The buckstay members, being located externally of the unit and out of communication with the hot gases, are conversely not subject to any substantial amount of thermal expansion. Thus, provisions must be made for relative movement between the walls and buckstays due to the relative amounts of thermal expansion. Hereofore, it has been the usual practice to accommodate the vertical relative movement by hanging the buckstays on the furnace walls so that the buckstays "float" with the vertical expansion movements of the walls. Horizontal expansion of the walls relative to the buckstays is normally accommodated by providing pin and slot connections between the walls and buckstays. A more recent innovation for accommodating relative horizontal expansion movements between walls and buckstays is shown in U.S. Patent No. 3,007,455, issued November 7, 1961, in the name of C. Lieb et al., wherein pivotal linkage members interconnect the ends of the buckstays with the furnace walls. It should be noted, however, that even in this recent buckstay arrangement the weight of the buckstay members is carried by the walls, i.e., the buckstays are "hung" on the walls.

In recent years, economy has dictated a continual increase in the steaming capacity and size of vapor generating units. This trend, coupled with the operation of these units at higher positive fire-side pressures, dictates that the cross-sectional area of the buckstays required to afford adequate support to the walls of these large vapor generators be increased to almost impractical dimensions. As an example of this, in a recent design study of a large central station vapor generator of the usual top-supported design, the furnace was to be operated at a pressure of 30 inches of water, and a single wall span was almost 100 feet wide. Calculations indicated that the buckstay members of the design shown, for example, in the above-mentioned U.S. patent would have to be at least 60 inches in depth having a wall span of that magnitude. The use of such large buckstay members would result in more costly fabrication of support steel since the vertical support column centers normally used for the unit would have to be increased in order to accommodate the increased size of such wide buckstays. Since the tubes forming the vapor generator walls are preferably of relatively small diameter, i.e., about 1 inch O.D., the added weight of such large buckstays accentuates the problems of allowable loading limits which may be satisfactorily accommodated by the wall tubes.

It is therefore an object of the present invention to provide an improved buckstay arrangement for a large wall span of a high capacity vapor generator, the buckstay system being such that the size of the buckstay structural members is less than would be required by present design standards to afford adequate lateral wall support. It is a further object of the present invention to relieve the vapor generator walls of the burden of supporting the weight of the entire buckstay system.

To accomplish these and other objects which will become apparent, in accordance with the present invention there is provided a fluid heating unit comprising a vapor generator forming an upright furnace chamber wherein fuel is consumed to produce hot combustion gases, and walls defining an upright convection gas pass adjacent said furnace chamber. The upper portions of the furnace chamber and convection gas pass are interconnected for the flow of combustion gases from the former to the latter by means including a pair of spaced upright parallel side walls common to the furnace chamber and convection pass. A rigid support structure extends above the furnace chamber and convection gas pass, and support rods interconnect said support structure and the side walls for the pendent support thereof. The buckstay system for providing lateral support and reinforcement to the side walls includes a buckstay grid adjacent each of the side walls. Each grid includes a plurality of vertically spaced horizontal structural members, and at least one vertical structural member. The horizontal structural members are attached to their adjacent side walls so as to permit relative movement between the side wall and the horizontal structural members in a horizontal direction parallel to the plane of the side wall. Means are provided for rigidly attaching only one of the horizontal structural members to each vertical structural member and the side wall, thereby fixing the relative vertical positions of the side wall with respect to the vertical structural member and the one horizontal structural member at one elevation. The vertical structural member is pendently supported from the top support structure, and is engaged with the remainder of the horizontal structural member. Rigid side-to-side tie members extend transversely between the side walls outside of said heating chamber and interconnect the vertical structural members disposed adjacent opposite side walls to restrain said vertical structural members from movement away from their respective side walls.

The various features of novelty which characterize the 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 there is illustrated and described a preferred embodiment of the invention.

In the drawings:
FIG. 1 is a partially diagrammatic sectional side view of a fluid heating unit or vapor generator on which the inventive buckstay arrangement may be used;
FIG. 2 is a partially diagrammatic isometric view of the upper portion of the vapor generator of FIG. 1 showing the general arrangement of the buckstay system;
FIG. 3A is a partial sectional view taken along line 3A—3A of FIG. 2;
FIG. 3B is a partial sectional view taken along line 3B—3B of FIG. 2;
FIG. 3C is a partial sectional view taken along line 3C—3C of FIG. 2; and FIG. 4 is a section view taken along line 4—4 of FIG. 3B.

Referring to FIGS. 1 and 2, there is illustrated a vapor generating unit, the main portions of which include an upper chamber 10 of substantially rectangular horizontal cross-section defined by a front end wall 12, a rear wall 14, side walls 16 and a roof 18 and having a gas outlet 20 at its upper end opening to a horizontally extending gas pass 22 of rectangular vertical cross-section formed by a floor 23 and extensions of the furnace roof 18 and side walls 16. The gas pass 22 communicates its rear end with the upper end of an upright convection gas pass 24 of rectangular horizontal cross-section formed by a front wall 26, a rear end wall 28, side walls 27 in planes common with the side walls 16 of the furnace chamber 10, and a further extension of the roof 18.

The walls of the furnace chamber 10, horizontal gas pass 22 and convection gas pass 24 are preferably formed with a plurality of upright contiguous interconnected tubes 29 through which is passed the fluid to be heated. Fluid is supplied to these tubes via supply headers 30 to which the tubes are connected and which are generally disposed at the lower ends of the chamber. These headers 31 are similarly connected at their discharge ends to collection headers disposed generally at the upper ends of the walls. The initial heating of the fluid is accomplished in the economizer tube banks 34 disposed in the lower portion of the convection gas pass 24, and the final stages of fluid heating are accomplished in the penthouse type vapor heaters 32 disposed in the horizontal gas pass and in the horizontal tube banks 33 disposed in the convection gas pass 24.

Heating gases are supplied to the lower portion of the furnace burning fuel in the by-passing type burners 35, to which combustion air is supplied via ducts 36 and window box 37. Combustion of the fuel is completed in the furnace chamber 10 which is operated at a positive pressure of about 25 inches of water, and the hot gases combustion products pass upwardly through the furnace chamber 10 and then laterally through the horizontal gas pass 22 and then downwardly through the convection gas pass 24 to the discharge duct 38. The gaseous combustion products, the temperature of which has been decreased materially at this point, and then normally passed to an air heater (not shown) wherein ambient temperature combustion air is preheated by indirect heat exchange with the gaseous combustion products prior to their being exhausted to the atmosphere.

The entire vapor generating unit is pendently supported at its upper end from the top support structure 40 which is supported by upright columns 41 affixed to suitable foundations at ground level. The vapor generator walls are connected to the top support structure 40 by rigid support rods 42 preferably connected to the collection headers 31 disposed at the upper ends of the walls. It should be recognized that, with the vapor generating unit being pendently supported as described above, the linear thermal expansion of the unit between its cold (non-operating) condition and its hot (operating) condition will be in a downward direction. It should further be noted that the vertical thermal expansion movement of the lowermost portion of the unit will be greater than the vertical thermal expansion movement of any portion of the unit above its lowermost portion. As an example of the amount of linear thermal expansion involved in a large modern vapor generator, it is common that the lowermost portion of a unit will move downwardly by as much as 8 inches as the temperature of the vapor generator is increased from its non-operating condition to its normal equilibrium condition of operation.

For the purposes of affording lateral support to and maintaining the alignment of the walls of the vapor generating unit, and to reinforce the walls against the effects of the normal positive pressure within the unit as well as possible inordinate pressure surges, a buckstay system 50 comprising a plurality of structural members is provided about the exterior of the unit. It should be recognized that the buckstay system will not be subject to the same linear thermal expansion as the walls of the vapor generator, and that provisions must therefore be made to accommodate the resulting relative movements.

In a unit of the type described above, it should be observed that the portion of each of the side walls 16 spanning the upper furnace chamber 10, the horizontal gas pass 22 and the upper end of the convection gas pass 24 presents an extremely large continuous wall area, this area in some instances measuring nearly 100 feet in length and being about 40 feet high. With a positive fire-side pressure of 25 inches of water, this would produce a loading on a wall of this size of over 500,000 pounds under normal operating conditions. The present invention is concerned primarily with a buckstay arrangement suitable to provide adequate lateral support for such a large wall area; however, it should be recognized that the invention described herein may advantageously be utilized to reinforce any wall area or any part of a vapor generating unit or other device where lateral support is required. Moreover, the description of the invention in terms of a particular vapor generating unit is not meant to serve as a limitation on this invention.

The buckstay system 50, insofar as each of the upper side walls 16 is concerned, includes a side wall buckstay grid comprising a plurality of vertically spaced horizontal structural members 51, which may be of any suitable cross-sectional configuration, such as I-beams. The horizontal structural members 51 are engaged (preferably by rigid attachment as by welding or bolting) at the approximate midpoint of the side wall span with a vertical structural member 52 so that the vertical structural member 52 is in partial load bearing relationship with the horizontal structural members. The vertical structural member 52 may also be of any suitable structural shape, such as an I-beam. Additional vertical members, such as channels 53 and angle irons 54, may also be connected between adjacent horizontal structural members to afford additional rigidity to the side wall buckstay grid. Preferably, each side wall grid is formed as a unitary structure by rigidly interconnecting the horizontal structural members 51, a vertical structural member 52 and the additional vertical members 53 and 54.

The use of the vertical structural member 52 at the approximate midpoint of the side wall span 51 allows the members 51 to be significantly smaller than they would be if no vertical member were used. As an example of the benefits gained by the use of the vertical structural members 52, in a recent design study of a large vapor generator, the six horizontal buckstay members (corresponding to structural members 51) required would have had to be 60 inch deep I-beams if no vertical member were used. By using a single 36 inch I-beam vertical member, the required width of the six horizontal buckstay I-beams was reduced to 27 inches. Thus, it can be seen that the use of a centrally disposed vertical member in conjunction with the usual horizontal members results in a significant reduction in the weight and cost of the structural steel used for a given wall buckstay system.

The vertical structural members 52 and the vertical structural members 53 and 54 are pendently supported from the top support structure 40 by means of longer bars 55 connected to the upper ends of the vertical members 52, 53 and 54. Thus, where the side wall grid is formed as a rigid structure, substantially the entire weight of the grid is carried by the support bars 55 so that the wall support means are not endangered by the additional weight of the buckstay members 52. For reasons to be discussed hereinafter, constant-load spring supports 56 of a known type are preferably connected in load-bearing rela-
relationships between each of the hanger bars 55 and the top support structure 40.

As to the exposure of the wall tubes 29 of the hot gases within the unit, the side walls 16 obviously experience a significant thermal expansion between the extremes of the cold non-operating and the hot operating conditions of the unit, while the side wall buckstay grid will experience only an insignificant amount of thermal expansion, its temperature will be that of the substantially constant ambient atmosphere. Thus, provisions must be made for accommodating the relative expansion movements between the side wall 16 and the side wall buckstay grid in both the horizontal and vertical directions.

Referring to Figs. 3A, 3B, 3C and 4, at the elevation of each of the horizontal structural members 51, there are rigidly attached to the tubes 29 of the side wall 16 a tie bar plate 60 extending along the entire width of the wall 16 parallel to and immediately adjacent the horizontal structural member 51. Welded to each tie bar 60 at spaced locations along its entire length is a plurality of clip assemblies 61, each of which includes an outwardly extending vertically disposed tie plate 62 welded to the tie bar 60 and having welded thereto a pair of clips 63 which loosely engage the horizontal structural member 51 at the flange and closest to the side wall 16, (as shown in Figs. 3A and 3C), so that the horizontal structural member 51 is restrained from movement in the direction perpendicular to the side wall 16, while relative movement is permitted in a horizontal direction parallel to the plane of the side wall 16. Thus, as the side wall 16 is subject to heat and expands, relative movement with respect to the horizontal structural members 51 is allowed in the horizontal direction by virtue of the sliding engagement between the flange of the horizontal structural members 51 and the clip assemblies 61 which are secured to the wall tubes 29 as already stated.

Horizontal structural member (designated 51F for purposes of identification in Figs. 2, 3B and 4) is rigidly fixed to the side wall 16 so that there is no relative vertical movement between the buckstay grid and the side wall 16 at the elevation of the horizontal structural member 51F. As shown in Figs. 3B and 4, the tie assembly 65 connecting the horizontal structural member 51 to the side wall 16 includes a pair of spaced, vertical angle members 66, which have welded to the upper and lower ends thereof pairs of tie clips 67 which engage the flange end of the welded structural member 52 and also fit tightly against the top and bottom edges of the inner flange end of the horizontal structural member 51F, thus restraining the horizontal structural member 51F from vertical movement relative to the side wall 16. By virtue of the connection between the tie clips 67 and the vertical structural member 52, the vertical structural member 52 is also restrained from movement in a horizontal direction relative to the side wall 16, so that all such movement is accommodated in opposite directions on opposite sides of the vertical structural member 52. Tie rods 68 are welded between each pair of tie clips 67 immediately adjacent the flange end of the vertical structural member 52, so as to position the buckstay grid in a direction parallel to the side wall 16. Thus, it can be seen that at the junction of the vertical structural member 52 and the horizontal structural member 51, the side wall 16 is rigidly tied to the side wall buckstay grid so that substantially no relative movement is allowed therebetween in any direction. Since movement between the side wall 16 and the buckstay grid is prohibited at the elevation of the horizontal structural member 51F, it follows that relative vertical movement above and below this elevation will be in opposite directions. Accordingly, clearances are provided in the clip assemblies 61 to allow the necessary relative vertical movement. Referring particularly to Figs. 3A and 3B, which illustrate the typical clearance arrangements for the clip assemblies 61 attached to the horizontal structural members 51 respectively above and below the horizontal structural member 51F, it should be noted that the clearance space 64A (Fig. 3A) is at the bottom of its respective horizontal structural member flange, while the clearance space 64B (Fig. 3C) is at the top of its respective horizontal structural member flange. It should be recognized that the horizontal structural members 51 more distant from the fixed horizontal structural member 51F will require larger clearance spaces than the horizontal structural members 51 that are closer to the horizontal structural member 51F. As to the connection of the vertical structural member 52 to the side wall 16 at elevations of the horizontal structural members 51 other than the horizontal structural member 51F, the necessary vertical relative movement can be accommodated in the tie clip assemblies of the type shown as 65 by the appropriate positioning of the pairs of tie clips 67 to provide the proper clearance spaces above or below the flange ends of the horizontal structural members 51. Thus, by attaching the side wall buckstay grid to the side wall 16 as described above, the relative expansion movements in the horizontal and vertical directions parallel to the plane of the side wall 16 may be readily accommodated. In this regard, it should be noted that the independent support of the buckstay grid by hanger bars 35 is not materially effected by the thermal expansion of the side wall 16 and resultant relative vertical movements of the side wall 16 and buckstay grid due to the operation of the constant-load spring supports 56. Thus, even though the buckstay grid, by virtue of its rigid connection to the side wall 16 at the elevation of the horizontal structural member 51F, does move downwardly upon the expansion of the side wall 16, the constant-load spring supports are constructed so as to continue carrying the same load.

It should be recognized that the above description is merely illustrative and that the present invention is not confined to the specific construction whereby the side wall 16 is rigidly connected in a vertical direction to the particular horizontal structural member 51F. Any of the other horizontal structural members 51 could be used as the zero relative movement elevation simply by providing the proper clip assembly arrangement with appropriate clearance spaces. For example, if so desired, the uppermost horizontal structural member 51 could be rigidly tied to the side wall 16 (in the same manner disclosed above with respect to the horizontal structural member 51F) to preclude vertical movement therebetween, in which instance all of the clip assemblies 61 on the other horizontal structural members 51 would be constructed with clearance spaces 64 as substantially as shown in Fig. 3C.

In addition to the side wall buckstay grids described above, the buckstay system 50 includes horizontally disposed end wall buckstay members 71 which are interconnected at their ends through corner tie assemblies 72 to the ends of the horizontal structural members 51 so that in substance the horizontal buckstay members of the unit extend completely therearound. The corner tie assemblies may suitably be of the type disclosed in the aforementioned U.S. Patent 3,007,455. Since the end walls (furnace chamber front end wall 12 and convection gas pass rear end wall 28) generally are not so wide as the side walls 16, it is normally not necessary to use the type of buckstay grid system herein disclosed on the end walls. In the embodiment shown, the end wall members are attached to the end walls 12 and 28 in the usual manner (as disclosed in U.S. Patent 3,007,455) so that the weight of the members 51 is carried by the end walls 12 and 28. The differential expansion and contraction movements of the end wall buckstay members 71 and the horizontal structural members 51 of the side wall buckstay grid may suitably be accommodated by providing adequate pivotal clearances in the corner tie assemblies 72.

Additional lateral support is afforded the side walls 16 by virtue of the rigid side-to-side interconnection of the
vertical structural members 52. The upper tie bars 57 extend between the upper ends of the vertical structural members 52 at an elevation immediately above the roof 18 and within the penthouse enclosure 11 (see FIG. 1), so that the upper tie bars 57 experience substantially the same linear thermal horizontal expansion as do the end walls 12 and 28. The lower tie bars 58 (see FIG. 2) extend between the lower ends of the vertical structural members 52 at an elevation immediately below the floor 23 of the horizontal convection pass 22. Linear thermal expansion of the lower tie bars 58 may be substantially equalized with that of the end walls 12 and 28, by placing the tie bars 58 in intimate contact with the tubular heating surface of the floor 23, and by enclosing the lower tie bars 58 within suitable insulation. While in accordance with the provisions of the statutes there is illustrated and described herein a specific embodiment of the invention, those skilled in the art will understand that changes may be made in the form of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of the other features.

What is claimed is:

1. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system disposed outside of said heating chamber for providing lateral support and reinforcement to said walls, said walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached to said horizontal structural members at the approximate midpoint of the adjacent wall, means restraining said grids from movement away from said walls, means rigidly connecting one of said grids with its adjacent wall at one location, and means permitting relative vertical movement between said one grid and its adjacent wall in opposite directions above and below the location of the connection.

2. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system disposed outside of said heating chamber for providing lateral support and reinforcement to said walls, said walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached to said horizontal structural members at the approximate midpoint of the adjacent wall, means restraining said grids from movement away from said walls, means rigidly connecting one of said grids with its adjacent wall at one location, and means permitting relative vertical movement between said one grid and its adjacent wall in opposite directions above and below the location of the connection.

3. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system disposed outside of said heating chamber for providing lateral support and reinforcement to said walls, said walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached to said horizontal structural members at the approximate midpoint of the adjacent wall, means restraining said grids from movement away from said walls, means rigidly connecting one of said grids with its adjacent wall at one location, and means permitting relative vertical movement between said one grid and its adjacent wall in opposite directions above and below the location of the connection.

4. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system disposed outside of said heating chamber for providing lateral support and reinforcement to said walls, said walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached to said horizontal structural members at the approximate midpoint of the adjacent wall, means restraining said grids from movement away from said walls, means rigidly connecting one of said grids with its adjacent wall at one location, and means permitting relative vertical movement between said one grid and its adjacent wall in opposite directions above and below the location of the connection.

5. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system disposed outside of said heating chamber for providing lateral support and reinforcement to said walls, said walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached to said horizontal structural members at the approximate midpoint of the adjacent wall, means restraining said grids from movement away from said walls, means rigidly connecting one of said grids with its adjacent wall at one location, and means permitting relative vertical movement between said one grid and its adjacent wall in opposite directions above and below the location of the connection.
horizontal structural member, and third clips formed with clearance spaces for permitting relative vertical movement in the other direction between said wall and those of said horizontal structural members below said one horizontal structural member, and rigid tie members extending transversely between said walls and interconnecting said grids for restraining said members from movement away from said walls.

6. A fluid heating unit comprising a pair of spaced upright parallel walls defining therebetween a heating chamber wherein the flow of hot combustion gases is confined, a rigid support structure extending above said heating chamber, support rods interconnecting said support structure and said walls for the pendent support thereof, a buckstay system for providing lateral support and reinforcement to said walls, said buckstay system including a grid adjacent each of said side-walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached with said horizontal structural members at the approximate midpoint of the adjacent wall, clip means connecting each of said grids to their adjacent walls, said clip means being constructed so as to permit relative transverse movement between each grid and its adjacent wall, to fix the relative vertical positions of each grid and its adjacent wall at one elevation adjacent said wall, and to permit relative vertical movement between each grid and its adjacent wall in opposite vertical directions respectively above and below said elevation, means for pendently supporting the weight of said grids from said support structure substantially independently of the support of said walls, and means restraining said grids from movement away from said walls.

7. A fluid heating unit comprising walls defining an upright furnace chamber wherein fuel is consumed to produce hot combustion gases, walls defining an upright convection gas pass adjacent said furnace chamber, means interconnecting the upper portions of said furnace chamber and said convection gas pass for the flow of said gases from said furnace chamber to said convection gas pass, and means including a pair of spaced, upright, parallel side-walls common to said furnace chamber and said convection gas pass, a rigid support structure extending above said furnace chamber and said convection gas pass, support rods interconnecting said support structure and said side-walls for the pendent support thereof, and a buckstay system for providing lateral support and reinforcement to said side-walls, said side-walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said side-walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member engaged with said horizontal structural members at the approximate midpoint of the adjacent wall and a rigid tie member extending transversely between said side-walls and interconnecting said grids from movement away from said side-walls, said tie members being disposed between said furnace chamber and said convection gas pass and being installed so as to be substantially heated by said gases.

8. A fluid heating unit comprising walls defining an upright furnace chamber wherein fuel is consumed to produce hot combustion gases, walls defining an upright convection gas pass adjacent said furnace chamber, means interconnecting the upper portions of said furnace chamber and said convection gas pass for the flow of said gases from said furnace chamber to said convection gas pass, a pair of spaced, upright, parallel side-walls common to said furnace chamber and said convection gas pass, a rigid support structure extending above said furnace chamber and said convection gas pass, support rods interconnecting said support structure and said side-walls for the pendent support thereof, and a buckstay system for providing lateral support and reinforcement to said side-walls, said side-walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said side-walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member engaged with said horizontal structural members at the approximate midpoint of the adjacent wall and a rigid tie member extending transversely between said side-walls and interconnecting said grids from movement away from said side-walls, said tie members being disposed between said furnace chamber and said convection gas pass and being installed so as to be substantially heated by said gases.

9. A fluid heating unit comprising walls defining an upright furnace chamber wherein fuel is consumed to produce hot combustion gases, walls defining an upright convection gas pass adjacent said furnace chamber, means interconnecting the upper portions of said furnace chamber and said convection gas pass for the flow of said gases from said furnace chamber to said convection gas pass, said means including a pair of spaced, upright, parallel side-walls common to said furnace chamber and said convection gas pass, support rods interconnecting said support structure and said side-walls for the pendent support thereof, and a buckstay system for providing lateral support and reinforcement to said side-walls, said side-walls and said buckstay system being subject to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said side-walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member engaged with said horizontal structural members at the approximate midpoint of the adjacent wall and a rigid tie member extending transversely between said side-walls and interconnecting said grids from movement away from said side-walls, said tie members being disposed between said furnace chamber and said convection gas pass and being installed so as to be substantially heated by said gases.

10. A fluid heating unit comprising walls defining an upright furnace chamber wherein fuel is consumed to produce hot combustion gases, walls defining an upright convection gas pass adjacent said furnace chamber, means interconnecting the upper portions of said furnace chamber and said convection gas pass for the flow of said gases from said furnace chamber to said convection gas pass, said means including a pair of spaced,
upright, parallel side-walls common to said furnace chamber and said convection pass, said side-walls comprising a plurality of upright fluid-cooled tubes interconnected along their lengths to form gas impervious panels, a rigid support structure extending above said furnace chamber and said convection gas pass, support rods interconnecting said support structure and said side-walls for the pendent support thereof, and a buckstay system for providing lateral support and reinforcement to said side-walls, said side-walls and said buckstay system being subjected to different rates of linear thermal expansion, said buckstay system including a grid adjacent each of said side-walls, each of said grids including a plurality of vertically spaced horizontal structural members, and at least one vertical structural member rigidly attached with said horizontal structural members at the approximate midpoint of the adjacent wall, slotted clip means connecting said horizontal structural members with their adjacent side-wall and slideably engaging said horizontal structural members in a horizontal direction parallel to the plane of said side-wall, said slotted clip means including first clips fixing the relative vertical position of an intermediate one of said horizontal structural members with its adjacent side-wall, second clips formed with clearance spaces for permitting relative vertical movement in one direction between said side-wall and those of said horizontal structural members above said one horizontal structural member, and third clips formed with clearance spaces for permitting relative vertical movement in the other direction between said side-wall and those of said horizontal structural members below said one horizontal structural member, means for pendently supporting the weight of said grids from said support structure substantially independently of the support of said side-walls, and rigid tie members extending transversely between said side-walls and interconnecting said grids for restraining said grids from movement away from said side-walls.

11. The invention according to claim 1 wherein the location of the connection of the grid to the walls is at the junction of said vertical and horizontal structural members.

12. The fluid heating unit according to claim 11 further including means for pendently supporting the weight of said grids from said support structure substantially independently of the support of said walls.

13. A fluid heating unit according to claim 12 wherein the means for pendently supporting the weight of said grids include substantially constant load bearing supports.

14. The invention according to claim 2 wherein said one location is at the approximate vertical and horizontal midpoint of said wall.

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