June 23, 1942. L V ANDREWS 2,287,592

STEAM PURIFYING APPARATUS

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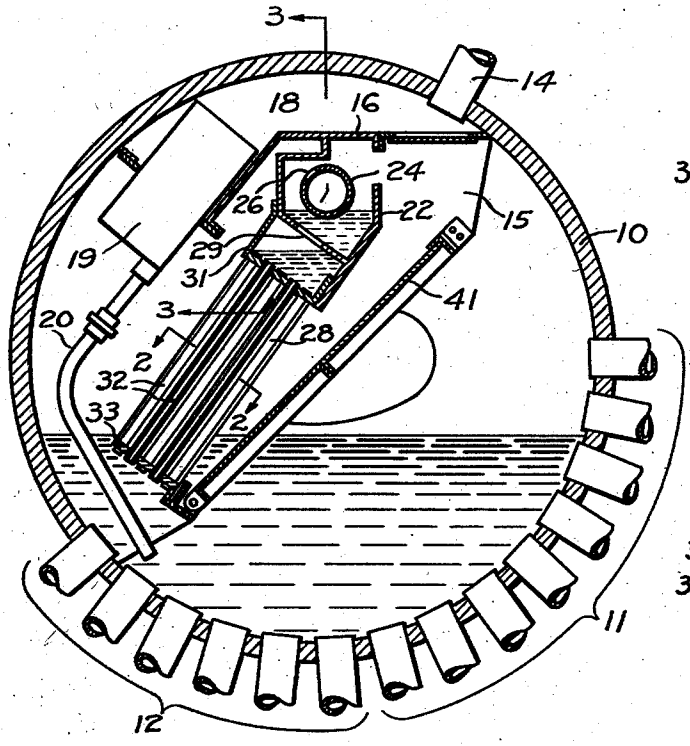


Fig. 1

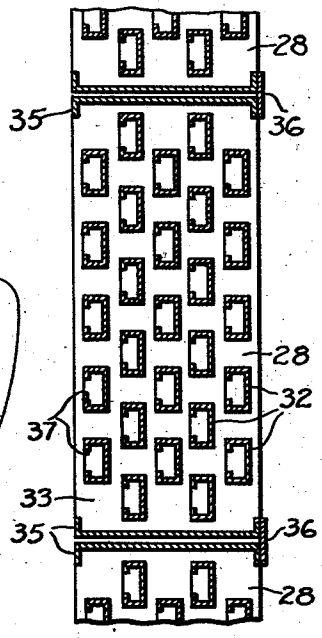


Fig. 2

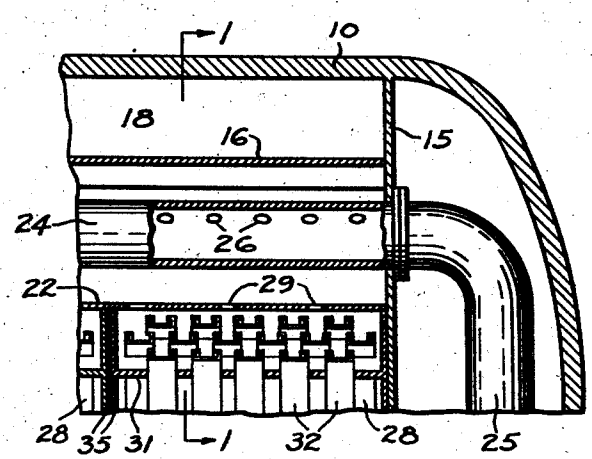


Fig. 3

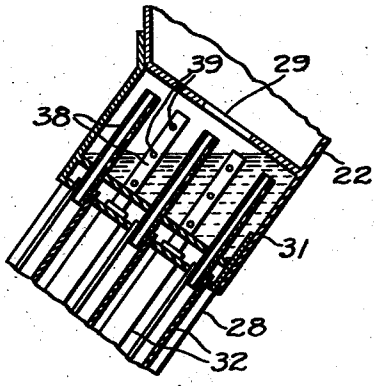


Fig. 4

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STEAM PURIFYING APPARATUS

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8 Claims. (Cl. 122—491)

This invention relates to steam purifying apparatus, and more particularly to apparatus capable of removing substantially all foreign matter from the steam before it leaves the boiler.

The water in a steam boiler is usually maintained at a rather high concentration of solids in order to reduce the amount of blow-down required. Consequently the steam when first liberated is appreciably contaminated by solid matter, some of which is insoluble and some of which is dissolved in the water carried in suspension in the steam. The suspended moisture can usually be evaporated in the boiler superheater, but if the solid matter is not removed it will cause serious difficulties, particularly by forming deposits in the machine, such as turbines, to which the steam is delivered.

It has heretofore been proposed to wash the steam by means of the feed water entering the boiler, and while this brings about an appreciable purification of the steam it is not thoroughly effective, since the feed water itself is usually contaminated to some extent and may even contain appreciable quantities of solids which have been added to reduce scale formation or other difficulties in the operation of the boiler. It has also been proposed to pass the steam through pools of water, and to replenish these pools by means of condensate which is obtained by bringing the washed steam into contact with the outside surfaces of horizontal metal tubes through which the boiler feed water flows. This apparatus requires an expensive drum, apart from the drums of the boiler, and it requires such a maze of baffles, compartments and pipes within this drum as to render access to the interior thereof substantially impossible. Furthermore, unless the steam velocities are very low, the steam will entrain large quantities of water from the pools, and it will be difficult to maintain the pools properly filled or to cause the water to flow through the pools consecutively in opposition to the steam flow, as contemplated. There is also considerable uncertainty as to the washing effect obtainable by passing steam through such pools. Adequate separation of moisture from the steam in such a construction appears to be impossible because of the space limitations and the high velocity of the steam passing over the condensing tubes immediately prior to its escape from the drum.

It is accordingly one object of the invention to provide a comparatively simple, compact and inexpensive apparatus which will be highly effective in removing impurities from steam.

It is a further object of the invention to provide a highly efficient steam purifying apparatus mounted within the steam-and-water drum of a boiler.

It is a further object of the invention to provide a dependable steam purifier which will remove substantially all foreign matter from the steam before it leaves the boiler, and which will be unaffected by variations in the purity of the boiler feed water.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawing illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a section through a steam purifying apparatus, taken on the line 1—1 of Fig. 3;

Fig. 2 is an enlarged fragmentary section on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary section on the line 3—3 of Fig. 1; and

Fig. 4 is a section similar to a portion of Fig. 1 but showing a slight modification.

The embodiment illustrated comprises a horizontal cylindrical boiler drum 10 which may form the steam-and-water drum of a well-known type of steam boiler. A bank of steam generating tubes 11 is connected to the lower front portion of the drum, and a bank of downcomer tubes 12 is connected to the lower rear portion of the drum. A row of steam discharge tubes 14 is connected to the upper front portion of the drum. The tubes 11 serve to deliver a mixture of steam and water to the drum in known manner, the steam escaping through the tubes 14, while the water for the most part separates from the steam by gravity and escapes downwardly through the tubes 12. The present invention is concerned primarily with means as purify the steam before it reaches the outlet tubes 14.

Near each end of the drum there is provided a vertical plate 15 approximately semi-circular in shape and welded or otherwise secured to the surrounding cylindrical surface of the drum. These plates are located in the upper rear portion of the drum, so that their free edges are at the front and slope downwardly toward the rear. A partition wall 16 extends between the two plates 15 and is connected to the wall of the drum both in front of the tubes 14 and in the rear thereof, thus providing in the upper portion of the drum a chamber 18 with which the

steam outlet tubes 14 communicate. Before entering this chamber, the steam is forced to pass through a moisture separator 19 which extends through the rear portion of the partition 16. A drain pipe 20 serves to return the separated moisture to the pool of boiler water in the bottom of the drum. This separator 19 may be of any desired type, one suitable construction being disclosed in the patent application of Max H. Kuhner, Serial No. 225,590, filed August 18, 1938.

Most of the foreign matter, whether soluble or insoluble, is removed from the steam before it reaches the separator 19. For this purpose there is provided a trough 22 which extends lengthwise of the drum in front of the separator 19 and directly beneath the partition 16. The rear wall of this trough is joined to the partition, whereas the front wall is preferably spaced from the partition, so that the boiler steam pressure is effective inside the trough. A horizontal pipe 24 is mounted within the trough 22 and extends longitudinally thereof, one end of this pipe passing through the adjacent plate 15 and connecting with the feed water supply pipe 25 of the boiler. The pipe 24 is provided with a row of holes 26 in its upper portion, so that the feed water will be distributed along the trough with substantial uniformity. Beneath the trough there is provided a row of steam purifying units 28, each of which is so proportioned that it can be introduced through the drum manhole. The boiler feed water is delivered to these units through openings 29 in the bottom of the trough 22.

Each purifying unit 28 comprises a distributing box 31 from which a group of conduits 32 extends downwardly. The lower ends of these conduits extend through openings in a bottom plate 33 which is connected to the box 31 by means of two side plates 35, the front edges of adjacent side plates being joined at assembly by splice plates 36 (Fig. 2). The conduits 32 are shaped as hollow rectangular tubes in cross-section, with an open slot 37 in the rear wall of each tube, the front walls of the tubes presenting substantially flat surfaces toward the on-coming steam. The conduits are arranged in rows which extend longitudinally of the drum, with the conduits in adjacent rows staggered, and they preferably slope downwardly toward the rear of the drum.

The distributing boxes 31 are located directly beneath the trough 22 in position to receive feed water from the openings 29 and to deliver this water to the conduits 32. Preferably the conduits in the front rows receive a greater proportion of the water than those in the rear rows, this result being obtained by tipping the boxes 31 downwardly toward the front and thus increasing the depth of the water above the front row of conduits. Instead of discharging the water from the boxes 31 directly into the conduits 32, as shown in Fig. 1, tubes 38 (Fig. 4) may extend upwardly from the conduits into the boxes, these tubes having perforations 39 therein. By varying the number and size of these perforations, any desired proportioning of the water among the conduits may be obtained.

In front of the purifying units 28 there is preferably mounted a baffle 41 (Fig. 1) which slopes upwardly and forwardly. The ends of this baffle are connected to the plates 15, and its lower edge is submerged in the water within the drum. The upper edge of the baffle is spaced from the partition wall 16 thereabove to provide a passage for the rearward flow of the steam.

The operation of the invention will now be apparent from the above disclosure. The boiler feed water will be supplied to the pipe 25 at a temperature considerably lower than that of the water in the boiler. From the pipe 25 the feed water will enter the pipe 24 whence it will escape through the holes 26 into the trough 22, and thence through the openings 29 into the boxes 31. From these boxes the feed water will enter the upper ends of the conduits 32, either directly as in Fig. 1, or through the perforations 39 and the tubes 38 as in Fig. 4, and flow downwardly through these conduits until it is discharged into the water within the drum. The tubes 11 will deliver a mixture of water and steam into the front portion of the drum, where most of the water will separate by gravity and eventually flow downwardly through the tubes 12. The steam, with considerable boiler water in suspension, will flow upwardly, and as it passes rearwardly over the top of the baffle 41 much of the suspended moisture will be thrown out centrifugally because of the abrupt change in the direction of flow. The steam and the remaining suspended moisture will then flow rearwardly into contact with the first row of conduits 32, and the resulting impingement will bring about a deposit of particles of moisture and suspended foreign matter, and a combining of such particles into larger particles. At the same time some of the steam will be continuously condensing on the outside of the conduits, which are maintained at a temperature below that of the steam by the transfer of heat to the feed water inside the conduits. The resultant condensate will mix with the deposited moisture and dilute the same, and a considerable part of the mixture will descend the front faces of the conduits to the boiler water line, aided by gravity and by the effect of the steam flow on the sloping surfaces of the conduits. Such of the mixture as does not thus escape from the steam will be swept along therewith into contact with the second row of conduits. The velocity of the steam past each conduit will tend to create a region of reduced pressure within the same, and much of the suspended moisture will leave the steam and be drawn inwardly through the slots 37 into the conduits, where it will mix with the feed water and be carried downwardly and out of the purifier. Condensate will form continuously on the outside of all the conduits 32, and since this condensate is pure water, free from either soluble or insoluble foreign matter, the moisture in the steam will not only be to a large extent removed at each row of conduits, but it will also be diluted more and more at each stage. Thus when the steam finally leaves the purifying units 28, such moisture as it carries in suspension will be substantially pure condensate, with a negligible amount of impurities. Most of this moisture will be removed from the steam as it passes through the separator 19 into the chamber 18. The clean dry steam will escape from the chamber 18 through the tubes 14.

It will be recognized that the invention provides a highly efficient steam purifying apparatus of such a compact construction that no extra drum is required, the customary steam-and-water drum of the boiler being sufficient for the purpose. Since the boiler feed water is not employed as the washing medium, the results obtained are not dependent upon the purity of the feed water.

Having thus described my invention, what I

claim as new and desire to secure by Letters Patent is:

1. Steam purifying apparatus comprising, in combination with a steam-and-water drum having a steam outlet, a series of parallel metal conduits located within the drum and arranged in a plurality of rows, the conduits extending downwardly across the path of the steam as it flows toward the outlet, and means to supply boiler feed water to the conduits for flow therethrough in amounts progressively decreasing in the direction of steam flow past the conduits.

2. Steam purifying apparatus comprising a drum having a steam outlet, a series of metal conduits located within the drum and spaced apart for the passage of steam between them as it travels toward the outlet, and means to supply boiler feed water to the interior of the conduits so that there will be a deposit on the outer surfaces of the conduits not only of moisture carried in suspension by the steam but also moisture resulting from partial condensation of the steam, the conduits being arranged at a sufficiently steep angle to cause the deposited moisture to travel downwardly along the conduits by gravity.

3. Steam purifying apparatus comprising a horizontal drum, tubes arranged to deliver steam to the front portion of the drum, means providing an outlet passage for steam from the upper portion of the drum, means to deflect the steam into a rearward path as it flows toward the outlet passage, a series of metal conduits located within the drum, the conduits extending downwardly across the said rearward path of the steam and being spaced apart longitudinally of the drum to allow the steam to pass between them, and means to supply boiler feed water to the interior of the conduits so that there will be a deposit on the outer surfaces of the conduits not only of moisture carried in suspension by the steam but also moisture resulting from partial condensation of the steam, the deposited moisture traveling downwardly along the conduits by gravity.

4. Steam purifying apparatus comprising a drum having a steam outlet, a series of metal conduits located within the drum and spaced apart for the passage of steam between them as it travels toward the outlet, and means to supply boiler feed water to the interior of the conduits, the conduits being shaped to present substantially flat outer surfaces toward the on-coming steam so that the steam will impinge thereon and cause a deposit thereon of moisture carried in suspension by the steam as well as moisture resulting from partial condensation of the steam, the conduits being arranged at a sufficiently steep angle to cause the deposited moisture to travel downwardly along the conduits by gravity.

5. Steam purifying apparatus comprising a drum having a steam outlet, a series of metal conduits located in the path of the steam within the drum and arranged in a plurality of rows, with the conduits in adjacent rows staggered, and means to supply boiler feed water to the interior of the conduits, the conduits being shaped to present substantially flat outer surfaces toward the on-coming steam so that the steam will impinge thereon and cause a deposit thereon of moisture carried in suspension by the steam as well as moisture resulting from partial condensation of the steam, the conduits being arranged at a sufficiently steep angle to cause the deposited moisture to travel downwardly along the conduits by gravity.

6. Steam purifying apparatus comprising a drum having a steam outlet, a series of metal conduits located within the drum and arranged in a plurality of rows across the path of the steam, with the conduits in adjacent rows staggered, and means to supply boiler feed water to the interior of the conduits, the conduits being positioned at a sufficiently steep angle to cause gravity flow of the feed water therethrough, the conduits being open at the side away from the on-coming steam so that moisture carried in suspension by the steam may be drawn into the conduits by the effect of the reduced pressure resulting from the velocity of the steam past the conduits.

7. Steam purifying apparatus comprising a drum having a steam outlet, a series of parallel metal conduits of approximately rectangular cross-section located within the drum and arranged in a plurality of rows across the path of the steam, with the conduits in adjacent rows staggered, and means to supply boiler feed water to the interior of the conduits, the conduits being positioned at a sufficiently steep angle to cause gravity flow of the feed water therethrough, the conduits having an open longitudinal slot at the side away from the on-coming steam so that moisture carried in suspension by the steam may be drawn into the conduits by the effect of the reduced pressure resulting from the velocity of the steam past the conduits.

8. Steam purifying apparatus comprising, in combination with a drum having a steam outlet, a series of parallel metal conduits located within the drum and arranged in a plurality of rows, the conduits extending across the path of the steam as it flows toward the outlet, and means to supply boiler feed water to the conduits for flow therethrough in amounts progressively decreasing in the direction of steam flow past the conduits.

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