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PLURAL DRUM VAPOR GENERATOR WITH DIFFERENTIAL SEPARATION
FOR HIGH DUTY AND LOW DUTY GENERATING TUBES

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2 Sheets-Sheet 1

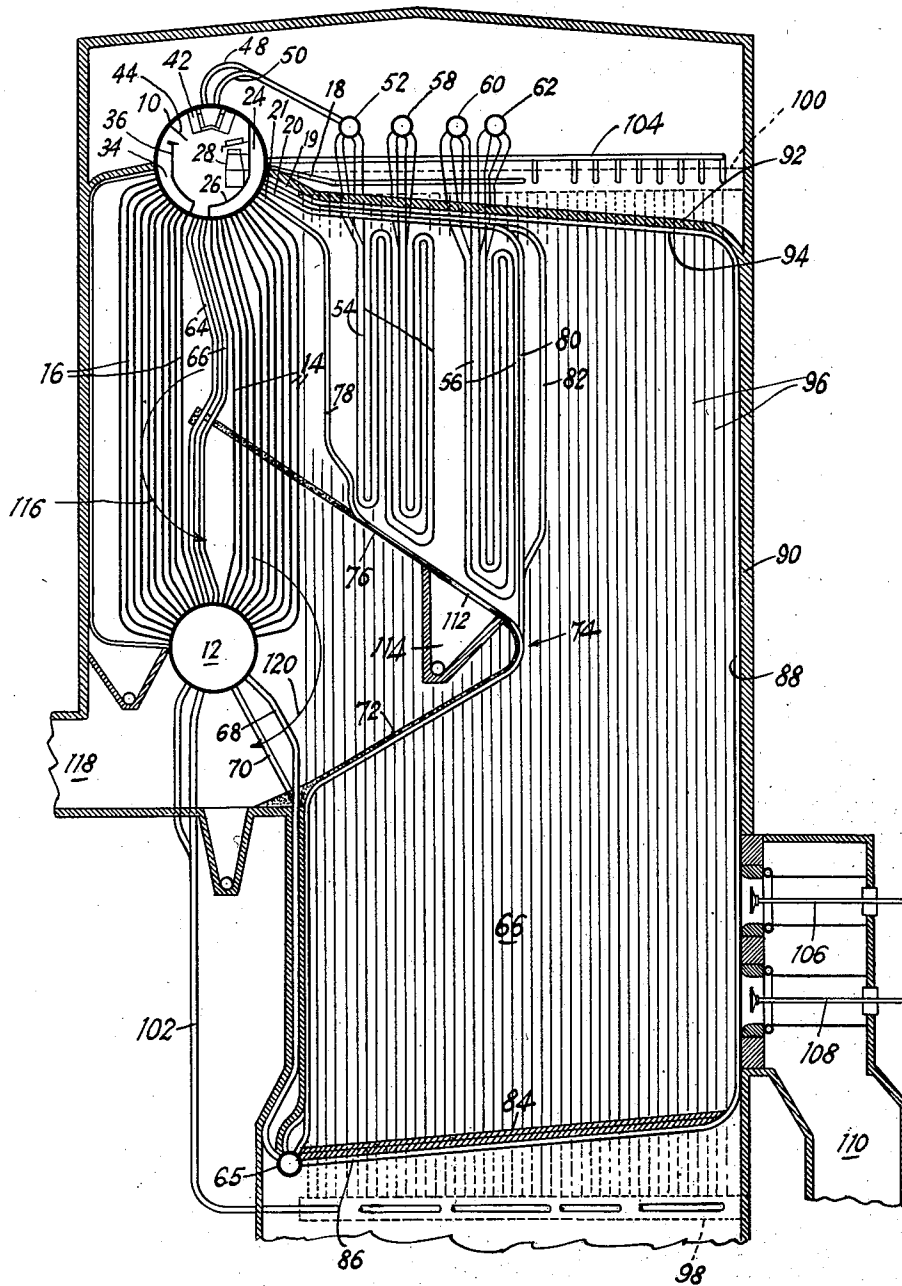


FIG. 1

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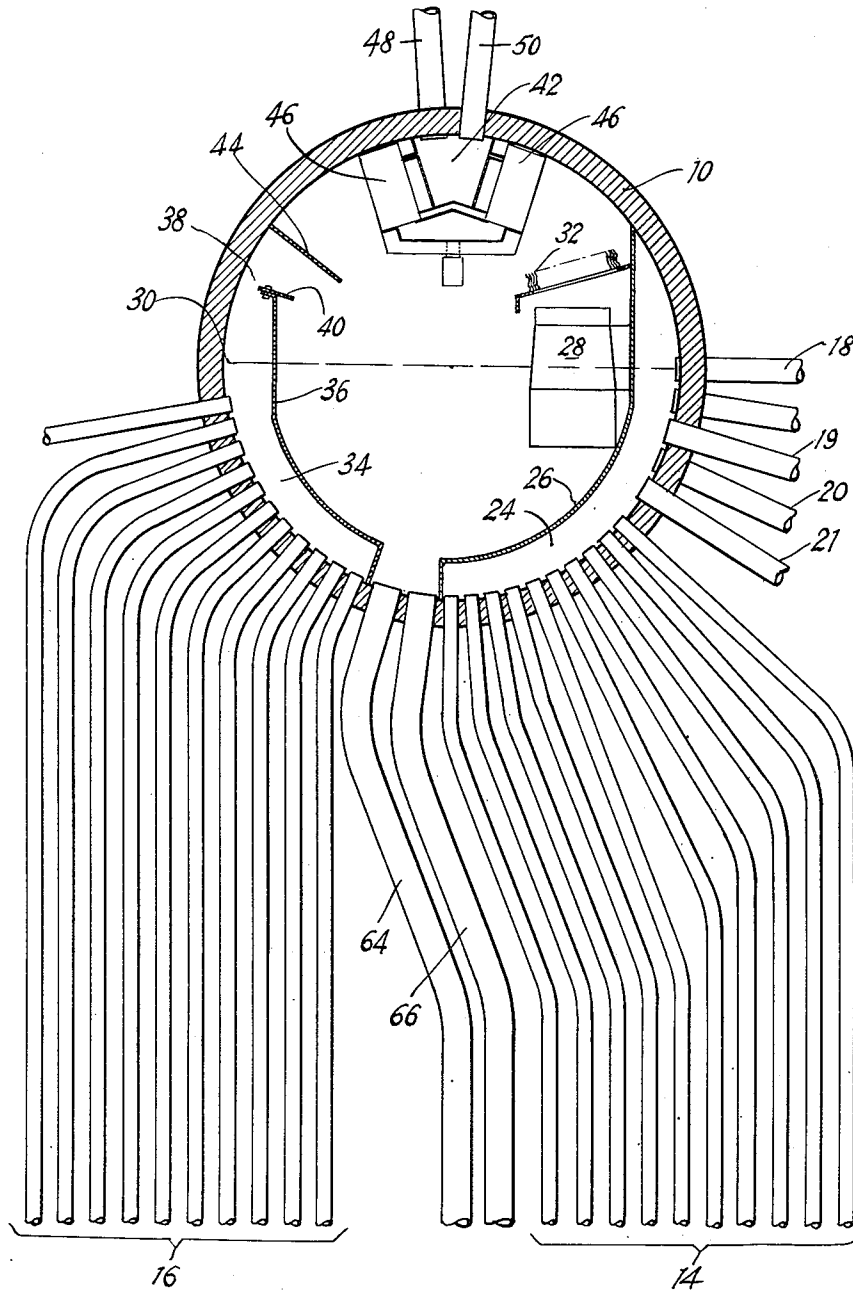


FIG. 2

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PLURAL DRUM VAPOR GENERATOR WITH DIFFERENTIAL SEPARATION FOR HIGH DUTY AND LOW DUTY GENERATING TUBES

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6 Claims. (Cl. 122-488)

This invention relates to a vapor generator unit having a group of high duty vapor generating tubes discharging into a vapor and liquid drum in one zone, and having another group of tubes which are low duty tubes discharging into the drum at another position.

The invention involves differential vapor and liquid separator provisions for the groups of tubes. These different vapor and liquid separator provisions are made within the drum to the end that the operation of the vapor generator will be improved by preventing unbalanced gas flows or unbalanced gas temperatures from so affecting the heat inputs to some of the low duty tubes that they recirculate vapor and liquid mixtures at low velocities and thereby cause steam separation and localized hot spots in the affected tubes.

More specifically, the invention involves, within the vapor and liquid drum, a separate manifold or inlet chamber receiving the vapor and liquid mixtures from the high duty vapor generating tubes and directing these mixtures through kinetic vapor and liquid separators associated with the manifold, a separate drum manifold receiving the vapor and liquid mixtures from the low duty vapor generating tubes, the low duty manifold discharging vapor and liquid mixtures through a restricted opening into the vapor space of the drum, and an arrangement of downcomer tubes at positions between the two drum manifolds.

The invention reduces the cost of the unit by substantially decreasing the number of necessary kinetic vapor and liquid separators, while at the same time avoiding such unbalanced circulatory conditions which would require increased downcomer capacity.

The invention will be described with reference to a preferred embodiment which is illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a sectional elevation of a vapor generator including a furnace with walls defined by vapor generating tubes, and a two-drum vapor generating convection section heated by the gases from the furnace; and

Fig. 2 is a fragmentary view of a part of the Fig. 1 unit showing the arrangement of high duty vapor generating tubes and the low duty generating tubes relative to the drum and the vapor and liquid separating manifolds therein.

Fig. 1 of the drawings shows a vapor and liquid drum 10 directly connected to a lower drum 12 by a bank 14 of high duty vapor generating tubes and a bank 16 of low duty vapor generating tubes. The high duty vapor generating tubes of the bank 14 together with the furnace wall risers 18-21 communicate with a primary vapor and liquid mixture inlet chamber formed within the drum 10 by the cyclone collecting baffle 26. The pertinent vapor and liquid mixtures flow from the chamber 24 through the cyclone vapor and liquid separators 28 which have their inlets communicating with the chamber 24. These cyclone separators discharge separated liquid down-

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wardly into the drum space below the liquid level 30, and they discharge separated vapor upwardly through the multiple plate scrubbers 32. These separators are of the type shown and described in the patent to Rowand et al. 2,321,628, dated June 15, 1943.

The low duty vapor generating tubes of the bank 16 discharge high density vapor and liquid mixtures into the secondary manifold or steam and water mixture inlet chamber 34 which is formed between the drum wall and the compartment baffle 36 as clearly indicated in the drawings. The vapor and liquid mixtures pass from the chamber 34 through the slot 38 into the vapor space of the drum. For the adjustment of the slot or opening 38 at the upper end of the baffle 36 an adjustable plate 40 is mounted at the top of the baffle, and the vapor and liquid mixtures passing upwardly through this slotted opening are prevented from interfering with the functioning of the vapor washer and secondary separator 42 by a baffle plate 44 which is secured to the drum in the position shown.

The secondary separator 42 may involve secondary multiple plate scrubbers 46 preferably arranged and constructed as shown in the patent to Fletcher et al. 2,143,191 (January 10, 1939). The separated vapor passes through these scrubbers and the vapor washer, and thence passes from the drum through the vapor outlet conduits 48 and 50 to the inlet header 52 of a convection superheater including a primary superheater section 54 and a secondary superheater section 56. Superheater vapor passes from the primary superheater section 54 through its outlet header 58 and thence through an attemperator (not shown) to the inlet header 60 of the secondary superheater 56. From the latter the superheated vapor passes from the outlet header 62 to a point of use.

The lower portions of drum manifolds 24 and 34 are spaced apart as shown in the drawings, and in this space large diameter downcomer tubes 64 and 66 are arranged to communicate with the liquid space of the drum. These downcomers directly connect the drums 10 and 12 as clearly indicated in Figs. 1 and 2.

The furnace wall risers 20 and 21 lead upwardly from the header 65 disposed at the lower part of the furnace 66, and appropriately connected with the drum 12 by downcomers 68 and 70. Immediately above the header 65 the risers 20 and 21 are disposed along the left hand furnace wall 71. Above this position these risers extend along the furnace side of the arch wall 72, and thence around the nose 74 of this arch and along the upwardly inclined wall or baffle 76 which forms the floor of the superheater gas pass and extends partially through the banks of tubes directly connecting the drums 10 and 12. Immediately rearwardly of the primary superheater section 54 some of the risers form the upright tubular screen 78. Others of the risers lead directly vertically from the nose 74 of the arch to form the tubular screen sections 80 and 82 immediately in front of the primary superheater 56.

Furnace floor 84 is cooled by the horizontally inclined sections 86 of the risers 19. At the right hand wall of the furnace these risers have the upright sections 88 extending along the furnace wall 90 and to the furnace roof 92. The roof is defined and cooled by the roof tube sections 94 leading to the drum 10.

The furnace side walls have vapor generating tubes 96 arranged in wall forming alignment and connecting lower headers such as 98 to upper side wall headers such as 100. The lower side wall headers have appropriate tubular connections 102 with the drum 12 and the upper side wall headers 100 have tubular connections 104 leading directly to the manifold 24.

The furnace is fired by burners 106 and 108, appropriately associated with the secondary air duct 110.

As the furnace gases pass beyond the nose 74 of the

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arch, solids separating from the gases along the inclined baffle 76 pass through the opening 112 into the hopper 114 for collection and periodic removal. The gases pass around the upper end of the baffle 76 in the path indicated by the arrow 116, and their flow continues to the flue 118 somewhat in the path indicated by the arrow 120.

The arrangement of the inlets of the large diameter downcomers 64 and 66 at the bottom of the drum 10 and between the manifolds 24 and 34 permits a maximum variation in normal liquid level of the drum without impairing the circulation of the unit. They also offer increased flow areas to eliminate tube pluggage which might otherwise be caused by sludge accumulations.

The arrangement of vapor generating surfaces above described has all of the high duty riser tubes discharging at the same side of the vapor and liquid drum. These riser tubes are subjected to the highest heat inputs and they therefore discharge low density mixtures (i. e. a high percentage of steam by weight) into the drum. All of the low duty vapor generating tubes 16 discharge high density mixtures into the separate manifold chamber 34 within the drum.

The described arrangement of drum manifolds and downcomers prevents steam generated in the low duty tubes from entering the downcomer tubes. This insures that the fluid flowing through the downcomers has a minimum specific volume resulting in the minimum restriction to flow. The effect of this is to increase the weight of fluid circulated so that the heat absorption per pound of fluid flowing in the downcomers is reduced. This increases the velocity of fluid in the downcomers and increases the circulating head on the vapor generator.

The kinetic or cyclone vapor and liquid separators 28 impose a specific pressure drop upon the flow of vapor and liquid mixtures from the high duty tubes 14 and through the manifold 24. Consequently, if the vapor and mixture streams through the low duty tubes and the manifold chamber to the drum (10) liquid space were not restricted by the opening 38, with its adjustable plate 40, the flow of liquid in those streams would be so great as to require greater downcomer capacity in order to keep the flow through the high duty tubes at the optimum rate. Such undesirable results are prevented by the adjustment of the opening 38 to provide the desired restriction.

Whereas the invention has been described with reference to the details of the illustrative embodiment, it is to be appreciated that the use of the invention is not limited to all of such details. The invention is rather to be taken as of a scope commensurate with the scope of the appended claims.

What is claimed is:

1. In a vapor generator, an upper liquid and vapor separating drum, a lower drum, a bank of upwardly extending high duty vapor generating tubes directly connecting said drums and arranged to discharge into one sector of the upper drum, a group of low duty vapor generating tubes arranged to discharge into another sector of the upper drum spaced from the first sector, a furnace from which gases flow over said tubes, large diameter tubular downcomers connecting upper and lower drums and disposed between said groups of tubes so as to be subject to the gas flow from the high duty tubes to the low duty tubes, kinetic liquid and vapor separating means including a manifold receiving only the vapor and liquid mixtures discharged from the high duty vapor generating tubes, and gravity vapor and liquid separating means including a manifold disposed within the drum and receiving only the discharges from the low duty vapor generating tubes.

2. In a vapor generator, an elevated liquid and vapor drum, means forming a water chamber at an elevation lower than that of the drum, large diameter upright downcomers directly connecting the lower part of the drum and said water chamber, a group of high duty vapor

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generating tubes subject to high heat inputs and normally discharging high velocity streams of vapor and liquid mixtures into the drum, said mixtures being predominantly vapor, a group of low duty vapor generating tubes normally discharging low velocity vapor and liquid mixtures into the drum, said last named mixtures being predominantly liquid, means providing high temperature gases for heating said tubes, the low duty tubes being subject to the heat of the gases after loss of heat to the high duty tubes, a gravity type vapor and liquid separator including a first manifold construction disposed within the drum so as to receive only the vapor and liquid mixture from said low duty vapor generating tubes, a second manifold construction separate from the first, said second manifold construction receiving the discharge of said low duty vapor generating tubes and being freely open to the vapor space of the drum at an elevation above the drum liquid level, and whirl chamber vapor and liquid separating devices receiving only the vapor and liquid mixtures from the high duty tubes and acting to separate the vapor from the liquid and discharge the separated vapor into the drum at a position above its liquid level.

3. In combination, an elevated liquid and vapor drum normally having a liquid level therein, a group of high duty vapor generating tubes subject to high heat inputs and normally discharging high velocity streams of vapor and liquid mixtures into the drum, said mixtures being predominantly vapor, a group of low duty vapor generating tubes subject to low heat inputs and normally discharging into the drum vapor and liquid mixtures, said last named mixtures being predominantly liquid, a first manifold construction disposed within the drum over the inlets of said high duty vapor generating tubes, a gravity type vapor and liquid separator including a second manifold construction separate from the first and disposed within the drum, said second manifold construction receiving only the discharge of said low duty vapor generating tubes and being freely open to the vapor space of the drum at an elevation above the drum liquid level, and whirl chamber vapor and liquid separating devices receiving only the vapor and liquid mixtures from the high duty tubes and acting to separate the vapor from the liquid and discharge the separated vapor into the drum at a position above its liquid level.

4. In a vapor and liquid separating apparatus, a vapor and liquid separating drum normally having a liquid level therein, compartment means within the drum and forming therewith first and second separate manifolds in different drum sectors, a group of highly heated high duty tubes normally discharging high velocity and low density vapor and liquid mixtures into the first manifold, kinetically operating liquid and vapor separating means associated with the first manifold to kinetically separate vapor and liquid and discharge them into the liquid and vapor spaces of the drum respectively, and a group of low duty tubes connected to the second manifold and subject to a heat input much less than the heat input to the high duty tubes so as to discharge high density and low velocity vapor and liquid mixtures into the second manifold, the second manifold constituting a gravity type vapor and liquid separator and having an elevated outlet communicating with the vapor space of the drum.

5. In vapor and liquid separation apparatus, a vapor and liquid separation drum normally having a liquid level separating its liquid and vapor spaces, baffle means within the drum and forming therewith first and second separate manifolds, a group of highly heated high duty vapor generating tubes connected to the first manifold and normally discharging low density and high velocity vapor and liquid mixtures thereinto, a group of low duty vapor generating tubes subject to heat inputs much less than the heat inputs to the high duty tubes and connected to the second manifold to normally discharge therein vapor and liquid mixtures of much higher density, the second manifold being formed at its upper portion with an outlet

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establishing communication with the drum vapor space whereby the second manifold constitutes a gravity type vapor and liquid separator, and kinetic vapor and liquid separation means having an inlet communicating with the first manifold and outlets for separated vapor and liquid communicating respectively with the vapor and liquid spaces of the drum.

6. In a vapor generator, an upper liquid and vapor separating drum, a lower drum for vaporizable liquid, a group of upright tubes directly connecting the drums and constituting high duty vapor generating tubes arranged to discharge into a first submerged sector of the upper drum, a group of low duty vapor generating tubes arranged to discharge vapor and liquid mixtures into a second submerged sector of the upper drum separate from the sector into which the high duty tubes discharge, means providing a heating gas flow serially over said high and low duty tube groups, liquid and vapor separating means in said upper drum including a first manifold in the first drum sector arranged to enclose the discharge ends of said

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high duty tubes and having a discharge opening at its upper end, a second manifold separate from said first manifold and arranged in said second drum sector to enclose the discharge ends of said low duty tubes and having an outlet therefrom at its upper end, and means associated with the outlets of each of said manifolds for separating liquid and vapor, and a plurality of down-comer tubes connected to a third submerged sector of said upper drum separate from said first and second submerged drum sectors and arranged in the heating gas flow path over said high and low duty tube groups.

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