July 3, 1956 L. G. TROUTMAN 2,752,898

VAPOR GENERATOR

Filed April 25, 1950 3 Sheets-Sheet 1

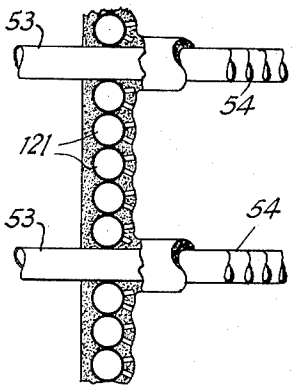



FIG. 2

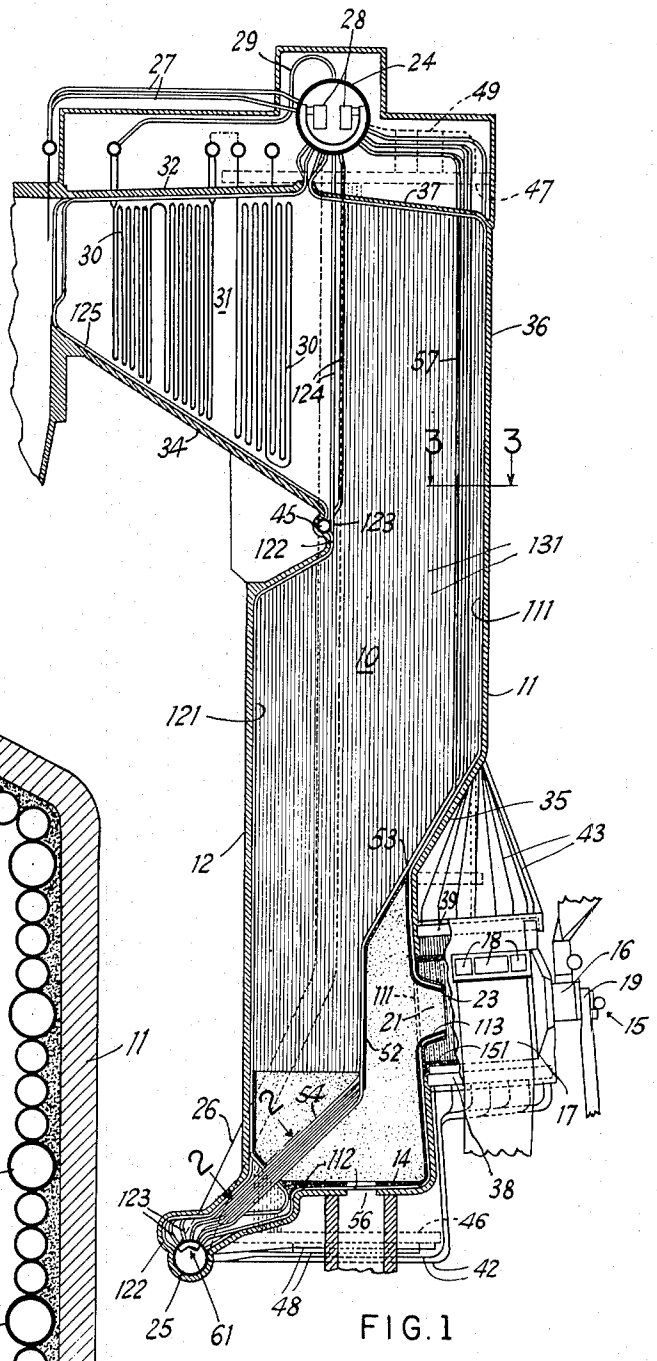



FIG. 1

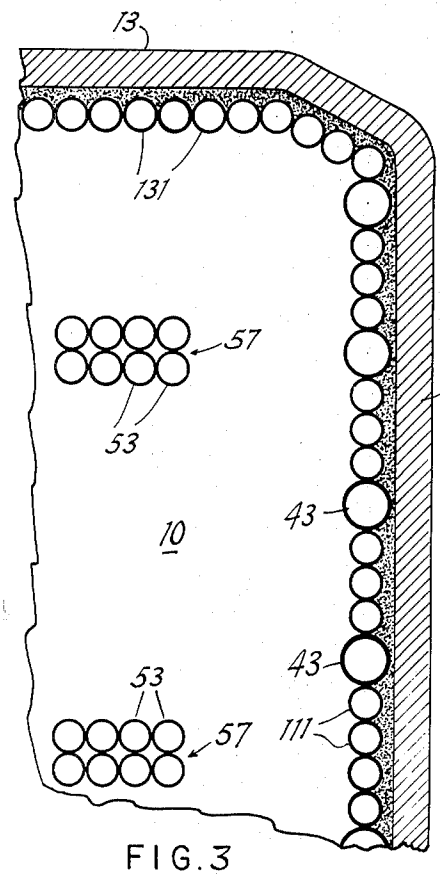



FIG. 3

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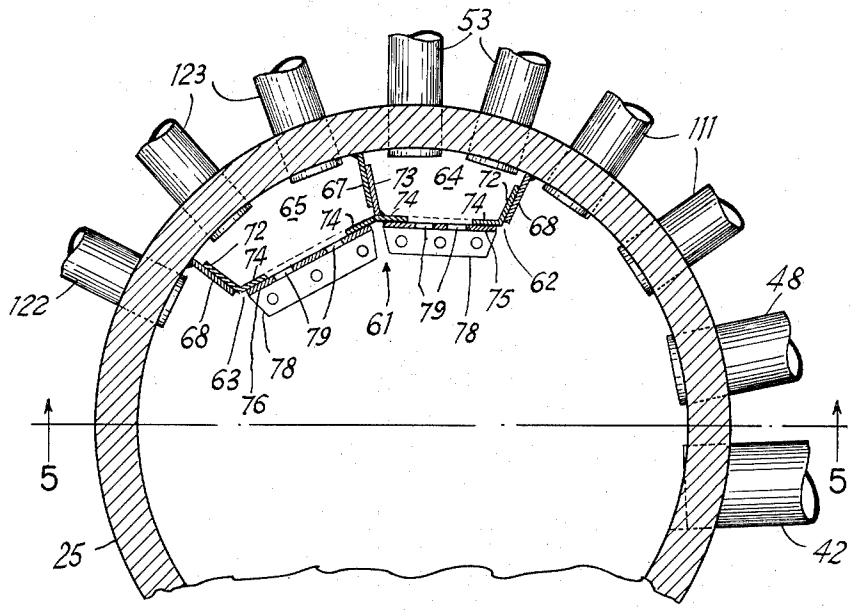



FIG. 4

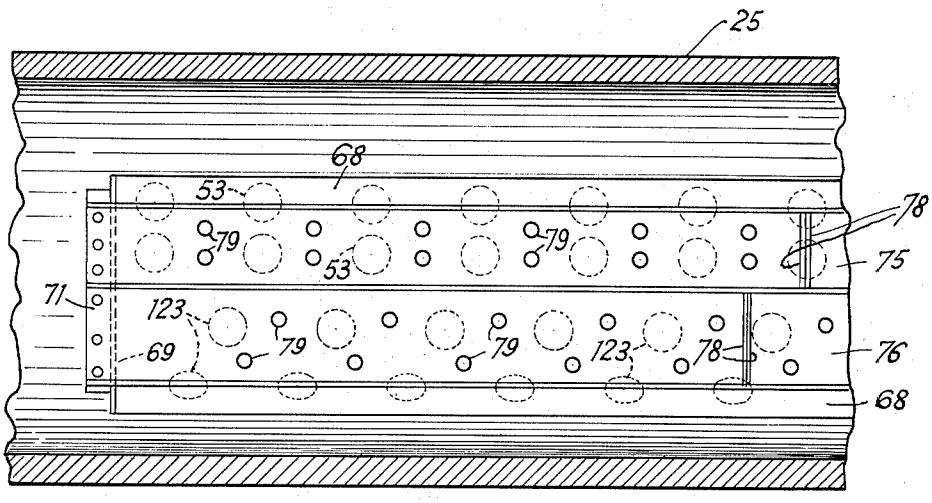



FIG. 5

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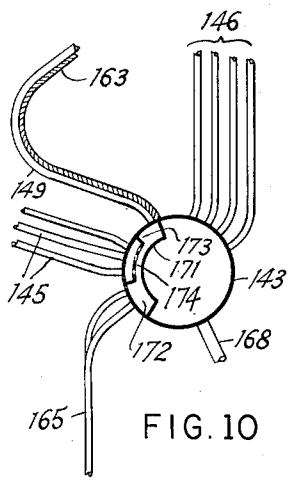



FIG. 10

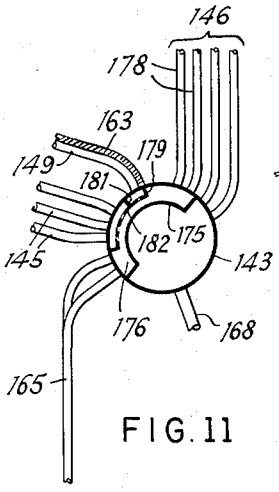



FIG. 11

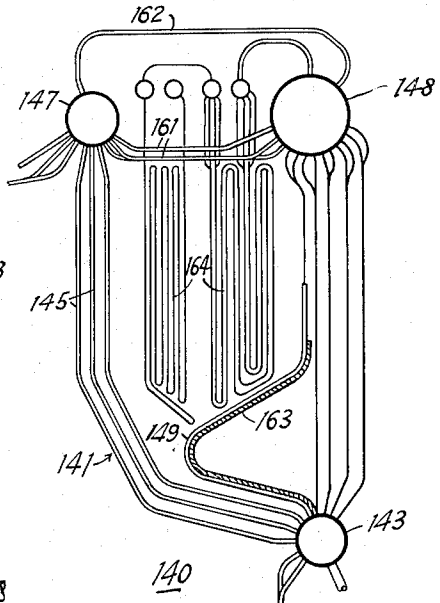



FIG. 9

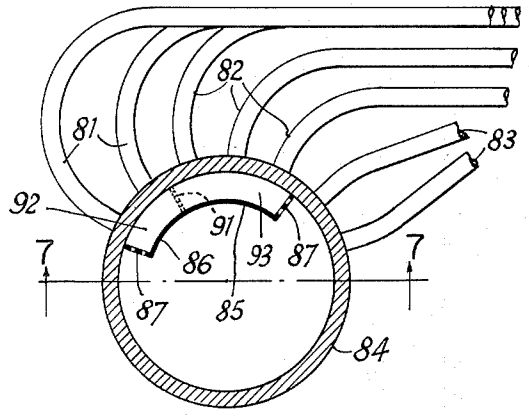



FIG. 6

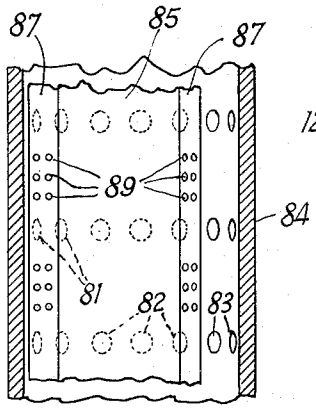



FIG. 7

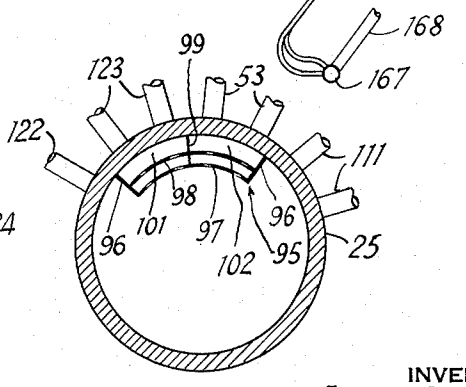



FIG. 8

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United States Patent Office 2,752,898
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2,752,898

# VAPOR GENERATOR

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Application April 25, 1950, Serial No. 157,927

3 Claims. (Cl. 122—406)

This invention relates in general to the construction and operation of vapor generators, and more particularly of steam generators of the natural circulation water tube type having a large proportion of the component heat absorbing surface formed of tubular elements arranged and connected so as to provide parallel upflow or riser paths in the circulatory system of the vapor generator. In high duty, high availability steam generating units of modern construction, such parallel fluid flow paths are provided in part by water tubes which form the furnace boundary and thus are subjected to high radiant heat absorption, whereas other flow paths are provided by water tubes disposed in lower temperature zones and thus are subjected to heat absorption at a lesser rate.

The heat received by the heated water tubes from the hot gases of the furnace is conducted through their walls to the water. Circulating flow is induced by thermo-siphonic action resulting from the heating of the up-flow path of the individual circuit, thereby reducing the specific weight of the fluid therein as compared with the specific weight of the fluid in the downflow path which receives little or no heat. It is essential for continuous and trouble-free operation that the flow rate of the steam-water mixture passing through the tube be of such a degree that steam blanketing will not occur on the inside surface of the tube, to the end that the tube metal temperature does not rise to a temperature appreciably above the saturated steam temperature corresponding to the pressure. A higher flow rate would not appreciably reduce the temperature of the tube metal and the higher flow rate would thus involve an excessive circulation of water. A heated path of a circuit is considered to have an optimum flow rate, at which a predetermined minimum quantity of fluid passing therethrough is sufficient to maintain both a homogeneous steam-water mixture and a tube metal temperature at substantially saturated steam temperature, without any appreciable excess of fluid above the quantity needed to meet that requirement.

The circuits differ as to thermo-siphonic characteristics in that some of them have paths of different frictional flow resistances and/or different heat inputs. When such circuits are combined to operate as parallel circuits in the same circulation system, a degree of flow rate disparity as compared with optimum flow rates exists. It is therefore desirable to provide means whereby the flow in the individual flow paths of the circuits can be controlled to limit the flows to optimum flow values throughout the entire range of operating capacities.

If the various dissimilar parallel circuits are not so controlled, but are arranged with flow areas to insure adequate flow rates in the vulnerable tubes of some circuits, excess flows will undoubtedly occur in other circuits. Such an excess water flow into the steam and water drum of the unit not only increases the loading on the steam and water separating devices in the drum but also increases the conduit requirements in the down-flow portion of the circulation system. The increased steam and water loading on the separating devices may also dictate a steam



and water drum of larger diameter, and/or a greater number of individual steam and water separating devices. As such components of the unit are costly, it is particularly advantageous from a cost standpoint to avoid any increase in size or number, or to effect a reduction in size or number.

The present invention is therefore directed to a method and means of limiting to an optimum flow rate the liquid flow through parallel thermosiphonic circuits which receive heat at different rates, suitably by means of flow resistances inserted in selected flow paths of the circuits.

The invention is more particularly directed to a flow controlling resistance apparatus or device of moderate cost for use in controlling the flow of liquid through a plurality of circuits. The invention embraces various forms of construction whereby the flow resistance apparatus for a plurality of circuits can be installed for convenient removal for tube inspection.

The introduction of a resistance into any particular circuit provides a control on the flow within that circuit whereby dissimilar parallel thermo-siphonic flow circuits may be arranged so that each will have its optimum flow. As a result, an economy in construction is effected since there is no necessity of increasing the flow in any of the respective circuits over that which experience has indicated is required and no necessity of providing larger and/or additional tubular components which would otherwise be required to accommodate the increase in flow.

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 illustrated and described a preferred embodiment of my invention.

Of the drawings:

Fig. 1 is a sectional side elevation of a vapor generator constructed in accordance with my invention;

Figs. 2 and 3 are fragmentary sectional views of Fig. 1 taken along lines 2—2, and 3—3, respectively;

Fig. 4 is a fragmentary sectional side elevation showing details of the lower drum and tube connections included in Fig. 1;

Fig. 5 is a fragmentary longitudinal sectional view of the lower drum, taken along line 5—5 of Fig. 4;

Figs. 6 and 7 are sectional views similar to Figs. 4 and 5, showing a modified construction of lower drum;

Fig. 8 is a transverse sectional view of the lower drum showing a further modification;

Fig. 9 is a sectional side elevation of a modified form of vapor generator in which my invention may be incorporated;

Fig. 10 is a fragmentary enlargement of Fig. 9 illustrating additional features of my invention; and

Fig. 11 illustrates a modification of drum internals shown in Fig. 10.

In the embodiment of my invention, as illustrated in Fig. 1, the vapor generator is of the radiant boiler type of which the furnace heating chamber 10 is vertically elongated and defined by front and rear walls 11 and 12, respectively, and by opposing side walls 13, to provide a chamber of generally rectangular horizontal cross-section throughout its height. The chamber 10 is fired by means of a cyclone furnace or burner 15 of the type more fully disclosed in U. S. Patent 2,594,312. The fuel, in the form of crushed coal, for example, is transported in a high velocity stream of preheated high pressure primary air and introduced in a tangential direction into the cylindrical primary burner zone 16 adjacent the front end. The fuel thus moves rearwardly through the burner along a helical path into and through a sec-

ondary burner zone 17 where secondary air is introduced tangentially through ports 18 in the same direction of rotation as the primary air and fuel. Tertiary air may be similarly introduced into zone 19 forwardly of the primary zone 16.

The resulting flame and hot gaseous products of combustion discharge through a central, conically formed outlet passage or throat 21 having its wall 23 integral with the front wall 11 of the furnace heating chamber 10.

The walls of both the heating chamber 10 and cyclone burner 15 are fluid cooled throughout by means of tubes arranged and connected to form parallel flow paths or circuits of a single circulatory system through which the flow of cooling water from and back to a steam and water drum, for example, is maintained solely by thermo-siphonic circulation. Thus, the upper ends of wall cooling tubes in the respective walls are connected, either directly or indirectly, to an upper steam and water drum 24, while the lower ends of the same wall cooling tubes are connected, either directly or indirectly, to a lower water drum 25; the upper and lower drums 24 and 25 being interconnected at their respective opposite ends by downcomer pipes 26, of which one only is shown in Fig. 1 the lower ends of which are coextensive with the lower drum diameter. Water is fed to the upper drum 24 through economizer outlet connections 27, the economizer not being shown. Steam separators 28 suitably of the cyclone type disclosed in U. S. Patent #2,368,211, James Fletcher, dated January 30, 1945, are arranged in rows along opposite walls of the upper drum 24 for separating water from the steam before the steam is discharged from the drum. Steam outlet connections 29 lead from the steam space of the upper drum 24 to a superheater 30 located within a tapered gas outlet passage 31 having upper and lower boundaries 32 and 34, between opposite side walls 13, 13.

In the front heating chamber wall 11, tubes 111 are connected at their lower ends to the lower drum 25 from which the lower end tube portions 112 extend forwardly and upwardly along the furnace chamber floor 14. In the lower upright portion of wall 11 certain front wall tubes 111 are offset forwardly and bent as at 113 into semicircular form to define the throat wall 23 while the remaining tubes 111 continue upwardly in the plane of the wall at opposite sides of the throat. Above the cyclone discharge throat 21, the front wall 11 includes a forwardly inclined intermediate wall portion 35 extending upwardly to and joining a forwardly offset vertical wall portion 36 which extends upwardly to the roof 37. The tubes 111 continue upwardly along the wall portions 35 and 36, and along the roof 37, to the upper drum 24 to which the upper ends of tubes 111 are directly connected. In the upper wall portion 36, tubes 111 are interspersed at intervals with riser tubes 43 which lead from the wall cooling means of the cyclone furnace 15 and which extend through the roof 37 and are directly connected to upper drum 24.

The wall cooling means of the cyclone furnace 15 includes tubes 151 bent into semicircular form and arranged along inner circumferential wall portions of the furnace, with lower and upper ends of the tubes connected respectively to lower and upper header means 38 and 39. The lower header means 38 which, as shown, consists of a single header, is connected by water supply tubes 42 to the lower boiler drum 25, while the upper header means 39, also indicated as a single header, is connected by riser tubes 43 to the upper boiler drum 24, as previously described.

In the rear wall 12, tubes 121 are all connected at their lower ends to the lower drum 25 whereas tubes 122 of one group are connected at their upper ends to a transverse header 45 at the lower end of the inclined superheater chamber floor 34, while tubes 123 extend upwardly beyond the header 45 and are connected at their upper ends to the upper drum 24, the tubes 123



extending across the gas outlet passage 31 in the form of a staggered tube screen 124 forwardly of the superheater 30. The superheater chamber floor header 45 is connected to drum 24 by means of a row of tubes 125 which extend along the superheater chamber floor 34, thence in staggered formation across the gas outlet from passage 31, beyond the superheater, and thence along the superheater roof 32.

In opposite side walls 13, the tubes 131 extend between and are connected at their lower and upper ends to lower and upper headers 46 and 47 respectively, which in turn are connected by water supply tubes 48 and riser tubes 49 to the lower and upper drums 25 and 24.

The lower portion of chamber 10 is partitioned by a reflecting arch 52 which extends downwardly from the inclined front wall portion 35 to an elevation lower than the position of the cyclone discharge throat 21; the arch 52 being formed mainly of tubes 53 which extend between drums 24 and 25 and which are connected thereto at their upper and lower ends. Below the arch 52, the tubes 53 are bent so as to extend downwardly and rearwardly toward the lower drum 25 and furthermore are grouped in successive vertical planes so as to form horizontally spaced tube platens 54, Figures 1 and 2, distributed across the width of chamber 10. Lower end portions of some of the rear wall tubes 121 extend between the platens to form a closure across the lower rear corner of the chamber, as indicated in Fig. 2. The reflecting arch 52 causes the heating gases leaving the burner throat 21 to flow downwardly toward the furnace floor 14, and then rearwardly and upwardly through the furnace slag screen formed by the horizontally spaced inclined tube platens 54. Slag accumulations in chamber 10 are discharged through a floor outlet 56.

Above the arch 52, the tubes 53 continue upwardly along the inclined front wall portion 35 to a position spaced from the front wall 11 where the tubes 53 are bent into successive vertical planes and suitably grouped therein so as to form horizontally spaced tube platens 57 as indicated in section in Fig. 3, the tubes 53 continuing through the roof 37 and being connected at their upper ends to drum 24.

As thus arranged, all heat absorbing tubes 53, 111, 121, 131 and 151, associated with both the furnace chamber 10 and cyclone burner 15, receive their total supply of water from the lower drum 25, and discharge the total mixture of steam and water into the upper drum 24. Each group of tubes provides a separate and continuous fluid flow path from the water supply drum 25 to the upper drum 24 and since all groups are connected to a common source of water supply, namely the lower drum 25, all such upflow paths are connected in parallel with respect to fluid flow therethrough.

In the form of vapor generator herein shown, the various parallel flow circuits thus provided are dissimilar in their thermo-siphonic flow characteristics due to their different formations and/or their different arrangements relative to the respective heating zones. Tubes 53, for example, which extend diagonally across a lower portion of chamber 10, are exposed to radiant heat throughout the major portions of their lengths and furthermore are subject to convection heating by hot gases which pass between the lower platens 54 and upper platens 57. Certain rear wall tubes 123 are also exposed to radiant heat throughout the major portions of their lengths and furthermore are subject to convection heating by gases which pass between tube lengths forming the screen 124. Both sets of tubes 53 and 123 are directly connected to drums 24 and 25 and otherwise are arranged so as to provide a minimum of resistance to the upflow of fluid therethrough. In contrast, the front wall tubes 111, although directly connected to drums 24 and 25, are necessarily formed with relatively abrupt turns therein so as to conform to the lower boundaries of chamber 10 and to the configuration of the burner discharge throat

23, whereby a resistance is imposed to natural circulation of fluid through the tubes. Moreover, tubes **111** are exposed to high temperatures only throughout their lower portions whereas their upper portions along the inclined front wall portion **35** are shielded by inclined portions of tubes **53**, while at higher elevations, the tubes **111** are shielded by vertical portions of tubes **53** which form the platens **57**. Rear wall tubes **122**, although exposed to radiant heat throughout the greater portion of the height of chamber **10**, are exposed to relatively cool gases at their upper portions where the circuit is continued through tubes **125** associated with the gas outlet **31**. Moreover, the tubes **122** and **125** are connected to the header **45** whereby, in conjunction with the bends formed in tubes **125**, a resistance is imposed on fluid flow through the circuit. Similarly, with respect to the wall cooling circuits comprising tubes **131** in side walls **13**, and tubes **151** in the cyclone burner walls, the various header connections interpose resistances which act to restrict natural circulation flow of fluid through the circuits as compared with the free flow afforded through circuits comprising the partition tubes **53** and boiler screen tubes **123**.

Due to the dissimilarity of flow circuits involved, and the disposition of associated tube lengths in heating zones of different temperatures, there arises the problem of maintaining optimum rates of fluid flow in the respective parallel circuits. For example, one circuit from and to the steam and water drum includes serially connected downcomer **26**, drum **25** and front wall tubes **111**. A second circuit includes downcomer **26**, drum **25**, rear wall tubes **122**, header **45** and tubes **125**. A third circuit includes downcomer **26**, drum **25**, tubes **42**, header **38**, cyclone wall tubes **151**, header **39**, and tubes **43**. A fourth circuit includes downcomer **26**, drum **25**, tubes **48**, headers **46**, side wall tubes **131**, headers **47**, and tubes **49**.

Circuits of another class having thermo-siphonic flow characteristics which are different from those of the circuits above mentioned are represented by the circuit from and to the steam and water drum which includes downcomer **26**, drum **25**, and boiler screen tubes **123**. A second circuit of this class includes downcomer **26**, drum **25**, and division wall tubes **53**.

The last named two circuits are of such thermo-siphonic flow characteristics, due to the relation of the heat absorption of their tubes **123** and **53** as related to the flow resistance of their various components above mentioned, that they would circulate fluid in excess of the optimum flow rate, and therefore a flow restriction unit such as **61** for these two circuits is included in them in accordance with the invention, for the purpose of giving them thermo-siphonic flow characteristics which will result in optimum flow rates in both circuits.

The flow paths of the class of circuits first defined as represented by the one including front wall tubes **111**, have thermo-siphonic flow characteristics which result in optimum flow rates, when operated in parallel with the circuits involving the flow restriction unit **61**.

As illustrated in Figs. 4 and 5, the restriction unit **61** is of box-like formation, and assembled over the inlet ends of the division wall tubes **53** and boiler screen tubes **123** which are arranged in successive pairs of parallel rows extending longitudinally of drum **25**. The restriction unit comprises two tray-like sections **62** and **63** providing separate compartments **64** and **65** opening to tubes **53** and **123** respectively and having a common dividing wall **67** together with outer side walls **68**, and end walls **69**. The longitudinal walls **67** and **68** are formed mainly by flat bars extending radially with respect to the drum and welded thereto. End plates **69**, each having a bolting flange **71**, extend across the ends of compartments **64** and **65** and are welded to the side bars **67** and **68**. Longitudinal bar members **72** and **73** having inturned flanges **74** are bolted or otherwise detachably secured to the longitudinal wall members **68** and **67**, the flanges **71** and **74** cooperating to provide a rectangular seating area for removable cover plates **75** and **76** which are preferably made in separate longitudinal sections having upstanding bolting flanges **78** for joining successive cover plate sections. Each cover plate is perforated with holes **79** staggered or otherwise arranged in non-alignment with respect to the tube inlets to avoid unequal distribution of water to inlets of heat absorbing tubes forming the circuit, due to jet action from the holes in the restrictor if the holes and the tubes were in alignment and the plate were in close proximity to the tube inlets. Each compartment **64** or **65** constitutes a type of plenum chamber and as such will tend to distribute the flow of water to all tubes of the heat absorbing circuits extending therefrom. In the embodiment shown, the tubes **53** and **123** are of 3" outside diameter, with the plurality of tubes **53**, in two rows, supplied with liquid from compartment **64**, and the plurality of tubes **123**, in two rows, supplied with liquid from compartment **65**. The respective cover plates **75** and **76** are each perforated with a plurality of one-inch diameter holes **79**.

Figs. 6 and 7 illustrate a modification wherein tubes **81**, **82** and **83** of dissimilar parallel circuits are connected to a water supply drum **84**. A restrictor baffle **85** is assembled over the inlet ends of tubes **81**, in two rows, and tubes **82**, in three rows, leaving the inlet ends of tubes **83**, in two rows, open to the main water space of the drum. It is assumed that tubes **81** and **82** are associated with circuits of relatively high thermo-siphonic flow characteristics that require restriction of the liquid supply thereto so as not to exceed the predetermined optimum rate of fluid flow therethrough, whereas tubes **83** are associated with a circuit or circuits of relatively low thermo-siphonic flow characteristics for which no restriction is required. The restrictor unit **85** comprises an imperforate cover plate **86**, imperforate end plates, not shown, and side plates **87** which are perforated with holes **89** of the requisite size and number depending upon the extent of flow area restriction to be effected. If the circuits represented by tubes **81** and **82** are sufficiently dissimilar to require separate control of the water supply thereto, a diaphragm **91** may be included so as to divide the space under the baffle into separate compartments **92** and **93**, each supplied with water through holes in a separate side plate **87**.

Fig. 8 illustrates a modified form of restrictor unit **95** having imperforate side plates **96**, imperforate end plates, not shown, radially spaced and perforated arcuate cover plates **97** and **98**, and a radially disposed diaphragm **99** dividing the total interior space into separate compartments **101** and **102**. The tube circuits involved are, for purpose of illustration, assumed to be the same as described in connection with Figs. 1–4. In this construction, the supply of liquid is compelled to pass through holes in successive parallel plates **97** and **98**. By providing two perforated plates, in spaced relation, with the flow serially through the holes of the respective plates, more flexibility is afforded in the selection of arrangement and size of holes to give a desired flow resistance.

Figs. 9 to 11 illustrate an application of my invention to parallel flow circuits of a vapor generator comprising an upper three-drum water tube boiler section **141** and a lower water tube furnace wall section **142**, and having an intermediate drum **143** common to both sections; the wall section **142** defining a boundary of a fuel fired combustion chamber **140** from which heating gases are directed over tubes of the upper boiler section **141**. The upper boiler section **141** includes front and rear banks of upright tubes **145** and **146** having lower ends connected to the intermediate drum **143** and upper ends connected respectively to upper steam and water drums **147** and **148** which are interconnected by lower and upper circulating tubes **161** and **162**. Tubes **149** forming the rear row of tubes of the front bank **145** are bent upwardly and rearwardly and connected at their upper ends to the rear upper

drum 148, the tubes 149 supporting a baffle 163 to provide a superheater floor whereby gases are directed across the superheater 164. The furnace wall section 142 comprises upright tubes 165 having upper ends connected to the intermediate drum 143, and lower ends connected to a lower water wall header 167 to which tubular downcomer means 168 are connected, the downcomer means 168 extending downwardly from an elevated water compartment of the boiler, such as the intermediate drum 143 or upper drum 148 whereby water is continuously supplied to the lower water wall header 167.

In a boiler of the arrangement shown, in order to effect optimum flow conditions, it is desirable to control the distribution of fluid flow between the circuits formed by the screen tubes 145 and the superheater chamber floor tubes 149, inasmuch as the screen tubes 145 are located in a high temperature zone and are subject to a higher rate of heat absorption than the superheater chamber floor tubes 149 which are located in a lower temperature zone. In view of the inherent dissimilarity in thermo-siphonic characteristics of the parallel circuits including tubes 145 and 149, a structure as shown in Fig. 10 may be provided in the intermediate drum 143 for effecting a suitably proportionate supply of water to the respective circuits. The structure includes a junction box 171 having imperforate walls and defining an interior space or compartment 172 which serves as a riser path connecting the upper ends of wall tubes 165 to the lower ends of the superheater floor tubes 149. Interiorly of compartment 172, a restrictor unit 173 is positioned over the water inlet ends of boiler screen tubes 145, with holes in the arcuate wall 174, for example. In this arrangement, all tubes 146 throughout the rear boiler bank act as downcomers to the intermediate drum 143, from which the exterior downcomers 168 extend to the lower water wall header 167.

In the modified arrangement shown in Fig. 11, a junction box 175 defines an interior space or compartment 176 which serves as a riser path connecting the upper ends of wall tubes 165 to the lower ends of tubes 178 in two front rows of the rear boiler bank 146. Interiorly of compartment 176, a restrictor unit 179 is positioned over the water inlet ends of boiler screen tubes 145 and superheater chamber floor tubes 149, with an imperforate diaphragm 181 dividing the interior restrictor space into separate compartments opening respectively to the inlet ends of tubes 145 and tubes 149, and with holes in the arcuate wall 182, for example, of such size and number as to effect the optimum proportionate distribution of fluid flow to the dissimilar flow paths through tubes 145 and 149.

Although the representation of the flow distributing means in Figs. 6–8, 10 and 11, is largely diagrammatic, it is to be understood that the restrictor units and junction boxes included therein are intended for fabrication and assembly in such form and manner as to enable certain elements to be removed for access to tube ends for rolling, inspection, turbining and replacement of tubes and, if necessary, for substitution of a different restrictor plate or plates for modifying the distribution of water supply to the various tubes.

The application of this invention in a number of high capacity vapor generator installations has resulted in substantial economies in the production of component pressure parts.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form of my 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 a vapor generator of the natural circulation type, means forming parallel vapor generating circuits of dissimilar thermo-siphonic flow characteristics, said circuits including both a drum common to all of said circuits and riser tubes of dissimilar circuits having lower end connections to said drum in a plurality of separate longitudinal rows, downcomer means having a fluid supply connection to said drum, means defining a fuel-fired heating chamber supplying heat to said riser tubes and to which a considerable number of said tubes are exposed, means within said drum for restricting fluid flow from said drum into the riser tubes of selected circuits having the higher thermo-siphonic flow characteristics, said flow restricting means comprising a chambered restriction unit within said drum embracing the ends of all the riser tubes of said selected circuits, and means partitioning said unit into sections respectively communicating with the ends of riser tubes in said separate rows.

2. In a vapor generator, the combination as defined in claim 1 wherein each of said restriction unit sections is formed with a removably assembled wall portion having fluid flow openings therein providing communication with the drum space exteriorly of said unit.

3. In a vapor generator, means forming parallel vapor generating circuits of dissimilar thermo-siphonic flow characteristics, said circuits including a common lower drum together with riser tubes of dissimilar circuits having spaced lower end connections to said drum, downcomer means connected to said drum, means for supplying heat to said riser tubes, and means for restricting the flow of fluid from said drum into the riser tubes of a selected circuit having the higher thermo-siphonic flow characteristics, said last named means comprising a continuously submerged restriction unit within said drum having wall means defining a compartment embracing only the lower ends of said riser tubes of said selected circuit, said wall means having perforations therein providing restricted communication with said downcomer means, said wall means being formed with a removable wall section in which at least some of said perforations are formed, said removable wall section being arranged opposite said lower ends of riser tubes of said selected circuit and being formed with said perforations arranged only at positions opposite spaces separating said last named riser tube ends.

4. A vapor generator having fluid cooled upright walls defining a furnace heating chamber, fuel firing means discharging into said chamber, an upper and a lower drum arranged respectively adjacent upper and lower portions of said chamber, external downcomer means connecting said drums, tubes associated with said walls and having upper and lower end connections with said drums, said tubes being disposed in different heating zones of said chamber and forming with said downcomer means parallel vapor generating circuits of dissimilar thermo-siphonic flow characteristics, said tubes and said downcomer means combining with said drums to form a thermo-siphonic fluid circulation system, a group of said tubes having portions in the path of hot products of combustion from said fuel firing means and constituting the riser tubes of a selected circuit having the higher thermo-siphonic characteristics, and means continuously submerged within said lower drum for restricting the flow of fluid into the riser tubes of said selected circuit, the tubes of said group having connections to said lower drum disposed in a plurality of longitudinal rows, and said restricting means having walls defining a compartment embracing the tube connections in said rows, one of said compartment walls having openings therein offset from positions of alignment with the lower ends of all tubes of said group.

5. In a vapor generator, means forming parallel natural circulation vapor generating circuits of dissimilar thermo-siphonic flow characteristics, said circuits includ-

ing an upper and a lower drum common to said circuits together with riser tubes of dissimilar circuits having lower end connections to said lower drum, downcomer means forming a fluid supply connection direct from said upper drum to said lower drum, means for supplying heat to said riser tubes, and flow restricting means within said lower drum formed with compartments embracing the lower ends of all the riser tubes only in circuits having the higher thermo-siphonic flow characteristics, said compartments including wall portions formed with fluid flow openings therein connecting said compartments to an interior lower drum space to which said fluid supply connection is provided, said openings in said wall portions affording a total flow area substantially less than the total flow area afforded by all the riser tubes having ends embraced by said compartments.

6. In a vapor generator, the combination as defined in claim 5 wherein the openings formed in said compartment wall portions are out of alignment with the lower ends of all the riser tubes connected to said compartments.

7. In a vapor generator, the combination as defined in claim 6 wherein the compartment is defined in part by



an imperforate wall portion arranged arcuately of said drum, and wherein said wall portion containing said openings is disposed in a substantially radial direction.

8. In a vapor generator, the combination as defined in claim 7 and further comprising means partitioning the compartment into separate sections, and wherein the flow restricting openings are formed in radially extending wall portions associated with the respective sections.

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