United States Patent [19]

Mayer et al.

[11] **3,841,272**

[45] **Oct. 15, 1974**

[54] **FLOW DISTRIBUTOR FOR A STEAM GENERATOR**

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[73] Assignee: **Siemens Aktiengesellschaft**, Munich, Germany

[22] Filed: **July 13, 1973**

[21] Appl. No.: **379,158**

[30] **Foreign Application Priority Data**

Sept. 4, 1972 Germany 2243402

[52] **U.S. Cl.** **122/32,** 165/159

[51] **Int. Cl.** **F22b 1/06**

[58] **Field of Search** 122/32, 33, 34; 165/114, 165/159, 162, 163

[56] **References Cited**

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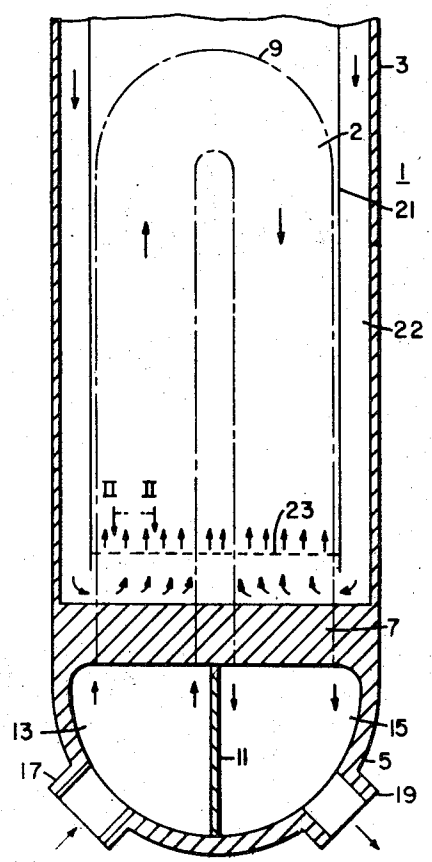
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Attorney, Agent, or Firm—F. J. Baehr, Jr.

[57] **ABSTRACT**

A steam generator having a tube-sheet, a plurality of U-shaped tubes extending upwardly from the tube sheet to form a tube bundle and a perforated plate disposed generally adjacent and parallel to the tube sheet, the perforated plate being so disposed to cause feedwater to flow across the tube sheet in such a manner that a substantial quantity flows to the central portion of the hot leg portion of the tube bundle and thereby prevents premature boiling in this area.

9 Claims, 8 Drawing Figures



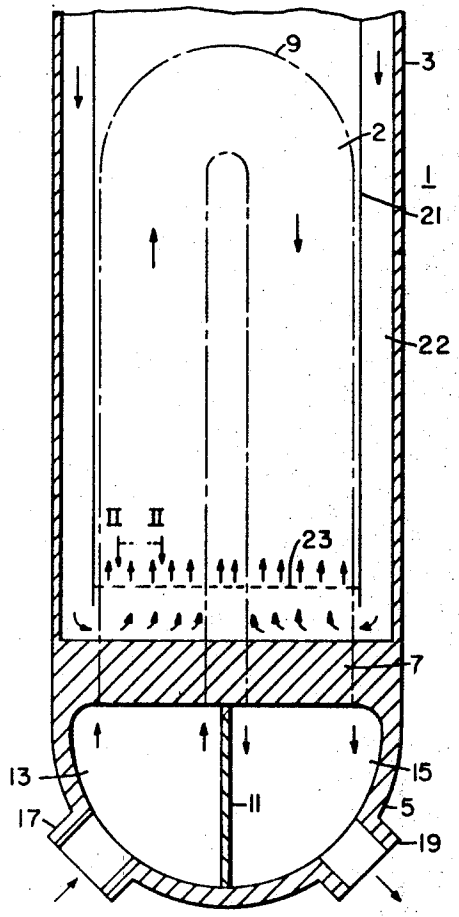


FIG. 1

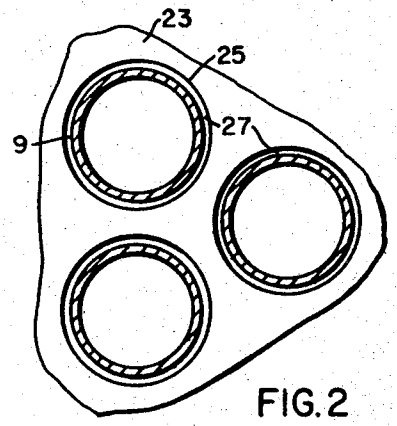


FIG. 2

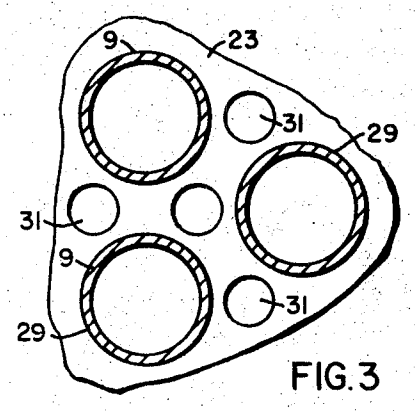


FIG. 3

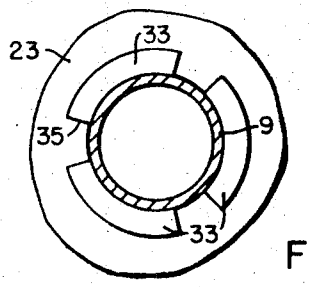


FIG. 4

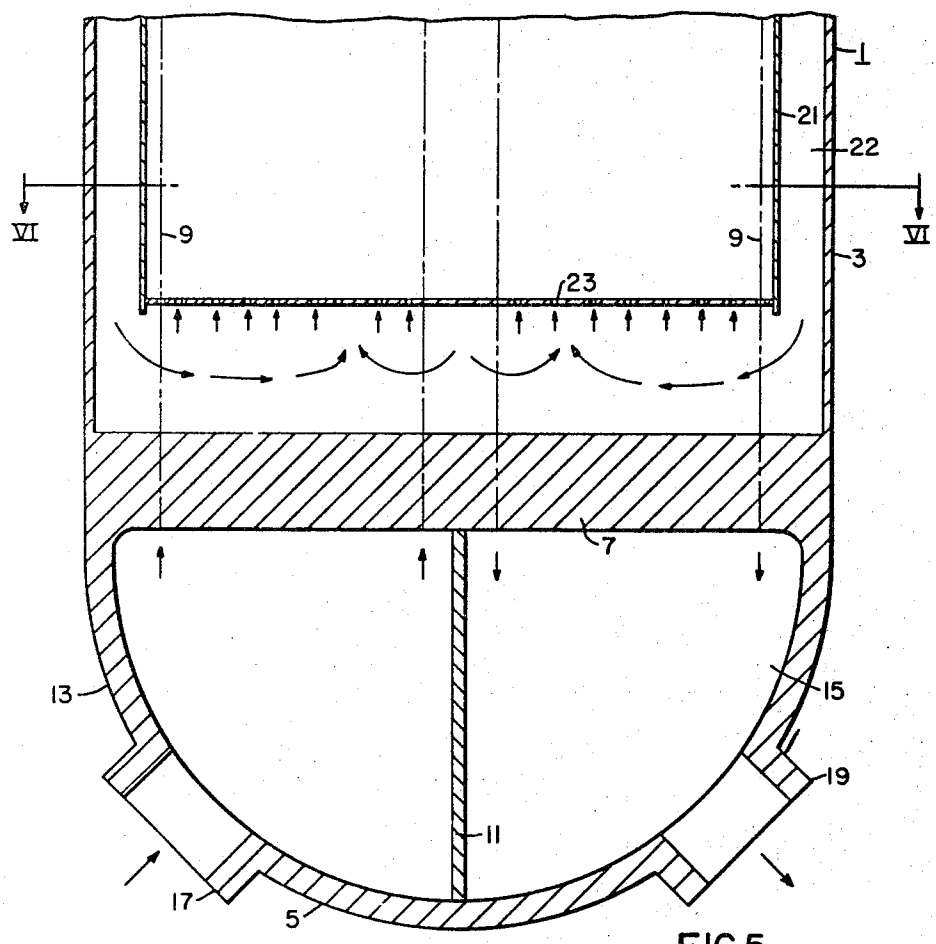


FIG.5

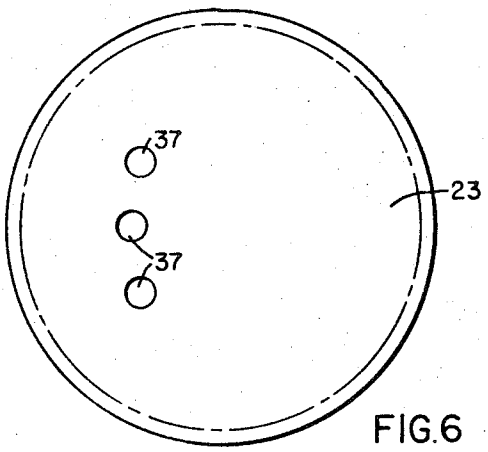


FIG.6

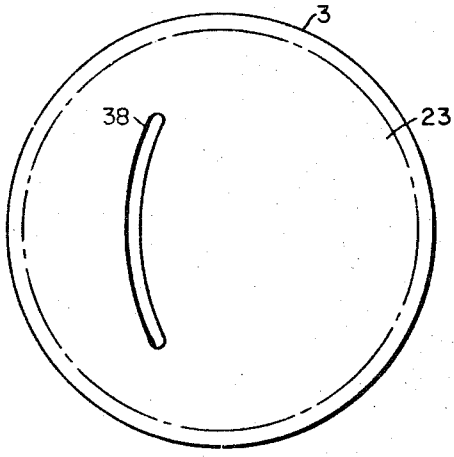


FIG. 7

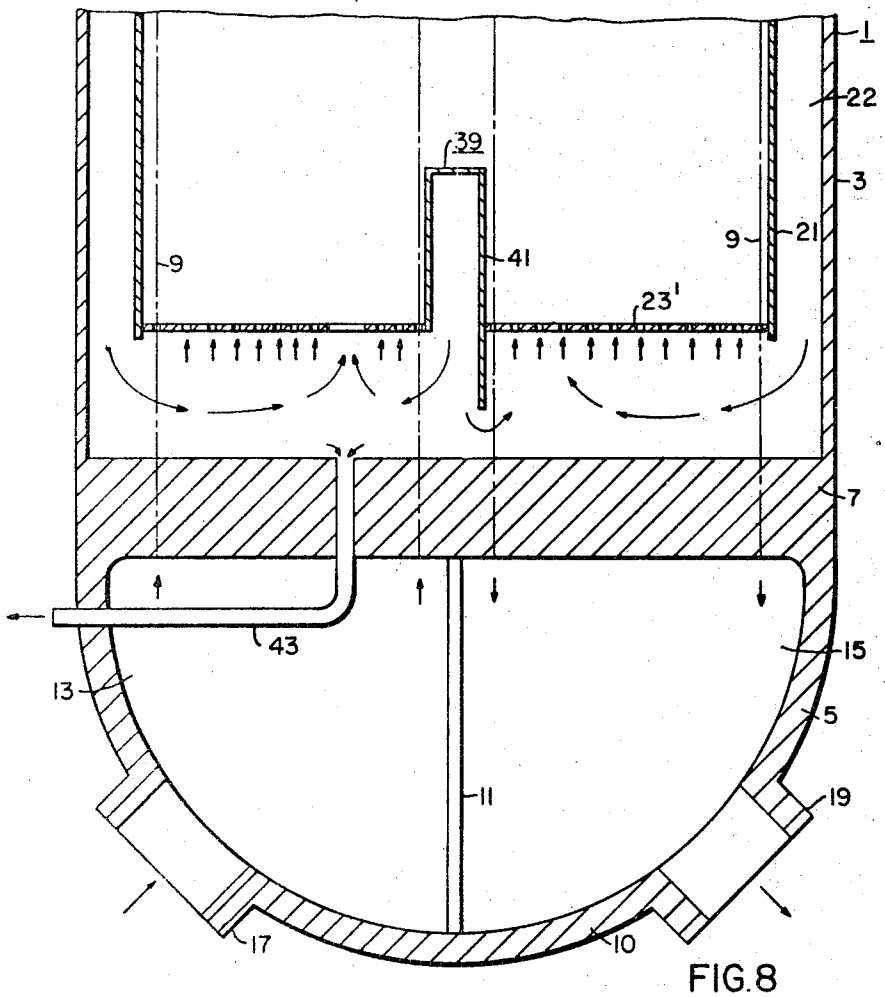


FIG. 8

FLOW DISTRIBUTOR FOR A STEAM GENERATOR

CROSS-REFERENCE TO RELATED APPLICATION

This invention is based on a German application filed by the inventor in Germany and having the following German serial number and filing date: Ser. No. P-22-43-402.2, filing date Sept. 4, 1972.

BACKGROUND OF THE INVENTION

This invention relates to steam generators and more particularly to a steam generator having a bundle of U-shaped tubes and a feedwater distribution plate disposed adjacent a tube sheet into which the tubes are fastened.

Steam generators having such U-shaped tube bundles have been subjected to boiling adjacent the tube sheet causing cyclic temperature excursions which produce thermal stress that result in premature tube failures in an area next to the tube sheet.

SUMMARY OF THE INVENTION

In general, a steam generator, which utilizes a primary fluid to vaporize feedwater to produce steam, when made in accordance with this invention, comprises a tubular shell, a plurality of U-shaped tubes forming a tube bundle disposed in the shell, a tube sheet into which the tube ends are fastened, the tube bundle having a hot leg portion in which influent primary fluid flows and a cold leg portion disposed downstream of the hot leg portion, and a perforated plate disposed adjacent and generally parallel to the tube sheet. The perforated plate has flow distribution openings or holes so disposed to increase the fluid flow adjacent the central portion of the hot leg portion of the tube bundle.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of this invention will become more apparent from reading the following detailed descriptions in connection with the accompanying drawings in which corresponding reference characters indicate corresponding portions throughout the drawings and in which:

FIG. **1** is a partial sectional view of a steam generator made in accordance with this invention;

FIG. **2** is a partial sectional view taken on line II—II of FIG. **1**;

FIGS. **3** and **4** are modifications of the view shown in FIG. **2**;

FIG. **5** is an enlarged partial sectional view of a steam generator;

FIG. **6** is a sectional view taken on line VI—VI of FIG. **5**;

FIG. **7** is a modification of the view shown in FIG. **6**;

FIG. **8** is an enlarged partial sectional view of a steam generator showing another modification thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail, FIG. **1** shows a portion of a steam generator **1** utilized in a pressurized water nuclear power plant. The steam generator **1** is a pressure vessel comprising a tubular or cylindrical shell **3**, the lower end of which is closed by a spherical head **5** having an integral tube sheet **7**. The tube sheet

7 has a plurality of openings or holes disposed therein. A plurality of U-shaped tubes **9** form a tube bundle having a hot leg portion and a cold leg portion. The ends of the tubes **9** extend through the holes in the tube sheet **7** and are fastened thereto by rolling, welding, or other means or any combination thereof.

The head **5** has a dividing plate **11** centrally disposed therein in order to form a primary fluid inlet chamber **13** and a primary fluid outlet chamber **15**. A primary fluid inlet nozzle **17** and a primary fluid outlet nozzle **19** are disposed in the head **5** in fluid communication with the inlet and outlet chambers **13** and **15**, respectively.

A cylindrical wrapper or sleeve member **21** enwraps the tube bundle forming an annular space or chamber **22** adjacent the shell **3**. A flow distribution plate **23** is disposed at the lower end of the wrapper **21** and generally adjacent and parallel to the tube sheet **7**. The flow distribution plate **23** has openings or holes disposed therein for accommodating the tubes and the secondary fluid, which generally flows upwardly therethrough.

As shown in FIG. **2**, the holes **25** may be larger in diameter than the tubes **9** and thus they provide an annular space **27** surrounding the tubes **9** through which the secondary fluid flows upwardly and around the tubes.

In FIG. **3**, there are two sets of holes, one set of holes **29** tightly embraces the tubes **9** and another set of holes **31** providing an opening in the space between the tubes for the upward flow of secondary fluid.

Another arrangement is shown in FIG. **4**; in this arrangement the holes **33** are generally larger than the diameter of the tubes **9**, however, they have webbs or prongs **35** which engage the tubes **9** to provide support and produce segmented openings surrounding the tubes for the upward flow of the secondary fluid. The size of the openings may vary and they may be disposed in arrays which will provide an increased flow adjacent the central portion of the hot leg to increase the flow of secondary fluid in this region to prevent premature boiling.

As shown in FIGS. **5**, **6**, and **7**, the flow distribution holes **37** and **38** may be sufficiently large to accommodate a number of tubes; they may be arcuately shaped, as shown in FIG. **7**, circular, as shown in FIG. **6**, or they may take on any shape necessary to increase the flow of secondary fluid through a particular portion of the tube bundle, as for example, adjacent the center portion of the hot leg.

As shown in FIG. **8**, the distribution plate **23'** may be segmented and provided with a salient or projecting portion **39** disposed between the hot and cold legs of the tube bundle. The salient portion is in the shape of an inverted channel or trough **39** and has open ends, which are in communication with the annular space **22** between the wrapper **21** and the shell **3**. The lengthwise opening in the trough or channel **39** is in fluid communication with a chamber disposed between the tube sheet **7** and the fluid distribution plate **23'**. One side wall **41** of the trough or channel **39**, the side adjacent the cold leg, extends downwardly beyond the distribution plate **23'** reducing the flow of secondary fluid to the region of the chamber below the cold leg portion of the distribution plate and increasing the flow of secondary fluid to the region of the chamber below the hot leg portion of the distribution plate **23'**.

A blowdown conduit **43** is disposed to drain secondary fluid from the chamber between the flow distribution plate and the tube sheet. The blowdown conduit **43** is disposed adjacent the central portion of the hot leg to further increase the flow of secondary fluid in that region, to reduce local boiling and thus minimize the cyclic temperature excursions, which result in premature failure of the tubes adjacent the tube sheet.

What is claimed is:

1. A steam generator which utilizes a primary fluid to vaporize feed-water to produce steam, said steam generator comprising a tubular shell, a plurality of U-shaped tubes disposed in said shell, a tube sheet into which the tube ends are fastened, said tubes being arranged to form a tube bundle having a hot leg portion in which influent primary fluid flows and a cold leg portion downstream of the hot leg portion, and a perforated plate disposed adjacent and generally parallel to the tube sheet, said perforated plate having flow distribution openings so disposed to increase the fluid flow adjacent a central portion of said hot leg portion of the tube bundle, said flow distribution holes including at least one large opening in said perforated plate, said opening encompassing a plurality of tubes and being disposed adjacent said central portion of said hot leg portion of said tube bundle.

2. A steam generator as set forth in claim **1,** wherein the opening encompassing a plurality of tubes is generally arcuately shaped.

3. A steam generator as set forth in claim **1,** wherein the opening encompassing a plurality of tubes is generally circular.

4. A steam generator as set forth in claim **3,** wherein there are a plurality of openings encircling a plurality of tubes and said openings are generally circular in shape.

5. A steam generator which utilizes a primary fluid to vaporize feed-water to produce steam, said steam generator comprising a tubular shell, a plurality of U-shaped tubes disposed in said shell, a tube sheet into which the tube ends are fastened, said tubes being arranged to form a tube bundle having a hot leg portion in which influent primary fluid flows and a cold leg portion downstream of the hot leg portion, and a perforated plate disposed adjacent and generally parallel to the tube sheet, said perforated plate having flow distribution openings so disposed to increase the fluid flow adjacent a central portion of said hot leg portion of the tube bundle, a wrapper enwrapping the tube bundle to form an annular chamber between the wrapper and the shell, said perforated plate having an outer periphery which engages said wrapper, and channel means disposed between said legs of said tube bundle, said wrapper having openings to provide fluid communication between said channel means and said annular chamber.

6. A steam generator as set forth in claim **5,** wherein the channel means has at least one leg portion that extends beyond said perforated plate and toward said tube sheet, said one leg portion of said channel means being adjacent said cold leg portion of the tube bundle, whereby the major portion of said fluid flowing into said channel means flows to that portion of the perforated plate associated with the hot leg portion of the tube bundle.

7. A steam generator as set forth in claim **6,** wherein that portion of the perforated plate associated with the hot leg portion of the tube bundle has at least one opening encompassing a plurality of tubes.

8. A steam generator as set forth in claim **7,** wherein said opening encompassing a plurality of tubes is centrally disposed with respect to said hot leg portion of said tube bundle.

9. A steam generator as set forth in claim **8,** wherein said opening encompassing a plurality of tubes is arcuately shaped.

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