United States Patent

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[54] **STEAM DRUM BAFFLE ARRANGEMENT FOR A FORCED RECIRCULATION STEAM GENERATOR**
7 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **122/491,** 55/444, 55/465
[51] **Int. Cl.** **F22b 37/30**
[50] **Field of Search** 55/442, 443, 444, 445, 446, 462, 465; 122/459, 488, 491

[56] **References Cited**
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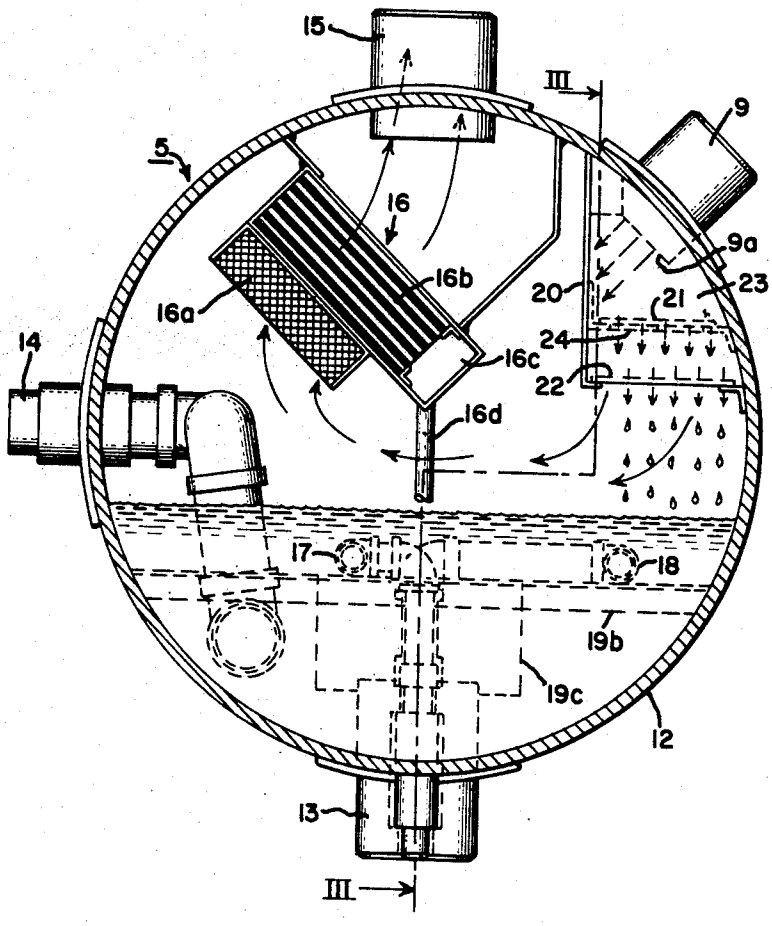
ABSTRACT: A steam drum for a forced recirculation steam generator with a number of evaporator return lines supplying a high velocity steam/water mixture to the upper portion of the drum. A baffle arrangement of perforate and imperforate plates reduces energy of the incoming mixture and supplies low velocity liquid to the lower part of the drum. An additional baffle controls the outgoing liquid flow.



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SHEET 1 OF 2

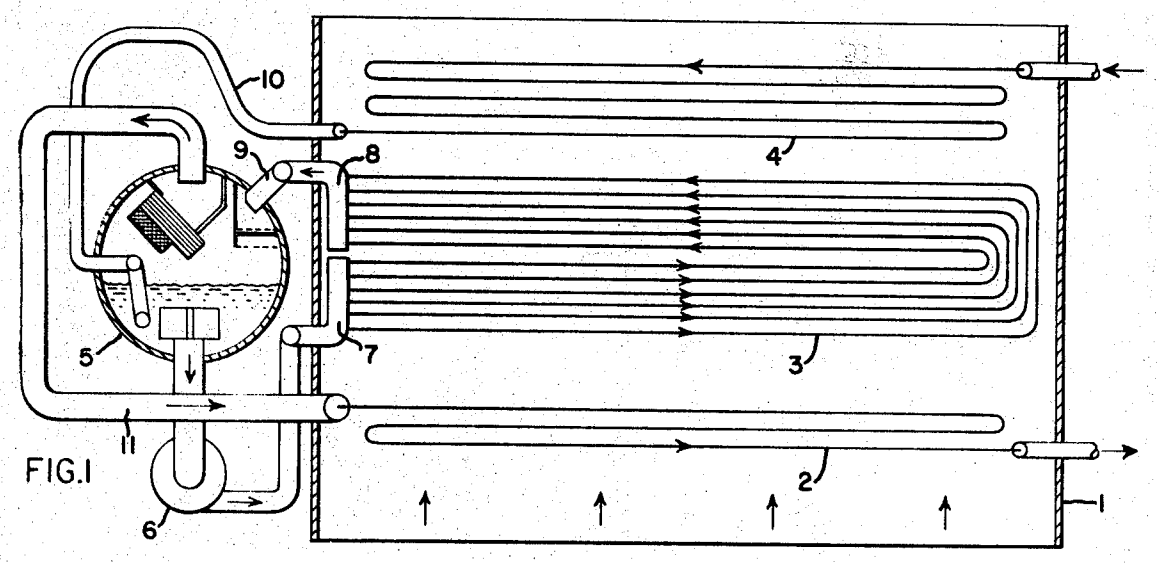

FIG.1

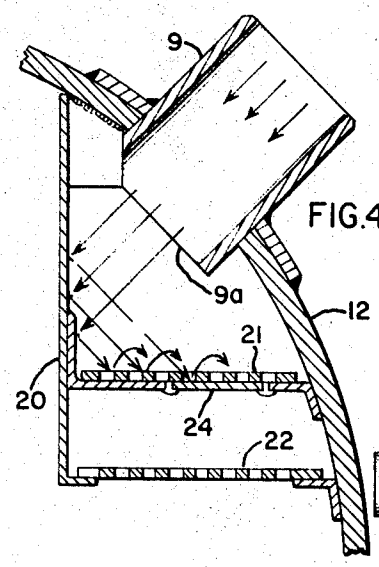

FIG.4

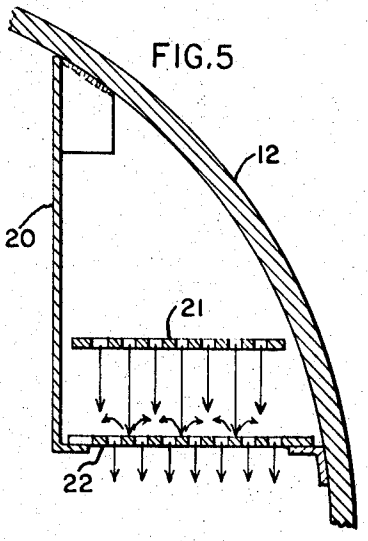

FIG.5

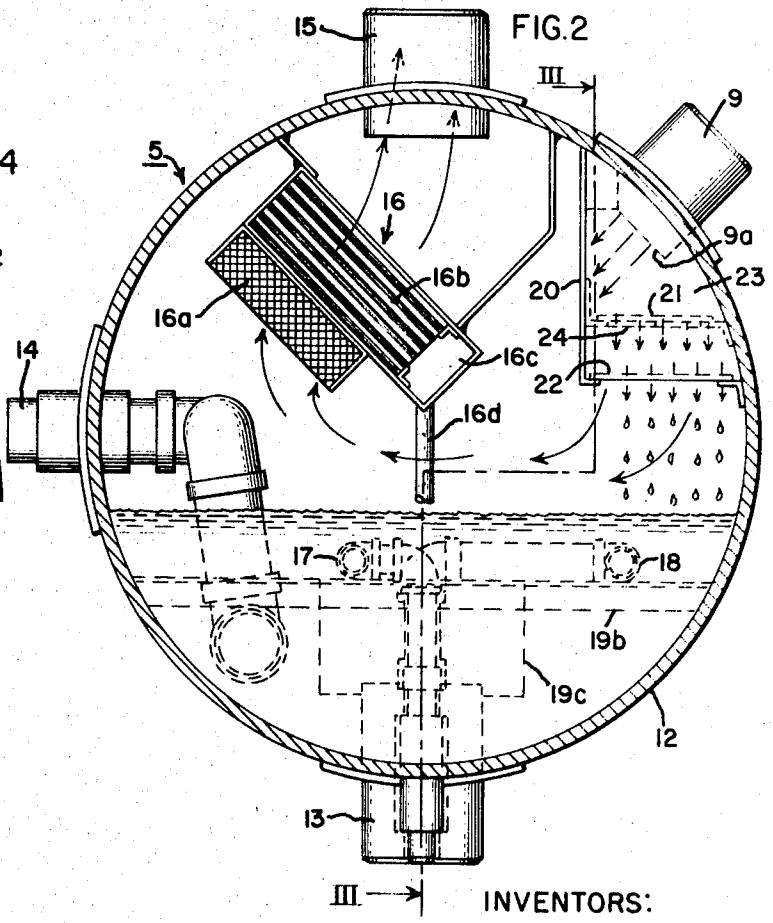

FIG.2

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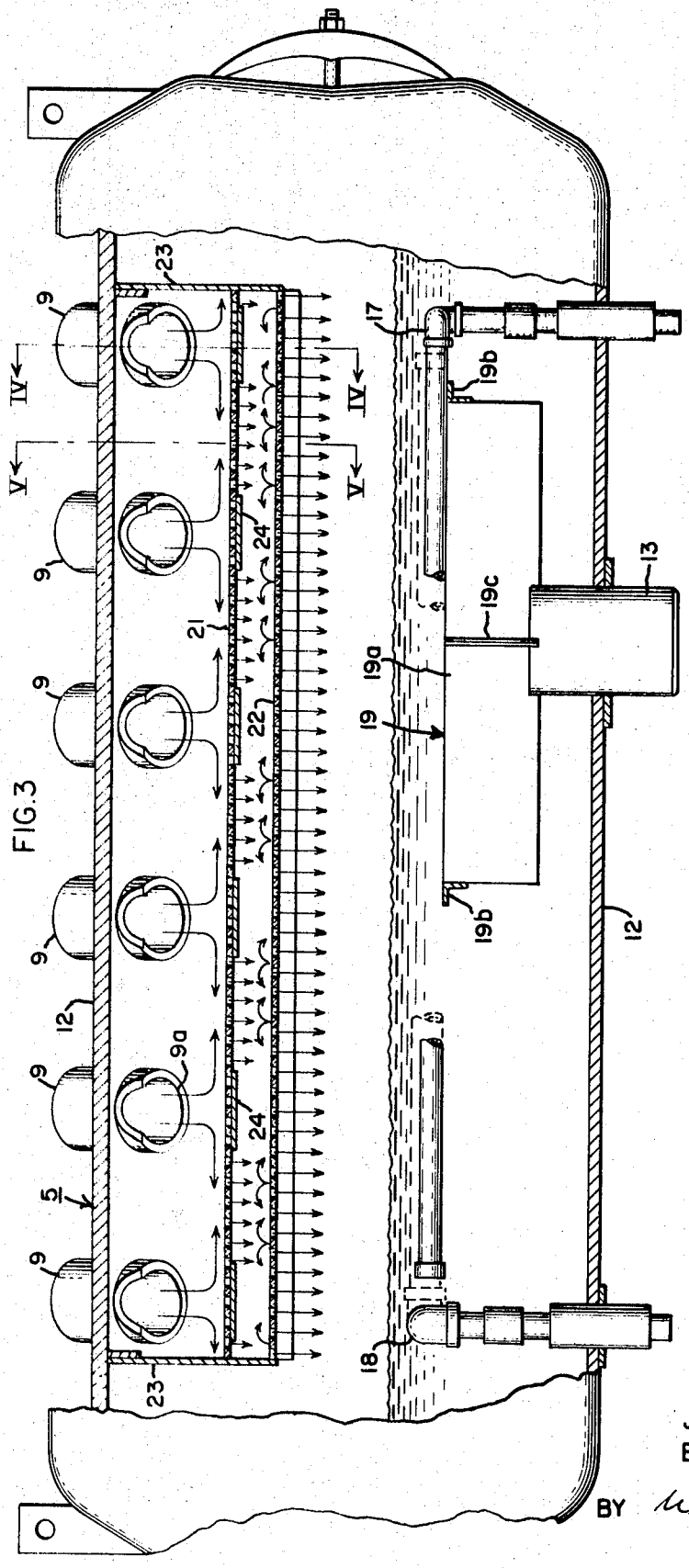

FIG.3

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STEAM DRUM BAFFLE ARRANGEMENT FOR A FORCED RECIRCULATION STEAM GENERATOR

BACKGROUND OF THE INVENTION

This invention relates to an improved baffle arrangement in a forced recirculation steam drum. A forced recirculation steam generator, is one wherein incomplete evaporation takes place in the evaporator tubes and the resulting wet steam/water mixture is collected in a drum. The wet steam is drawn off from the drum and the liquid portion is returned again to the evaporator tubes, usually by a pump. The rate of steam generation may be expressed in terms such as pounds of steam per hour generated, but a much higher mass rate of flow passes between the drum and the evaporator tubes. This recirculated flow rate may be on the order of 5 to 1 and is defined as the "circulation ratio."

It is desired to keep the steam drum as small as possible, yet a very large volume of recirculating mixture of steam and water is forced into the drum with high energy and velocity. Also liquid is drawn from the bottom of the drum at a high rate. In the past, this has resulted in violent agitation of the water in the drum, standing waves, and carryover of impurities and droplets into the steam line through the steam purifier which is also usually located in the drum.

Accordingly, one object of the present invention is to provide improved baffle arrangements for dissipating energy in the steam/water mixture returned to the drum and for reducing water agitation in a forced recirculation steam generator.

Another object of the invention is to provide improved baffle arrangements for forced recirculation steam generators which reduce the likelihood of carrying over water and impurities to the steam purifier.

DRAWING

These and many other objects of the invention will become apparent by reference to the following description, taken in connection with the accompanying drawing, in which:

FIG. 1 is a simplified schematic of a forced circulation steam generator,

FIG. 2 is a transverse cross section of the steam drum,

FIG. 3 is a longitudinal cutaway view taken along lines III–III of FIG. 2 showing details of the baffle and evaporator return pipes,

FIGS. 4 and 5 are enlarged detail cross sections of the upper baffle arrangement, taken along lines IV–IV and V–V respectively of FIG. 3.

SUMMARY OF THE INVENTION

Briefly stated, the invention is practiced by providing in the steam drum of a forced recirculation boiler, a baffle arrangement comprising imperforate plates receiving the high velocity steam/water mixture from the return lines, and two or more horizontal vertically spaced perforate plates which collect and distribute low velocity water uniformly to the bottom of the drum. An additional antiswirl baffle may be used to stabilize water flow from the bottom of the drum.

DESCRIPTION OF THE INVENTION

Referring to FIG. 1 of the drawing, a heat recovery steam generator includes a duct 1 carrying waste heat gases, such as from an industrial process or a gas turbine. These gases may be additionally heated by supplementary firing in a burner (not shown). Inside duct 1 are horizontal tube banks comprising superheater tubes 2, evaporator tubes 3, and economizer tubes 4. Outside the duct is a steam drum 5. A high capacity circulating pump 6 is connected to receive liquid from the bottom of the drum 5 and supply it to the header 7 to flow at a high rate in parallel through evaporator tubes 3, into header 8, and from there into a number of evaporator return pipes 9 spaced along the steam drum 5.

The drum is supplied with heated feedwater from the economizer through pipes 10, and saturated steam is drawn off at the top of drum 5 through line 11 to pass to the superheater. The rate of flow through return pipes 9 is on the order of five times as great as that through pipes 10, 11.

Referring to FIG. 2 of the drawing, the drum 5 includes a pressure shell 12, a liquid outlet 13 connected to the circulating pump, a feedwater inlet pipe 14, a saturated steam outlet pipe 15, and the aforementioned group of evaporator return lines 9 spaced axially along the pressure shell 12 at the upper part thereof. These discharge transversely into the shell above the normal liquid level.

Inside the upper portion of the drum is a steam purifier 16 which includes a screen mesh element 16*a* for coalescing particles and a separator element 16*b* of chevron baffle vanes. Entrained liquid droplets impinge and coalesce on the mesh 16*a* before passing into the separator, where the increased particle size improves the moisture separating effectiveness of the vaned elements. Liquid is collected in a lower chamber 16*c* and drains through line 16*d*.

Piping arrangements below the water level are indicated by reference numerals 17, 18. These are used for blow down to control the concentration of impurities and also to add chemicals for water treatment.

Disposed above the liquid outlet pipe 13 is an antiswirl baffle 19. It consists of two flat plates in a cruciform configuration centered above the outlet. A first plate 19*a* extends longitudinally and is supported at either end by transverse angles 19*b*. A second transverse plate 19*c* is attached to 19*a*.

Referring now to the baffle arrangement in the upper right-hand corner of FIG. 2, a vertical longitudinally extending plate 20 is attached to the inside of the pressure vessel and extends along in front of the outlets 9*a* of the return lines 9.

Extending between the pressure vessel wall and vertical plate 20 are two horizontal vertically spaced plates 21, 22. These are of substantial construction and are perforated to provide about 60 percent opening. As notes from FIG. 3, the perforated plates 21, 22 extend substantially the entire length of the drum. Transverse end plates 23 complete the baffle chamber enclosure. Thus the arrangement of perforate and imperforate plates 10—23 completely enclose a baffle chamber which serves to receive the high energy mixture of steam and water from the return lines 9.

Referring now to the detail view of FIG. 4, it will be seen that the perforate plates 21, 22 are supported on angle members. A distribution plate 24 is employed below the outlet of each of the pipes 9 and is arranged horizontally to receive high velocity liquid which has previously impacted the vertical plate 20. Distribution plates 24 are axially spaced and serve to spread the flow longitudinally over the top perforate plate 21.

Referring to FIG. 5, which is a cross section taken between return lines 9, it can be seen that the perforate plates 21, 22 are staggered with respect to one another so that the holes are not in line. Thus there is no possibility of high velocity droplets passing through both plates without having their energy reduced.

The size and vertical spacing of the perforate baffles will vary somewhat with application. It has been found in a steam drum of the type shown, having a diameter as small as 3½ to 4 feet and a length of 7 to 8 feet, suitable results have been obtained with baffles spaced about 4 inches apart. With such dimensions, a recirculating flow of greater than 500,000 pounds per hour has been achieved with steam generation of 120,000 pounds per hour at 600 p.s.i.g. with no significant carryover. In some designs, it may be desirable to have more than two spaced baffles, but two is deemed to be a minimum for effective results.

OPERATION

The operation of the invention is as follows. The high velocity steam and water mixture from return lines 9 impacts against the imperforate plate 20 and, in the vicinity of the pipes, also against the imperforate distribution plates 24. The liquid is spread in both directions longitudinally and dis-

tributed over the top perforate plate **21** over the length of the steam drum inside the baffle chamber. The liquid flows through the holes and is redistributed on the next horizontal perforate plate **22**. From there the liquid drops into the bottom of the drum. Steam flows through the purifier **16** and out the saturated steam outlet **15**. Any entrained particles are coalesced on mesh **16*a*** and separated by vaned element **16*b***.

Liquid flows through the antiswirl baffle **19** and out the pipe **13** to the recirculating pump. The antiswirl baffle aids in water level control since it prevents a low water level over the outlet pipe which should otherwise be present due to a vortical swirl. Due to the effectiveness of the baffle chamber and the antiswirl baffle **19**, liquid can be pumped through the evaporating tubes at a high circulation ratio without violent agitation of the water in the drum which would result in impurities or liquid being carried over into the steam outlet **15**.

While the invention has been described herein in what is considered to be the preferred embodiment, other modifications will occur to those skilled in the art and it is intended to cover herein such modifications.

We claim:

1. In a forced recirculation steam generator, the combination of:

a steam drum comprising a horizontal annular pressure vessel with a normal liquid level and having a plurality of longitudinally spaced evaporator return conduits connected along an upper portion thereof and arranged to discharge a high velocity steam and water mixture transversely into the upper part of the pressure vessel above said liquid level, a baffle chamber enclosing said conduit outlets within the pressure vessel and comprising:

an imperforate wall portion arranged to receive the high velocity mixture from said conduits;

a first perforate wall portion disposed to catch and distribute the mixture from said imperforate wall portion; and

a second perforate wall portion disposed below and vertically spaced from the first perforate wall portion and arranged to catch liquid flowing therethrough and to redistribute it to the lower part of the pressure vessel.

2. The combination according to claim **1**, further including a liquid outlet conduit in the bottom of the vessel and antiswirl baffle means mounted above said outlet conduit comprising plates arranged to reduce vortical swirl into said conduit.

3. The combination according to claim **1**, including a steam separator disposed in said pressure vessel outside of said baffle chamber and a steam discharge conduit arranged to draw off steam from the upper portion of the pressure vessel through said separator.

4. The combination according to claim **1** including a feedwater supply conduit arranged to discharge liquid into the pressure vessel below said liquid level.

5. The combination according to claim **1**, wherein said first and second perforate wall portions comprise a pair of horizontal plates each having uniformly spaced openings covering approximately 60 percent of the total plate area, the openings in one plate being offset with respect to the holes in the other plate.

6. The combination according to claim **1**, wherein said imperforate wall portion includes a continuous vertical plate and a plurality of spaced horizontal distribution plates, said distribution plates being disposed below the discharge ends of said return conduits.

7. In a forced recirculation steam generator of the type having a steam drum, an evaporator, and means for circulating liquid from the drum to the evaporator and returning a steam/liquid mixture to the drum at a rate substantially in excess of steam generation, the improvement comprising:

a plurality of evaporator return conduits, connected along the drum and discharging above the normal water level;

a baffle chamber enclosing said conduit outlets within the drum, said chamber including a pair of horizontal, vertically spaced perforate plates disposed above the water level and arranged to distribute liquid to the lower part of the drum; and

an antiswirl baffle including plates disposed below the water level and arranged to reduce vortical swirl in liquid recirculated to said evaporator.