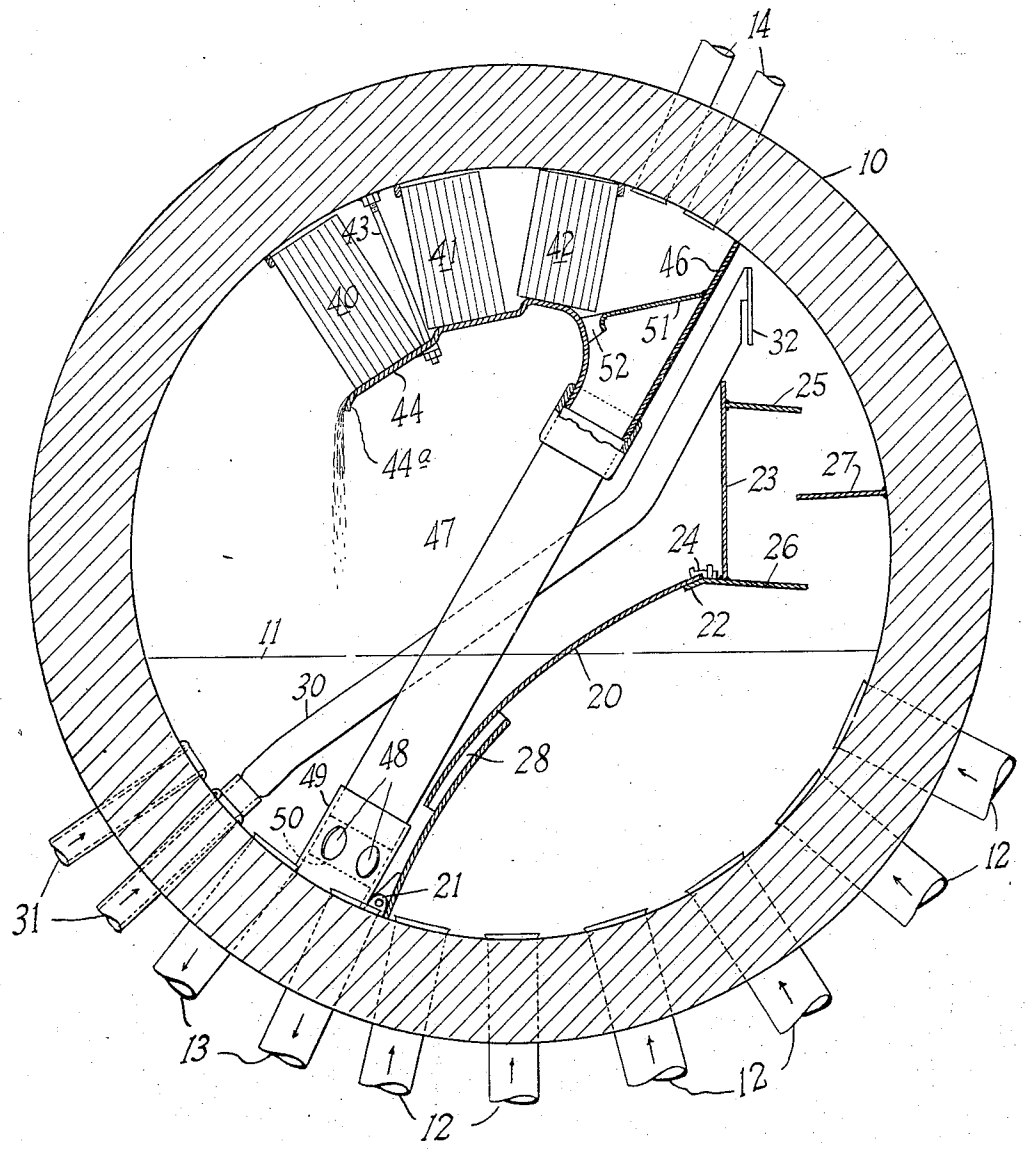
Sept. 16, 1941. J. C. HOBBS 2,256,115

SEPARATOR

Filed Dec. 4, 1937 4 Sheets-Sheet 1

Fig. 1



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James C. Hobbs

BY

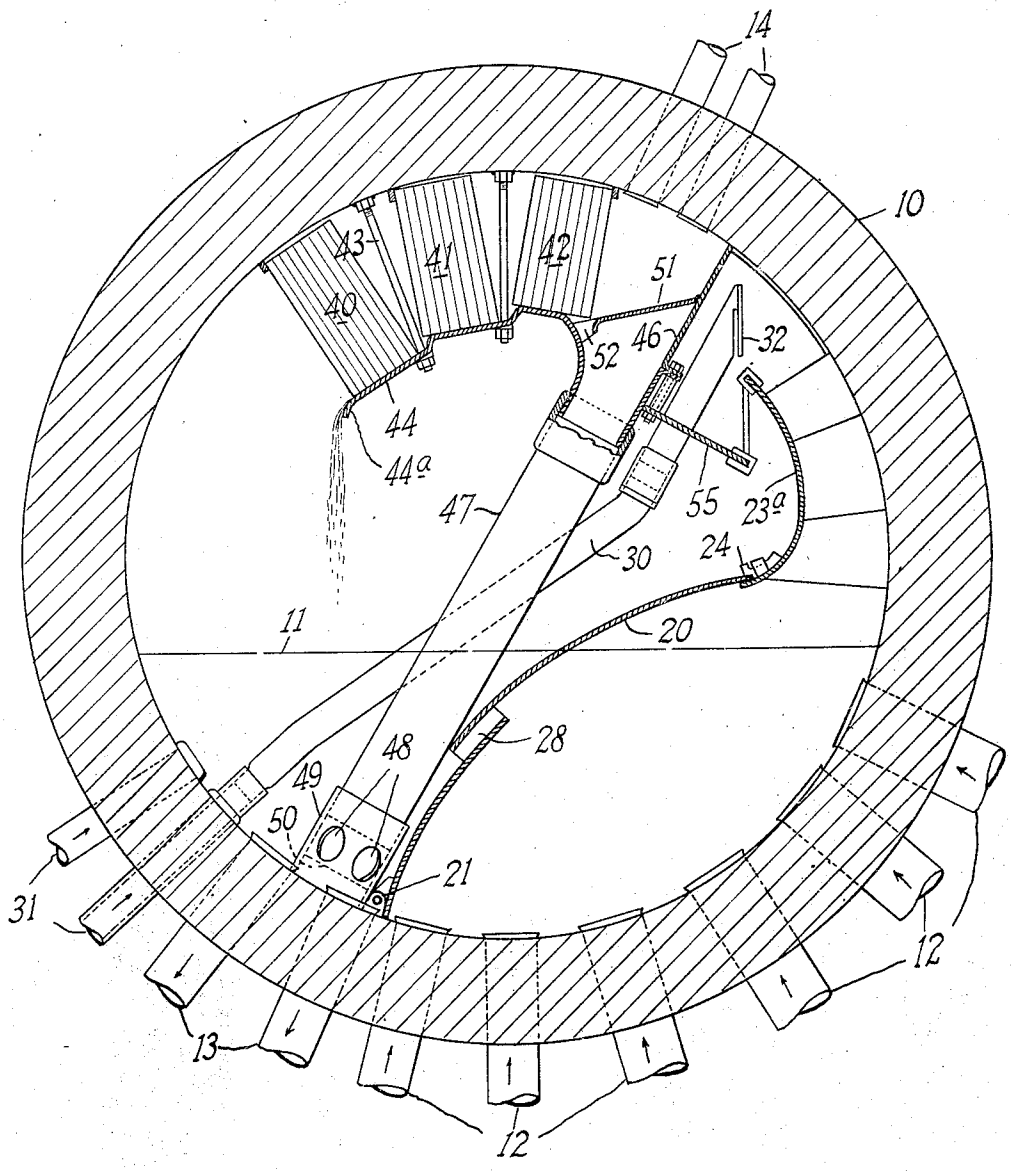
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Fig. 2



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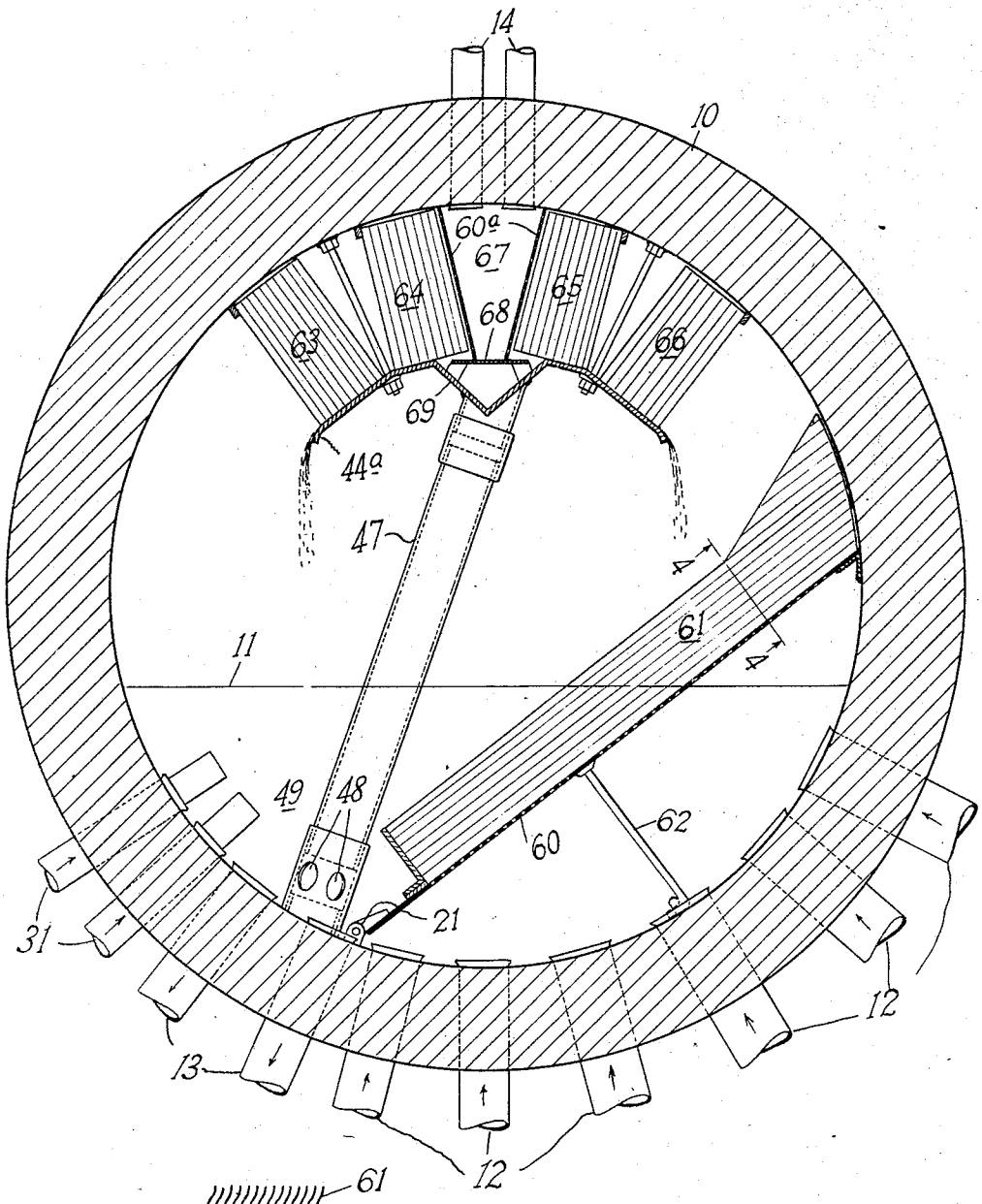
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Fig. 3



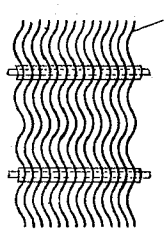


Fig. 4

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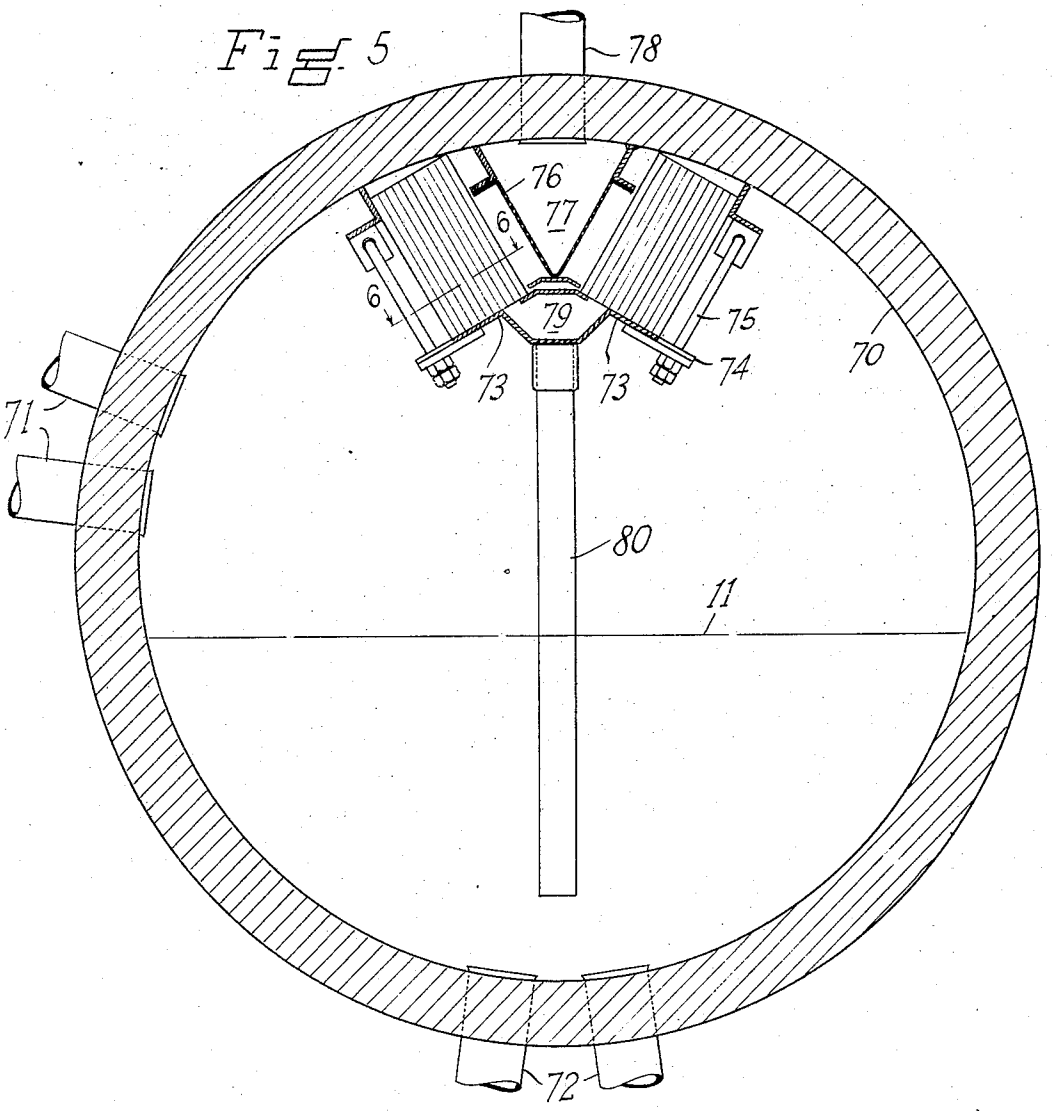
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SEPARATOR

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Fig. 5



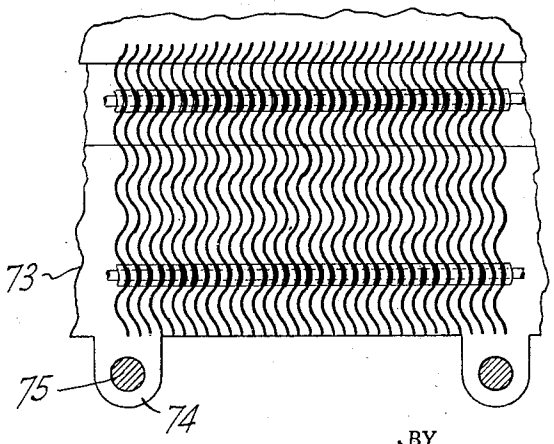


Fig. 6

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UNITED STATES PATENT OFFICE

2,256,115

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Application December 4, 1937, Serial No. 178,164

12 Claims. (Cl. 122—491)

The present invention relates in general to the construction and operation of gas washing and separating apparatus and more particularly to apparatus of this type which is adapted to be incorporated in the steam and water drum of a high pressure steam generating unit for washing and/or separating moisture from the steam generated.

The main object of the invention is the provision of apparatus of the type described which is capable of effectively eliminating the moisture from the steam generated in a high pressure high capacity steam generating unit while maintaining relatively quiescent water level conditions in the steam and water drum. A further and more specific object is the provision of moisture separating apparatus of the above type which is further characterized by a uniform distribution of the separating load throughout the separator surface, its ease of installation, accessibility of the associated tube connections, low pressure drop and velocity flow through the separating parts, compactness, and simplicity of construction. Another specific object is the provision of gas washing apparatus of the type described which is further characterized by the passage of the vapor being treated in successive effective washing contacts with the washing liquid and by its effective arrangement relative to the associated separating apparatus.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illusrrated and described various embodiments of my invention.

Of the drawings:

Fig. 1 is a somewhat diagrammatic sectional elevation of a high pressure steam and water drum having steam washing and separating provisions constructed and arranged according to my invention;

Fig. 2 is a view similar to Fig. 1 illustrating a modified construction;

Fig. 3 is a view similar to Figs. 1 and 2 illustrating a second modification;

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3;

Fig. 5 is a view similar to Figs. 1, 2 and 3, illustrating a third modification; and

Fig. 6 is a transverse section taken on the line 6—6 of Fig. 5.

In Fig. 1 I have illustrated a relatively small diameter thick walled drum 10 as constructed for the steam and water drum of a high capacity high pressure steam generating unit, the normal water level in the drum being indicated by the broken line 11. The drum receives the discharge from a multiplicity of steam generating tubes 12 opening through the drum wall along the length of and below the normal water level in the drum. Submerged downcomer tubes 13 are also radially connected to the bottom of the drum at one side of the tubes 12. Steam outlet tubes 14 open to the upper part of the steam space of the drum.

The drum includes provisions for successively effecting a primary separation of the steam and water, washing of the steam, and a secondary separation of the moisture from the washed steam. The primary separating provisions include a transversely curved baffle 20 extending from the bottom of the drum between the riser tubes 12 and downcomers 13 to a point above the normal water level. The baffle 20 is divided into sections longitudinally of the drum, each section having its lower end hinged to the drum wall, as indicated at 21, and its upper end clamped to a horizontal extension 22 of a longitudinally extending vertical baffle plate or partition 23, as indicated at 24. The baffle plate 23 is suitably supported in the position shown and provided with upper and lower laterally extending plates 25 and 26 sloping towards the adjacent portion of the drum wall. An inwardly sloping plate 27 extends from the drum wall towards and intermediate the plates 25 and 26 and provides a sinuous flow path for the ascending wet steam between the baffle plate 23 and the drum wall. The space enclosed by the baffles 20 and 23 extends the full length of the portion of the drum to which the tubes 12 and 13 are connected and may be wholly or partly closed at its ends. A submerged portion of each curved baffle section 20 is of double walled construction to form a passage 28 therein opening to the remaining portion of the drum water space.

The described arrangement and construction of the plates 23, 25, 26, and 27 is advantageous for washing the ascending wet steam. For this purpose pipes 30 are connected to some or all of the discharge ends of a group of economizer tubes 31 entering the drum adjacent the downcomer tubes 13. Each pipe 30 extends upwardly into the steam space of the drum to a slotted

discharge end 32 above the plate 25 and directs a sheet of feed water onto the plate 25 from which it cascades onto the plates 27 and 26 before reaching the body of water in the drum.

With the described baffle arrangement, the mixture of steam and water discharged by the tubes 12 passes across the water space of the drum and impinges against the baffle plate 20 whereby the fluid jets are broken up, facilitating the separation of the steam bubbles, and the discharge distributed over the water surface area in the chamber. The steam then passes upwardly through the sinuous passage between the baffle 23 and the drum wall, and in this zone is subjected to successive washing actions by the cascading sheet of wash water and passes over the upper end of the baffle 23 into the portion of the steam space therebeyond.

In this section of the steam space the steam is subjected to a secondary separating action. The secondary separation is formed by a plurality of spaced sections 40, 41 and 42, each of which has a multiplicity of uniformly curved corrugated metal plates spaced as indicated in Fig. 6 to form a multiplicity of parallel narrow sinuous passages therebetween through which the steam flows, the moisture carried thereby being collected on the plates and flowing downwardly along the corrugations. The arrangement of the corrugated separating surface in three spaced sections provides flow equalization spaces therebetween and interrupts the plate surfaces, thereby assisting in the drainage of the sections by preventing separated moisture from being swept along the corrugated surfaces beyond a single section. The separator sections 40, 41, and 42 are arranged along the top of the drum with their upper ends substantially in contact with the drum wall and are supported from the drum wall by hangers 43 carrying a common bottom plate 44.

As shown, the section 40 and the corresponding portion of the bottom plate 44 have a greater inclination than the section 41, while the section 42 is slightly inclined oppositely to the section 41. The flow area through the separator sections is relatively large to permit a low steam velocity therethrough and a pressure drop low enough to allow the separated moisture to flow downwardly along the bottom plate 44 against the steam flow. At its steam inlet end the bottom plate 44 has a downwardly curved lip 44a which causes the steam flowing past the underside of the plate to exert a wiping entrainment or ejector effect on the moisture flowing over the lip, particularly at high water levels in the drum. The corrugated plates in the separator sections 41 and 42 are preferably more closely spaced than those in the section 40, since most of the solids in suspension in the steam will be separated in the section 40, permitting narrower steam passages to be used in the other sections.

The separator section 42 is located adjacent the ends of the steam outlet pipes 14. All of the steam leaving the drum is caused to flow successively through the separator sections 40, 41 and 42 by means of plates (not shown) closing the ends of the space between the bottom plate and the drum wall, the bottom plate 44 and a side plate 46 extending downwardly from the drum wall at the opposite side of the pipes 14 from the separator sections. Drain pipes 47 are detachably connected to the space below the steam outlet pipe connections and extend downwardly adjacent the baffle 20 towards the bottom of the drum. Openings 48 are provided in a sleeve 49 extending between the lower end of each pipe 47 and a nipple 50 welded to the drum wall for the discharge of separated water into the water space. A sloping plate 51 extends between the side plate 46 and bottom plate 44 adjacent the separator section 42 to separate the steam flow space from the drain connections. Openings 52 are formed in the lower end of the plate 51 for the passage of moisture separated in the section 42 and in the space above the plate 51 to the drain pipes 47.

The construction shown in Fig. 2 employs a modified steam washing construction having a parallel flow of the steam and the wash water in contrast to the contra-flow arrangement of Fig. 1. In the Fig. 2 construction, the baffle members 25, 26, and 27 are omitted and the baffle plate 23a curved and supported from the drum wall. A sloping baffle plate 55 extends from the outer side of the plate 46 to a point below the upper end of the baffle 23a. The washing pipes 30 extend through the baffle 55 with their upper slotted ends above the upper end of the baffle 23a. With this arrangement the wash water is discharged onto the baffle 55 from which it drops onto the baffle 20. The wet steam is forced to pass successively through the descending wash water to reach the remaining portion of the steam space.

In the modified construction illustrated in Figs. 3 and 4, the steam washing provisions are omitted and different primary and secondary separators employed. The primary separator section is formed by an inclined corrugated separator section 61 extending between spaced portions of the drum wall and over the discharge end of the tubes 12. At its upper end the section has a progressively increasing amount of corrugated surface, as shown in Fig. 3, while its lower portion is normally submerged. A uniform distribution of the generating tube discharge to the separator channels is effected by the location of a perforated diffusion plate 60 along and substantially in contact with the lower edges of the corrugated plates. Rods 62 aid in supporting the plate 60 and separator section 61. With this construction all of the steam discharged by the tubes 12 is caused to pass through the narrow sinuous passages between the plates of the separator section 61, breaking up the fluid jets and initially separating some of the entrained moisture. The passage of the wet steam through the separator 61 instead of over the top of a baffle or partition in the steam space decreases the circulation head required.

In Fig. 3 the corrugated secondary separator sections 63, 64, 65, 66 are arranged in a symmetrical twin formation along the top of the drum with a common steam collecting chamber 67 therebetween to which the outlet pipes 14 are connected. Plates 68 are supported in spaced relation from the V-shaped plate 69 forming the bottom of the chamber 67 above each drain pipe 47 to avoid the exiting steam picking up separated moisture flowing to the drain connection. Perforated plates 60a are arranged along the outlet side of the sections 64 and 65 to create a flow resistance providing a substantially uniform steam flow through the channels of the corresponding section.

In Figs. 5 and 6, some of the present improvements are incorporated in a twin type corru-

gated plate separator. The separator is arranged in the steam and water drum 70 of a B. & W. cross drum boiler having circulator tubes 71 entering along the side of the drum above the normal water level and downcomer tubes 72. A back flow of a substantial portion of the separated moisture is provided by extending the inclined bottom plate 73 along a major portion of the bottom of each separator section and lowering the pressure drop and steam velocity through the sections by avoiding any flow restriction at the inlet side of the separator sections. For this purpose the bottom plates 73 terminate at the outer edge of the corrugated plates except for short extensions 74 to which hanger bolts 75 are connected. A V-shaped perforated plate structure 76 surrounds the common steam collecting space 77 to which steam outlet pipes 78 open. The bottom plates 73 are oppositely inclined below the inner ends of the sections to form a moisture collecting space 79 to which the drain pipes 80 open.

With this arrangement the separated moisture reaching the bottom of a major portion of the corrugations will flow back along the bottom plates 73 and over the inlet edge of the plates 73, while the remaining portion of the separated moisture flows into the chamber 79 to the drain pipes 80.

In all of the corrugated separator sections described, substantially all of the corrugated plate surface is utilized for moisture separation under steam flow conditions highly suitable for moisture separation and drainage. The described construction and location of the drum internal parts facilitate their installation and provide easy access to the tubes entering the drum.

While in accordance with the provisions of the statutes I have illustrated and described herein the best forms of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, a steam and water separator in said steam space comprising a multiplicity of side-by-side inclined corrugated moisture collecting plates arranged to form unobstructed narrow channels therebetween having an unobstructed inlet thereto and a substantially uniform flow area throughout their extent, an inclined bottom plate arranged to close the bottom of said channels for at least a major portion of their length, means forming a moisture collecting chamber opening to the remaining portion of said channels, and continuously closed drain pipes connected to said collecting chamber and having their lower ends submerged in and opening to said water space.

2. In combination, a horizontally elongated steam and water drum having a water space and a steam space, a steam outlet from said steam space, a steam and water separator in said steam space comprising a plurality of inclined separator sections, each having a multiplicity of side-by-side corrugated moisture collecting plates arranged to form unobstructed narrow channels therebetween, each of said sections having an unobstructed inlet thereto and a substantially uniform flow area throughout its extent and an inclined stepped bottom plate arranged to close the bottom of said channels for at least a major portion of their length, means forming a moisture collecting chamber opening to the remaining portion of said channels, and continuous drain pipes connected to said collecting chamber and having their lower ends submerged in and opening to said water space.

3. In combination, a horizontally elongated steam and water drum having a water space and a steam space, a steam outlet from said steam space, a steam and water separator in said steam space comprising a plurality of oppositely inclined separator sections, each having a multiplicity of side-by-side corrugated moisture collecting plates arranged to form unobstructed narrow channels therebetween, each of said sections having an unobstructed inlet thereto and a substantially uniform flow area throughout its extent and an inclined bottom plate arranged to close the bottom of said channels for at least a major portion of their length, means forming a moisture collecting chamber opening to the remaining portion of said channels, and continuously closed drain pipes connected to said collecting chamber and having their lower ends submerged in and opening to said water space.

4. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, a steam and water separator comprising a plurality of inclined separator sections arranged for a steam flow serially therethrough, each having a multiplicity of side-by-side corrugated moisture collecting plates arranged to form narrow channels therebetween, said sections having an inclined stepped bottom plate arranged to close the bottom of said channels, and a downwardly curved lip at the lower end of said bottom plate extending into the path of steam flow to the inlet end of said channels.

5. In combination, a horizontally elongated steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes opening into said water space along the length of said drum, a submerged impingement baffle extending upwardly over the discharge ends of said generating tubes, a baffle forming a continuation in the steam space of said impingement baffle and defining a steam flow space along one side of said drum, and means for passing the steam ascending through said steam flow space in successive washing contacts with a washing liquid.

6. In combination, a horizontally elongated steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space along the length of said drum, a submerged impingement baffle extending upwardly over the discharge ends of said generating tubes, a baffle forming a continuation in the steam space of said impingement baffle and defining a steam flow space along one side of said drum, means for passing the steam while ascending through said steam flow space in successive washing contacts with a descending washing liquid, and means for separating moisture from the washed steam.

7. In combination, a horizontally elongated steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space along the length of said drum, a submerged impingement

baffle extending upwardly over the discharge ends of said generating tubes, a baffle forming a continuation in the steam space of said impingement baffle and defining a steam flow space along one side of said drum, means for passing the steam after ascending through said steam flow space in successive washing contacts with a washing liquid, and means for separating moisture from the washed steam.

8. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space, and a group of side-by-side corrugated plates in said water space arranged to form narrow sinuous channels therebetween extending across the discharge ends of said generating tubes.

9. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space, a group of side-by-side corrugated plates in said water space arranged to form narrow sinuous channels therebetween extending across the discharge ends of said generating tubes, a second group of side-by-side corrugated plates in the upper part of said steam space arranged to form narrow sinuous channels therebetween, and means for directing the steam through the channels of said second group before reaching said steam outlet.

10. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space, a submerged group of side-by-side plates arranged to form narrow channels therebetween extending across the discharge ends of said generating tubes, and a submerged perforated diffusion plate arranged across the lower edge of said plates and tending to uniformly distribute the discharge from said generating tubes to said channels.

11. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, steam generating tubes arranged to discharge upwardly into said water space, a submerged group of side-by-side corrugated plates arranged to form narrow sinuous channels therebetween extending across the discharge ends of said generating tubes, and a submerged perforated diffusion plate arranged across the lower edge of said corrugated plates and tending to uniformly distribute the discharge from said generating tubes to said sinuous channels.

12. In combination, a steam and water drum having a water space and a steam space, a steam outlet from said steam space, a steam and water separator in said steam space comprising a multiplicity of side-by-side inclined corrugated moisture collecting plates arranged to form unobstructed narrow channels therebetween having an unobstructed inlet thereto, an inclined bottom plate arranged to close the bottom of said channels for at least a major portion of their length and having a downwardly curved lip at its lower end extending into the path of steam flow to the inlet end of said channels, means forming a moisture collecting chamber opening to the remaining portion of said channels, and continuously closed drain pipes connected to said collecting chamber and having their lower ends submerged in and opening to said water space.

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