March 24, 1942. O. HARTMANN 2,277,100

HIGH PRESSURE STEAM GENERATOR

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Fig. 1.

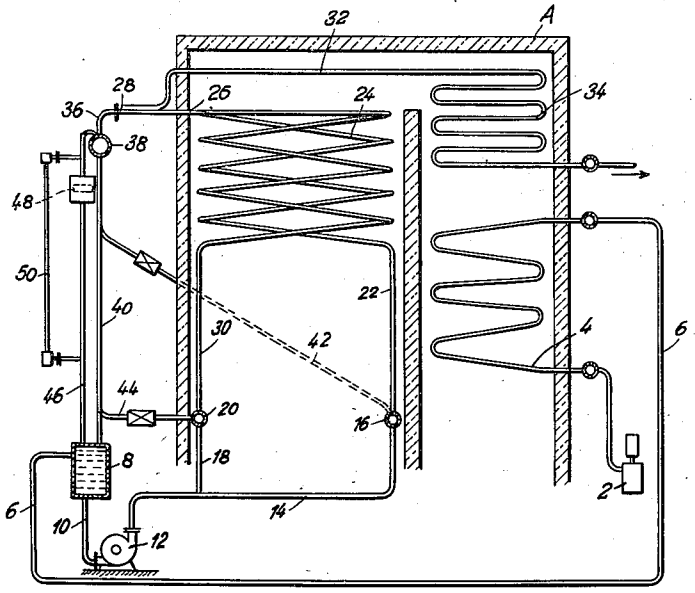


Fig. 2.

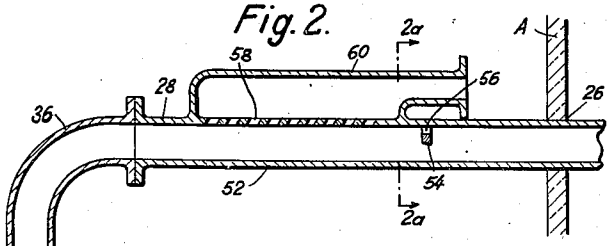


Fig. 2a.

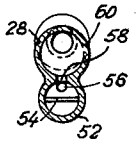
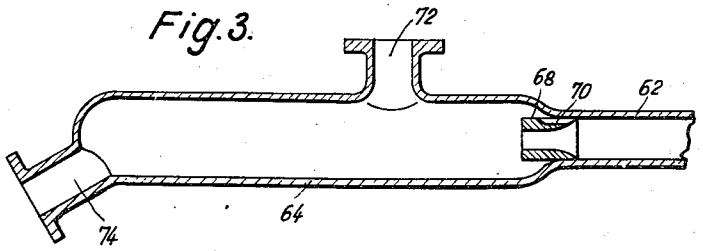


Fig. 3.



Inventor
Otto Hartmann,

Bailey & Larson
Attorneys

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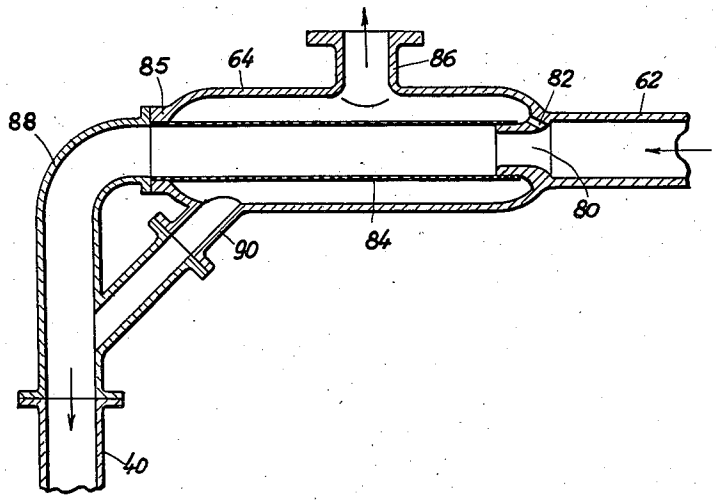
Fig. 4.



Inventor:
Otto Hartmann,
Bailey & Carson
Attorneys

Patented Mar. 24, 1942 2,277,100

UNITED STATES PATENT OFFICE

2,277,100

HIGH PRESSURE STEAM GENERATOR

Otto Hartmann, Kassel-Wilhelmshohe, Germany

Application December 30, 1938, Serial No. 248,629
In Germany January 17, 1938

6 Claims. (Cl. 183—2.5)

This invention relates to a high pressure heavy duty steam generator in which forced circulation of water is used, and in which the conventional steam drum is replaced by individual tubular steam and water separators provided for each vaporizer tube, or for each group of vaporizer tubes.

It is an object of the invention to construct a steam and water separating device in which the flow of steam and water is throttled just prior to the point where the water is separated from the steam.

A further object of the invention is to construct a tubular steam and water separator where the steam and water flow is throttled before the separation takes place, the means for throttling comprising a diaphragm, or a nozzle.

The prior art has constantly sought to produce high pressure steam generators of less weight, and therefore of less construction expense. Boilers having a forced circulation have been tried, but because steam drums are not ordinarily used therewith, it has been necessary to use feed water having a purity of less than five milligrams of salt per liter, otherwise the tubes would, in a short while, become clogged. Furthermore, such boilers are objectionable for marine work because in maneuvering, heavy loads are intermittently placed upon the boiler, and the water pressure therein drops rapidly below permissible limits. This incidentally causes a change in the vaporizing area of the boiler tubes and consequently a change in the temperature of the superheated steam.

Where steam drums have been used, a large increase of weight and bulk is immediately had, which is objectionable, and, moreover, these boilers have a tendency to foam, and in spite of the use of baffles in the steam drums, the water content of the steam passed to the superheater is objectionably high.

Where natural circulation has been used, it has been proposed to replace the steam drum by individual steam and water separators at the end of each vaporizing tube, but these boilers are especially suitable for light duty because of the reliance upon the natural circulation of the water.

It has been discovered that by using forced circulation of the water in the tubes, and by using an individual steam and water separator for each vaporizer tube, or one steam and water separator for a group of tubes, a heavy duty high pressure drumless boiler can be constructed which is capable of producing 100 tons of steam per hour up to pressures of 100 atmospheres. At the same time, the heavy and bulky steam drums are eliminated and the boilers can use feed water containing up to 100 milligrams of salt per liter. Again, because of the particular construction of the tubular steam and water separators in the associated apparatus, steam having a very low moisture content is passed to the superheater, while, at the same time, proper provision can be made for blowing off deposits of sludge and scale. Because of the forced circulation of water, fluctuations in loads do not produce a lowering of the water in the tubes, and a consequent danger of burning the tubes, while, at the same time, boiling of the tubes until they are empty is prevented, and the tubes are maintained relatively cool.

These objects and advantages of the invention are in general obtained by constructing a tubular steam and water separator in which the steam leaving the vaporizer tubes is throttled immediately before being passed through the separator, whereby steam having a very low moisture content is taken off in the separator and passed to the superheater, while the water continues past the separating points and is returned to the vaporizer tubes. Means for obtaining these objects and advantages of the invention are more fully described with reference to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view showing the vaporizing system.

Fig. 2 is a sectional view of one embodiment of the novel tubular steam and water separator in which a throttling diaphragm is used.

Fig. 2*a* is a cross-sectional view on the line 2*a*—2*a* of Fig. 2.

Fig. 3 is a sectional view of a modified form of the invention in which a nozzle is used; and

Fig. 4 is a sectional view of a further modified form of the invention using a screen in combination with a nozzle.

As shown in Fig. 1, the boiler A contains a circulating system as follows:

Feed water comes from the pump 2, passes through preheater 4, and is conducted through pipe 6 to reservoir 8. From reservoir 8 water is passed through pipe 10, through pump 12 and pipe 14 into a lower header 16 located on one side of the combustion chamber. A branch pipe 18 conducts water from pipe 14 to a second lower header 20 located on the other side of the combustion chamber. From header 16, vaporizer tubes 22 extend upwardly for a portion of the combustion chamber to provide a plurality of

adjacent tubes which form a cooling wall for one side of the combustion chamber, these tubes being projected transversely of the upper portion of the combustion chamber at 24, and then passed outwardly of the combustion chamber at 26 into a steam and water separator 28.

From header 20 another similar set of tubes 30, on an opposite side of the chamber from the tubes 22, are likewise extended and passed into steam and water separator 28. It is noted at this time that the tubular steam and water separator can be applied to but one vaporizer tube, or for both of the vaporizer tubes in the same plane on opposite sides of the combustion chamber, or for groups of tubes 30 or groups of tubes 22.

From the steam and water separator 28, steam is conducted through pipe 32 to superheater 34, and from the superheater to a point of use.

From the steam and water separator 28, the separated water is conducted through pipe 36 to a header 38, and from header 38 downwardly through pipe 40 to reservoir 8. The pump 12 creates a constant circulation of water from reservoir 8 through the vaporizer tubes back to the reservoir 8. When the pump is not being used, the water can be conveyed from pipe 40 through pipe 42 to header 16, and through pipe 44 to header 20, valves being provided in these pipes 42 and 44, respectively, so that the same can be closed off when the pump is being used. The pipes 42 and 44 provide a means for maintaining a circulation of water through the vaporizer tubes, should the pump 12 become temporarily inactive.

A stand pipe 46 can be inserted between the header 38 and the reservoir 8, and a float 48 and water gauge 50 connected to this stand pipe 40 so that the water level in the boiler can always be observed.

As the steam and water separator is located outside of the combustion chamber, the point at which the steam is separated from the water is not heated, and therefore, it is impossible for foaming to occur at this point. This is one of the reasons why exceptionally dry steam is obtained from the device.

The novel steam and water separator is constructed as follows:

As shown in Fig. 2, the steam and water mixture leaves the furnace at 26 and passes into tube 52, within which is mounted a baffle 54. This baffle, as shown, may cut off approximately half of the passageway 52, and may be provided with one opening, or a plurality of openings, 56 through which steam in the upper portion of the pipe 52 may pass, while water passes beneath the baffle. This baffle causes the steam and water mixture coming from the vaporizer tubes 22 and 30 to dam up, and thus causes a partial separation of water from the steam. As the thus partially separated steam and water passes beyond the baffle 54, the steam escapes through perforations 58 in the upper portion of the tube 52 into a chamber 60, from which the steam is passed through pipe 32 to the superheater. Of course, steam which has passed under the baffle 54, is, to a large extent, separated from the water beneath the perforations 58, and passed through the perforations along with the steam which has gone through the opening 56 in the baffle 54. Water remaining in pipe 52 is passed through the pipe into pipe 36, and down to the reservoir 8.

Experiment has shown that pulsation or hammering takes place in vaporizer tubes having forced circulation, as well as in tubes having natural circulation. With the relatively high rate of steam and water flow in tubes having forced circulation, such pulsations would cause a great deal of water to be carried along with the steam to a point of use, were it not for the damming effect of the baffle 54 upon the steam and water mixture.

In particular, the baffle 54 causes a reduction of the steam and water flow in the separating device 28. Steam which has already separated from the water in the vaporizer tubes is therefore compressed and is forced to escape from the separator through openings 56 in the form of relatively dry steam. The water containing the residual steam passes beneath and beyond baffle 56 as a uniform non-pulsating stream to the portion of the separating device below perforations 58. There, the residual steam escapes from the water. The baffle 56 prevents pulsations in the vaporizing tubes from causing such surges of the steam and water mixture beneath the perforations as would cause water to be carried along with the steam to a point of use.

In Fig. 3, a modified form of the steam and water separator is shown. Here, steam and water coming from the vaporizer enters pipe 62, and from pipe 62, is passed into an enlarged pipe 64. At the juncture of these two pipes, a nozzle 68 is placed which produces a constriction of the passage in a manner similar to the baffle 54 in Fig. 2. A groove, or grooves, 70 is provided in the upper part of the nozzle to provide an opening for the steam in the upper portion of the pipe 62 into pipe 64. Steam and water separation further takes place in pipe 64, from which steam is conducted through opening 72 to the superheater, while water is conducted through opening 74 to the pipe 40.

The nozzle 68 increases the velocity of flow of the steam and water coming from pipe 62, and an expansion of the steam takes place in the enlarged chamber 64, thus aiding the separation of the steam from the water. Consequently, a very dry steam is passed from the separator to the superheater.

A further embodiment of the invention is shown in Fig. 4, which is very similar in construction to Fig. 3. In Fig. 4, steam again passes from pipe 62 into an enlarged pipe 64 through a nozzle 80 which, as shown, may be integrally formed in the pipe 64. The nozzle performs a throttling function as the nozzle in Fig. 3. A slot, or slots, 82 forms an opening for steam in the upper part of the tube 62 to by-pass the nozzle into pipe 64. A screen 84 extends from the outlet end of nozzle 80 to the outlet end 85 of pipe 64. As shown, screen 84 is held in place by being telescoped over the nozzle 80, and within outlet 85. The steam and water mixture coming from the nozzle passes through this screen, and therein the steam separates from the water and passes through the screen to the opening 86, from which it goes to the superheater. Water which goes through the tube 64 without passing through the screen 84 is conducted through elbow 88 to the pipe 40, whereas water which has gone through the openings in the screen 84 is passed to the pipe 40 through drain 90. Although the screen 84 is shown coaxially arranged with respect to pipe 64, it is possible to place the nozzle 80 eccentrically with respect to pipe 64, so that the steam and water are discharged into the lower half of pipe

64. In such a condition, the screen is arranged as a curved screen separating the upper from the lower half of the pipe 64, and the nozzle, of course, discharges below the screen.

It thus appears that the means of generating steam by forced circulation of water as shown, and the means of separating the water from the steam, enables a very dry steam to be obtained in a high pressure heavy duty boiler which does not, by reason of the individual steam and water separators provided, necessitate the use of a steam drum. Although forced water circulation is used, it is not necessary to use condensers to reclaim the pure water, and this is further advantageous, as condensers are difficult to use with high pressure boilers. The separators disclosed allow the steam to be separated from the water at an even rate, so that the spitting and jerking experienced in the prior art, despite the use of baffles in the steam drums, and which caused excess water to be passed to the superheater is avoided. At the same time, the use of forced water circulation prevents the danger of the tubes burning and retains the advantages of the use of relatively long vaporizer tubes, while the novel separator removes the danger of the steam and water remixing immediately prior to their separation.

Likewise, the reservoir 8 constitutes a means whereby the deposits of sludge and scale can be removed, and the apparatus as a whole enables the tubes to be substantially continuously filled with water so that load fluctuations do not result in steam with a high water content to be passed to the boiler, or a dangerous drop in water pressure in the vaporizing tubes.

Having now described means by which the objects of my invention are obtained, what I claim is:

1. A steam and water separating device for a steam generator comprising a pipe for conducting a steam and water mixture, means for removing separated steam from said pipe, means for throttling the flow of said mixture in said pipe toward said removing means, means for by-passing the flow of steam from the inlet side of said throttling means around said throttling means to said separated steam removing means, and means for discharging water from said device remote from said throttling means.

2. A steam and water separating device for a steam generator comprising a substantially horizontally disposed pipe for conducting a steam and water mixture, a throttling member in said pipe adjacent the inlet to said device for retarding the flow of said mixture through said device, an opening in the upper portion of said throttling member providing a steam by-pass around said member, means for removing separated steam from the upper portion of said pipe after said mixture has passed by said throttling members, and means for removing separated water from said pipe.

3. A steam and water separating device for a high pressure steam generator having forced water circulation comprising a pipe for conducting a steam and water mixture, a baffle located in the upper half of said pipe adjacent the inlet to said device for throttling the flow of said mixture in said pipe, opening means in the upper wall of said pipe for allowing steam to escape from said device, and water outlet means at the end of said device opposite said baffle.

4. A device as in claim 3, said baffle having at least one opening in the upper portion thereof.

5. A steam and water separating device for a high pressure heavy duty steam generator with forced water circulation, comprising a first pipe for conducting a steam and water mixture, an enlarged pipe joined to said first pipe, a nozzle interposed at the jointure of said first pipe with enlarged pipe and restricting the passageway between said first and enlarged pipes, at least one opening through the upper wall of said nozzle for providing a steam by-pass around said nozzle from said first pipe to said enlarged pipe, and steam outlet means and water outlet means connected to said enlarged pipe.

6. A device as in claim 5, a screen extending from said nozzle to said outlet means and being between the steam and water discharge end of said nozzle and said steam outlet means.

OTTO HARTMANN.