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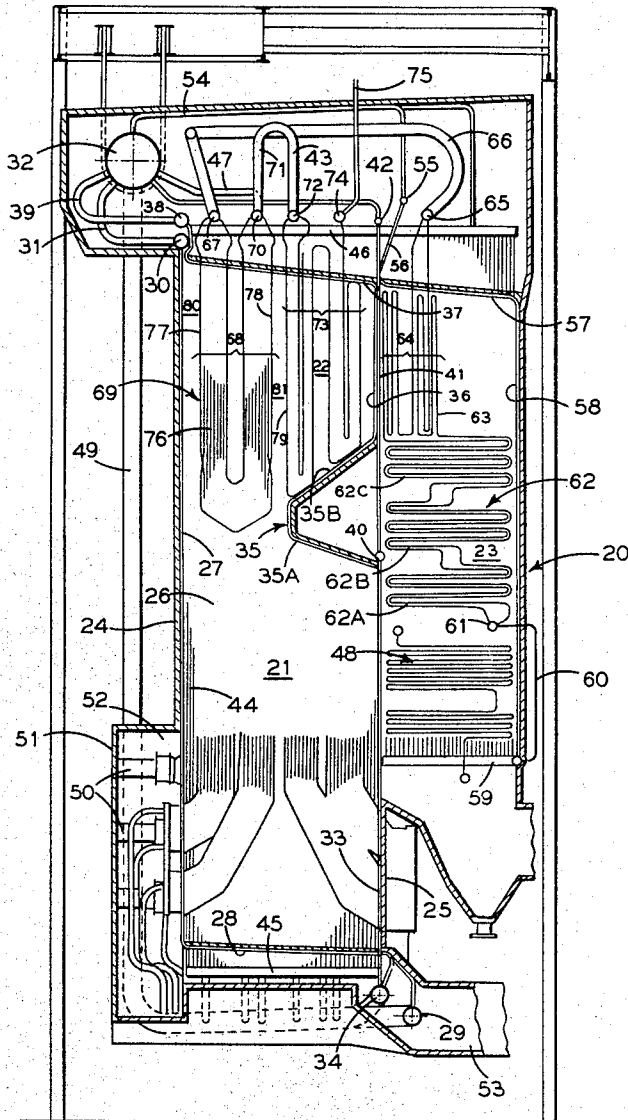
W. H. ROWAND
VAPOR GENERATOR

2,914,040

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2 Sheets-Sheet 1

FIG. 1



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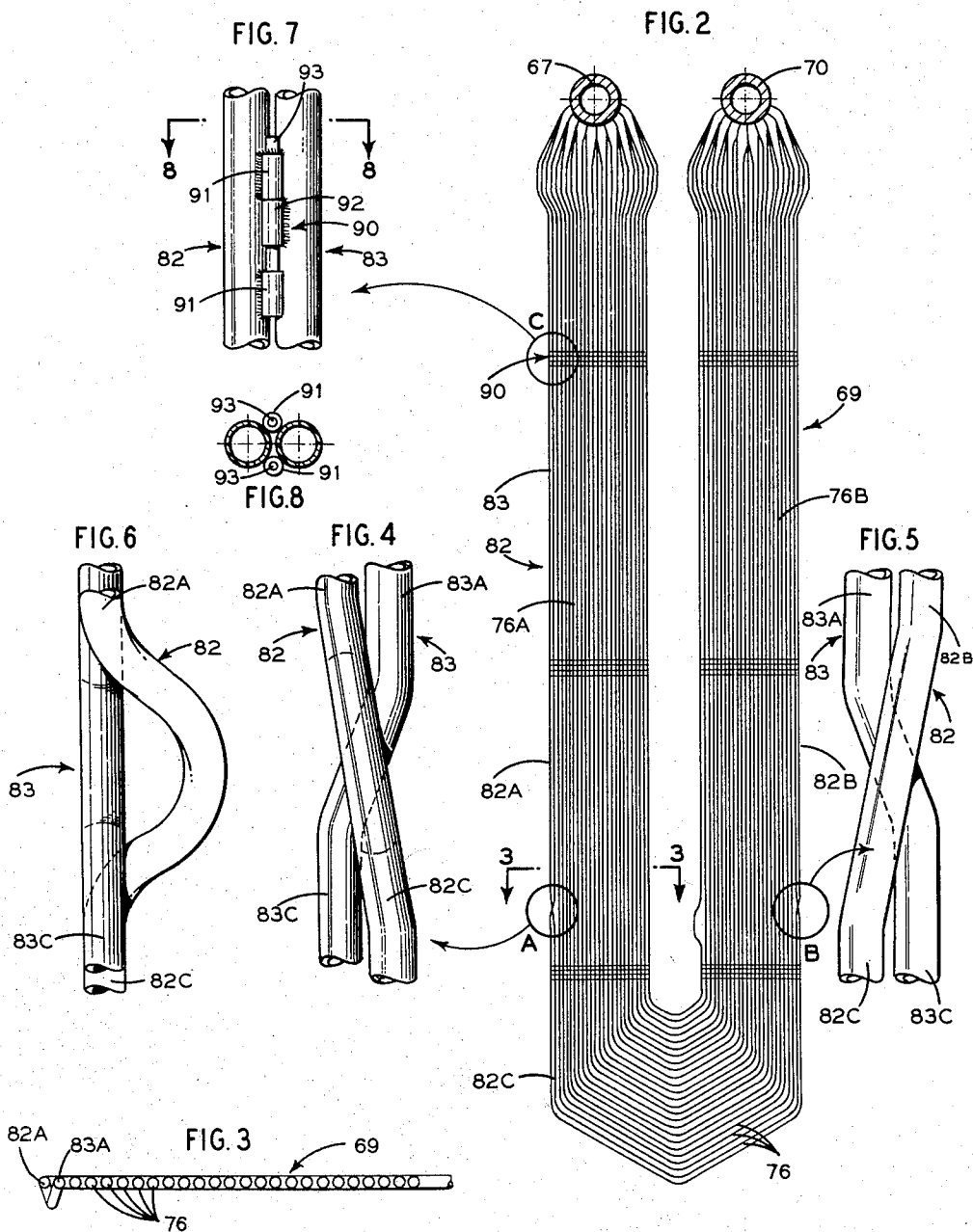
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1

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VAPOR GENERATOR

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6 Claims. (Cl. 122-476)

This invention relates to a vapor generating and heating unit and more particularly to a high capacity, high temperature vapor or steam generating and heating unit having an improved tubular steam heating construction and arrangement for effecting an equalization in the heat absorption rates thereof.

In the design and construction of a steam generating unit of a type to be herein described, it is oftentimes necessary to provide a cavity adjacent or between banks of steam heating tubes for access, soot blowers, or to leave space for the installation of additional steam heating surfaces as might be required. As a result the heating gases passing through such cavities or spaces transmit heat to the heat absorbing surfaces of that portion of the steam heater bordering thereon by what is known in the steam generating art as "cavity radiation." An effect of this "cavity radiation" phenomenon results in increasing the heat absorption rates in the tubes which form the boundary of such cavities. This effect is particularly critical on cavity boundary tubes which constitute a part of a high temperature steam heater in that the absorption rates of such tubes strongly influence the tube metal temperatures and the selection of alloys for forming the same.

Heretofore, in order to compensate for the increased heat absorption rate due to cavity radiation in the cavity bordering tube of a steam heating component, it had been customary to either increase the alloy requirements of the boundary tubes over that required by the succeeding inner or non-boundary tubes or in a steam heating component having the tubes thereof formed of a given alloy by increasing the wall thickness of the tube bordering on the cavity. In either event the prior practice of correcting for cavity radiation involved an initial cost factor.

An object of this invention is to provide in a vapor generator having a radiant, high temperature tubular steam heating element bordering on a cavity an improved steam heating arrangement for minimizing the difference in the heat absorption characteristics of the boundary tube as compared to the succeeding inner or non-boundary tubes of the element.

Another object is to effect equalization of heat absorption rates in a platen element of a tubular steam heater which borders a radiation cavity, in a relatively simple, economic and positive manner.

The above objects together with other allied features and advantages are attained, in a steam generator having a steam heater bordering on a cavity, by interchanging the outermost or cavity boundary tube of a high temperature steam heater exposed to cavity radiation and an adjacent tube disposed in a zone of lower heat absorption in position with respect to one another so that each of the tubes defines a part of the boundary of the cavity. This results in the reduction in the absorption rate by the outermost tube by reason that only a portion thereof is exposed directly to cavity radiation. As a feature of the invention, this construction tends to

2

work in the direction of either reducing the alloy requirement of the outermost tube or in a vapor heater having the tubes thereof formed of a given quality of alloy, reducing the thickness of the outermost tube wall over that which would be otherwise required if the outermost tube was exposed to cavity radiation over its full length.

Other features and advantages will be readily apparent when considered in view of the drawings and description thereof in which:

Fig. 1 is a schematic sectional side view of a steam generating and heating unit embodying the instant invention.

Fig. 2 is an enlarged detail side view of a high temperature vapor or steam heating means arranged in accordance with the instant invention.

Fig. 3 is a plan section view taken along line 3-3 of Fig. 2.

Fig. 4 is an enlarged front view of Detail A of Fig. 2.

Fig. 5 is an enlarged side view of the Detail A of Fig. 2.

Fig. 6 is an enlarged side view of Detail B of Fig. 2.

Fig. 7 is an enlarged detail side view of Detail C on Fig. 2.

Fig. 8 is a plan section view taken along line 8-8 of Fig. 7.

The illustrated vapor or steam generating and superheating unit in which the present invention is embodied has a steam generating capacity of approximately 1,900,000 lbs. of steam per hour with a total steam temperature at the superheater outlet in the order of 1100° F. at about 2400 lbs. p.s.i.

Referring to Fig. 1, the unit comprises a setting 20 including an elongated furnace chamber 21, a laterally extending gas pass 22 adjacent the upper end of the furnace in open communication therewith at one end and a downwardly extending convection section 23 connecting with an opposite end of the gas pass. The furnace chamber 21 is preferably rectangular in cross-section and is defined by a front wall 24, a rear wall 25, and connecting side walls 26. The front wall 24 includes a row of steam generating tubes 27 which extend upwardly in the wall 24 as continuations of the furnace floor tubes 28, the floor tubes 28 and the upward front wall extensions 27 thereof being supplied from a lower water header 29 and discharge into an upper front wall header 30. One or more conduits 31 in turn connects header 30 into the steam and water separating drum 32.

The furnace rear wall 24 includes a row of tubes 33 in which a portion thereof extend upwardly from supply header 34. At an intermediate elevation tubes 33 are bent inwardly to form an arch 35 having sections 35A and 35B with extensions of section 35B continuing upwardly as screen tubes 36 adjacent the exit of the gas pass 22. Adjacent the top of the furnace the screen tubes 36 bend inwardly and extend across the top of the furnace as roof tubes 37 having their discharge ends connecting into header 38. One or more conduits 39 connect header 38 to the drum 32.

Another portion of the rear wall tubes 33 extends vertically between supply header 34 and an intermediate header 40 which extends transversely of the furnace rear wall in the vicinity of the arch 35. Connected to the intermediate header 40 and extending upwardly therefrom to form the remainder or upper portion of the furnace rear wall is a row of screen tubes 41 which connect into header 42, and the latter being connected by one or more conduits 43 to the steam drum 32.

The opposed furnace side walls 26 each include a row of steam generating tubes 44 which extend upwardly between a respective lower side wall header 45 and upper side wall header 46, the latter being connected to the steam drum 32 by one or more conduits 47.

Water, supplied to the water space of the drum 32 by

the usual economizer means 48 through suitable piping, is circulated to headers 29, 34 and the lower side wall supply headers 45 through suitable downcomer pipes 49.

Suitable burner means 50 are arranged to fire into the furnace and generate therein heating gases which flow upwardly through the furnace 21 and thence flow serially through the gas pass 22 and connected convection section 23. As shown, the burner means 50 are housed in a casing 51 which defines a windbox 52 which is in communication with an air duct 53 connecting with an appropriate air heater (not shown).

Steam generated as a result of radiant absorption by the furnace wall tubes 24, 33, and 44 of heat given up by the heating gases within the furnace, is separated from the steam and water mixture entering the drum 32 and exits from the steam space thereof through one or more steam pipes 54 which direct the steam to header 55. From header 55 the steam flows through a row of tubes 56 which extend along the top of the gas pass to form a roof section 57 and thence downwardly as the rear wall tubes 58 of the gas pass, tubes 58 having their discharge ends connecting into header 59 of the bottom of the downpass 23. From header 59 the steam flows through an appropriate steam connection 60 to the inlet header 61 of the primary superheater 62 and thence serially through the horizontally disposed multiple loop tube banks 62A, 62B and 62C in the convection section and the connected upright tubes 63 and their connected tube sections which comprise the vertically disposed tube bank 64. The steam flowing through tube bank 64 discharges therefrom and into header 65 from whence the steam flows through one or more conduits 66 to the inlet header 67 of the secondary superheater section 68. This section 68 comprises a plurality of space platen elements 69 of nested tubes exposed to radiant absorption of the hot gases in the upper zone of the furnace. The steam flowing through the platen elements 69 discharges into header 70 from whence it flows through one or more suitable steam conduits 71 to the inlet header 72 of the second portion 73 of the secondary superheater. Upon flowing through portion 73 the finally heated steam is collected in outlet header 74 from whence the steam is delivered to a point of use through appropriate steam conduits 75.

According to this invention the first section 68 of the secondary superheater is formed of a plurality of tube platens 69 that are spaced on relatively wide centers across the width of the furnace, each platen comprising a radiant superheater element depending from the top of the furnace in the upper high temperature zone of the same. Each platen 69 comprises a plurality of closely spaced, nested, return bend or U-shaped tubes 76 which depend or project downwardly into the furnace, the tubes 76 of each platen element having their inlet leg segments 76A and outlet leg segments 76B depending from inlet and outlet header 67 and 70, respectively.

As shown in Fig. 1 the tube platens 69 extending into the furnace chamber have the outer marginal portion disrupted as 77 of its inlet leg section 76A spaced from the front wall 24 of the furnace and the outer marginal portion 78 of outlet leg section 76B spaced from the leading edge 79, gas flow wise, of tube bank 73 so as to define therebetween cavities 80 and 81, respectively. Since the outermost tube in the platen element of the type described bordered on cavities 80, 81 and thereby subjected to increased heat absorption due to the phenomenon of "cavity radiation," it had been heretofore necessary to either increase the wall thickness of the cavity boundary tube or to increase the alloy requirements thereof in order to control the tube metal temperature thereof. For example in a radiant platen tubular steam heater disposed adjacent a cavity, such as 80 and 81 and having tubes of the platen formed of a given alloy with a $2\frac{1}{4}$ inch O.D. x .180" thick wall, it was heretofore necessary for the outermost tube bordering on the cavity to be formed as a $2\frac{1}{2}$ inch O.D. having a

.220" thick wall to correct for the increased absorption rate due to cavity radiation; or as an alternative construction steam heaters having their tubes normally formed of 9 Cr-Mo ferritic alloy steel required the cavity boundary tubes thereof to be formed of a higher grade 18-8 austenitic alloy steel.

In order to more economically correct for cavity radiation and to reduce the heat absorption rate in the outermost platen tube, which heretofore comprised the cavity boundary tube, the instant invention contemplates the interchanging of the relative positions of a portion of two or more of the outer tubes of a platen element with respect to one another so that the amount of heat absorbed by the outer marginal edge of the platens which defines a planar boundary of the cavity and therefore subjected to increased absorption, may be distributed over more than one tube. For example, with particular reference to Figs. 2 to 6 the outermost pair of tubes 82, 83 of a radiant platen element 69 described have the lower portions 82C, 83C thereof respectively interchanged in their positions relative to each other. More specifically the outermost U-shaped tube 82 has its upper inlet leg portion 82A and outlet leg portion 82B exposed to cavity radiation and the lower portion 82C connecting legs 82A, 82B disposed in a lower temperature or lower heat absorbing zone, while the next adjacent tube 83 has its corresponding inlet and outlet leg portions 83A, 83B positioned inwardly of the outermost tube leg portions 82A, 82B in a lower temperature zone and portion 83C connecting leg portions 83A, 83B disposed exteriorly of tube portion 82C in the higher temperature zone.

While only the outermost pair of tubes 82, 83 are shown as having only portions thereof interchanged or crossed over with respect to one another, it will be understood that three or more of the outer tubes, depending upon the make-up of the platen, may have portions thereof interchanged so that the boundary or marginal edge portion 77 or 78 of the platen is defined by portions of three or more different tubes. With this arrangement the increased absorption in the marginal portion of the platens 69 due to cavity radiation is distributed to several tubes which are arranged to define the boundary of the cavity. As a result of this invention the design and fabrication of radiant platen elements made to border on a cavity is simplified and the initial cost thereof reduced in that all the tubular elements thereof may be formed all of a given alloy having the same dimensions, i.e. wall thickness and tube diameter.

As shown in Figs. 2, 7 and 8, the platen tubes 76 are tied together by connector means 90. The connector means 90 include aligned sleeve members 91, 92 which are welded to adjacent tubes and a pin 93 inserted through the aligned sleeve openings. Referring to Figs. 7 and 8 the sleeves 91 are welded in spaced relationship to one tube and sleeve 92 is welded to the next adjacent tube, sleeve 92 being so positioned that it will be disposed in the space between sleeves 91, and the opening therein aligned with the opening in sleeves 91 to receive the pin 93. Each tube element in the platen is thus tied to its next adjacent tube.

While the instant invention has been disclosed with reference to a particular embodiment thereof, it is to be appreciated that the invention is not to be taken as limited to all of the details thereof as modifications and variations thereof may be made without departing from the spirit or scope of the invention.

What is claimed is:

1. A vapor generating and heating unit having walls defining a radiation chamber adapted to receive a heating gas flow, vapor heating means including a plurality of tubes forming a substantially co-planar platen element wherein the longitudinal center-lines of said tubes lie in the plane of said platen, said platen element being disposed in said radiation chamber in spaced relationship

5

to one of said walls with the plane of said platen element being disposed substantially normal to said one wall whereby an outer marginal portion of said platen element next adjacent said one wall and said one wall define therebetween a radiation cavity so that the marginal portion of said platen is exposed to a greater degree of cavity radiation than the inner planar portions thereof, and said marginal portion of said platen element including a pair of marginal forming tubes, said pair of marginal forming tubes including an outermost tube having a portion thereof exposed to said greater degree of radiation of said cavity and a next adjacent tube having a co-planar portion thereof shielded by said exposed portion of the outermost tube and disposed in lower radiant absorption zone, one of said marginal forming tubes having a portion thereof bent out of the plane of said platen to cross over a planar portion of said other marginal forming tube so that a second portion of said outermost tube and next adjacent tube, respectively, are displaced with respect to one another in the plane of said platen element whereby said second portion of said outermost tube becomes an inner marginal tube disposed in a lower radiant absorption zone and in shielding relationship with respect to said second portion of the next adjacent tube which becomes the outermost marginal tube and disposed in an absorption zone of higher cavity radiation.

2. A vapor generating and heating unit having front, rear and side wall means defining a furnace adapted to receive a heating gas flow, vapor heating means including a plurality of dependingly supported, nested, U-shaped tubes forming a substantially co-planar platen element wherein the longitudinal center-lines of said tubes lie in the plane of said platen, said platen element being disposed in said furnace in spaced relationship to said front wall means with the plane of said platen element being disposed substantially normal to said front wall means whereby an outer marginal portion of said platen element adjacent said front wall and said front wall means define therebetween a radiation cavity, said marginal portion of said platen being exposed to a greater degree of cavity radiation than the inner portions thereof and said marginal portion of said platen element including a pair of marginal forming tubes, said pair of marginal forming tubes including an outermost tube having a portion thereof exposed to said greater degree of radiation of said cavity and a next adjacent tube having a co-planar portion shielded by said exposed portion of the outermost tube and disposed in a lower radiant absorption zone, one of said marginal tubes having a portion thereof bent out of the plane of said platen to pass over a planar portion of said other marginal tube so that a second portion of said outermost tube and next adjacent tube, respectively, are displaced with respect to one another in the plane of said platen element whereby said second portion of said outermost tube becomes an inner marginal tube disposed in a lower radiant absorption zone and in shielding relationship with respect to said second portion of the next adjacent tube which becomes the outermost marginal tube and disposed in a higher cavity radiant absorption zone and each of said tubes being free to expand independently of the other.

3. A vapor generating and heating unit comprising a setting having front, rear and side wall means defining a furnace chamber, burner means for discharging hot gaseous products of combustion into said furnace, and a vapor heating platen element exposed in heat transfer relationship to said combustion gases, said platen element being spaced from said front wall means to form a cavity therebetween, thereby subjecting the spaced outer cavity bordering portion of said platen element to more intense cavity radiation than an inner portion thereof, said platen element including a plurality of closely spaced, co-planar, nested, U-shaped tubes having the plane of

6

said platen normal to said front wall means, said U-shaped tubes having upwardly extending opposed leg segments whereby the exposed outermost tube and the next adjacent tube form the planar boundary of said platen element, said planar boundary of said platen element being formed by said outermost tube and next adjacent tube having respective portions thereof displacing other respective portions of one another in the plane of said platen whereby the heat absorption rate of the outermost tube is reduced in a portion thereof by disposing that portion of its length in a shielding relationship with respect to a corresponding portion of the next adjacent tube and a complementary portion of said next adjacent tube having a section of its length disposed in shielding relationship to a corresponding complementary section of said outermost tube in the plane of said platen.

4. A high capacity, high temperature vapor generating and heating unit comprising a setting including front, rear and side wall means defining an upright furnace chamber, burner means discharging heating products of combustion into said furnace chamber, a vapor heating means disposed in heat transfer relationship to said products of combustion, said vapor heating means including a plurality of spaced platen elements, extending transversely of said upright chamber in spaced relationship to said front wall means to form therebetween a radiation cavity whereby the plane of each of said spaced platens is disposed substantially normal to and spaced from said front wall means so that the outer cavity bordering marginal portion of each of said platens is exposed to a greater degree of cavity radiation than the inner portion of said platen, each of said platen elements comprising a plurality of closely spaced, nested, co-planar, U-shaped tubes depending vertically into said cavity, said platen having upwardly extending opposed marginal portions each defining a planar boundary of said platen, said opposed marginal portions including a pair of tubes, said pair of tubes including a U-shaped outer tube and a next adjacent U-shaped inner tube, said outer tube having end portions of its opposed leg segments forming an outermost part of said platen and said next adjacent U-shaped tube having an intermediate portion between its opposed end portions displaced with respect to the intermediate portion of said outermost tube in the plane of said platen to define another outermost portion of said platen.

5. A vapor generating and heating front, rear and side unit having a wall means defining a radiation chamber, means for providing a heating gas flow therethrough, vapor heating means including an inlet header forming a source of a vapor having a uniform, predetermined temperature and a plurality of tubes connected to said header for parallel vapor flow therethrough, said tubes forming a substantially co-planar element having their longitudinal center-lines lying in the plane of said platen, said platen element being disposed in said radiation chamber in heat exchange relationship to the gas flow therethrough and in spaced relationship to said front wall means to form therebetween a radiation cavity whereby the plane of said platen element is disposed substantially normal to said front wall means so that an outer cavity bordering marginal portion of said platen element is exposed to a greater degree of radiant heat absorption than said other portions thereof, said marginal portion including a pair of marginal tubes, said pair of marginal tubes including an outermost tube and a co-planar inner tube, said inner tube having a first portion thereof in shielding relationship with respect to a first corresponding portion of said outermost tube whereby said first portion of said inner tube is disposed in a lower radiant absorption zone than said first corresponding portion of the outermost tube so that the vapor flowing through said first portion of said inner tube is heated to a lesser degree than the vapor flowing through said first portion of said outermost tube, and at a predeterminate intermediate point along

the length thereof said outermost tube and inner tube each have a second portion, respectively, displaced with respect to one another in the plane of said platen so that the second portion of said outermost tube which has the higher heated vapor flowing therethrough is disposed in a lower heat absorption zone in shielding relationship with respect to said second portion of said inner tube which is exposed to higher heat absorption and has the lower heated vapor flowing therethrough thereby promoting uniform heat absorption in the marginal portion of the platen.

6. A vapor generating and heating unit having walls defining a radiation chamber adapted to receive a heating gas flow, vapor heating means including a plurality of tubular members forming a substantially co-planar platen element wherein the longitudinal center-lines of said tubes lie in the plane of said platen, said platen element being disposed in said radiation chamber in heat exchange relationship to the gas flow therethrough and in spaced relationship to one of said walls with the plane of said platen element being disposed substantially normal to said one wall whereby an outer marginal portion of said platen next adjacent said one wall and said one wall define therebetween a radiation cavity so that the marginal

portion of said platen is arranged to receive a greater amount of cavity radiation than an inner planar portion thereof, and said marginal portion of said platen element including at least an outermost tube having a first portion thereof arranged to receive said greater amount of cavity radiation and an inner tube having a co-planar first portion in shielding relationship with said first portion of said outermost tube and disposed in a lower radiant absorption zone, one of said tubes having a portion thereof bent out of the plane of said platen to cross over the other so that a second portion of said outermost tube and inner tube, respectively, are displaced with respect to one another in the plane of said platen element whereby said second portion of the outermost tube is disposed in a zone of lower radiant absorption in shielding relationship with a second portion of said inner tube which is disposed in a zone of higher radiant absorption.

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