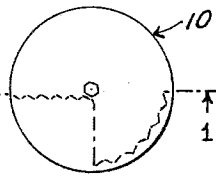


Fig. 1.

Fig. 4.



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Fig. 2.

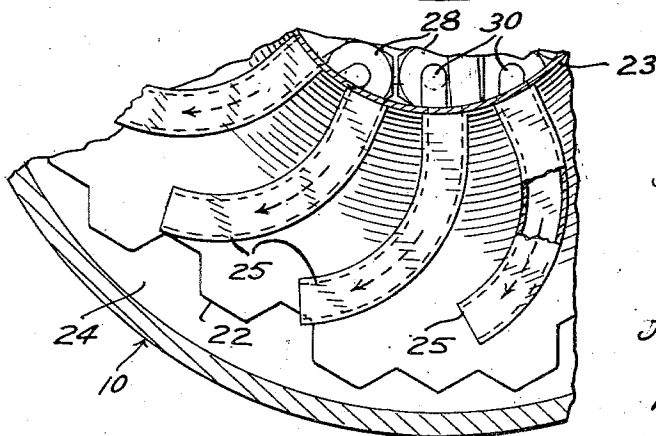
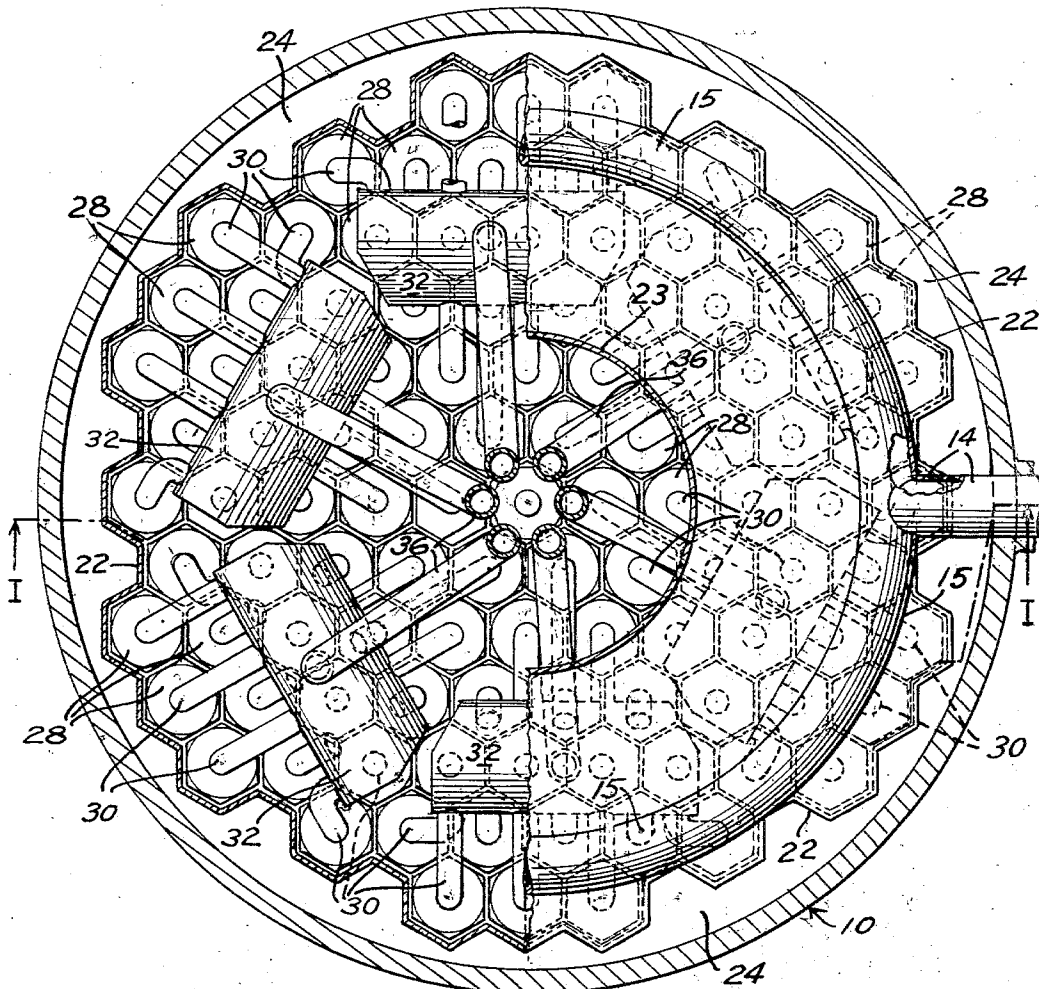


Fig. 3.

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STRAIGHT TUBES IN A VERTICAL SHELL STEAM GENERATOR

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5 Claims. (Cl. 122—34)

This invention relates to steam generators of the vertical type. In such generators, the heating surface is provided by tubes which are disposed in a vertical shell containing the liquid to be evaporated and are shrouded by a baffle. The space within the baffle forms a riser for the steam and water mixture produced in it which passes to separators arranged within the shell while the space between the shroud and the shell forms an annular downcomer for the liquid separated by the separators. The steam from the separators leaves the shell at its upper end.

In such generators, the heating tubes are generally in the form of U-tubes connecting together inlet and outlet headers or tube plates in the lower part of the shell. The invention is concerned, however, with the case in which the tubes are straight, i.e. extend axially but not necessarily rectilinearly between headers at different levels in the shell, as is very desirable, if not essential, where the heating fluid is to be circulated downwards.

The object of the invention is to ensure in a straight tube vertical steam generator compactness, the maintenance of good natural circulation and a high operating efficiency.

According to the invention, the heating tubes are arranged within the shell to form clusters which at the upper end terminate in sub-headers which are themselves grouped and connected to a number of main headers having connections to a point outside the shell consisting of pipes which pass upwards from the headers in the vicinity of the axis of the shell to a level above the separators before passing through the wall of the shell.

This avoids the necessity of piercing the baffle as well as the shell for the passage of the connecting pipes. The saving in work thus achieved is quite important but still more important is that it avoids the risk, which is unavoidable if the downcomer baffle is pierced, of a leak between the riser and the downcomer which could lead to disturbance of the natural circulation.

The invention also, as will be seen later on, leads to an arrangement of tubes and pipes which compensates for the effects of the inevitable longitudinal expansion of the tubes.

In the preferred form of the invention, the heating tubes are arranged to form hexagonal clusters which have the advantage of ensuring a very high utilization of the available space within the baffle.

An example of such an arrangement is shown in the accompanying drawings, in which:

FIGURE 1 is a sectional elevation through the steam generator taken on line I—I of FIGURES 2 and 4;

FIGURE 2 is a section on an enlarged scale taken on the line II—II in FIGURE 1;

FIGURE 3 is a horizontal section of a portion of the generator shown in FIGURES 1 and 2; and

FIGURE 4 is a graphic outline showing how the section I—I is taken.

The generator in accordance with the invention comprises a cylindrical shell 10 set with its axis vertical and containing heating tubes 12.

The water to be evaporated is supplied through an inlet 14 and the steam produced from it leaves through an outlet 16. The heating fluid is supplied through inlets

18 and leaves through outlets 20 after passing through tubes 12.

The heating tubes 12 are shrouded by a cylindrical baffle 22 which is open at the lower end and closed at the upper end. The water to be evaporated descends through the downcomer space 24 between the baffle and the shell and rises through the riser formed by the space inside the baffle as a mixture of steam and water which passes through the separators 25 surrounding the upper end 23 of reduced diameter of the baffle 22. The water separated in the separators flows into the downcomer 24 while the steam rises and passes through driers 26 before leaving through the outlet 16.

The heating tubes 12 are arranged in clusters 27, each cluster terminating at the upper end in sub-headers 28 of hexagonal outline. These sub-headers are grouped so that a number of them are connected by connecting pipes 30 to main headers 32. There may, for example, be six main headers 32 (FIG. 2) at each end.

At the outlet or lower end, the sub-headers 29 are connected via pipes 31 to main headers 32, the latter having the pipe connections 20 which lead straight out of the shell. No problem arises at the lower end because the shell is unobstructed at the lower end by anything but the heating tubes and their headers.

At the inlet or upper end, however, the situation is different. If the headers 32 are provided with pipe connections which follow the shortest or most natural path, they must be taken through the downcomer baffle 22 as well as through the shell. This, in itself, is a complication but its most important undesirable feature is that it involves the risk of a leakage path through the baffle. If steam from within the baffle were to leak into the downcomer outside the baffle, the natural circulation of the water could be impaired with possible serious consequences.

Consequently, the pipe connections 36 from the headers 32 are taken up through the upper part of the baffle, through top closed end 37 of the baffle, in the vicinity of the axis of the shell past the separators 25 and out through the shell above the level of the separators. There is no difficulty about piercing the closed end 37 of the baffle as this is a mere cover and any leak from the inside of the baffle to the space surrounding the upper end of the baffle could not have serious consequences.

Steam generators of the kind in question are generally of substantial size. The heating tubes 12 can have a length of 8 feet or considerably more. Consequently, provision has to be made for dealing with the thermal expansion of the tubes. The pipe connections 36 make that provision incidentally. As can be seen in FIGURE 1, these pipes have two right angle bends 38 which allow them to adjust themselves to any displacement of the headers 32 which may occur.

The heating tubes 12 have been shown as following rectilinear paths between the sub-headers 28. This is not essential. While always being arranged to run generally axially, they can be made to follow curved paths such as helical paths, which can be advantageous from the point of view of heat transmission.

It should be noted that the baffle 22 can be made to closely follow the outline of the sub-headers 28 as shown in FIGURE 2. This has the advantage of providing greater downcomer area (space 24) permitting reducing the diameter of the shell 10.

Although the invention has been described with reference to a specific embodiment, variations within the spirit and scope of the following claims will be apparent to those skilled in the art.

What is claimed is:

1. A steam generator comprising

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- a vertical cylindrical shell having a liquid space and a vapor space;
- a vertically oriented baffle within the shell liquid space defining a steam generating chamber, and, between the shell and baffle, an annular downcomer passageway;
- a riser at the upper end of the baffle in communication with the chamber;
- a plurality of radially spaced vapor-liquid separators at the upper end of the riser, the riser being closed at its top;
- a plurality of rectilinear tubes extending axially within the baffle steam generating chamber;
- a plurality of upper and lower sub-headers of hexagonal outline at the upper and lower ends of the steam generating chamber respectively, the tubes terminating in the sub-headers, the sub-headers and tubes being arranged such that the tubes are regularly and uniformly distributed over the cross-section of the vapor generating chamber, adjacent sub-headers being staggered in an axial direction to permit the flow of vapor and liquid from the vapor generating chamber to the riser;
- a plurality of main headers;
- means communicating the main headers with the sub-headers;
- a plurality of connections for the main headers, the connections for the upper main headers extending upward in the vicinity of the axes of the baffle and riser and penetrating the riser and shell at a level above the level of the separators.
2. A steam generator according to claim 1 wherein said main headers at each end number six, said main headers being uniformly spaced annularly at the top and bottom of the vapor generating chamber.
3. A steam generator according to claim 1 wherein the heating fluid is contained in the tubes, further including means flowing the heating fluid downwardly in the tubes.
4. A steam generator according to claim 1 wherein the connections for the main headers are provided with two right angle bends which permit displacement of the main

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- headers longitudinally of the generator responsive to expansion and contraction of the rectilinear tubes.
5. A vapor generator comprising
- a vertical cylindrical shell having a liquid space and a vapor space;
- vertically oriented baffle means within the shell liquid space defining a vapor generating chamber;
- a riser at the upper end of the baffle means in communication with the vapor generating chamber;
- at least one vapor liquid separator at the upper end of the riser, the riser being closed to the vapor space except for the vapor liquid separator;
- a downcomer passageway by which liquid from the liquid space is circulated to the lower portion of the vapor generating chamber;
- a plurality of rectilinear tubes extending axially within the vapor generating chamber;
- a plurality of upper and lower sub-headers at the upper and lower ends of the vapor generating chamber respectively, the tubes terminating in the sub-headers, the sub-headers and tubes being arranged such that the tubes are regularly and uniformly distributed over the cross-section of the vapor generating chamber;
- a plurality of main headers;
- means communicating the main headers with the sub-headers;
- a plurality of connections for the main headers, the connections for the upper main headers extending upwardly within the riser and penetrating the riser and shell at a level above the level of the separator.

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