My invention relates to equipment for securing dry steam from mixtures of steam and water as taken from the vaporizing surfaces or tubes of steam generating boilers, and it has special reference to separator apparatus installable in the steam and water drums of such boilers to accomplish the purpose named.

In modern boilers for both marine and stationary application, the steam and water drum usually contains equipment for: (1) distributing incoming feed water; (2) separating steam from water; and (3) delivering steam with a minimum of entrainment of water or solids. The general term "drum internals" covers this class of equipment, which has assumed great importance as the rates of steam liberation have increased.

Broadly stated, the object of my invention is to improve the design, extend the usefulness and better the performance of such "drum internal" apparatus.

A more specific object is to increase the quantity of steam of acceptable dryness which may be taken from a steam and water drum of given diameter and length.

Another object is to increase the effectiveness of the steam-from-water separating portions of the drum-internal equipment.

A further object is to provide an improved separator unit which can readily be adjusted for optimum performance under a variety of conditions of steam generator operation.

A still further object is to increase the effectiveness of the dry-portions of the drum-internal equipment.

Additional objects and advantages will become apparent from the following description of illustrative embodiments of the invention, when read in conjunction with the accompanying drawings wherein:

Figure 1 is a simplified schematic representation (in the nature of a vertical section) of a steam generating installation that has a steam and water drum, equipped with the improved drum-internal apparatus herein disclosed.

Figure 2 is a transverse section of the steam and water drum of Figure 1 enlarged to show how the installed drum-internal apparatus may be constructed in accordance with one embodiment of the invention.

Figure 3 is an enlarged sectionallation of one of the separator units as described by the apparatus of Figure 2.

Figure 4 is a sectional view indicating how each separator unit of Figures 2-3 may be supplemented by a lower shroud and by a second or upper set of spinner blades.

Figure 5 is a simplified section (to reduced scale) on line 5—5 of Figure 2 showing two rows of separator units installed in the drum: and

Figure 6 is a section on line 6—6 of Figure 2 schematically showing further features of the dry-portion apparatus beneath the drum's steam offtake.

The drum-internal apparatus of my invention is especially well adapted for use on forced-circulation boilers and on natural circulation boilers with liberal circulating head; it may, moreover, advantageously be employed to obtain a high degree of steam and water separation in steam generators of a wide variety of types (marine, stationary or other) and capacities. Illustrative of these is the steam generator shown in Figure 1.

The steam generator of Figure 1.

There steam and water mixtures are discharged at high velocity into the drum 10 from vaporizing tubes 12 arranged in five rows a—b—c—d—e (see Figure 2) along the lower right portion of the drum wall; each of these five rows extends lengthwise of the drum and contains a plurality of similar tubes; the tubes in rows c—d are fed from a primary vaporizing circuit 14 constituting the side walls, floor and roof of the combustion chamber fired by burners 15: the tubes in rows 12e—b are fed from a secondary vaporizing circuit 16 positioned at a somewhat higher elevation in the boiler furnace; and the tubes in row 12e are fed from a third circuit 18 which lines the combustion chamber wall (not shown) opposite the burners 15.

The illustrative boiler furnace of Figure 1 is further provided with a forced-circulation pump 20 for passing the water from drum 10's bottom discharge outlet 21 into a main distributing header 22 and thence through the three vaporizing circuits 14, 16 and 18 earlier named; with a superheater 24 in the heating chamber through which saturated steam leaves drum 10 by way of top outlet 25 to have its temperature further raised before entering superheated steam header 26: and with an inlet water connection 28 through which boiler feed water is admitted into the drum 10 in a manner later to be described. To lay the basis for subsequent description it will be assumed that this steam generator of Figure 1 is designed to operate at pressures up to 1200 pounds per square inch and higher; also that its three vaporizing circuits 14, 16 and 18 are jointly capable of generating steam and passing same through tubes 12 into steam and water drum 10 at rates up to 200,000 pounds per hour.

As the description hereof proceeds it will be-
come apparent that my improved drum-internal apparatus may with comparable benefit also be used with steam generators of either higher or lower capacity and/or pressure and with a wide variety of other types and designs which employ natural as well as forced circulation of the boiler water being vaporized.

The steam and water drum 10

In the illustrative steam generator of Figure 1 the steam and water drum 10 has an internal diameter of 42 inches and a length (see Figures 6-8) of 10½ feet between drum ends; the steam outlet therefrom takes the form of a single pipe 25 leading out of the drum top midway (see Figure 6) of the drum length; the outlet 21 from the drum bottom takes the form of two downcomer pipes (see Figures 1 and 5) respectively leading out of the two drum ends and acting in parallel to carry the drum-leading water into pumps 20 (one or more) for circulation through header 22 and boiler vaporizing circuits 14, 15 and 18; the vaporizing circuit tubes 12 of drum-entering rows a—b—c—d—e have an inside diameter of one inch; the end man hole opening 30 into the drum has a horizontal dimension of 16 inches and a vertical dimension of 12 inches; and feed water under suitable pressure is admitted by way of connection 26 (see Figure 1) through an inlet pipe that enters the drum by way of a suitable opening (as in the rear drum end but not shown).

As the description hereof proceeds it will become apparent that the steam separator improvements of my invention are not restricted to installation in drums of the dimensions and organization just described but may with comparable benefit also be installed in steam and water drums of different dimensions, proportions and organizations.

The drum internals of Figure 2

In the illustrative embodiment of my invention shown in Figure 2 the drum 10 has installed therein: (1) feed water distributor means which include submerged pipe 32 perforated as at 33 and supplemented by water baffle 34; (2) steam-from-water separating means which take the form of centrifugal units 38 projecting upwardly out of the drum water in two lengthwise rows (see Figure 5) along the drum interior and organized to act on all steam and water mixture so that enters the drum by way of generator tubes 12; and (3) dry-pipe means 40 for distributing and further drying the steam on its way from separator units 38 to outlet pipe 25 in the drum top.

The incoming feed water from connection 28 (see Figure 1) is conveyed by pipe 28a (see Figure 2) into the midpoints of the downcomer pipe 32 which extends lengthwise through the drum's lower portion as indicated and which is co-extensive with a major portion of the drum's length. This distributor pipe 32 is closed at both ends and provided along its top with the spaced openings 33 through which incoming feed water must pass in a way assuring diffusion (aided by baffle plate 34 positioned above admission openings 33 along the entire pipe length) into the main body of the drum water submerging the pipe.

By eliminating any large particles of solid matter out of the water which leaves the drum by way of the two downcomer outlets 21, each of those outlets has positioned around its open top end a cylindrical screen 35 organized as shown in Figure 2 to require all outlet-entering water (feed from pipe 33 plus discharge from separators 38) first to pass through the screen. Other equivalent means for diffusing and mixing condensing feed water through the lower body of drum contained water and for taking the feed and discharge water out of the drum are of course useable in combination with the improved separator units 38 and dry-pipe means 40 now to be described.

The new separator units 38

Single-drum boilers (as typified by Figure 1) require very efficient and compact means to meet current demands for high capacity and steam purity. In such boilers steam and water mixture entering the drum from tubes 12 may consist of two to ten parts of water to one part of steam by weight, but the steam delivered from the drum through outlet 25 preferably should contain as little as two-tenths of one per cent of moisture.

To provide steam of such dryness the units 38 of Figure 2 are novelty organized to accomplish separation in three stages. In the first two of these, use is made of centrifugal force and in the third use is made of combined centrifugal force and low velocity drying.

As illustratively arranged in Figure 2 these new separator units 38 have upwardly passed therethrough from a compartment 42 all of the steam and water mixture that is delivered into the drum 10 by tubes 12; that compartment 42 is enclosed by partition walls 43 which are organized as shown around the ends of tubes 12 and which extend along the entire tube-entering length of the drum to divide the enclosed compartment space from the remainder of the drum interior; and seven separator units 38 constituting a right row are mounted along horizontal compartment walls 43a while six other similar units 38 constituting a left row are supported in similar upright position through supply pipes 44 which connect into vertical compartment wall 43b.

It will be obvious that either a lesser or a greater number of units 38 are usable depending upon the size and quantity of steam to be separated and that arrangement in less or more than two rows is possible; in fact only a single unit may be found adequate in certain situations.

As here illustratively shown by Figures 2 and 3 each of the units 38 comprises an upright pipe or tube 46 (four inches in diameter here) connected with compartment 42 at its bottom and flared outwardly at its top into the radial flange represented; a spinner 47 adjustably positioned in the lower portion of each tube 46; a circular baffle plate 48 supported above tube 46's top flange in spaced relation therefrom through bolts and spacers 49—50 (three or more around the plate circumference) and having the downwardly sloping outer edge shown; a reduced diameter (3½ inches here) sleeve or tube 52 supported (as by welding) from baffle plate 48 above but in which all incoming feed water is provided with outflow slots 51 spaced around its upper edge in the general manner shown; a flat disc-like member 55 secured (as by welding) to the top of sleeve 52 and deriving support therefrom while being open at its center; a plate 58 positioned on top of disc 55 and also open at its center; a second sleeve 62 of further reduced diameter (three inches here) extending downwardly from plate 58 into the first sleeve 52 with
an inwardly flaring lower edge related to the first sleeve's outflow water slots 51 in the manner shown by Figure 3; an upper plate 56 supported above lower plate 55 in spaced relation thereto through bolts and spacers 59-66 (three or more around the plate circumference); one or more (three shown here) consecutively spaced screens 64 encircling the structure formed by spaced plates 55 and 56 and there supported in part from disc member 55 and in remaining part as indicated; a flared conical fitting 54 attached to the bottom of upper plate 56 (as by the represented stud bolts); and a central rod 53 attached at its threaded top to conical fitting 54 by adjustable clamp nuts 55 and extending downwardly through sleeve 52 for attachment of its lower end (through threading or otherwise) into spinner 47 for support of same at a selected vertical position within upright tube 46.

The thus constructed unit 36 of Figures 2 and 3 has an overall height (bottom of tube 46 to top of plate 56) of approximately 18 inches and a diameter for the outer circular screen 64 of approximately 12 inches. Other dimensions and spacings have the proportional relation indicated. As the description proceeds it will become apparent that other equivalent mechanical constructions are readily possible and that the unit itself may be made either larger or smaller depending upon available drum space and steam separating requirements.

**Operation of new separator**

During normal operation of the steam generator of Figure 1 the water level in drum 16 stays close to the drum's center line as indicated at 66 in Figure 2; and under such conditions the top edge of upright tube 46 in each separator unit 36 is several inches above the drum water line while higher parts of the unit (as screens 64) are even further above the water level. The steam and water mixture entering the separator unit 36 from compartment 42 is preferably passed through a perforated plate 61 suitably positioned in that compartment (see Figure 2) to prevent impact of steam-water mixture from evaporator tubes to cause the inlet connections to the separator units 36.

Steam and water mixture passing from compartment 42 upwardly through the tube 46 of each unit 36 is whirled by spinner 47 so that upon reaching the tube top the mixture rapidly swirls around the tube interior. The water content of the mixture has a density from four to twenty or more times as great as the steam content, depending upon the mixture pressure; hence the heavier water thus acted upon by centrifugal force due to the whirling is concentrated near the wall of upright tube 46 while the lighter steam is concentrated toward the tube center. Reduced diameter sleeve 52 (projecting down into the flaring top of tube 46) conducts this central concentration of steam directly up through the sleeve and at the same time allows the water concentra tion of whirling water to pass outside of the sleeve and radially beneath baffle plate 48 into the drum space (above water level 65) surrounding unit 33, this outflowing water being directed into the main body of drum water by baffle 48's down-turned brim.

By proper proportion of the annular water-discharge space 70 (see Figure 3) around the lower edge of sleeve 52 relative to the total passage area for whirling steam and water mixture inside the upright tube 46, a major portion of the total water will in this "first" stage of separation be skimmed off from the steam and discharged from the unit 36 through space 70 beneath baffle 48; the central stream of thus partially dried steam (which still contains a small amount of entrained moisture) will thereupon continue upwardly through first sleeve 52 for subjection to the "second" stage of separating action.

In the illustrative unit 36 of Figures 2-3 said "second" stage of separation occurs at outflow slots 51 around the top of first sleeve 52 where the second sleeve 52 projects downwardly therewithin with the small annular spacing shown. The steam and moisture mixture within sleeve 52 continues to whirl during its upward passage through due to the rotary motion earlier imparted to the mixture by spinner 47 in tube 46. Result is that the heavier moisture content of that mixture is thrown outwardly against the wall of sleeve 52, leaving the steam content concentrated at the sleeve's central portion. In progressing out of the sleeve 52 the further dried steam thus moves upwardly through second sleeve 62 while the wall concentrated-moisture is skimmed therefrom and passes through slots 51 by way of path 11 out of the separator unit 36; this further outflowing water receiving downward direction toward the main body of drum water from impingement with plate 65 and then draining over the down-turned edge of baffle 48 there beneath. Provision of some mechanical support for plate 65 other (not shown) than the slot-spacing wall sections of sleeve 52 will enable that sleeve to be terminated at the lower edge of slots 51 thereby giving outflow passage 71 an unobstructed opening.

The "third" stage of separation by unit 36 takes place in the uppermost compartment and in the circular screens 64. The now nearly dried steam entering this upper compartment through sleeve 52 (in lower plate 55) still retains some of its earlier whirling motion. By that motion steam is urged in radial flow outwardly toward screens 64, which flow is augmented by the flaring shape of conical fitting 54 and by the pressure within unit 36, incident to such radial flow, entrained moisture still in the mixture is advanced toward the outer edge of lower plate 53, from which edge such moisture drops downwardly into the main body of drum water.

The circular screens 64 complete the "third stage" drying by removal of any remaining moisture in the mixture. Such removal is produced by adherence to the screen wires of the moisture particles and foam film. These form into water drops which flow down the screen sides and drop therefrom (over the outer edge of lower plate 65) into the main body of drum water there beneath.

The steam finally emerging from screens 64 of unit 36 thus has been successively subjected to a "first" stage of water separation at the top of upright tube 46; to a "second" stage of separation at the top of sleeve 52; and to a "third" stage of moisture separation in the screen assembly 64 between plates 55 and 56. Steam thus passed through and acted upon by each unit 36 is found to be dried to a remarkably high degree.

**The modified separator design of Figure 4**

Under certain circumstances it may be desirable that the primary spinner 47 in upright tube 46 of each separator 36 be supplemented by a second spinner such as is represented at 80 in Figure 4. There the added or second spinner 80 is positioned in sleeve 52 where it assures that the
steam and moisture mixture moving upwardly from the tube 46 through that sleeve will rotate with sufficient rapidity to provide maximum effectiveness in the "second" and "third" stages of separate at top sleeve 62 and by circular screens 64. For most applications, however, the primary spinner 47 can be designed satisfactorily to provide all requisite whirling of the steam and water mixture during its full progression through the separator unit 38.

In order to reduce foaming and otherwise improve the operation of the separator, each unit 38, such as by Figures 2-3, may with advantage likewise be provided with a shroud as represented at 82 in Figure 4. This shroud extends downwardly as shown from the outer edge of screen-supporting plate 65 to somewhat below the normal level 66 of water in the drum, as indicated by dotted line 67 in Figure 2. By thus surrounding all of the separator unit parts below the screen 64 assemblage, this added shroud 82 assures that separated water leaving the unit both at the top of tube 46 and at the top of sleeve 52 will not intermingle with the steam in the generator drum space but instead will be guided directly down into the drum water immediately beneath and around the separator unit.

Other features of separator design

As earlier indicated the mounting of units 38 inside the drum is such that the top of each upright tube 46 is normally several inches above the drum water level 66 with other unit parts (as screen assemblage 64) even further above the water line. While such relation is desirable, operating experience shows that primary separation of water from steam at the top of upright tube 46 will still be efficient even if baffle plate 48 becomes temporarily submerged due to high water level in the drum. However, base plate 58 of the top screen assemblage 64 should be located high enough in the drum so that it will not become submerged, and in the organizations here represented such requirement is amply met.

The novel separator design here shown has the further advantage of permitting a change in the proportion of discharge openings for both water and steam by the simple operation of substituting a few spacer-parts of different length. For example, the area of primary water passage 10 and the spacing of baffle plate 48 above the top flange of tube 46 may both be reduced by the simple operation of substituting shorter spacers at points 50. This changes the area of both passages named by lowering sleeve 52 with respect to upright tube 46, and serves to modify the primary water outlet to suit the operating conditions for which the boiler is designed.

The utility of this adjustment will be apparent when it is considered that the percentage of water in the drum-entering mixture on a volumetric basis is higher in a 1500 pound pressure boiler than in a 500 pound pressure boiler in the ratio of three to one, even when the weight of water in the mixture per pound of steam is the same. It is therefore an important feature of this design that the ratio between water skimming area 70 and steam inside area of tube 46 may be readily modified to suit the operating conditions.

Another advantageous feature is that the passage area leading to concentric screens 64 between plates 56 and 58 can be varied by lowering or raising the upper plate 56, and this is accomplished without any change except to substitute different length spacers at points 50. Decreasing the flow area (beneath fitting 54) into the screen structure 64 increases the pressure in the tube 46 and sleeve 52 and therefore provides a means of increasing the flow through passages 10 and 75 without making any physical change at those points.

It will accordingly be seen that the separator unit 38 of Figures 2-3-4 has novel adjustable features which permit a single standard size to be used for a wide variation of operating conditions; moreover, the unit represented as having a diameter of 12 inches for screen assemblage 64 can be fully put together with upright tube 46, spinner 47, baffle plate 48, sleeve 52, central rod 53 and all other parts outside of the drum 10 and as so fully assembled passed through the drum's standard twelve-by-sixteen inch manhole 30 for ready installation or removal as a unit. Attachment to the compartment wall 45a (right row) or to the supply pipe 44 elbow (left row) may satisfactorily be through standard screw thread connections as represented so there is very little field assembly work required.

The new dry-pipe apparatus 50

In order to distribute and further dry the steam on its way from the several separator units 39 to the single outlet pipe 25 in the top of drum 10, I additionally provide the apparatus generally indicated at 49 in Figure 2 and shown as to further detail in Figure 6. It comprises a V-shaped plate 73 positioned beneath outfit 25 and extending in either direction therefrom for substantially the entire length of the drum but with the two plate edges spaced from the drum top as indicated at 74; a pair of baffle strips 75 welded along the drum top interior as shown and further functioning as supports for V-plate 73; plate holding spacers 76 provided as intervals along the drum length to secure (as through cap screw connections) V-plate 73 (and taper strips 78) to support strips 75; a horizontal screen 77 spanning a portion of the V-plate bottom; and taper strips 78 adjustably fixed to the sides of V-plate 73 (see Figure 2) and shaped as shown in Figure 6 to give each side steam-admission space 74 a minimum dimension at the location of steam outlet 25 and a progressively widening dimension as the outlet location is departed from lengthwise of the drum.

Preferably the V-plate portion beneath screen 77 has one or more drain holes 79 passing downwardly therefrom through the plate material (see Figure 6) so that such water as may accumulate in the V-plate may be drained to a point of lower pressure.

Steam leaving the several separator units shown at 38 in Figures 2 and 5 can now pass out of the drum through outlet 25 only by way of openings 74 which direct the steam from both sides (see Figure 2) downwardly along the plate surface and against the V-plate 73 centering the V-plate in the drum's center beneath outlet 25 (where the admission openings 74 are narrowest) thereupon flows upwardly from the screen and into the outfit; steam entering the V-plate at points removed (lengthwise of the drum) from the center outfit location (where the admission openings 74 progressively widen) moves lengthwise therefrom through the V-plate space above screen 77 and in both instances any moisture still remaining in the steam tends to adhere to and drain from the main body of drum water through the openings 79 earlier mentioned.
The improved dry-pipe apparatus 40 thus not only distributes the steam in its flow from separator units 38 out of the drum by way of center outlet 25 but also effects a further separation of sand and moisture therefrom and thereby adds to the dryness of the steam thus finally leaving the drum.

Moreover, by reason of the tapered shaping of admission openings 74 (see Figures 2 and 6) the natural tendency for steam from the lengthwise-distributed separator units 38 to unduly crowd the location of central outlet 25 is minimized and the distribution efficiency of V-plate 73 beneath that outlet is thereby raised.

Performance data

The new drum-intenal apparatus herein disclosed performs exceedingly well under conditions of practical operation. One test set up for verifying this performance made use of the earlier-described steam generator of Figure 1 equipped with the 42 inch by 10% foot drum 10 of Figures 2, 5-6 having positioned therein according to the plan of Figure 5 thirteen of the separator units 38 of Figures 2-3 and being further provided with the dry-pipe apparatus 40 of Figures 2 and 6 plus the feed water and other parts shown.

The tests were made under a boiler pressure of 1200 p. a. 1. Using relatively uncontaminated water in the boiler, the thirteen separator units 38 (each 16 inches tall and 12 inches maximum diameter as earlier described) functioned so effectively that steam containing less than one-quarter of one percent of moisture could be taken from the single drum outlet 25 at the high rate of 200,000 pounds per hour. This called for delivery of over 15,000 pounds of dry steam per hour by each of the thirteen separator units 38. Results with boiler water containing solid contaminants in dissolved and suspended form were somewhat less favorable but still very good.

Summary

From the foregoing it will be seen that I have improved the design, extended the usefulness and bettered the performance of “drum-internal” apparatus for steam generators; that I have included a system of said of acceptable dryness which may be taken from a steam and water drum of given diameter and length; that I have increased the effectiveness of the steam-from-water separating portions of the drum-internal equipment; that I have provided an improved separator unit which can readily be adjusted for optimum performance under a variety of conditions of steam generator operation; and that I have increased the effectiveness of the dry-pipe portions of the equipment.

My inventive improvements are accordingly capable of wide application and hence are not to be restricted to the specific form here disclosed by way of illustration.

What I claim is:

1. In a steam separator, the combination of an upright tube, means for passing steam and water mixture upwardly through said tube, spinner means in the tube for imparting to said upflowing mixture a whirling motion which throws water therefrom outwardly against the tube wall for discharge from the separator over the tube's top edge and which allows steam from the mixture to flow upwardly out of the tube's central portion, an upright sleeve of smaller diameter than said tube positioned above the tube in substantially coaxial relation thereto with the lower sleeve end spacedly projected into the upper tube end whereby said discharge water passes outside of the sleeve over the tube top and is thereby separated from said upflowing steam as same passes out of the tube's central portion upwardly through the sleeve interior, an enclosure in communication with the top of said sleeve for receiving the steam issuing therefrom and for directing same radially out of the separator in substantially horizontal flow, and screening means in the path of said horizontal flow for subjecting said discharge steam to a drying action which effects still further removal of moisture therefrom.

2. In a steam separator, the combination of a first upright tube, means for passing steam and water mixture upwardly through said tube, spinner means in the tube for imparting to said upflowing mixture a whirling motion which throws a portion of the mixture's water content outwardly against the tube wall for spillage from the separator over the tube's top edge and which allows the remaining mixture to discharge upwardly from the tube's central portion, a second upright tube of smaller diameter than the first positioned above said first tube in the upward path of said whirling discharge mixture to collect therefrom on the second tube's inner wall further water for spillage out of the separator over the top edge of that wall, an enclosure at the top of said second tube for receiving the steam issuing therefrom and for directing same radially out of the separator in substantially horizontal flow, screening means in the path of said flow for subjecting said separator discharge steam to a drying action which effects still further moisture removal, a conical member depending downwardly from the top wall of said enclosure toward the interior of said second tube in coaxial relation thereto, and means for adjusting the elevation of said top wall and conical member with respect to the second tube's upper end whereby to vary the area of steam-flow entrance into said screening means enclosure from said second tube and thereby to vary the pressure inside the lower part of the separator.

3. In a steam and water drum for a steam generator having a steam outlet in the drum's upper portion and being provided with a partition providing the drum interior into a first chamber which is adapted to receive incoming steam and water mixture and a second chamber which is separated from the first and which includes space for steam in the drum's upper portion communicating with said outlet together with an adjoining space in the drum's lower portion that is adapted to contain water, the combination of a first generally upright separator tube communicating with the interior of said first chamber and projecting upwardly through the level of the aforesaid water contained within said second chamber into the drum's said steam space above said level to convey steam and water mixture from the first chamber into that steam space, means in said first separator tube for whirling the steam and water mixture upon upward passage through the tube whereby to separate a major portion of the water content against the tube wall for spillage over the tube's top edge into said water space and to allow the whirling mixture of the separated water to flow further upwardly from the tube's central portion, a second generally upright separator tube of smaller diameter than the first positioned above said first tube in
said upward path of the whirling mixture to collect therefrom on the second tube's inner wall further water for spillage over the top edge of that wall and downward flow theretoform to the aforesaid water space, an enclosure communicating with the top of said second separator tube for receiving the steam issuing therethrough for directing same radially into said steam space in substantially horizontal flow above the aforesaid level of the water in the drum's said second compartment, and screening means in the path of said flow for subjecting said steam to a drying action which effects still further moisture removal prior to passage of the steam out of the drum by way of said outlet.

4. In a steam and water drum for a steam generator having a steam outlet in the drum's upper portion and being provided with a partition dividing the drum interior into a first chamber which is adapted to receive incoming steam and water mixture and a second chamber which is separated from the first and which includes space for steam in the drum's upper portion communicating with said outlet together with an adjoining space in the drum's lower portion that is adapted to contain water, the combination of a first generally upright separator tube communicating with the interior of said first chamber and projecting upwardly through the level of the aforesaid water contained within said second chamber into the drum's said steam space above said level to convey steam and water mixture from the first chamber into that steam space, means in said first separator tube for whirling the steam and water mixture upon upward passage through the tube whereby to separate a major portion of the water content against the tube wall for spilling over the wall's top edge into said water space and to allow the whirling mixture thus freed of the separated water to flow further upwardly from the tube's central portion, a second separator tube of smaller diameter than the first positioned above said first tube in said upward path of the whirling mixture to collect therefrom on the second tube's inner wall further water for spilling over the top edge of that wall, a baffle plate extending outwardly from above the top of said second separator tube, a skirt extending downwardly from said baffle plate around both said first and second tubes to below the aforesaid level of the water in said drum's lower portion and aiding the baffle plate in confining flow of spillage water from both of the tubes downwardly around the first-tube exterior, and screen means communicating with the top of said second separator tube for subjecting the steam issuing therefrom to a drying action which effects still further moisture removal prior to passage of the steam out of the drum by way of said outlet.

5. In a steam and water drum for a steam generator having a steam outlet in the drum's upper portion and being provided with a partition dividing the drum interior into a first chamber which is adapted to receive incoming steam and water mixture and a second chamber which is separated from the first and which includes space for steam in the drum's upper portion communicating with said outlet together with an adjoining space in the drum's lower portion that is adapted to contain water, the combination of a first generally upright separator tube communicating with the interior of said first chamber and projecting upwardly through the level of the aforesaid water contained within said second chamber into the drum's said steam space above said level to convey steam and water mixture from the first chamber into that steam space, means in said second separator tube for whirling the steam and water mixture upon upward passage through the tube whereby to separate a major portion of the water content against the tube wall for spilling over the wall's top edge into said water space and to allow the whirling mixture thus freed of the separated water to flow further upwardly from the tube's central portion, a second separator tube of smaller diameter than the first positioned above said first tube in said upward path of the whirling mixture to collect therefrom on the second tube's inner wall further water for spilling over the top edge of that wall, a baffle plate extending outwardly from above the top of said second separator tube, a skirt extending downwardly from said baffle plate around both said first and second tubes to below the aforesaid level of the water in said drum's lower portion and aiding the baffle plate in confining flow of spillage water from both of the tubes downwardly around the first-tube exterior, and screen means communicating with the top of said second separator tube for subjecting the steam issuing therefrom to a drying action which effects still further moisture removal prior to passage of the steam out of the drum by way of said outlet.

WARD S. PATTERSON.

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