

Oct. 13, 1942.

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APPARATUS FOR TREATING STEAM

Filed Nov. 5, 1938

2 Sheets-Sheet 1

Fig. 1.

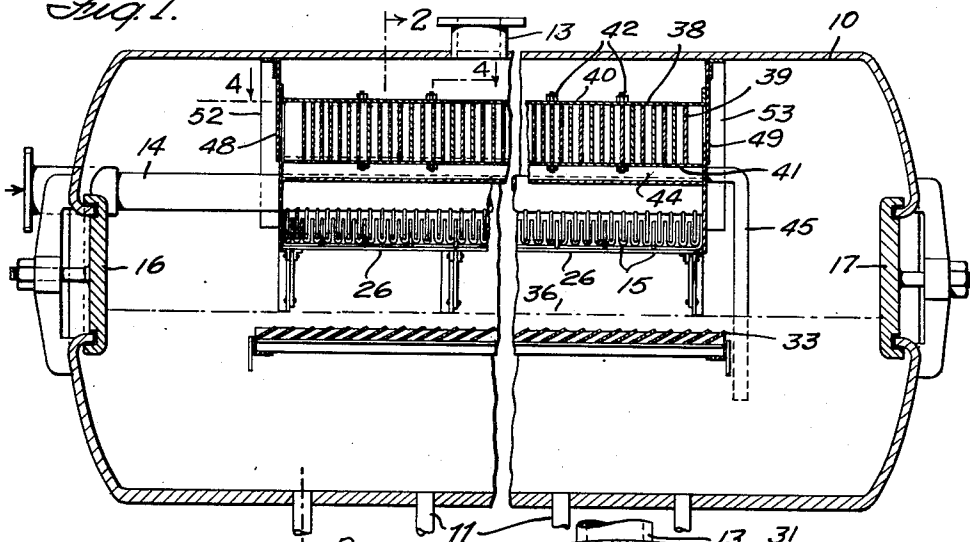


Fig. 2.

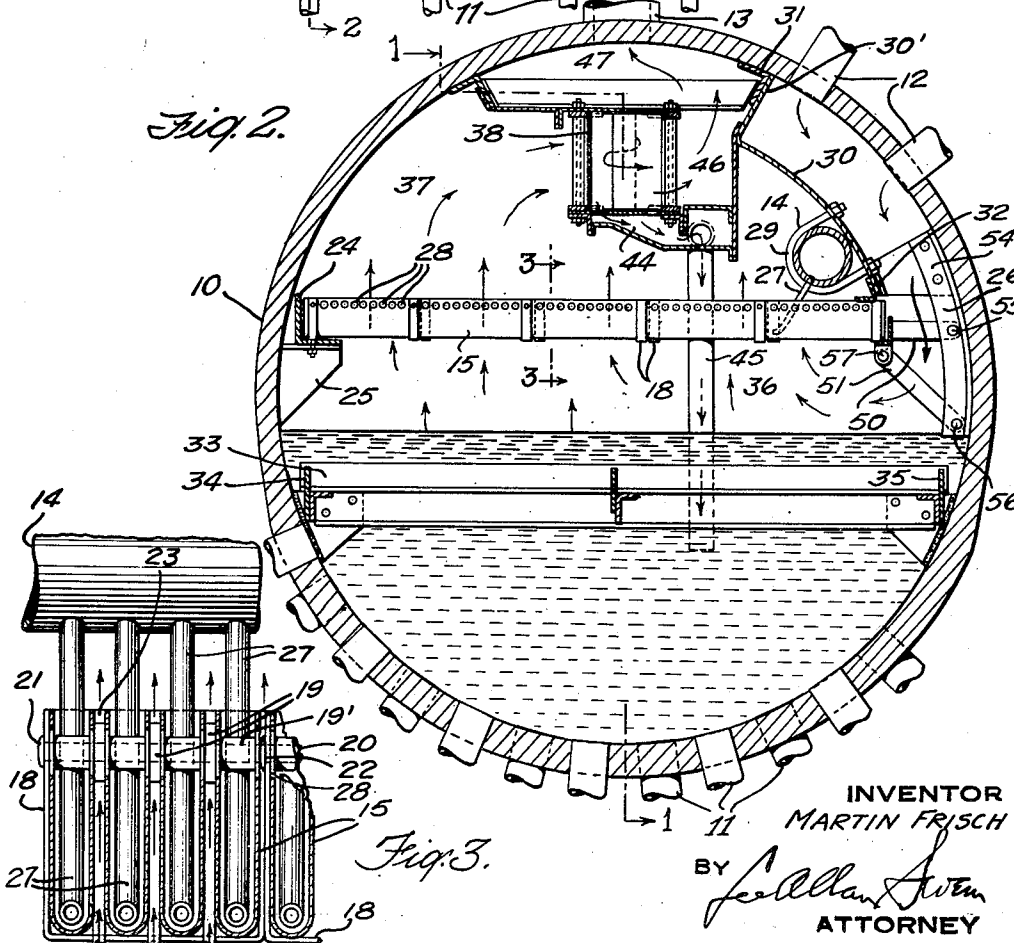


Fig. 3.

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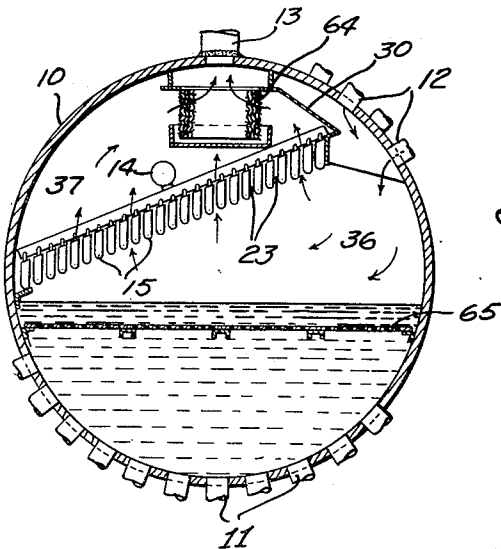
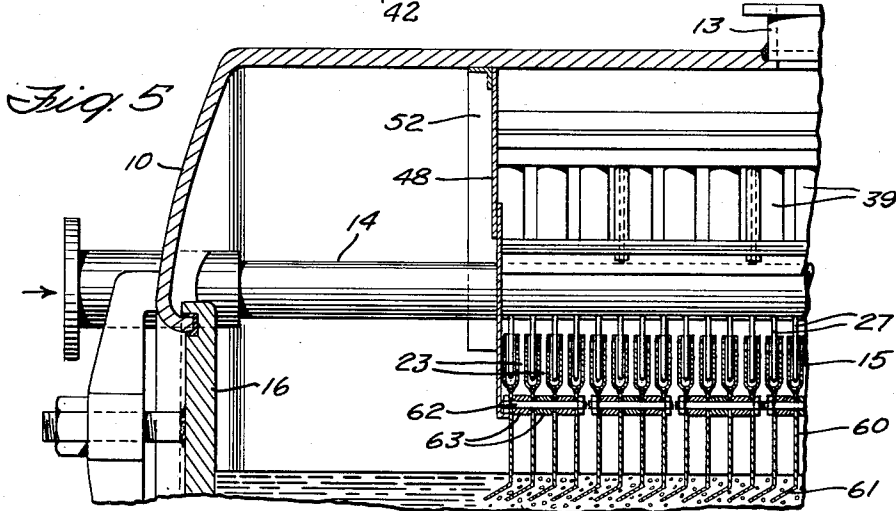
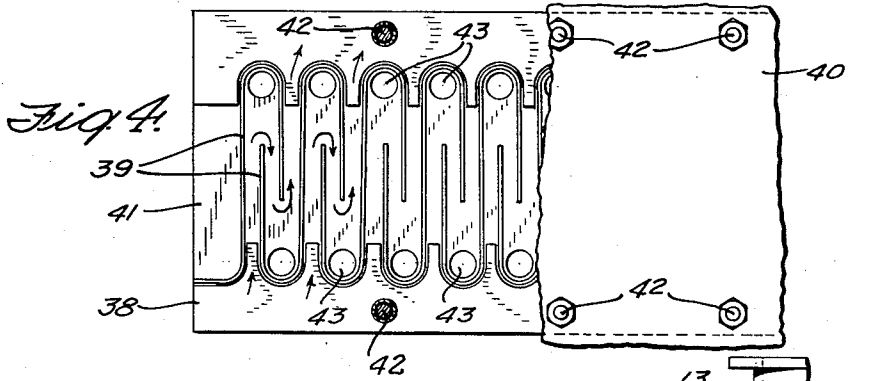
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APPARATUS FOR TREATING STEAM

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APPARATUS FOR TREATING STEAM

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11 Claims. (Cl. 261—112)

This invention relates to steam generators and particularly pertains to the purification of steam generated therein. More particularly, the invention provides an improved steam washer for removing solids, which are ordinarily entrained from the circulating water by the saturated steam generated in the boiler, by washing said steam with fresh feed water of relatively low solid concentration.

In accordance with the invention, all the steam which enters the steam drum of the boiler, or is liberated therein, is brought into intimate contact with a large number of fine streams or films of fresh feed water whereby a portion of the steam is condensed and at the same time moisture particles of high solid concentration, originally entrained by the steam, are replaced by moisture particles of low solid concentration. Subsequently this moisture may be removed from the purified steam by drying means before the steam leaves the boiler. The invention also provides a novel and effective steam drying device which may, if desired, be utilized with the washer.

For an understanding of the special features and advantages that characterize the invention, reference may be had to the following description considered in connection with the accompanying drawings forming a part thereof, and in which:

Fig. 1 is a longitudinal vertical sectional view, illustrating more or less diagrammatically, a boiler steam and water drum within which is disposed steam washing and drying devices embodying the invention, taken on line 1—1 of Fig. 2;

Fig. 2 is an enlarged transverse sectional view taken substantially on line 2—2 of Fig. 1;

Fig. 3 is a partial vertical section taken on line 3—3 of Fig. 2;

Fig. 4 is a partial horizontal section taken on line 4—4 of Fig. 1;

Fig. 5 is a partial longitudinal vertical sectional view, generally similar to Fig. 1, but illustrating another form of the invention, and

Fig. 6 is a transverse vertical sectional view illustrating a further form of the invention.

Like reference characters refer to the same or to similar parts in the several views.

Referring to the drawings, particularly Figs. 1 to 4, reference character 10 designates a boiler steam and water drum of the usual construction. A plurality of steam generating tubes 11 are connected to the lower portion of the drum 10, and a group of steam circulators 12 communicate with the steam space and serve to deliver steam

to the upper portion thereof. A steam outlet nozzle 13 delivers steam from the drum to a superheater, not shown. Fresh feed water is supplied to the boiler through feed pipe 14 which enters the drum at one end at an elevation approximately midway between the normal water level and the top of the drum and extends horizontally for the major portion of the length of the drum. The feed pipe 14 is supported by U-bolts 29 which are secured to a curved baffle structure 30. The baffle 30 is spaced from the inner wall of the drum opposite the ends of the steam circulators 12 and is suitably supported by angle members 31 and 32. A straight vertically inclined portion 30' of the baffle 30 closes the space between the upper end of the baffle and the drum wall.

The steam washer in the form shown, comprises a series of adjacent elongated, deep, narrow troughs 15, closed at both ends, and constituting reservoirs, which extend transversely to the longitudinal axis of the drum at a level slightly below that of the feed pipe 14. The trough assembly spans substantially the entire steam space excepting for the free areas required to allow the manhole doors 16 and 17, at each end of the drum, to open. As shown, the individual troughs are made of light sheet steel or other suitable material, and a number of troughs are secured together in spaced relationship by suitable means to provide groups of troughs, the width of each of which is such that it can readily be inserted or removed from the drum through either manhole. Each group of troughs, as clearly shown in Fig. 3, is bound by a plurality of spaced straps 18 and the spacing of the troughs and the side walls of each trough are maintained in their proper relationships by spacers 19 and 19' respectively, through which pass pins or rods 20, the ends of which pass through openings in the upper ends of the straps and which are upset to provide heads 21 and 22 to secure the several parts together. The trough groups are supported in a horizontal position at their ends by angle 24 fixed to spaced brackets 25 which are secured to the inner wall of the shell 10, and by movable angle sections 26 each of which may support one or more groups of troughs. Each angle section 26 is supported from a bracket 54 secured to the inner wall of the drum by means of links 50 and 51 at opposite ends of each section 26. Link 50 is fixed at one end to the section 26 and is pivotally connected at its other end to the bracket 54 by a pin 55. Link 51 is pivotally connected at its upper end

to a lug on the bottom of the section by pin 57 and at its lower end to bracket 54 by a removable or axially movable pin 56. The arrangement is such that to remove a trough group from the drum for repair or cleaning, it is only necessary to move or remove pin 56 to permit the lower end of link 51 to swing freely of bracket 54 which will allow the corresponding angle section 26 to swing about pin 55 and move downwardly, thus freeing the trough group which can then be removed through a manhole.

The feed pipe 14 is provided with a plurality of spaced, downwardly extending nozzles 27, each of which extends into a trough to a point near the bottom thereof and by means of which fresh feed water is introduced into the lower portion of each trough. In the sides of the troughs and adjacent the top edges thereof are a plurality of small, closely spaced holes 28. The feed water flowing through the nozzles 27 into the troughs 15, fills the troughs to the level of the holes 28, through which the water overflows and passes downwardly over the outer surfaces of the sides of each trough and through the slots or passages 23 between adjacent troughs in a large number of fine films or streams. The holes 28 serve to distribute the water flowing from the troughs along the outer walls thereof. Non-circular holes may be utilized for this purpose, or notches in the upper walls of the troughs will be effective for the purpose. In this manner a wetted surface is provided on each side of each passage between adjacent troughs, and these surfaces, which in the aggregate represent a relatively large area, are maintained at a temperature lower than the temperature of the steam liberated in the drum since the fresh feed water is ordinarily introduced at a temperature lower than the boiling point or saturation temperature of the water in the boiler.

In the form shown, a louvre grating 33, as shown in Figs. 1 and 2, is positioned below the surface of the body of circulating water in the drum. This grating consists of a series of inclined, spaced, parallel metal strips, extending across the drum and held in position by slotted members 34 and 35 which may be supported on the inner wall of the drum in any suitable manner. The upper edge of each strip overlaps the lower edge of an adjacent strip, so that saturated steam released below the water line, instead of bubbling up vertically through the water to the steam space, will hug the lower surfaces of the metal strips, and must move at an angle to the vertical before leaving the surface of the water. This reduces turbulence at the water line and thereby minimizes the amount of entrained water carried into the steam space and to the washing troughs by the released steam.

Saturated steam entering the drum 10 through the steam circulators 12 is directed downwardly between the wall of the drum and the baffle 30 to the steam space 36 below the troughs. Here, this steam joins with the steam liberated from the surface of the circulating water and flows upwardly through the narrow passages 23 between the troughs 15. Since, as already mentioned, the aggregate superficial area of all the troughs is quite large, a considerable amount of the steam passing therebetween will be condensed on the wetted and cooled trough surfaces. This condensed steam will increase the thickness of the water films on the trough surfaces by

enhancing the films formed by the fresh feed water spilling through the holes 28. The combined feed water and condensed steam films will drip off the lowermost portions of the trough surfaces in sheets or droplets. These droplets provide additional water surface for contacting the steam, and the steam passing upwardly between these water sheets or droplets, and thereafter between the wetted surfaces of the troughs, will have a large proportion of its originally entrained and suspended moisture washed out. Since the suspended moisture in the steam before it comes in contact with the fresh feed water and condensate is boiler water of high solid concentration, the washing process will reduce this concentration. Although the steam picks up moisture particles by its contact with the fresh feed water and condensate, the moisture so picked up will be relatively pure and free of dissolved solids. Any portion of this re-entrained moisture which is not finally removed in the steam drying device presently to be described, will be evaporated in the superheater, so that a very small percentage of contaminating solids will be found in the superheated steam.

The steam thus purified by the washing operation described enters a secondary steam space 37 in the drum above the troughs 15 and flows, in the form shown, in a generally upward direction therein to a steam drier 38, comprising a series of spaced and interrelated S-shaped baffles 39, as clearly illustrated in Fig. 4. These baffles are closely spaced and so arranged that their adjacent ends overlap forming a series of restricted S-shaped flow paths. Upper and lower plates 40 and 41 respectively, support the baffles and form a rectangular casing therefor. The joints between the upper and lower edges of the baffles 39 and the plates 40 and 41 are made tight by means of through bolts 42. The steam, from which a portion of the re-entrained moisture will have been eliminated by gravity in the steam space 37, enters the drier at one side (left hand side as viewed in Fig. 2) along the length of the drier, and flows in a plurality of streams through the restricted paths, each of which comprises two reverse 180° turns. The greater part of the remaining moisture is removed from the steam as it flows through the drier both by centrifugal force, due to the abrupt changes in direction of flow, and by friction from contact of the steam with the inner surface of the baffle walls. The moisture so removed drains through holes 43 in the lower plate 41 located at the bottom of each bend in the baffles 39 into a chamber 44 below the plate 41 from which it flows through drain pipe 45 to the circulating water in the lower portion of the drum. Chamber 44 may be enclosed by suitably arranged plates or the like so that it is separated from the steam space of the drum 10 and from the drier excepting for the drain holes 41. The steam after leaving the S-shaped passages, flows upwardly through space 46 to a dry steam collecting space 47 above the drier which is in direct communication with steam outlet nozzle 13. The washer and drier assemblies are enclosed between end plates 48 and 49, which are secured to the inner wall of the drum by angles 52 and 53, as a result of the use of which, all the steam that is delivered to the drum or liberated therein is forced to pass through both the washer and drier before leaving the boiler drum.

The velocity of the steam flowing between the

washer troughs 15 may be controlled by varying the number of troughs and their spacing, and the velocity of the steam approaching the troughs may be controlled by properly determining the distance of the troughs above the normal drum water level.

In the form of the invention illustrated in Fig. 5 which is generally similar to the form shown in Figs. 1 to 4, means are provided whereby the louvre grating 33 may be replaced by an assembly which includes additional surface to be wetted by the combined feed water and condensed steam dripping from the washer troughs. This additional surface, in the form shown, is provided by a series of spaced plates 60 each of which is disposed below and in alignment with a washing trough 15, and welded thereto so that drips from the troughs will wet both surfaces of the plates. The lower portion 61 of each plate 60 is bent so that the bent portions are inclined to the vertical and overlap in a vertical direction to form a series of louvres which are normally submerged below the level of the circulating water, and serve to minimize turbulence or geysering as already described, and to distribute the steam bubbles throughout the steam liberating water surface. The troughs 15 are grouped and uniformly spaced by rods 62 and pipe spacers 63.

With this arrangement, the steam bubbling out of the body of water in the drum passes through three zones. First, through a layer of water adjacent the water surface which is purer than the rest of the boiler water due to the fact that fresh water is constantly diluting the surface layer so that steam passing through this layer progressively meets purer and purer water before entering the steam space immediately thereabove. Second, after joining with the steam delivered to the steam space by the steam circulators 12, as shown in Fig. 2, the steam flows between, and parallel with the plates 60 which are wetted by the drippings from the troughs, and so comes in contact with still purer water. Third, the steam passes to the main washing section formed by the troughs 15 where it meets the purest water and comes intimately in contact therewith because of the narrow steam passages between the troughs. It will be seen that the lower bent or hook portions 61 provide means for retarding the flow of feed water from the troughs into the boiler water since the louvres formed by the lower portions of the plates 60 force the mixture of feed water and condensate from the washing section to change its direction of flow and to flow in a direction substantially parallel to the surface of the boiler water before mingling with the main body thereof below the surface. The plates 60 or their bent lower portions 61, or both, may or may not, be perforated as desired.

In Fig. 6 the troughs 15 are shown as extending longitudinally of the drum, with the assembly arranged at an angle to the horizontal with one side of the assembly supported at a point just above the water level in the drum, and with the other side supported at a higher elevation. This arrangement provides a somewhat larger steam space than is provided in the other forms, for the mingling of the steam liberated from the water in the drum and the steam delivered to the drum by the steam circulators. After leaving the trough assembly, the steam enters a drying device 64, which as shown, consists of spaced groups of parallel, vertical wire mesh screens 65 which remove the moisture from the steam that was not eliminated by gravity in the upper steam space

37 between the troughs and the drier. In the arrangement shown in Fig. 6, it will also be noted that a perforated plate 65 is positioned below the water level to prevent turbulence, and to provide adequate distribution of the steam bubbles instead of the louvre grating heretofore disclosed. One or more of these perforated plates may be employed with other forms of washers and driers, if desired.

It will be understood that a steam washer embodying the invention, may be used alone, or in conjunction with a steam drier either of a form herein disclosed or of any other form. Additionally, the washer may be utilized with or without a louvre grating. The invention is not limited to the particular forms herein disclosed, since these are merely preferred forms, and changes may be made in the form, location and relative arrangement of the several parts of the washer or drier or both, within the principles of the invention. Accordingly, the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A steam washer comprising a drum, a plurality of reservoirs in the drum, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, a water supply pipe having at least a portion in the drum and extending transversely of the reservoirs, a conduit extending from said pipe into each reservoir to supply water to each reservoir in such quantity that the water flows from the reservoirs into the spaces therebetween, and means causing steam to flow through said passages in contact with water from the reservoirs.

2. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, means causing steam to flow through said passages in contact with water from the reservoirs, and means below the reservoirs and beneath the normal water level in the drum to reduce the quantity of water entrained in the steam liberated in the water in the drum.

3. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, means causing steam to flow through said passages in contact with water from the reservoirs, and means comprising a plurality of spaced, substantially parallel and inclined members disposed below the reservoirs and beneath the normal water level in the drum to reduce the quantity of water entrained in the steam liberated in the water in the drum.

4. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reser-

voirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, means causing steam to flow through said passages in contact with water from the reservoirs, and means comprising a plurality of spaced, substantially parallel and inclined members disposed below the reservoirs and beneath the normal water level in the drum to reduce the quantity of water entrained in the steam liberated in the water in the drum, said members being secured to the reservoirs.

5. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, means causing steam to flow through said passages in contact with water from the reservoirs, and spaced, plate-like members extending from the lower portion of the reservoirs to points below the normal water level in the drum, the lower end portions of said members being inclined to the vertical.

6. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, means causing steam to flow through said passages in contact with water from the reservoirs, and means comprising a perforated plate disposed below the reservoirs and beneath the normal water level in the drum to reduce the quantity of water entrained in the steam liberated in the water in the drum.

7. A steam washer comprising a drum, a plurality of reservoirs in the drum, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, the reservoirs being located to provide a group of reservoirs which is inclined to the horizontal, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween, and means causing steam to flow through said passages in contact with water from the reservoirs.

8. A steam washer comprising a drum, a plurality of reservoirs in the drum adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow pas-

sages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween and down said side walls, means for introducing steam into the drum, and means causing the steam to flow into the region immediately below said reservoirs, the arrangement being such that the steam flows upwardly through said passages counter-current to and in contact with the water from said reservoirs and thereby is washed.

9. A steam washer comprising a drum, a plurality of reservoirs in the drum adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween and down said side walls, the reservoirs having means for distributing the water along said side walls as it flows from the reservoirs, means for introducing steam into the drum, and means causing the steam to flow into the region immediately below said reservoirs, the arrangement being such that the steam flows upwardly through said passages counter-current to and in contact with the water from said reservoirs and thereby is washed.

10. A steam washer comprising a drum, a plurality of reservoirs in the drum adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween and down said side walls, the reservoirs having spaced apertures in the side walls adjacent the upper edges thereof through which water flows from the reservoirs into said passages, means for introducing steam into the drum, and means causing the steam to flow into the region immediately below said reservoirs, the arrangement being such that the steam flows upwardly through said passages counter-current to and in contact with the water from said reservoirs and thereby is washed.

11. A steam washer comprising a steam and water drum, a plurality of reservoirs in the drum above the normal water level therein, the reservoirs being adjacently disposed laterally of each other and having substantially parallel side walls with adjacent side walls spaced to provide relatively narrow passages between the reservoirs, means for supplying water to the reservoirs in such quantity that the water flows from the reservoirs into the spaces therebetween and down said side walls, means for introducing steam into the drum, and means causing the steam to flow into the region between said water level and said reservoirs, the arrangement being such that the steam flows upwardly through said passages counter-current to and in contact with the water from said reservoirs and thereby is washed.

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