Sept. 27, 1966 E. K. RICKARD ET AL 3,274,977

ARRANGEMENT OF A BUCKSTAY SYSTEM FOR WIDE FURNACE STEAM GENERATORS

Filed Nov. 12, 1964 4 Sheets-Sheet 1

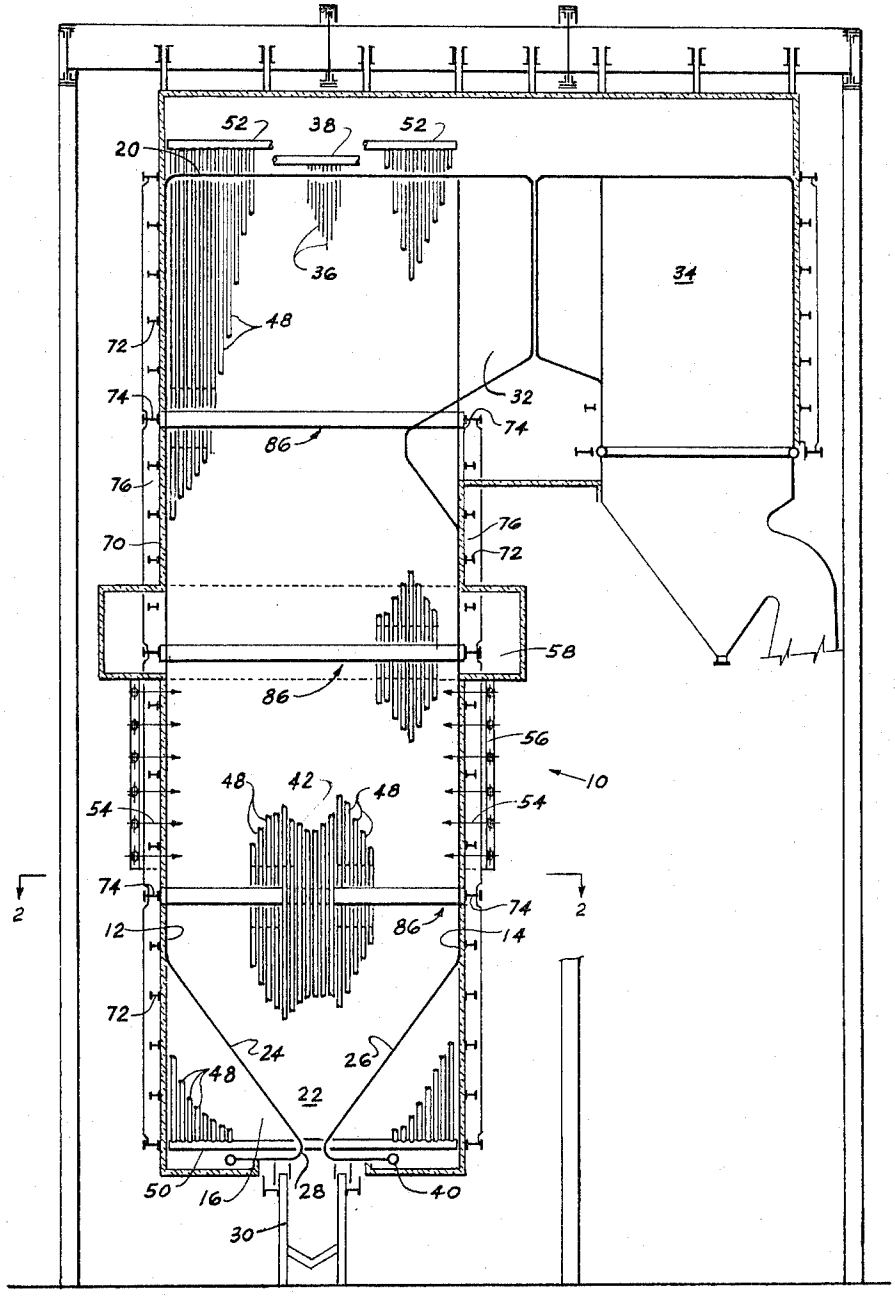


FIG. - 1

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Filed Nov. 12, 1964 4 Sheets-Sheet 2

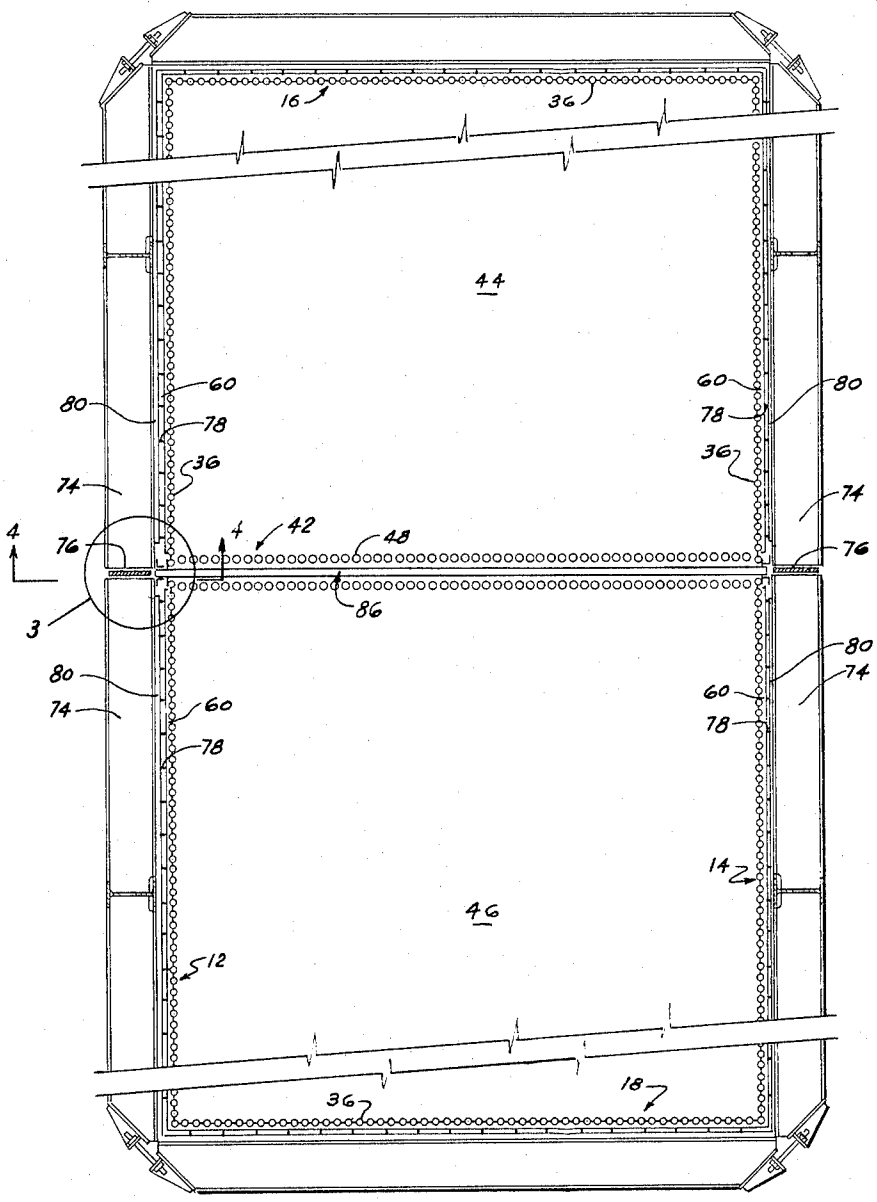


FIG. - 2

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Filed Nov. 12, 1964 4 Sheets-Sheet 3

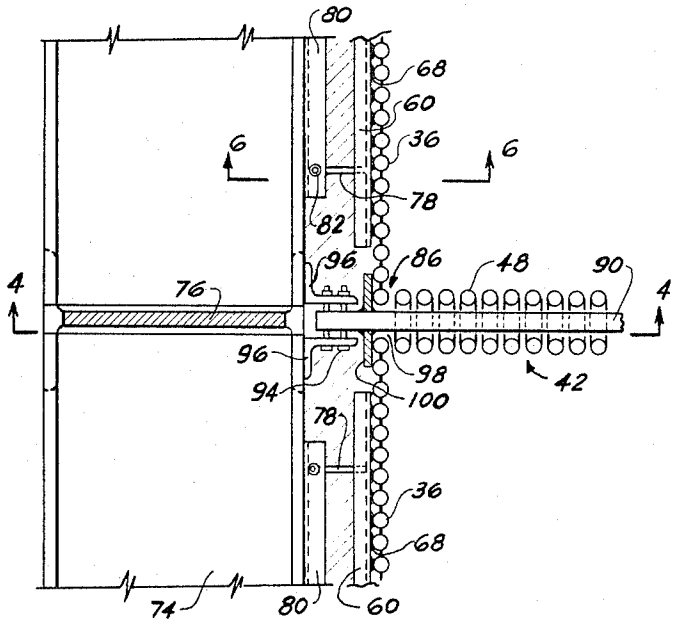


FIG.-3

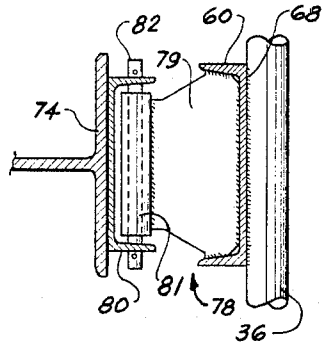


FIG.-6

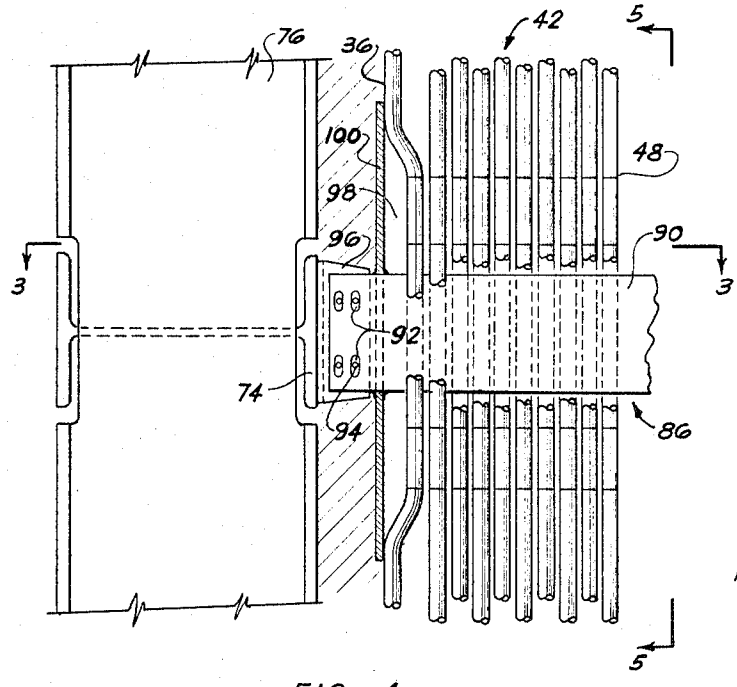


FIG.-4

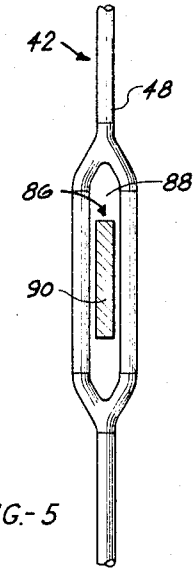


FIG.-5

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Filed Nov. 12, 1964 4 Sheets-Sheet 4

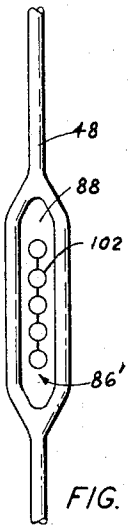


FIG. 10

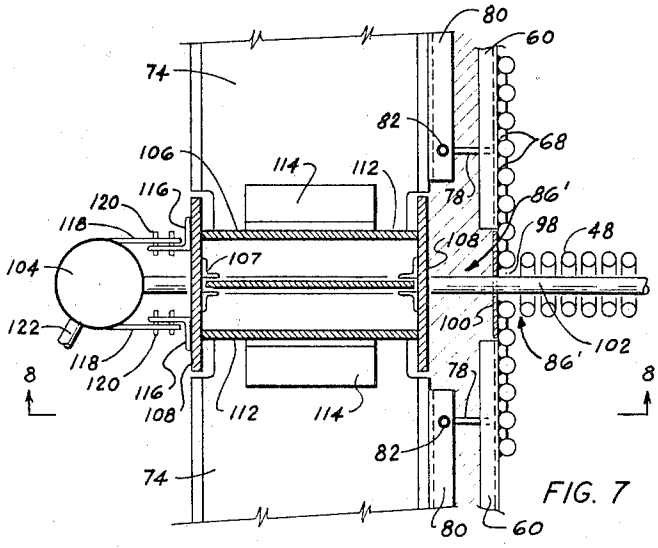


FIG. 7

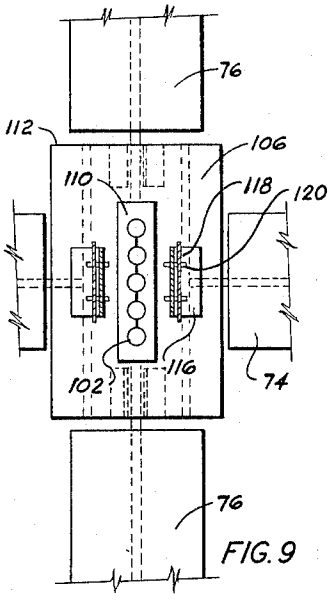


FIG. 9

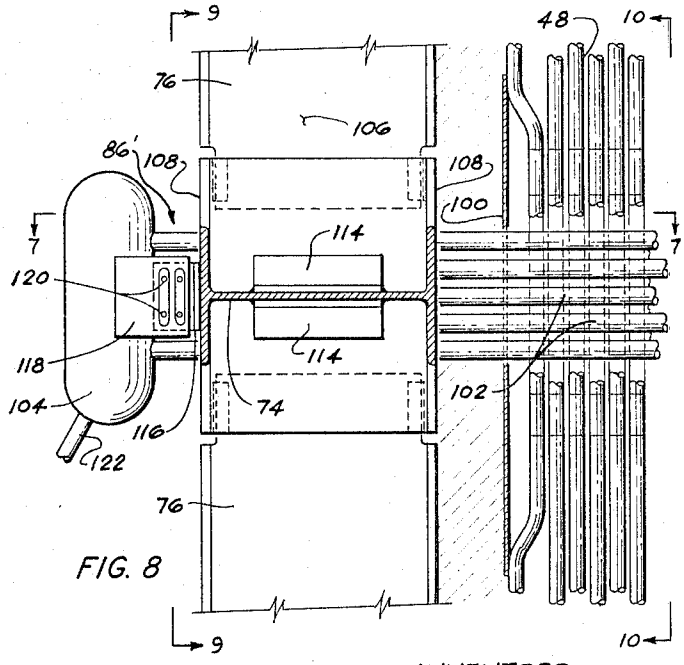


FIG. 8

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3,274,977

ARRANGEMENT OF A BUCKSTAY SYSTEM FOR WIDE FURNACE STEAM GENERATORS

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8 Claims. (Cl. 122—240)

The present invention relates to the construction of vapor generators. More particularly, the invention relates to a furnace wall stiffening structure especially adapted for use with vapor generators and furnaces having fluid cooled walls of large lateral dimensions where it is desirable to reduce the unsupported span of the buckstays employed in such a system.

In pressure operated vapor generators the walls defining the furnace thereof generally include a row of upright fluid cooled tubes. These walls are reinforced or stiffened by laterally supported buckstay assemblies that are vertically spaced along the height of the walls in order to contain the tubes and other pressure parts against internal furnace pressure due to operation or fire puffs. Heretofore it was customary to form the buckstays of standard cold rolled sections of up to approximately 36 inch depth for spanning vapor generator furnace walls of up to 50 feet in width. However, with the advent of divided furnaces where furnace widths exceeded this 50 foot dimension, the amount of deflection undergone by standard cold rolled steel sections having such a long unsupported span became excessive. It therefore became incumbent to construct buckstay assemblies for wide furnaces as truss members having increased depth dimensions to enable them to withstand fire and furnace operating pressures without undue deflection. This increase in depth of the buckstay dimensions, of course, gave rise to several manifest disadvantages. The time, labor and material costs for constructing such assemblies greatly increased the over-all cost of the vapor generator units. The greater depth of the buckstays increased the amount of floor space required for installing the unit and the greater size of the buckstay assemblies increased the problem of installing piping and other equipment ancillary to the unit.

It is accordingly one object of the present invention to provide in a vapor generator an improved furnace wall stiffening system wherein the amount of unsupported buckstay span is reduced.

Another object is to provide an improved furnace wall stiffening system especially adapted for use in divided furnace vapor generators having wide furnace dimensions whereby the size of the buckstays required in the system can be maintained within the limits of standard cold rolled sections.

Another object is to provide an improved buckstay tie arrangement for use in wide, divided furnace constructions that reduce the unsupported span of the buckstays, thereby permitting use of buckstays of smaller, conventional dimensions.

Other features and advantages of the present invention will become readily apparent when considered in view of the following description and drawings wherein:

FIGURE 1 is a sectional elevation of a vapor generator setting constituting an embodiment of the invention;

FIGURE 2 is a plan section of the vapor generator taken along line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged view of the area indicated as 3 in FIGURE 2;

FIGURE 4 is a partial sectional elevation taken along line 4—4 of FIGURE 3;

FIGURE 5 is a section taken along line 5—5 of FIGURE 4;

FIGURE 6 is a section taken along line 6—6 of FIGURE 3;

FIGURE 7 is a view similar to FIGURE 3 but depicting another embodiment of the invention;

FIGURE 8 is a partial sectional elevation taken along line 8—8 of FIGURE 7;

FIGURE 9 is a section taken along line 9—9 of FIGURE 7; and

FIGURE 10 is a section taken along line 10—10 of FIGURE 8.

In the drawings, referring first to FIGURES 1 and 2, there is shown a vapor generator 10 of the divided furnace type having a setting of generally rectangular cross section as defined by upright tubulous walls including front and rear walls 12 and 14, respectively, together with oppositely disposed side walls 16 and 18 and an upper enclosing wall or roof 20. The lower portion of the furnace defined by these walls is formed as an ash hopper 22 having inclined wall portions 24 and 26 converging downwardly toward a rectangular throat passage 28 discharging into an ash pit 30 located therebelow. As shown, the inclined hopper walls 24 and 26 are essentially lower extensions of the furnace front and rear walls 12 and 14. The upper portion of the described furnace is in communication, through the rear wall 14, with a horizontal gas pass 32 which extends substantially entirely across the rear wall and which communicates with the upper end of a vertical gas pass 34 leading to a stack (not shown).

As is customary in vapor generators, the upper and lower ends of the tubes 36 that form the furnace walls are appropriately connected to upper and lower headers 38 and 40 which connect them into a fluid circulation system. The space within the furnace is divided by an upright interior tubulous partition wall 42, thereby forming a pair of adjacent combustion chambers 44 and 46 within the furnace cavity. The wall 42 is formed by parallelly arranged tubes 48 that are positioned in closely adjacent side-by-side relation across the depth of the furnace between the front and rear walls 12 and 14. This wall 42 extends vertically from the bottom of the furnace cavity below the inclined hopper walls 24 and 26 where the tubes 48 connect to a lower header 50 through the furnace roof 20 where the tubes forming the wall are connected into the fluid circulation system by an upper header 52.

One or more burners 54 of a type suitable for the fuel to be burned are installed in association with appropriate openings in the furnace walls to provide a source of heating gases. Air for combustion is supplied to the burner or burners 54 through a windbox 56 to which air under pressure is supplied through a conduit 58 by the customary force draft fan (not shown).

The operation of the herein disclosed vapor generator is as follows. A vaporizable liquid, most usually in the form of water under pressure, is admitted to the lower headers 40 of the furnace walls and 50 of the partition wall while at the same time fuel for combustion is burned by the burners 54, whereby the combustion gases so generated are caused to flow vertically upwardly through the combustion chambers 44 and 46 and out through the horizontal and vertical gas passes 32 and 34 whereupon a transfer of heat occurs between the gases and the liquid flowing through the furnace tubes 36 and partition wall tubes 48, thereby transforming the liquid into vapor that

is removed from the upper furnace wall headers 38 and upper partition wall header 52.

The herein disclosed vapor generator is provided with a furnace wall stiffening system for rigidifying the walls against excessive furnace pressures. As shown in FIGURES 3, 6 and 7, intermediate the vertical height of the furnace walls 12–18, appropriately vertically spaced, horizontally extending channel ties 60, 62, 64 and 66 secure the tubes 36 in the respective walls in operative relationship to one another. The channel ties of each wall are held in place by weld connections 68, the juxtaposed ends of the channels being welded together at the corners, in effect forming a band around the periphery of the vapor generator. The outer surface of the walls is then covered with suitable insulation 70. In order to prevent any buckling of the tubular walls which may occur under excessive furnace operating pressure or fire puffs, reinforcing horizontal buckstays 72 and vertical buckstays 76 are connected to the respective walls, the horizontal buckstays 72 at vertically spaced intervals and the vertical buckstays 76 at horizontally spaced intervals throughout the unit periphery. At selected intervals enlarged horizontal buckstays 74 are provided for reasons to be described hereinafter.

As shown in FIGURES 2, 3 and 7, a plurality of horizontally spaced stirrups 78 attach each horizontal buckstay 72 or 74 to its respective wall intermediate the ends thereof, the buckstays terminating, as shown in FIGURE 2, adjacent the marginal edges of their respective walls. A detail of a typical stirrup is shown in FIGURE 6. It consists of an arm 79 having one end edge weldedly connected to channel member 60 and an apertured boss 81 at its other end. The boss 81 is of a size to be received between the spaced arms of a channel 80 that is fastened, as by means of welding, to the end flange of the buckstay 74. A connecting pin 82 adapted to extend through accommodating apertures in the spaced arms and through the boss 81 completes the connection.

In constructing vapor generators having the disclosed type of furnace wall stiffening system, it has heretofore been the practice of forming the buckstays 74 as a single horizontally extending cold rolled steel section that spans the entire length of the walls 12, 14 and 16. As vapor generator capacities increased, however, and the dimensions of the furnace front wall 12 and rear wall 14 expanded it became necessary to abandon the use of continuous standard cold rolled sections and resort to truss members for the horizontal buckstays that are capable of withstanding excessive furnace pressures with unsupported spans of from 50 feet to above 90 feet in length. According to the instant invention, the use of these truss members is obviated by providing tie means 86 that are capable of extending through the furnace cavity and attaching to the opposed horizontal buckstays mounted on the opposite walls thereby tying the buckstay span intermediate its length to reduce the unsupported buckstay span. As shown in FIGURE 1 these tie means 86 are located at vertically spaced positions throughout the height of the furnace and attach horizontal buckstays 74 mounted on the opposed front and rear walls 12 and 14. In the arrangement shown the partition wall 42 contains spaced elongated passages 88 that accommodate the tie means 86 and that provide a fluid cooled shield about the tie means and thereby prevent its being unduly heated by the combustion gases that flow through the combustion chambers 44 and 46. By supporting the horizontal buckstays 74 intermediate the length of their span the size of the buckstays required to prevent buckling thereof under adverse furnace conditions is reduced to approximately half the size that would be required for buckstays that are not so supported. Therefore, for a vapor generator having front and rear walls of about 90 feet in length, the buckstays required for the support of these walls may be formed of conventional cold rolled steel sections.

In FIGURES 3, 4 and 5 is shown a typical embodiment of the invention wherein the tie means 86 comprises an elongated tie bar 90 that is connected at each of its ends to opposed buckstay spans on the front and rear walls 12 and 14. As shown in FIGURE 4, the tie bar 90 contains slotted apertures 92 at each of its ends that provide a means for attaching connecting pins 94 through them and corresponding apertures 95 in angle members 96 that are weldedly attached to the buckstays 74. In the arrangement shown, the span of the horizontal buckstays 74 is actually split with the angle members 96 that connect the tie bar 90 being attached to the adjacent ends of separate buckstays that extend to a point immediately adjacent a vertical column 76. Openings 98 are provided in the front and rear walls 12 and 14 to accommodate passage of the tie bar 90 therethrough and a plate 100 that is apertured to receive the tie bar is weldedly attached to furnace tubes 36 adjacent the openings, thereby sealing the opening.

In order to cool the tie bars 90 the partition wall is provided with longitudinal passages 88 that surround and cool the tie bars. These passages 88 are formed by bifurcated portions of the partition wall tubes 48 as shown in FIGURE 5. In this manner, the cooling fluid that flows through the tubes 48 is directed around the tie bar 90 thereby to protect it against the adverse effects of excessive heating by the combustion gases that flow through the combustion chambers 44 and 46.

In FIGURES 7–10 is shown another embodiment of the invention. In these figures like elements are ascribed like numerals as in FIGURES 3–5. In this embodiment of the invention the tie means 86′ comprises a plurality of horizontally extending tubes 102 that are connected at each of their ends for fluid circulation by means of headers 104 that are in turn connected by means of a pin connection to an adaptor 106 provided in the vertical buckstays 76. The tubes 102 may be united by welded fins 103 for the sake of strengthening the tie means. The adaptor 106 comprises a pair of end plates 108 that are apertured as shown at 110 to receive the tubes 102 and a pair of spaced side plates 112 to which are attached the horizontal buckstays 74 by means of angle members 114 that are weldedly fastened to the side plates 112 and to the buckstay web. As shown in FIGURE 7 the flanges at the ends of the adjacent horizontal buckstays 74 are undercut in order to accommodate the adaptor 106. The adaptor 106 is mounted to the vertical buckstays 76 by removing a portion of the flanges of the former whereby the vertical buckstay webs are caused to extend into the adaptor to points immediately above and below the tie tubes 102 between opposed vertically extending angles 107 thereby to provide a sliding fit. In this embodiment the tie means is connected to the furnace stiffening system by means of slotted angles 116 that are weldedly fastened to the adaptor 106 and slotted attaching plates 118 that are weldedly fastened to the headers 104 such that the slotted apertures in each are in alignment whereby pins 120 can be inserted to complete the connection. Fluid conductors 122 connect to the headers 104 to thereby supply the tubes 102 with a cooling fluid. In the preferred embodiment this cooling fluid is steam that is extracted from such a point in the fluid circulating system that the tie means 86′ is permitted to expand laterally at substantially the same rate as the partition wall thereby reducing the amount of relative expansion that must be overcome between the vapor generator pressure parts and the tie means.

It can thus be seen that the present invention provides a simple, inexpensive means for reducing the unsupported span of buckstays employed to stiffen the walls of extremely wide furnaces. By means of the invention, conventional cold rolled steel sections that are inexpensive and readily available can be employed in vapor generators having furnace wall lengths that are far in excess of those adapted for use of standard cold rolled steel sections.

Also by means of the present invention the amount of floor space required to mount such vapor generators is considerably reduced since the depth of the buckstays that surround the unit are materially reduced.

It will be understood that various changes in the details, materials, and arrangements of parts which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

What is claimed is:

1. A vapor generator having a furnace with upright, rectangularly disposed tubulous side walls; a tubulous division wall dividing said furnace into spaced chambers; a furnace stiffening system surrounding said furnace including horizontally arranged buckstay means secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstay means including tie means positioned intermediate the ends of said buckstay means, said tie means extending through said furnace parallel to said division wall between a pair of opposed side walls; openings in said side walls permitting passage of said tie means, means external of said furnace securing the opposite ends of said tie means to said buckstay means; and the tubes of said division wall enclosing said tie means for cooling said tie means.

2. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending tubes dividing said furnace into laterally spaced chambers; a furnace stiffening system surrounding said furnace including horizontally arranged buckstay means secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstay means including horizontally disposed tie means positioned intermediate the ends of said buckstay means, said tie means extending through said furnace parallel to said division wall between a pair of opposed side walls, the tubes of said division wall being laterally offset to surround said tie means through said furnace; openings in said side walls permitting passage of said tie means; and means external of said furnace securing the opposite ends of said tie means to said buckstay means.

3. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending parallel tubes dividing said furnace into laterally spaced chambers; the tubes of said division wall containing longitudinally aligned opposed bifurcates defining passage means through said division wall; a furnace wall stiffening system surrounding said furnace including horizontally arranged buckstay means secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstay means including horizontally disposed tie means positioned intermediate the ends of said buckstay means, said tie means extending through said passage means in said division wall between a pair of opposed side walls; openings in said side walls permitting passage of said tie means; and means external of said furnace securing the opposite ends of said tie means to said buckstay means.

4. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending, parallel tubes dividing said furnace into laterally spaced chambers; a furnace wall stiffening system surrounding said furnace including a plurality of horizontally arranged, vertically spaced buckstays secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstays including a plurality of horizontally disposed, vertically spaced tie means positioned intermediate the ends of said buckstays, said tie means extending through said furnace in the plane of said division wall between a pair of opposed side walls; the tubes of said division wall

containing vertically spaced, longitudinally aligned, offsets forming vertically spaced passages through which said tie means extend; openings in said side walls permitting passage of said tie means; and means external of said furnace securing the opposite ends of each of said tie means to a pair of opposed buckstays.

5. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending parallel tubes dividing said furnace into laterally spaced chambers; a furnace wall stiffening system surrounding said furnace including horizontally arranged buckstays secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstays including a plurality of horizontally disposed fluid conducting tubes extending between a pair of opposed side walls; header means connecting said tubes in fluid circulation; the tubes of said division wall being laterally offset defining a passage through which said horizontally disposed tubes extend; opening means in said opposed side walls to permit passage of said tubes; and means securing the opposite ends of said tubes to said buckstays intermediate the ends thereof.

6. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending, parallel tubes dividing said furnace into laterally spaced chambers; the tubes of said division wall containing longitudinally aligned, opposed bifurcates defining passage means through said division wall; a furnace wall stiffening system surrounding said furnace including horizontally arranged buckstays secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstays including a plurality of horizontally disposed, vertically spaced fluid conducting tubes extending through said passage means between a pair of opposed side walls; metal strips coextensive with and positioned between said tubes joining them in structural unison; header means external of said furnace connecting said tubes in fluid circulation; opening means in said opposed side walls to permit passage of said tubes; apertured attaching members oppositely mounted on said headers and said buckstays; and pin means extending through said apertures securing the opposite ends of said tubes to said buckstays intermediate the ends thereof.

7. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls: an upright tubulous division wall comprising vertically extending, parallel tubes dividing said furnace into laterally spaced chambers; the tubes of said division wall containing lateral offsets defining passage means through said division wall; a furnace wall stiffening system surrounding said furnace including horizontally arranged buckstays secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstays including a horizontally disposed tie bar extending through said passage means between a pair of opposed side walls; opening means in said opposed side walls to permit passage of said tie bar; and means securing the opposite ends of said tie bar to said buckstays intermediate the ends thereof.

8. A vapor generator having a furnace with upright, rectangularly disposed, tubulous side walls; an upright tubulous division wall comprising vertically extending, parallel tubes dividing said furnace into laterally spaced chambers; the tubes of said division wall containing longitudinally aligned, opposed bifurcates defining passage through said division wall; a furnace wall stiffening system surrounding said furnace including horizontally arranged buckstays secured to and supported on the tubes of said side walls externally of said furnace; means for reducing the unsupported span of said buckstays including a horizontally disposed tie bar having apertured ends extend-

ing through said passage means between a pair of opposed side walls; opening means in said opposed side walls to permit passage of said tie bar; apertured attaching members mounted on the buckstays of said opposed side walls intermediate the ends of said buckstays; and pin means extending through the apertures of said attaching members and said tie bar securing the opposite ends of said tie bar to said buckstays.

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