

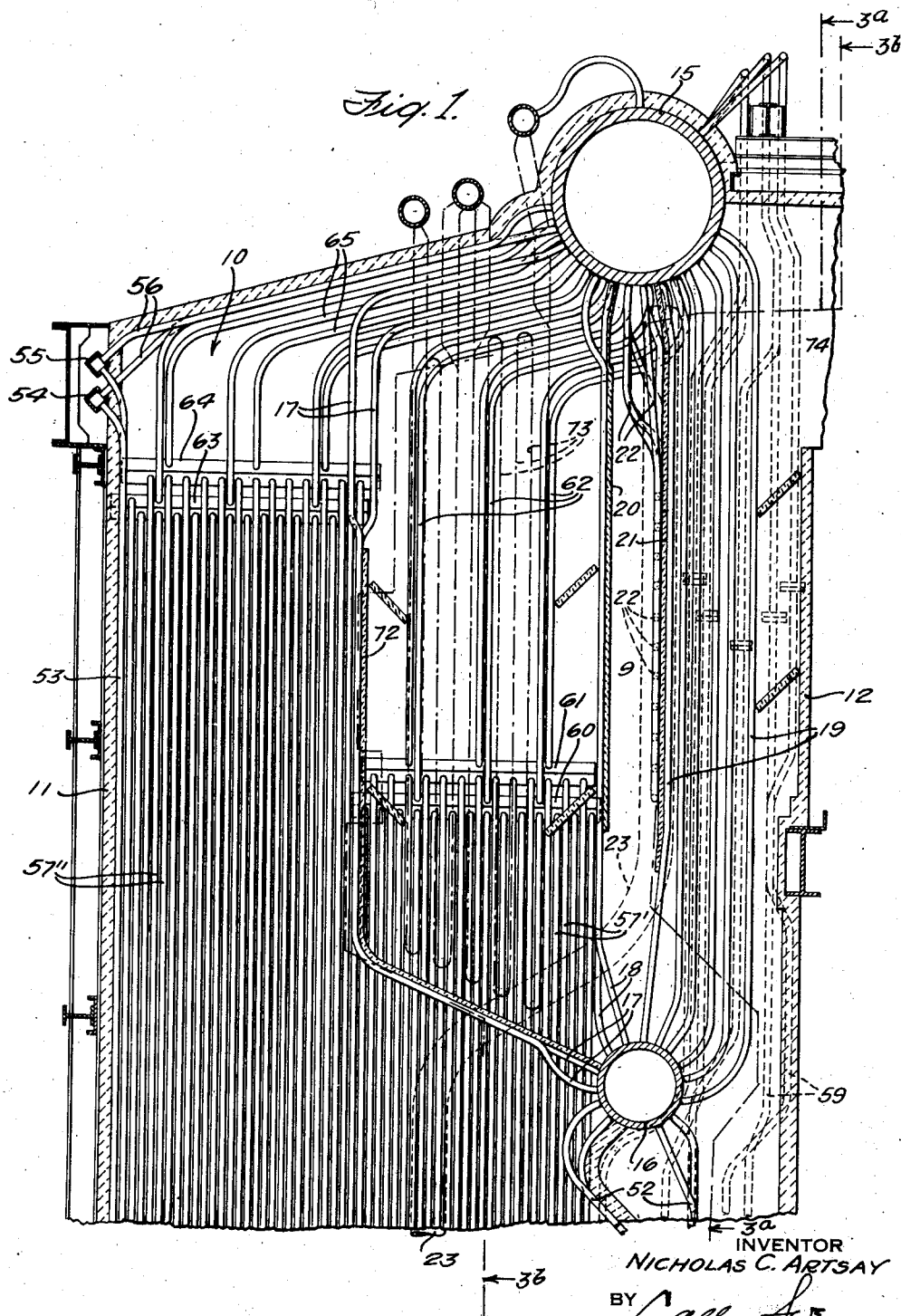
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N. C. ARTSAY
VAPOR GENERATOR

2,325,583

Filed May 2, 1939

5 Sheets-Sheet 1



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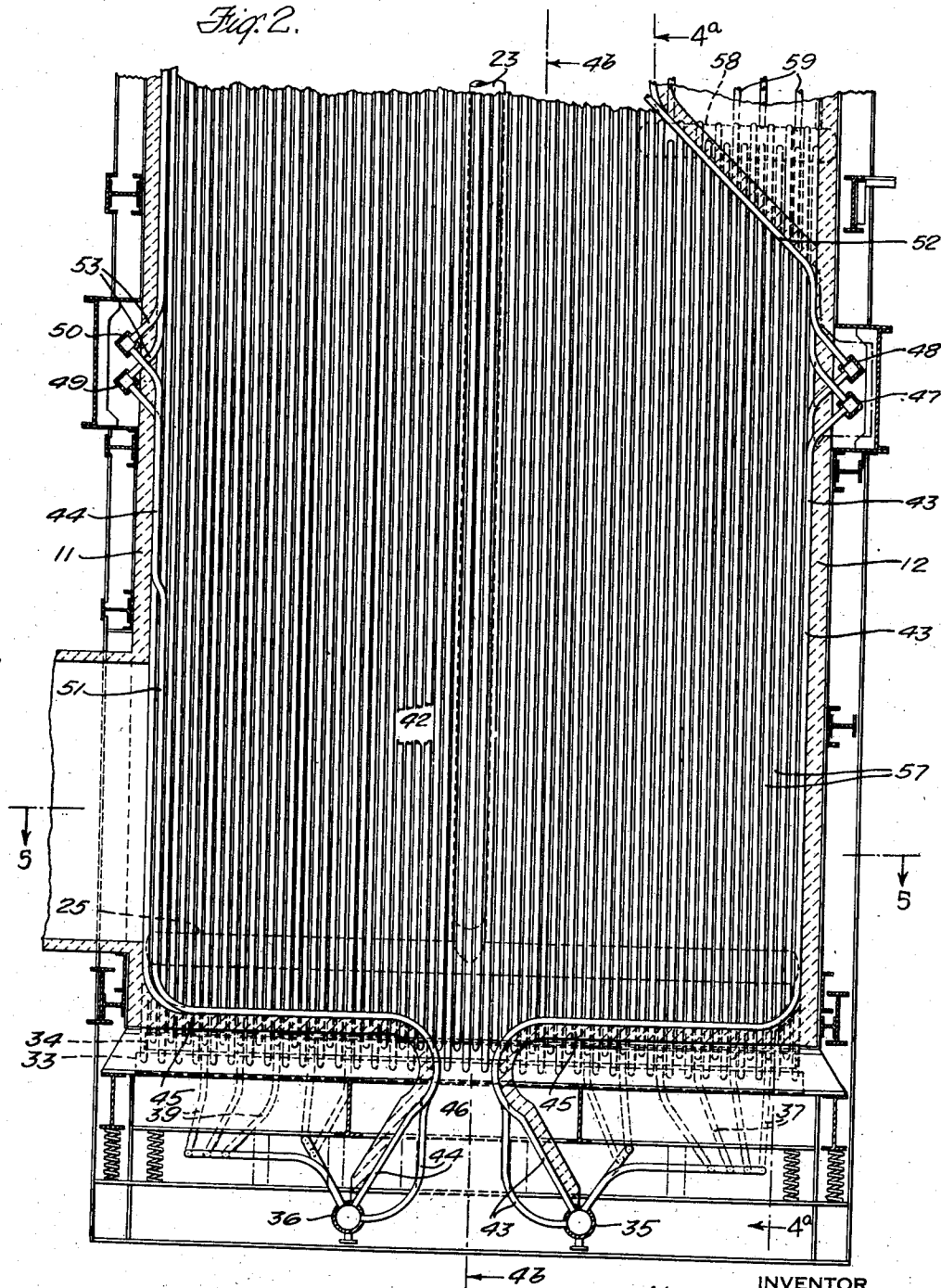
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Fig. 2.



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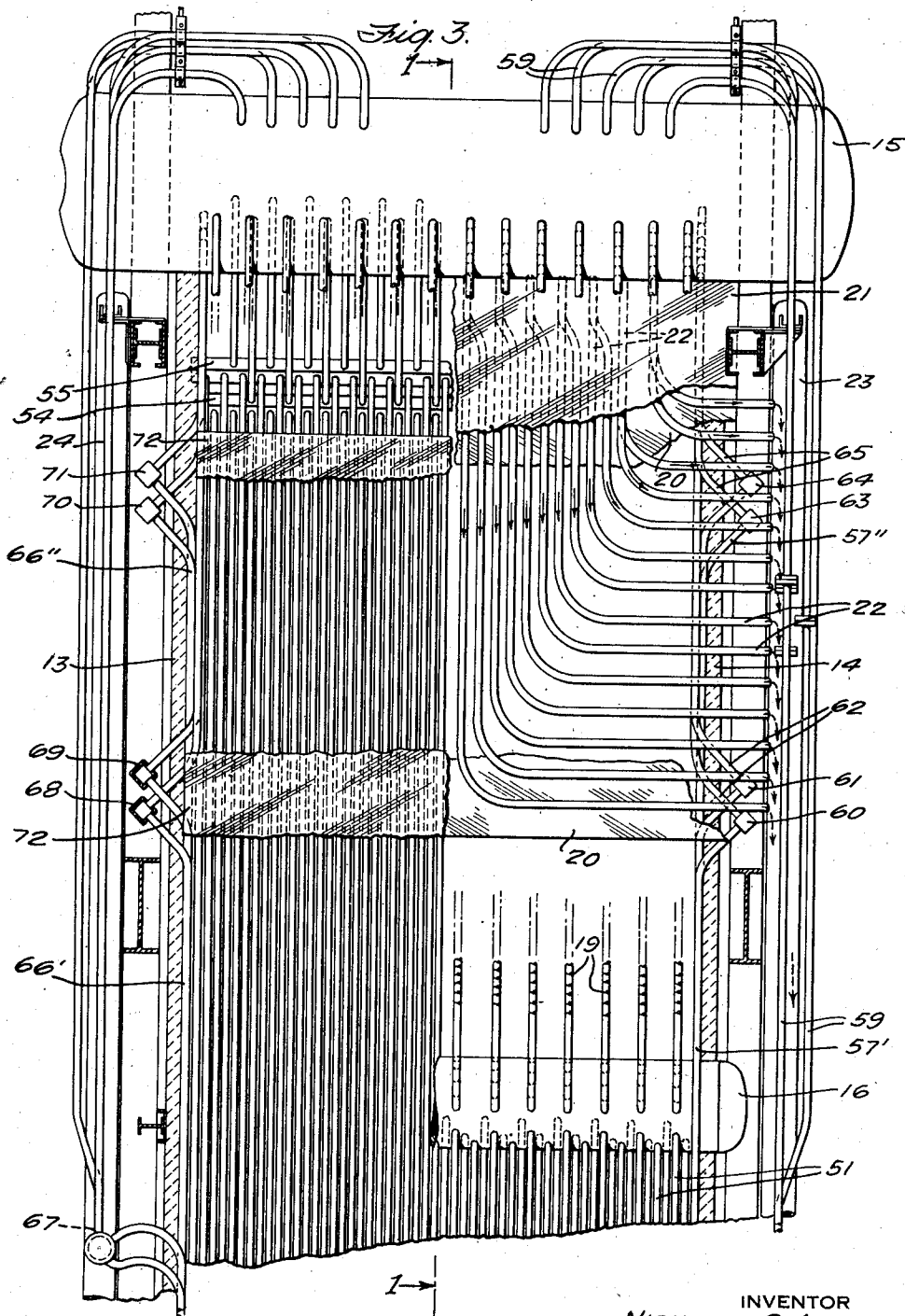
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5 Sheets-Sheet 3



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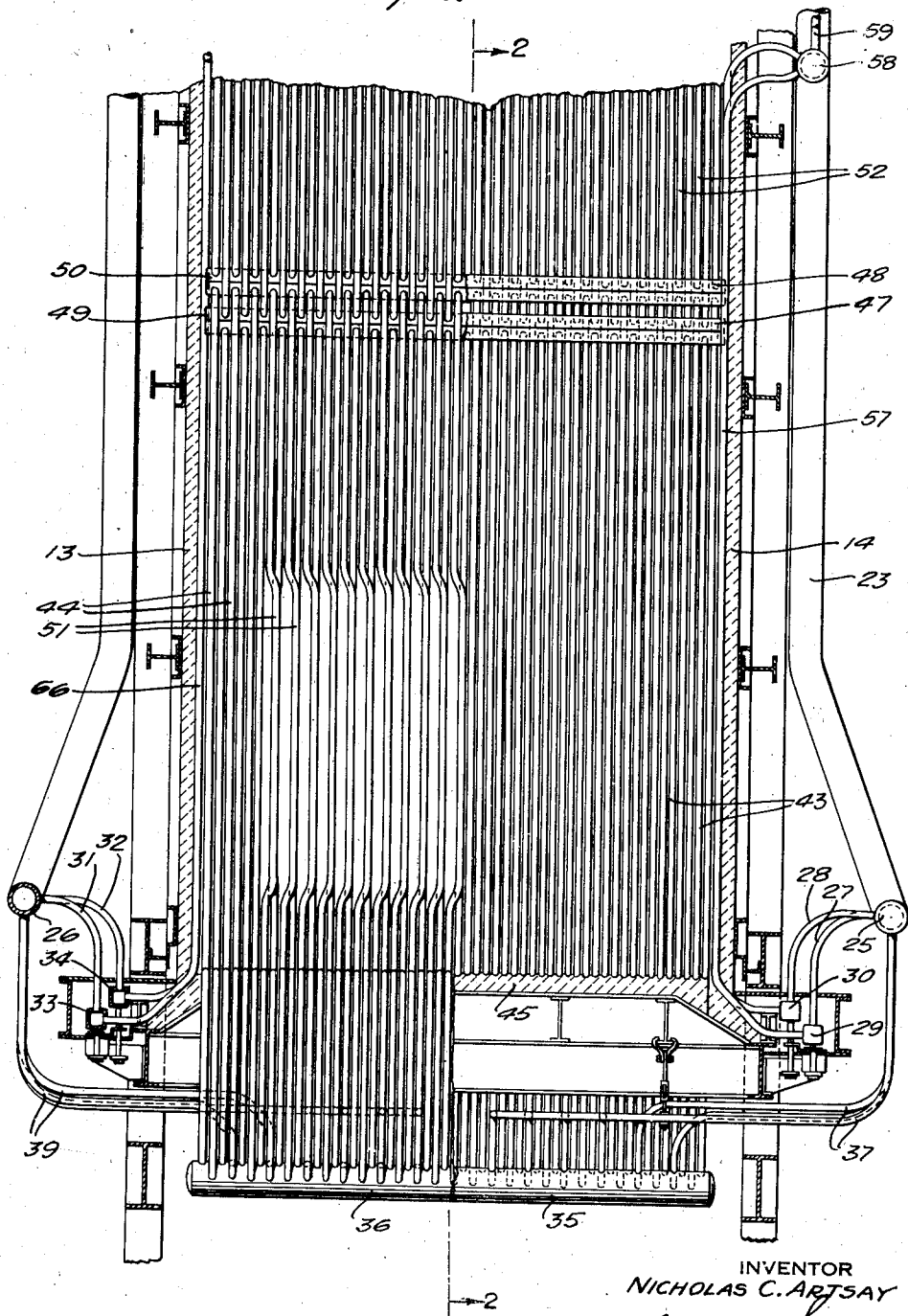
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Fig. 4.



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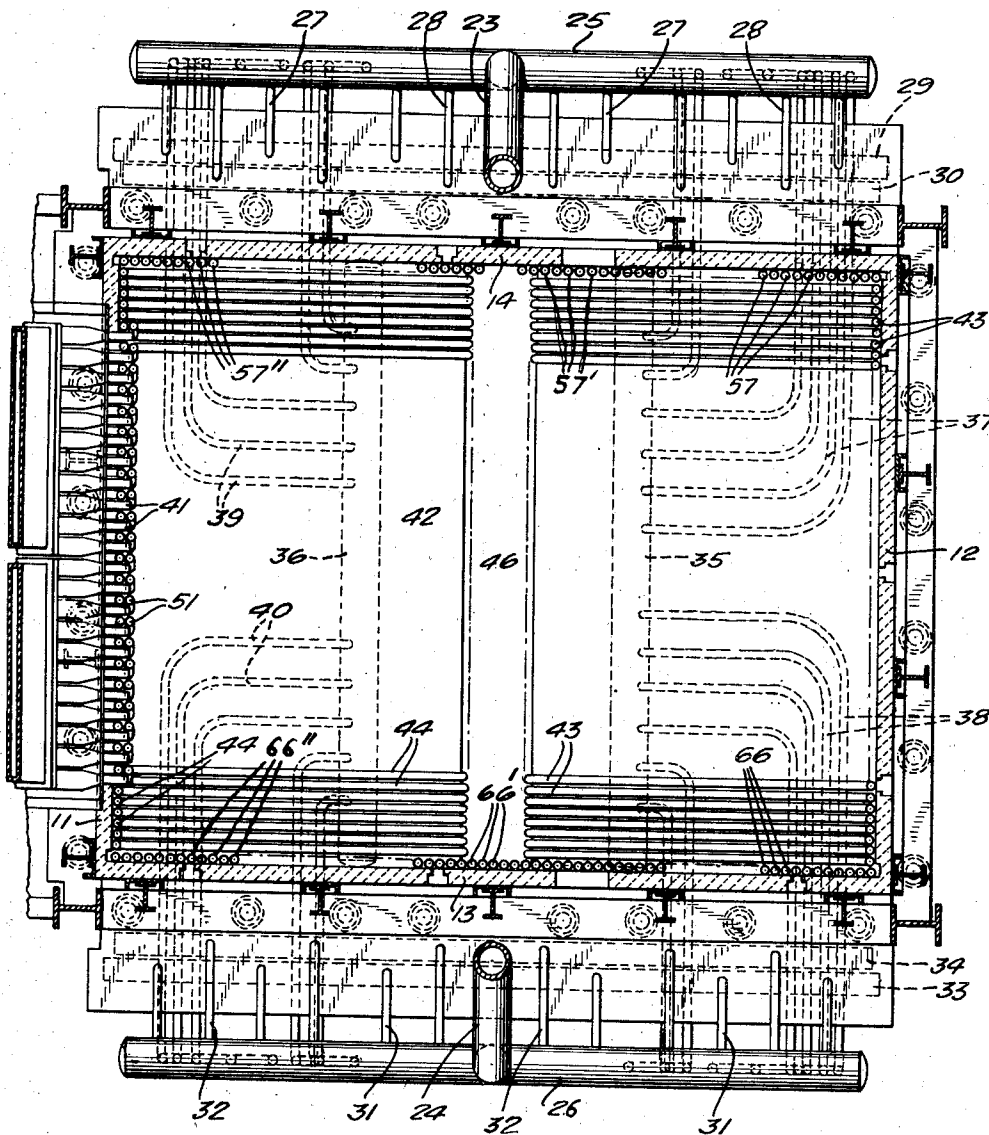
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Fig. 5.



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UNITED STATES PATENT OFFICE

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VAPOR GENERATOR

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Application May 2, 1939, Serial No. 271,292

14 Claims. (Cl. 122—235)

This invention relates to vapor generators and more particularly pertains to steam generators and to circulating systems therefor.

The invention provides a steam generator having natural circulation uni-directionally in all portions of the heating surface, and in which there is a minimum disturbance of the water level in the upper drum of the generator.

This is accomplished in general, by completely isolating the downcomers from the gas flow in the generator to prevent the generation of any steam within the downcomer tubes, and by providing a relatively large number of downcomer connections which are distributed along the bottom of the upper drum so as to minimize disturbance of the water level in the drum. The downcomers transfer liquid to the upper end portion of large vertical manifold headers disposed outside of the setting on each side of the unit, the lower ends of which discharge into horizontally disposed distributing manifolds which extend from the front to the rear of the furnace and connect with the lower headers for the front, rear and side water walls. The downcomer system is of adequate capacity to transfer the full available circulating head of the generator between its upper drum and the lowest ends of the heated elements, to the lowest water distributing headers without undue resistance at the required rate of water flow.

The advantages of the invention include a minimum disturbance of the water level in the steam drum, the prevention of any steam liberation in the downcomers, maximum head for circulation, low differential between maximum tube temperature and saturation temperature, and positive circulation in one direction.

These and other advantages of the invention and the features of novelty which characterize the invention will be apparent from the following description considered in connection with the accompanying drawings forming a part thereof, and in which:

Fig. 1 is a vertical transverse sectional view of the upper half of a steam generator embodying the invention, taken on line 1—1 of Fig. 3;

Fig. 2 is a vertical transverse sectional view of the lower half of the steam generator, taken on line 2—2 of Fig. 4;

Fig. 3 is a vertical longitudinal sectional view of the upper half of the steam generator, the right and left hand portions of which are taken respectively on lines 3a—3a and 3b—3b of Fig. 1;

Fig. 4 is a vertical longitudinal sectional view of the lower half of the steam generator, the

right and left hand portions of which are taken respectively on lines 4a—4a and 4b—4b of Fig. 2, and

Fig. 5 is a horizontal sectional view taken on line 5—5 of Fig. 2.

Like characters of reference refer to the same parts throughout the several views.

Referring to the drawings, reference character 10 designates generally a steam generator having a setting formed by steel-encased refractory side walls 11 and 12, and end walls 13 and 14, and having generally the configuration of a rectangular parallelepiped. An upper separating or steam and water drum 15, and a lower drum 16 are connected by spaced groups of steam generating tubes 17, 18 and 19.

Adjacent the tubes 18 and extending downwardly from the drum 15 to a point short of drum 16, is a vertical baffle 20, and spaced therefrom and adjacent the innermost row of the group of tubes 19 is a vertical baffle 21 similar to baffle 20 but extending somewhat further toward drum 16. These baffles provide a chamber 9 between them which is isolated from the gas flow, as will hereinafter appear, and in which are disposed the boiler downcomers 22. These downcomers are connected at spaced intervals to drum 15 along the bottom thereof and for the greater part of the central portion of its length. Each downcomer extends downwardly from the lowermost portion of drum 15 and makes a 90° turn within the chamber 9 and thereafter extends horizontally to, and through, the end wall of the setting to a large manifold header which extends vertically outside the setting and adjacent thereto. The downcomers are symmetrically arranged in two groups with respect to a vertical plane passing transversely through the center of drum 15, and the tubes in each group are arranged in nested relationship as shown in Fig. 3. One group only of downcomers is shown in Fig. 3, but it will be understood that the left hand group is similar to the right hand group but oppositely disposed. The outer ends of the right hand group of downcomers are connected to a manifold header 23 and the outer ends of the left hand group connect with a manifold header 24. The number and the capacity of the downcomers 22 and the capacity of the manifold headers 23 and 24 is such as to transfer the available circulating head to the lowest portion of the circulatory system without material resistance at the required rate of water flow.

As shown in Figs. 4 and 5 of the drawings,

manifold header 23 is connected at its lower end to the central portion of an external, horizontally extending distributing manifold or header 25, which extends for the full width of the setting adjacent the lower portion of each wall 14, and header 24 has its lower end connected to the central portion of a horizontal manifold or header 26 which extends for the width of the setting outside end wall 13. A plurality of tubes 27 connect the header 25 with a horizontal end wall header 29 which is disposed outside of end wall 14 and adjacent thereto and below header 25, while a similar group of tubes 28 connects the header 25 with a horizontal end wall header 30 also disposed outside of wall 14 and adjacent thereto and at a higher elevation than header 29. Tubes 27 and 28 are connected in alternate relationship with each other along the greater part of the manifold header 25. A similar circulatory arrangement is provided at the opposite end of the setting, adjacent and outside end wall 13. Tubes 31 connect header 26 with header 33 and tubes 32 connect header 26 with header 34.

Additional horizontally disposed headers 35 and 36 are located at a lower elevation than the headers 29, 30, 33 and 34 and below the lower ends of the vertical walls of the setting. These headers extend at right angles to the manifold headers 25 and 26 and are located at opposite sides of and adjacent a vertical plane passing through the axes of the vertical headers 23 and 24. Header 35 is connected to headers 25 and 26, to the former by a group of bent tubes 37 and to the latter by a group of bent tubes 38, each group of tubes being arranged and disposed to supply water to half of the header 35. Likewise header 36 is connected to headers 25 and 26, to the former by a group of bent tubes 39 and to the latter by a group of bent tubes 40.

From the headers 35 and 36, which are disposed substantially below the bottom of the furnace chamber 42, groups of tubes 43 and 44 respectively extend upwardly a short distance and then turn outwardly toward the adjacent side wall and thereafter extend horizontally in closely spaced relationship to the side walls 11 and 12 respectively, thus forming a water cooled furnace floor 45 having a central slag discharge opening 46. The tubes 43 then turn vertically upwardly and line the entire inner surface of the lower portion of side wall 12 between the floor of the furnace and horizontal wall headers 47 and 48 to which the upper ends of these tubes are alternately connected. Similarly the water wall tubes 44 line the inner surface of the lower portion of the side wall 11, and are alternately connected at their upper ends to headers 49 and 50. However, as indicated at 51, certain of the tubes 44 are bent inwardly from the wall 11 and laterally for a substantial portion of their length, to provide inter-tube spaces for the firing of the fuel burners 41 which extend through the side wall 11 and between the tubes 44 in the lower part of the furnace. From the headers 47 and 48, tubes 52 extend upwardly and inwardly of the furnace 42 and are connected at their upper ends to the lower portion of the drum 16. From the headers 49 and 50 water wall tubes 53 extend upwardly and are alternately connected at their upper ends to two similar headers 54 and 55 respectively at the top of the setting, and line the inner surface of the upper portion of the side wall 11. A plurality of roof tubes 56 connect the headers 54 and 55 with the steam and water drum 15.

The inner surface of the end wall 14 is lined by groups of closely spaced vertical water wall tubes 57, 57' and 57'', alternate tubes in the several groups being connected at their lower ends to the headers 29 and 30 respectively. The tubes 57 line that portion of wall 14 which is adjacent side wall 12, tubes 57' line that portion of wall 14 which is adjacent side wall 11, and tubes 57'' line the intermediate portion of wall 14. The tubes 57 of the group which is located adjacent the side wall 12, are connected at their upper ends to a relatively short horizontal header 58, which is positioned in the wall 14 at a level slightly below that of the drum 16. The header 58 is connected with the drum 15 by a group of external riser tubes 59. The water wall tubes 57' are alternately connected at their upper ends to horizontal headers 60 and 61 which are located at an elevation intermediate the headers 58 and the drum 15. Headers 60 and 61 are connected to drum 15 by a plurality of upwardly extending tubes 62. Water wall tubes 57'', adjacent the side wall 11, extend upwardly to and connect with headers 63 and 64 in the upper portion of the setting and the headers 63 and 64 are connected to the drum 15 by circulating tubes 65.

The inner surface of the end wall 13 is similarly lined by three groups of closely spaced vertical water wall tubes 66, 66' and 66'' which are alternately connected at their lower ends to the headers 33 and 34, and which at their upper ends are respectively connected with the drum by means of intermediate headers 67, 68, 69, and 70, 71, the entire arrangement being similar to the arrangement for the opposite wall 14. A baffle 72 disposed on or adjacent tubes 17 and extending from drum 16 upwardly to a point short of the elevation of headers 63 and 64 provides with the wall 11, a first pass for the gases leaving the furnace. Upon leaving the first pass, the gases flow downwardly through the second pass between baffles 72 and 20 over a superheater 73 disposed in the second pass, and upon leaving the second pass, the gases flow upwardly through the third pass between the baffle 21 and the wall 12 to the gas outlet 74 and then to an economizer or other heat recovery apparatus, not shown. The baffles 20 and 21 completely isolate the downcomer tubes 22 from contact with gases flowing through the setting, and no steam generation will take place within these downcomer tubes at any point throughout their lengths.

In operation, water flows from the steam and water drum 15 into and through the large number of downcomers 22 to the vertical external manifolds 23 and 24, which convey the water to the horizontal external distributing headers 25 and 26. Water then flows from manifold 25 through pipes 27 and 28 to headers 29 and 30 and thence into the water wall tubes 57 which line wall 14, and steam and water is conducted from the upper ends of these tubes into the steam and water drum 15 through the headers 58, 60, 61, 63 and 64, as previously described. Similarly, water flows from manifold 26 through pipes 31 and 32 to headers 33 and 34 and thence into tubes 66 which line wall 13, and steam and water is conducted from the upper ends of these tubes into the drum 15 through headers 68, 69, 70 and 71. Water is also conducted from manifolds 25 and 26 through pipes 37 and 38 to header 35 from which water is supplied to tubes 43 which line wall 12. Steam and water is delivered from the upper ends of tubes 43 to lower

drum 16 through headers 47 and 48. Water is further conducted from manifolds 25 and 26 through pipes 39 and 40 to header 36 from which water is supplied to tubes 44 which line wall 11. Steam and water is delivered from the upper ends of tubes 44 to the steam and water drum 15 through headers 49 and 50, tubes 53, headers 54 and 55 and tubes 56. From lower drum 16, steam and water flows upwardly through the tubes of banks 17, 18 and 19 to the steam and water drum 15. There is no downward flow through any of the tubes of the banks 17, 18 and 19, or in any of the water wall tubes, since all downflow takes place in the downcomers 22 and the vertical external manifold headers 23 and 24, all of which have an adequate capacity to transfer the available circulating head to the lowest portion of the circulating system without undue resistance at the required rate of water flow. Hence a positive upward circulation is produced and maintained at all times throughout all the tubes of the water wall surfaces as well as in the several tube groups which connect the drums 15 and 16. The downcomer arrangement permits the installation of a large number of downcomers, the drum connections of which open well under the surface of the water and thus precludes the entrainment of steam through eddies and reduces the ebullition which normally takes place in saturated water upon its movement at an accelerated rate into tubular members.

The effectiveness of a circulatory system embodying the invention in preventing overheating of any of the tubes has been demonstrated by the fact that numerous temperature readings made with thermo-couple wires peened into the tubes of a full sized unit embodying the invention shows a maximum tube temperature of only 50 degrees above the saturation temperature corresponding to the pressure of the unit.

The form of the invention herein disclosed is a preferred form and since various changes may be made in the form, location and relative arrangement of the several parts thereof without departing from the principles of the invention, it will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, means providing a chamber in the setting below the drum and outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the bottom portion of the drum and along a substantial portion of the length thereof and disposed in said chamber, and a manifold header outside the setting, the downcomers extending from said chamber through the wall of the setting and connecting with the manifold header at one end portion thereof, the other end portion of the manifold header being connected with the lower portion of the circulating system of the generator.

2. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, a water wall for the furnace, means providing a chamber in the setting below the drum and outside the path of the gases produced in the furnace in their flow through the setting,

downcomers connected to the bottom portion of the drum and along a substantial portion of the length thereof and disposed in said chamber, and a manifold header outside the setting, the downcomers extending from said chamber through the wall of the setting and connecting with the manifold header at one end portion thereof, the other end portion of the manifold header being connected with the lower portion of the furnace water wall.

3. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, water walls for the furnace, means providing a chamber in the setting below the drum and outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the bottom portion of the drum and along a substantial portion of the length thereof and disposed in said chamber, and a manifold header outside the setting, the downcomers extending from said chamber through the wall of the setting and connecting with the manifold header at one end portion thereof, the other end portion of the manifold header being connected with the lower portions of a plurality of water walls.

4. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, a second drum in the setting at a lower elevation than the other drum, vapor generating tubes in the setting connecting the drums, a water wall for the furnace, means providing a chamber in the setting substantially intermediate said drums and outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, a manifold header outside the setting and connected to the downcomers at one end portion, the other end of the manifold header being connected to a distributing header, and conduits connecting the distributing header with the lower portion of said water wall.

5. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, a second drum in the setting at a lower elevation than the other drum, vapor generating tubes in the setting connecting the drums, water walls for the furnace, means providing a chamber in the setting substantially intermediate said drums and outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, a manifold header outside the setting and connected to the downcomers at one end portion, the other end of the manifold header being connected to a distributing header, and conduits connecting the distributing header with the lower portion of a plurality of said water walls.

6. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, a second drum in the setting at a lower elevation than the other drum, vapor generating tubes in the setting connecting the drums, water walls for the furnace, means providing a chamber in the setting substantially intermediate said drums and outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, a manifold header outside the setting and connected to the downcomers at one end portion, the other end of the

manifold header being connected to a distributing header, and conduits connecting the distributing header with the lower portion of more than two of said water walls.

7. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, a second drum in the setting at a lower elevation than the other drum, vapor generating tubes connecting the drums, a water wall for the furnace, means providing a chamber in the setting adjacent tubes connecting the drums and outside of the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the bottom portion of the drum and along a substantial portion of the length thereof and disposed in said chamber and extending through a wall of the setting, a manifold header outside the setting having its upper end portion connected to the downcomers and having its lower end portion connected to the lower portion of the water wall.

8. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, a second drum in the setting at a lower elevation than the other drum, vapor generating tubes connecting the drums, a water wall for the furnace, means providing a chamber in the setting intermediate the outermost rows of tubes connecting the drums and outside of the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the drum and disposed in said chamber and extending through a wall of the setting, a manifold header outside the setting having its upper end portion connected to the downcomers and having its lower end portion connected to the lower portion of the water wall.

9. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, water walls for the furnace, means providing a chamber in the setting outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, one group of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, and manifold headers outside of the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to the lower portion of at least one of said water walls.

10. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, water walls for the furnace, means providing a chamber in the setting outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, one group of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, manifold headers outside of the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to a distributing header, and means connecting each distributing header to the lower portion of at least one of said water walls.

11. A vapor generator comprising a setting, a furnace, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, water walls for the furnace, means providing a chamber in the setting outside the path of the gases produced in the furnace in their flow through the setting, downcomers connected to the lower portion of the drum and disposed in said chamber, one group of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, manifold headers outside of the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to more than two of said water walls.

12. A vapor generator comprising a setting, a substantially rectangular furnace in the setting, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, a water wall for each of the vertical walls of the furnace, means providing a chamber in the setting outside of the path of the gases produced in the furnace in their flow through the setting, downcomers connected with the lower portion of the drum and disposed in said chamber, one group of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, manifold headers outside the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to a distributing header, each of said furnace water walls having a lower header, and conduits connecting each distributing header with at least one of the lower headers of the furnace water walls.

13. A vapor generator comprising a setting, a substantially rectangular furnace in the setting, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, a water wall for each of the vertical walls of the furnace, means providing a chamber in the setting outside of the path of the gases produced in the furnace in their flow through the setting, downcomers connected with the lower portion of the drum and disposed in said chamber, one group of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, manifold headers outside the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to a distributing header, each of said furnace water walls having a lower header, and conduits connecting each distributing header with three of the lower headers of the furnace water walls.

14. A vapor generator comprising a setting, a substantially rectangular furnace in the setting, a drum in the upper part of the setting, vapor generating tubes in the setting and connected in the generator circulatory system with the drum, a water wall for each of the vertical walls of the furnace, means providing a chamber in the setting outside of the path of the gases produced in the furnace in their flow through the setting, downcomers connected with the lower portion of the drum and disposed in said chamber, one group

of downcomers extending through the wall of the setting at one end of the chamber and another group extending through the wall of the setting at the other end of the chamber, manifold headers outside the setting each having its upper end portion connected to one group of downcomers and having its lower end connected to a distributing header, each of said furnace

water walls having a lower header, conduits connecting each distributing header with the lower header of one water wall along substantially its entire length, and other conduits connecting each distributing header with one end portion of each of the lower headers of two other water walls.

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