April 24, 1962 E. C. WITZKE 3,030,937

FURNACE WALL AND SUPPORT

Filed Jan. 10, 1958 6 Sheets-Sheet 1

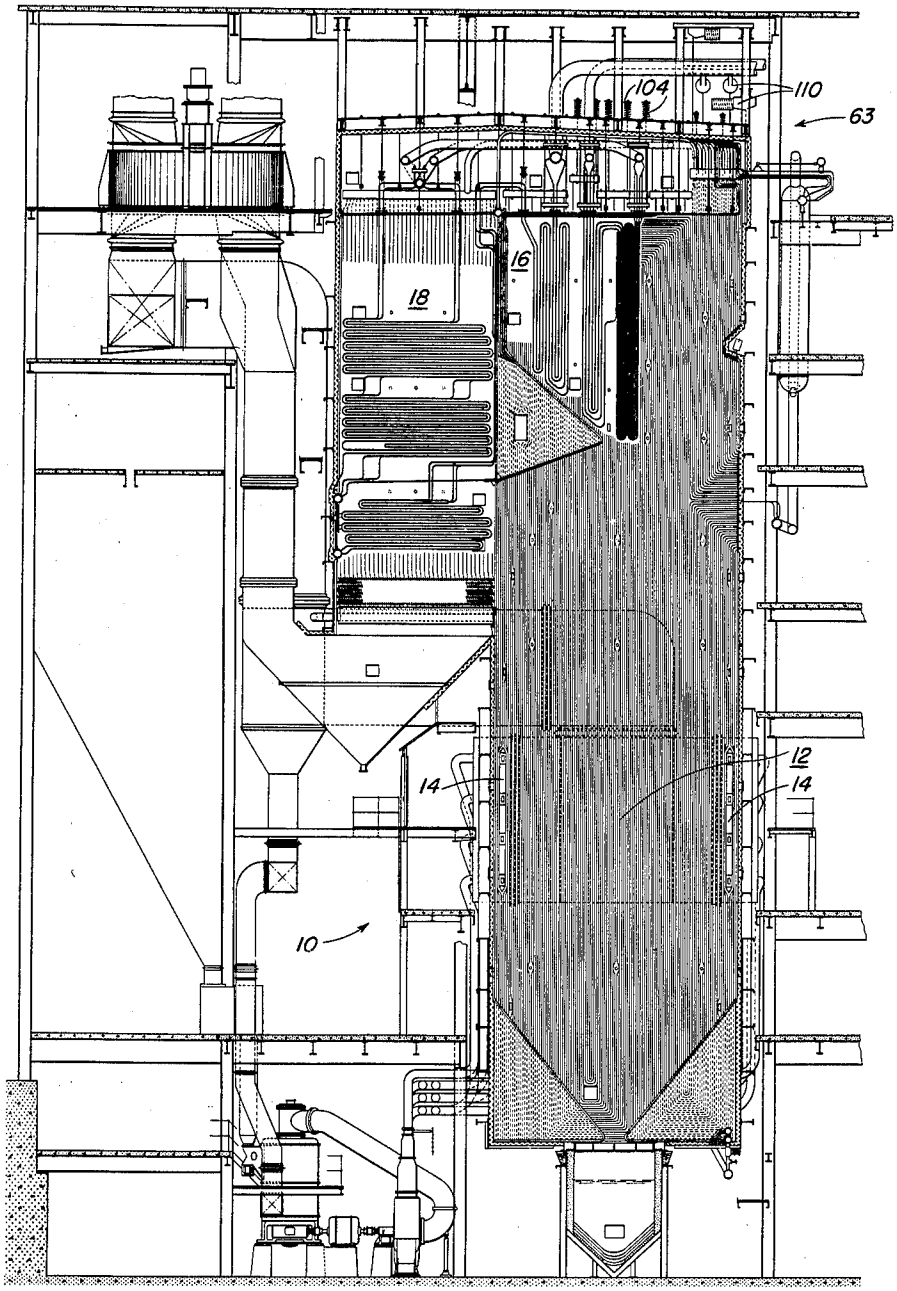

Fig. 1.

INVENTOR.
Ernest C. Witzke

BY Eldon H. Luther

ATTORNEY

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FURNACE WALL AND SUPPORT

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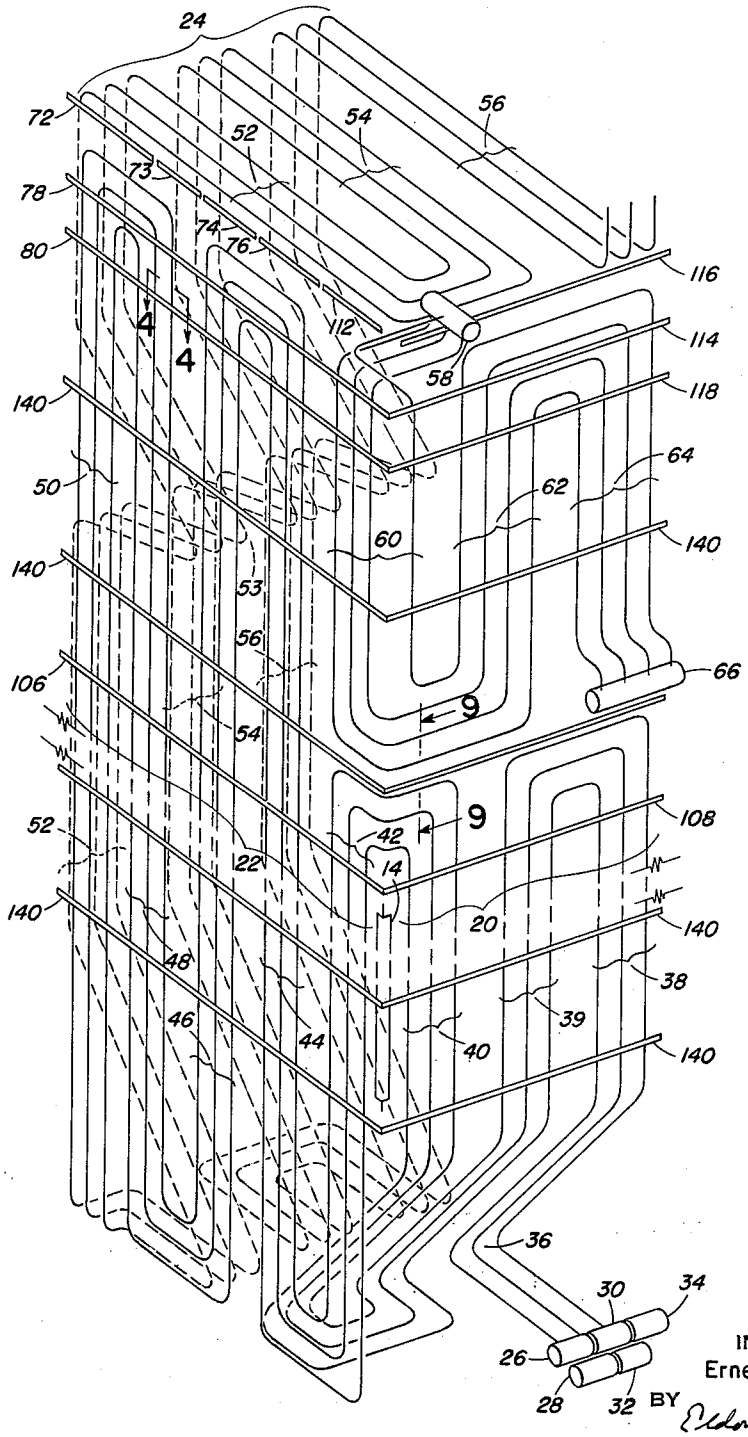

Fig. 2.

INVENTOR
Ernest C. Witzke

BY Eldon H. Luther

ATTORNEY

April 24, 1962 E. C. WITZKE 3,030,937

FURNACE WALL AND SUPPORT

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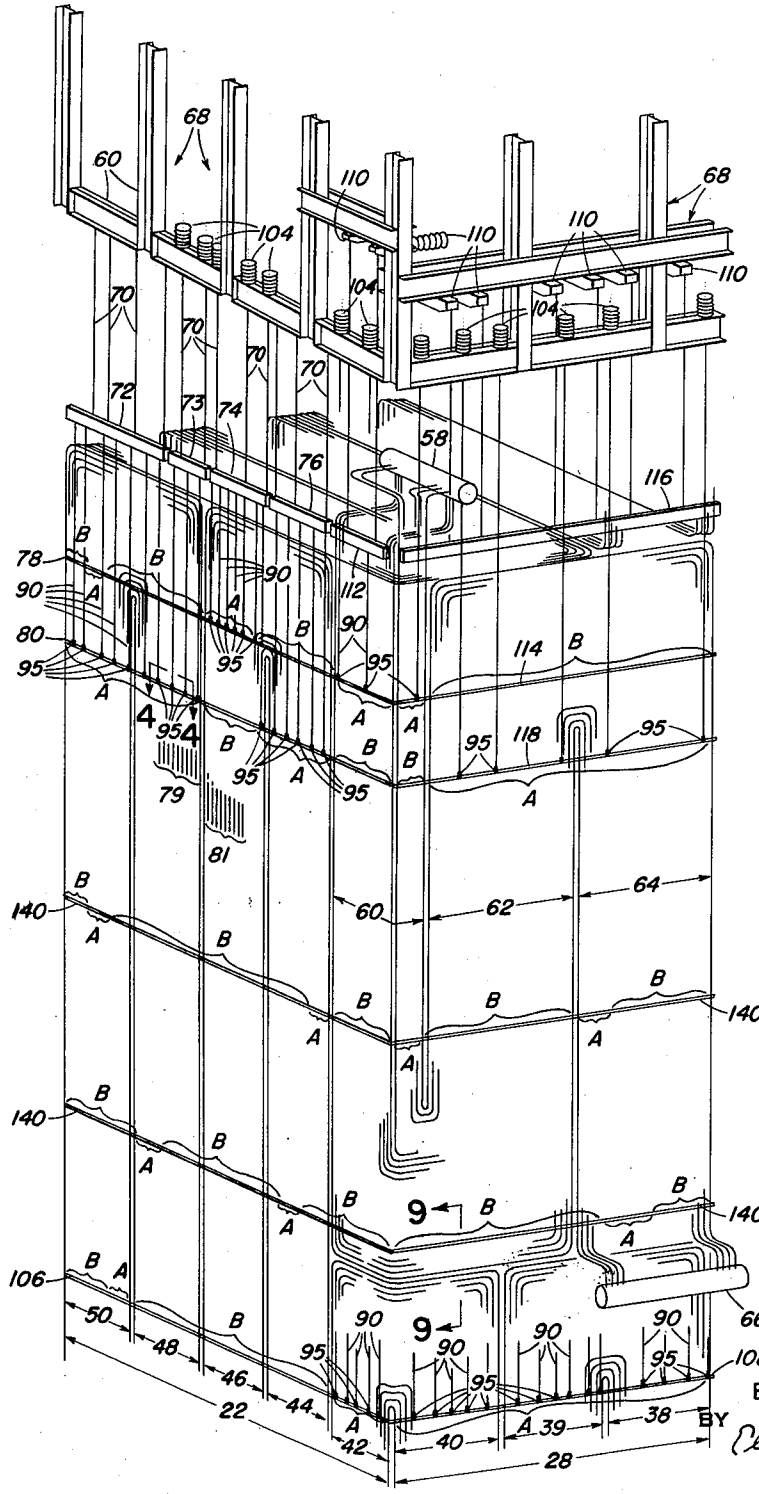

Fig. 3.

INVENTOR
Ernest C. Witzke
BY Eldon H. Luther
ATTORNEY

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FURNACE WALL AND SUPPORT

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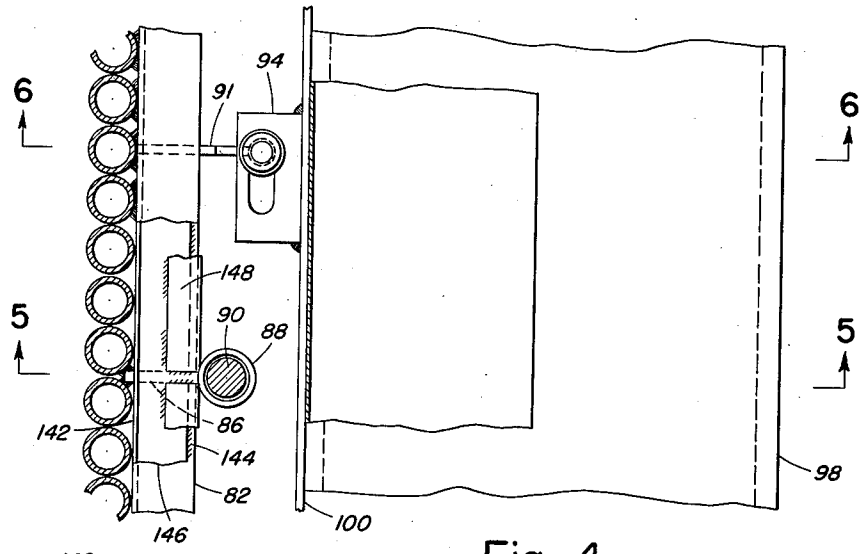

Fig. 4.

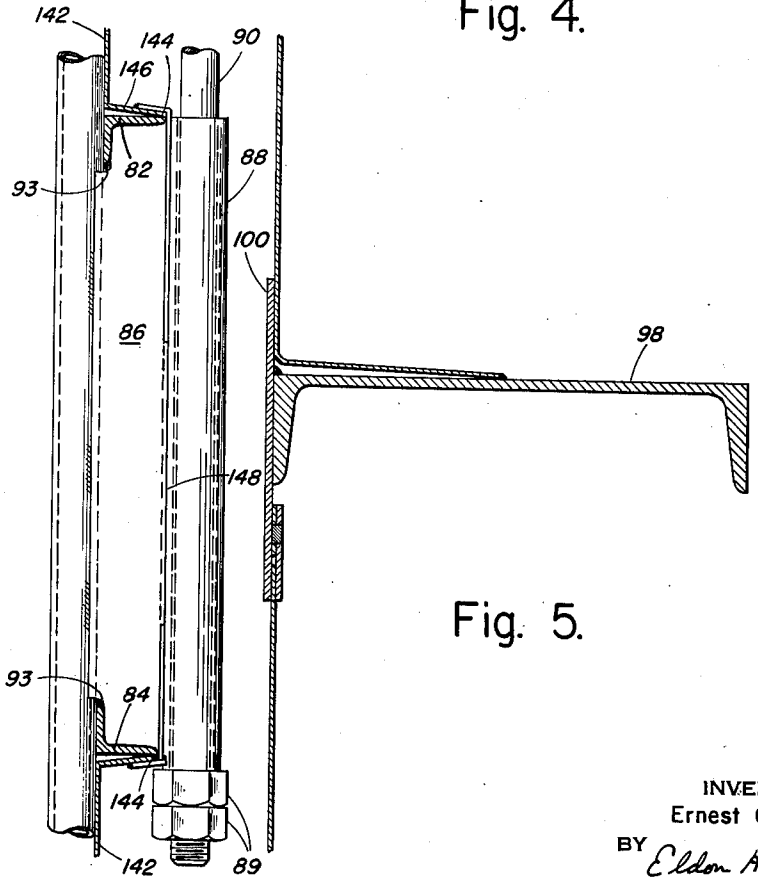

Fig. 5.

INVENTOR
Ernest C. Witzke
BY Eldon H. Luther
ATTORNEY

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FURNACE WALL AND SUPPORT

Filed Jan. 10, 1958 6 Sheets-Sheet 5

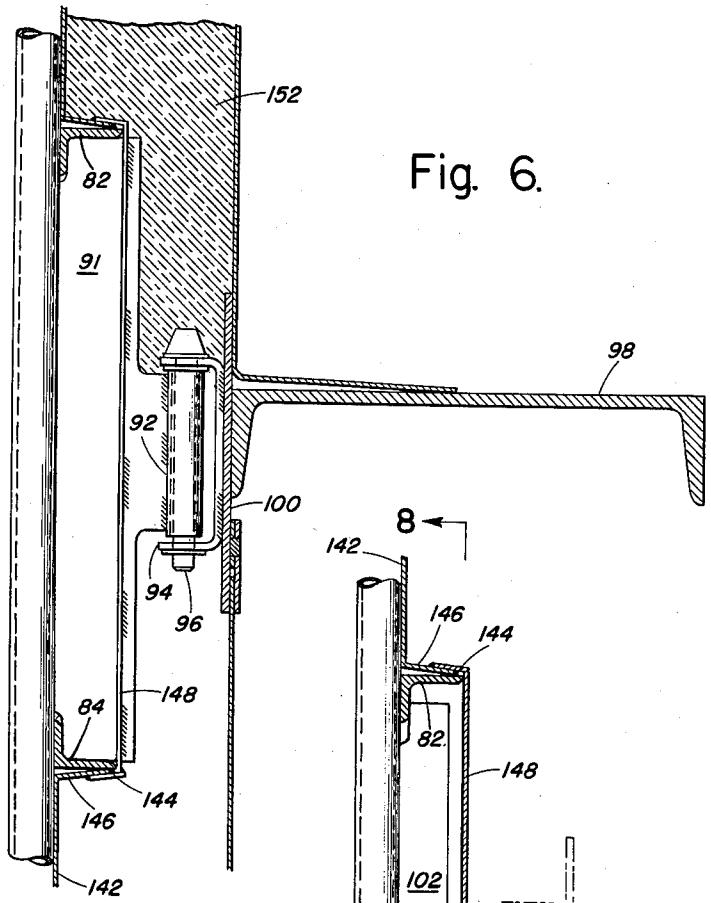

Fig. 6.

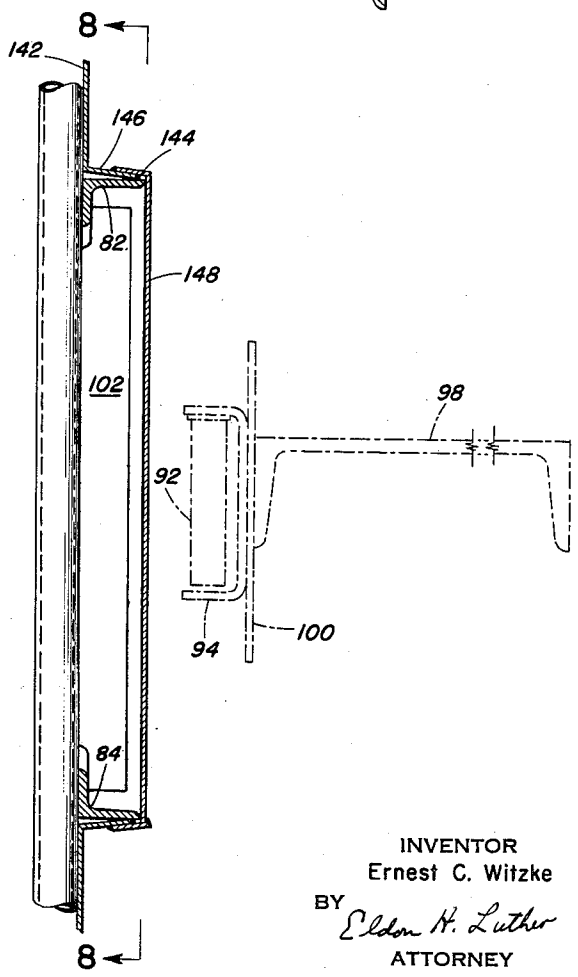

Fig. 7.

INVENTOR
Ernest C. Witzke
BY Eldon H. Luther
ATTORNEY

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FURNACE WALL AND SUPPORT

Filed Jan. 10, 1958 6 Sheets-Sheet 6

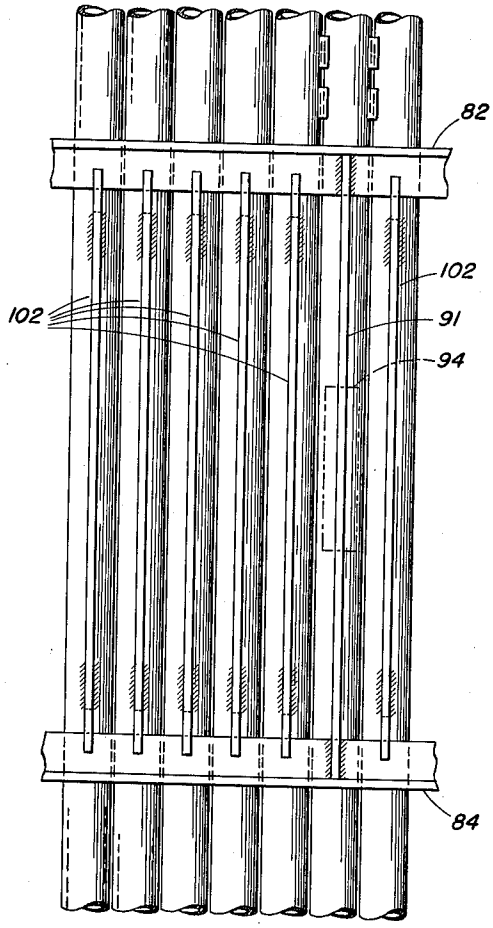

Fig. 8.

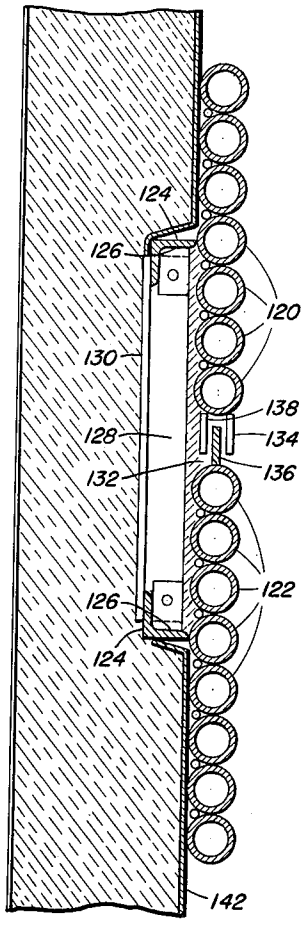

Fig. 9.

INVENTOR
Ernest C. Witzke
BY Eldon H. Luther
ATTORNEY

United States Patent Office 3,030,937 Patented Apr. 24, 1962

3,030,937

FURNACE WALL AND SUPPORT

Ernest C. Witzke, Bayside, N.Y., assignor to Combustion Engineering, Inc., New York, N.Y., a corporation of Delaware

Filed Jan. 10, 1958, Ser. No. 708,120
12 Claims. (Cl. 122—6)

This invention relates generally to furnaces which have the inner surface of their walls lined with heat exchange tubes and particularly to the construction of and support for furnace walls of this type.

In accordance with the invention there is provided an upright furnace into the lower portion of which fuel is fired with the combustion gases passing up through the furnace and out through a suitable outlet at the upper end. The furnace is supported at its upper end or region so that it may expand downwardly when it is heated from its cold non-operating condition. The inner surface of the walls of the furnace are lined with heat exchange tubes through which a suitable medium, as for example, water, is forced. These tubes are arranged in a number of parallel circuits with each of the circuits being rather long and with the tubes being sinuously bent or arranged so that they extend up and down the furnace walls to form, what may be termed, panels of tubes with the panels being in side by side relation and with a number of these panels being serially interconnected. This interconnection of tubes of adjacent panels is by U-bends formed at the upper and lower ends of the panels. Each of the panels is comprised of a number of circuits with each circuit having a plurality of tubes in it and with the tubes of different circuits being connected to separate supply headers. During operation of the furnace the temperature of the tubes may progressively increase from their beginning to their end and the temperature of the tubes in one circuit of a panel may vary with relation to the temperature of the tubes in other circuits of the panel. It is therefore necessary to support the wall in a manner to allow the tubes in one panel to expand relative to those in other panels in the wall and to allow the tubes in one circuit to expand relative to those in another circuit in each panel.

In supporting each wall of the furnace from its upper end a stationary support framework is provided which is connected with the tubes at the upper ends of the panels. This connection is effected by means of hanger rods that are supported from the support framework and that are connected to horizontal support members in the form of buckstay assemblies at the upper end of the panels with these assemblies being connected to the tubes of the panels. Two such buckstay assemblies are employed at the upper end of each wall and are vertically spaced from each other.

Side by side panels that are interconnected at their lower ends by nested return bends present a problem in regard to differential expansion of the tubes of the respective panels and particularly with regard to the tubes of the respective panels that are closest so that the interconnecting return bends are of relative small radius and accordingly not capable of flexing sufficiently to accommodate the required relative movement of the tubes. With regard to each of these pairs of interconnected panels, one of the buckstay assemblies is connected with the upper end of the tubes of one of the panels and the other buckstay assembly is connected with at least the tubes in the other panel which have interconnecting return bends that are too small to accommodate the required differential movement of the tubes they interconnect. The remaining tubes in the wall may be connected with either backstay assembly. The support for the buckstay assembly from

the stationary support framework and at the location of these tubes of adjacent panels that are interconnected at their lower ends by close return bends includes a spring mechanism which permits vertical movement of the support and accordingly the buckstay assembly and tubes.

At the upper portion of one or more walls of the boiler there is provided heat exchange surface lining the inner surface of the wall and which heat exchange surface is independent of that lining the lower portion of the furnace wall. As, for example, the upper portion of some walls of the furnace may be lined with radiant superheater or reheater surface while the lower portion of these walls as well as the entire surface of the other walls may be lined with the water heating or steam producing surface. With this arrangement this independent surface lining the upper wall portion and the surface below it and lining the surface of the wall therebelow are independently supported from the stationary support framework with both of these surfaces being entirely supported on springs so that the differential expansion that will take place may be accommodated.

It is the object of this invention to provide an improved furnace wall construction and support wherein the inner surface of the wall is lined with heat exchange tubes which are formed into long continuous circuits that extend up and down the furnace wall.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the inventive organization in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawing wherein:

FIG. 1 is a vertical sectional view of a steam generator employing the present invention;

FIG. 2 is a perspective view of the left half of the furnace with the outer portion of the furnace wall being removed so as to show the disposition of the tubes that line the inner surface of the furnace walls and with the support buckstay assemblies and the alignment buckstay assemblies being diagrammatically represented by horizontal lines and with only three tubes being shown in each panel for the sake of clarity. This view shows the left half of the front wall of the furnace, the entire left side wall, and in dotted lines, the left half of the rear wall of the furnace;

FIG. 3 is a perspective view of the upper region of the furnace only and is somewhat similar to FIG. 2 but to a larger scale and more detailed in its nature and showing the stationary support framework and the connection of the support and hanger rods with the buckstays.

FIG. 4 is a horizontal sectional view taken generally from line 4—4 of FIGS. 2 and 3 and showing the connection of the buckstay assemblies with the tubes and the support rod with the buckstay assembly;

FIG. 5 is a vertical section taken along line 5—5 of FIG. 4;

FIG. 6 is a sectional view showing how the buckstay channel is supported from the tubes and is taken from line 6—6 of FIG. 4;

FIG. 7 is a view in the nature of that of FIGS. 5 and 6 but showing the sliding interconnection of the buckstay assembly with the tubes;

FIG. 8 is a fragmentary view taken generally from line 8—8 of FIG. 7 further showing the sliding connection of the tubes with the buckstay assembly;

FIG. 9 is a vertical fragmentary sectional view showing how the lower end of the superheater is connected with the upper end of the tubular panels positioned below

the superheater with this section being taken generally from line 9—9 of FIG. 2.

Referring now to the drawings, wherein like reference characters are used throughout to designate like elements, there is illustratively shown therein a steam generator 10 which is provided with a furnace 12 into which fuel is introduced through burners 14 and burned therewithin. The combustion gases generated in the furnace pass upwardly therethrough and out through the outlet 16 which communicates with a suitable gas pass 18. The furnace is rectangular in transverse section and there is shown in FIG. 2 the left half of the front wall 20, the entire side wall 22, and the left half of the rear wall 24, with this latter being shown in dotted lines.

The inner surface of the furnace is lined with heat exchange tubes and in a preferred embodiment there are five groups of tubes that extend up and down walls 20, 22, and 24 with the tubes being extremely long and interconnected between suitable inlet and outlet headers. At the lower end of FIG. 2 there is shown five inlet headers 26, 28, 30, 32 and 34, each of which serves as the inlet header for one group of tubes with there being nine tubes in each group in one preferred construction and with each group in effect forming a separate circuit. For simplicity of illustration, only three tubes are illustrated as extending from these headers in FIG. 2 with these three tubes representing all the tubes for all five groups or forty-five tubes in the preferred embodiment where each group comprises nine tubes. These tube groups, which form separate circuits, are positioned in parallel side by side relation and extend horizontally from the inlet header to the location 36, which is the ash outlet at the lower end of the furnace, where they are bent, as shown, and extend up the furnace wall 20 to a location slightly above the midpoint of the furnace with these tubes forming panel 38. At this location they are reversely bent in internested fashion and extend down to the lower end of the furnace forming panel 39. At the lower end of the furnace they extend horizontally outward a short distance, are reversely bent and extend upward along the sloping hopper bottom of the furnace and up the front wall again to the location slightly above the midpoint of the furnace to form panel 40. They are again reversely bent at this location and are bent over onto or positioned on side wall 22 with these tubes then extending down and up side wall 22, as shown, forming panels 42, 44, 46, 48 and 50. The tubes of panel 50 are bent rearwardly at the lower end of the panel and then at right angles so that they extend horizontally toward the outlet of the hopper bottom of the furnace where they are bent upwardly so that they extend up along the rear wall of the furnace with the tubes conforming to and lining nose baffle 53 and extending along the top of the furnace to form the furnace roof with the tubes thus forming panel 52. At the front end of the furnace roof the tubes are reversely bent and extend back along the roof and down the rear furnace wall forming a panel 54 and at the lower end of which wall they extend horizontally outward and are again reversely bent so that they extend upward along this wall to form panel 56 with the tubes from panel 56 being connected to a suitable header or headers, not shown.

Positioned above panels 38, 39, 40 and 42 is a superheater which is in the form of a number of tubes that extend from inlet header 58 and are in parallel side by side relation with a portion of the tubes from this header extending down along the inner surface of wall 22 and another portion extending down along the inner surface of wall 20 to form a panel 60 with these tubes being reversely bent at a location adjacent the upper end of panels 40 and 42 and extending upwardly along wall 20 to form panel 62 with the tubes again being reversely bent at the upper end of the wall and extending down along the wall to form panel 64 and with the lower end of the tubes of this panel being connected with the outlet header 66.

A fluid to be heated, which may be water, is forced through the tubes of panels 38 through 56 with the water entering the headers 26, 28, 30, 32 and 34 and being collected at the outlet of the long continuous tubes that extend from these headers. The temperature of the fluid medium in these long continuous tubes and accordingly the temperature of the tubes themselves may vary so that the tubes of one panel will expand and contract a different amount than the tubes of other panels. Furthermore, since each of the panels is comprised of five tube groups or circuits which are connected with different inlet headers the temperature of the tubes of one circuit in the same panel may be different from the tubes of another circuit so that the tubes of different circuits may expand and contract within the same panel. Provision for this relative movement of the tubes of one panel with respect to the tubes of another panel and the tubes in one circuit in a single panel with relation to the tubes in another circuit of the same panel must be provided for and permitted by the support arrangement or mechanism for the furnace.

In order to support the furnace from its upper end so that it may expand downwardly there is provided a stationary support framework identified generally as 68 (FIG. 3) and which extends above the upper end of the furnace. Extending down from this framework are a number of hangers 70 which are connected at their lower end with intermediate support members 72, 73, 74 and 76 positioned above side wall 22. This side wall 22 is supported from these intermediate support members through the medium of the two vertically spaced support buckstay assemblies.

Each of these buckstay assemblies is comprised of a pair of vertically spaced horizontally extending angle members 82 and 84 (FIG. 5) which have one flange in overlying relation with the tubes at spaced locations along the length of these members. T lugs 86 are interposed and welded to the angles at certain locations along the length of the angles. These lugs, as shown in FIG. 5, have a tubular member 88 welded to their outer edge which receives a support rod 90 which extends down from the intermediate support members 72, 74 and 76. Also interposed between angles 82 and 84 are T lugs 91 (FIGS. 4 and 6) which have welded to their outer edge cylinder 92. This cylinder is received between the laterally extending ends of stirrup 94 and extending through the aligned openings in the stirrup and through the cylinder for the stirrup is the stirrup connecting pin 96. These stirrups support buckstay channel 98 which has its inner flange welded to plate 100 which is, in turn, welded to the stirrup. As shown in FIG. 4, stirrup 94 has horizontally elongated openings so as to permit easy assembly without extreme accuracy of placement of the parts and also to permit relative expansion and contraction between the buckstay channels and the inner surface of the wall.

The angles 82 and 84 of buckstay assembly 80 are welded to each of the tubes in wall 22 throughout overlying portions of the assembly identified as A in FIG. 3, thus each of the tubes in panels 50, 48 and 44 and a few tubes in panel 46 are directly welded to angles 82 and 84, with this weld being identified as 93 in FIG. 5. Connected with the buckstay assembly 80 at the location of panels 44, 46, 48 and 50 are support rods 90 which extend down from the intermediate supports 72, 73 and 76, respectively, with there being five such rods indicated (FIG. 3) as associated with each of the panels 44, 48 and 50 and one such rod associated with panel 46 although the number of rods employed may be varied. These rods are connected with the buckstay assembly by receipt of their ends in tubular member 88 and positioning nuts 89 on the ends of the rods. The connection of these rods with the buckstay assembly is identified as 95 in FIG. 3. Buckstay assembly 78 which is spaced above assembly 80 is welded to a number of tubes in panel 50, each of the tubes in panel 46 except for a few of the tubes that are nearest to panel 44 and are welded to assembly 80, and each of the tubes of panel 60 that is in wall 22. As de-

picted in FIG. 3 assembly 78 is welded to the tubes of the wall throughout the portions of the assembly identified as A. At the location of panel 46 support rods 90 connect buckstay assembly 78 with intermediate support member 74 and at the location of panel 60 buckstay assembly 78 is connected with stationary support framework 68 by the two support rods 90 with the connection of rods 90 with assembly 78 being identified as 95.

At the location of panels 46 and 60 buckstay assembly 80 has a sliding connection with the tubes (with the exception of the few tubes in panel 46 nearest to panel 44 which are secured to assembly 80) and likewise at the location of panels 48 and 44 as well as panel 50 with the exception of a few tubes, buckstay assembly 78 has a sliding connection with the tubes with the portions of assemblies 78 and 80 that have sliding connections with the tubes they overlie being indicated as B.

This sliding connection, shown in detail in FIGS. 7 and 8, comprises T lugs 102 positioned between angle members 82 and 84 in a manner to permit relative vertical and horizontal movement between the lug and the angle members while maintaining the tubes in alignment with the lug being welded to the tube and having a portion extending over the flat overlying flange of the angle members.

It is necessary to provide two support buckstay assemblies 78 and 80 rather than a single assembly secured to all of the tubes in order that the required relative movement between the upper ends of panels 48 and 46 and between panels 44 and 60 may be had. The return bends interconnecting the lower ends of the most adjacent tubes of panels 46 and 48, as for example, the tubes 79 in panel 46 and the tubes 81 in panel 48 (FIG. 3), are so close or small that they would be incapable of bending sufficiently to accommodate the necessary relative movement between these interconnected tubes of these panels without setting up intolerable stresses. Therefore, provision must be made so that relative movement between these interconnected tubes with close return bends may take place at the upper end of the panels. This is accomplished by mounting intermediate support members 73 and 74 on springs with coil springs 104 being connected with the upper ends of the hangers 70 that are connected at their lower ends to these intermediate support members. Through this spring support arrangement and by supporting the tubes of panels 48 and 46 which are interconnected by close return bends from a different one of the buckstay assemblies 80 and 78, these panels are permitted to move vertically relative to each other. In like manner panel 44 and the portion of panel 60 in wall 22 are supported from a different one of the support buckstay assemblies 78 and 80 and may move relative to each other. Panel 44 is secured to and supported from assembly 80 while the portion of panel 60 in wall 22 is secured to and supported from assembly 78, with the portion of the assembly 78 overlying this panel 60 being hung from springs as later described. While the tubes of panel 48 nearest to those of panel 46, and substantially all of the tubes of panel 46, are shown as being spring supported, this is done for ease of construction and is not essential with it being only necessary to so support the tubes of one of these panels which are connected with the tubes of the other panel at the lower end of the panels by return bends so small or close that the return bends are incapable of flexing sufficiently to accommodate the necessary relative movement between the interconnected tubes of the panels.

Panel 42 of wall 22 is supported from the stationary support frame 68 by means of the support rods 90 which are connected with support buckstay assembly 106 in the manner shown in FIG. 5, with this support buckstay assembly being similar to support buckstay assemblies 78 and 80 with the portion of assembly 106 welded to panel 42 identified as A. A small portion of assembly 106, identified as A, is welded to panel 50, this portion

overlying one group of tubes in panel 50. Panels 40, 39 and 38 are supported from framework 68 by the support rods 90 which are connected with support buckstay assembly 108 also in the manner shown in FIG. 5 and which is also similar to assemblies 78 and 80 with the welded connection of assembly 108 throughout its length with the tubes it overlies being indicated as A. These support rods 90 associated with panels 38 through 42 are spring supported from support framework 68 by means of the constant load spring support mechanism 110 with this mechanism being of known construction and therefore merely being diagrammatically illustrated and with the mechanism being operative to permit rods 90 and accordingly the tubes of panels 42, 40, 39, and 38 to move vertically through a limited range, while maintaining the same spring load or upward pull on the rod and tubes. The support rods 90 extending up from buckstay assembly 106 are connected to intermediate support member 112 which is in turn hung from spring mechanism 110 while the rods 90 extending up from the assembly 108 are connected to intermediate support 116 which is in turn hung from the spring mechanism 110.

It is necessary to support the tubes of panels 38 through 42 on springs for two reasons. First, this support is necessary in order that these panels may move up and down as a group a distance equal to the amount of expansion and contraction of that portion of panel 44 that extends above these panels to the upper end of wall 22. It will be noted that panel 44 is supported from buckstay assembly 80, which is, in turn, supported from intermediate support member 76, with this support member being hung from support frame 68 by hangers 70 with there being no spring connection provided. Thus, with the connection of the tubes of panel 44 with buckstay assembly 80 form a fixed connection and the tubes of the panel expand downwardly from this connection. Since the tubes of panel 44 are connected with the tubes of panel 42 by return bends at the lower ends of these panels, panel 42 will be carried downward by the expansion of panel 44 with the amount of this downward carry being equal to the expansion of the portion of panel 44 located above panel 42 and the difference in expansion between panel 42 and the adjacent portion of panel 44. This movement of panel 42 is imparted to panels 40, 39 and 38 so that they will all move vertically. The second reason for mounting panels 38 through 42 on springs is to permit these panels to move vertically through limited distances so as to maintain them in a predetermined relation with the superheater disposed thereabove, notwithstanding that the superheater tubes and the tubes of these panels expand different amounts.

Support for the superheater, i.e., tubular panels 60, 62, and 46 is such that the entire superheater may move vertically through a limited distance and the tubes of panel 60 may move vertically relative to panel 62. As illustratively shown, the tubes of panel 60 that are located in wall 22 are supported from buckstay assembly 78 with this assembly being supported from support rods 90 which are hung from the stationary support framework 68 through the medium of coil springs 104. Thus these tubes in panel 60 are spring supported. The tubes in panel 60 which are located in front wall 20 are also spring supported with these tubes being connected to support buckstay assembly 114 which is similar to assemblies 78 and 80 and which is supported from frame 68 by rods 90 and through spring 104. The tubes of panels 62 and 64 are supported from support buckstay 118 which is located below support buckstay 114 and is hung from support framework 68 by hangers 90 each to which is spring connected with the support framework through coil springs 104. By supporting panel 62 from the support buckstay assembly 118 and panel 60 from the support buckstay assemblies 114 and 78, and with the support for these buckstay assemblies being mounted on springs, relative movement between the panels 60 and 62

at the upper ends of the panels may take place with this being necessary for the tubes of these panels which are interconnected by close return bends as was explained with relation to the tubes of the panels in the side wall 22. The connection of the tubes of panel 60 with assemblies 78 and 114 and panels 62 and 64 with assembly 118 is as shown in FIG. 5, with angles 82 and 84 being welded to the tubes of the panel and with the portions of these assemblies welded to the tubes being indicated as A. The portions of these assemblies identified as B have the sliding connection of FIG. 7 with the tubes they overlie.

It is necessary that the tubes of the superheater, i.e., panels 60, 62 and 64 and the tubes of panels 42 through 38 located therebelow, be maintained in predetermined relation in order that a gas tight wall may be maintained and since these tubes expand differently they must be interconnected in a manner that will accomplish this result. The interconnection between these tubes is shown in FIG. 9 wherein the superheater tubes are designated 120 and the tubes in the panels below the superheater are designated 122. On the side of the tubes remote from the interior of the furnace, spaced angles 124 are welded with these angles extending horizontally across the furnace wall. Suitable brackets or plate members 126 are received in and welded to these angles and connecting link 128 extends between these brackets and is pinned at its opposite ends to the brackets. Positioned over and extending between the angles 124 in overlying relation with them is plate 130 which is seal welded to the angles with the space between the angles and between plate 130 and the tubes being filled with a suitable insulating material 132.

In order to prevent direct radiation from the furnace contacting this material a suitable baffle arrangement is provided between the adjacent tubes 120 and 122 with this baffle comprising fin 134 extending down from tube 120 and fin 136 extending up from tube 122 and past fin 134 with these fins being continuous and extending longitudinally of these tubes. In order to maintain these continuous fins 134 and 136 in adjacent relation there is provided a number of longitudinally spaced lugs or local fins 138 that extend down from tubes 122 and are located on the other side of fin 136.

In addition to the support buckstay assemblies which are connected with the stationary support framework 68 through suitable hanger, and/or support rods, there are a rather large number of alignment and stiffener buckstay assemblies that are provided at horizontally spaced locations throughout the height of the furnace. These alignment and stiffener buckstay assemblies do not support the wall but are for the sole purpose of strengthening and stiffening the wall and maintaining the tubes coplanar or in alignment. In the illustrative organization these alignment and support buckstay assemblies are designated 140 (only a few being shown in FIGS. 2 and 3) and they are connected with the tubes of the wall in a manner to permit the different panels to move relative to each other and also the tubes of different circuits in each panel to move relative to each other. These buckstay assemblies 140 are connected with the tubes of only one group or circuit in a single panel and are connected with the tubes of different panels at a sufficiently great distance so that the buckstay assembly may bend to accommodate the required relative movement between its point of fixed connection with the tubes of different panels. Generally speaking, each buckstay will be connected with tubes in only two panels. The connection of the buckstay assemblies with the tubes is as indicated in FIG. 6 with angles 82 and 84 being welded directly to the tubes. At the location where the buckstay assembly is not directly conneced with the tubes the sliding type of connection shown in FIG. 7 is provided where the tube may move horizontally and vertically with respect to the buckstay assembly but is maintained in a given plane so that the tubes are held in alignment. The location of the direct connection of these alignment and support buckstays 140 with the particular tube group of the particular panel to which they are connected is designated A on FIG. 3 while the sliding connection of the buckstay with the tube groups is designated B.

In supporting the rear wall 24 of the furnace, the tubes of the several panels that line the inner surface of this rear wall may be supported from a common support buckstay that is in fixed relation to the support framework 68 and is supported from this framework. The reason for this is that the portion of these panels that extends horizontally from the outlet at the hopper bottom is sufficiently great so that it will bend or flex to accommodate relative movement between adjacent tubes of adjacent panels that are interconnected at their lower ends thereby overcoming the difficulty that is experienced with close return bends at the lower ends of the panels on side wall 22.

The horizontally, laterally extending portion of panels 40 and 39 in wall 20, at the bottom of the furnace, will also flex to accommodate relative movement between these panels, thereby overcoming the difficulty caused by the close return bends interconnecting the most adjacent tubes in these two panels.

The wall of the furnace is pressure tight with this being accomplished by means of a so-called skin casing that is provided on the back of the tubes which line the inner surface of the wall. As shown in FIGS. 4, 5, 6 and 7, this skin casing comprises the sheet steel members 142 that are seal welded to the buckstay assemblies at 144 with these members being provided with a flexible flange 146. Extending around each of the buckstay assemblies is casing member 148 which is seal welded to sheet member 142 at the top and bottom of the buckstay assembly. At the locations where T lugs 86, 90, 102, and 105 extend outwardly from angle members 82 and 84, the casing member 148 is welded to these lugs, as indicated in FIGS. 4, 5 and 6.

Another casing is provided at the outer side of the wall and which may advantageously take the form of that disclosed in my U.S. Patent No. 2,773,487, issued December 11, 1956. Between the inner and outer casing a suitable thermal insulating material 152 is provided.

It will be understood that while the wall construction as described with relation to FIG. 2 is for only one-half of the furnace, this was done for simplicity of illustration and explanation with the other furnace half being constructed in a like manner.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What is claimed is:

1. A vertical furnace wall the inner surface of which is comprised of numerous juxtaposed heat exchange tubes having their axes coplanar and being sinuously bent and internested so that they extend vertically up and down the wall generally throughout its length with there being internested return bends at the upper and lower ends of the wall, means supporting said wall from its upper region comprising a support framework disposed thereabove, a first support member extending laterally across the wall at the upper end thereof and in overlying relation with vertical runs of the tubes, another support member similarly disposed but vertically spaced from the first support member, one of said support members being connected with at least the innermost tubes on one side of the return bend at the lower end of the wall and the other support member being connected with at least the innermost tubes on the other side of the return

bend, with the return bends interconnecting these innermost tubes being too short to adequately accommodate relative vertical movement therebetween with these tubes to which the respective support members are thus connected being vertically movable with respect to the opposite support member, means supporting each of the support members at the location of its connection with the tubes from said framework with the last named means associated with said one support member including spring mounting means arranged so that the support member at said location is hung from springs, and accordingly may move vertically, guiding and stiffener buckstay assemblies at vertically spaced intervals extending across the inner wall surface that is comprised of said tubes at the outer side thereof and connected therewith in a manner that retains the tubes in the plane of the wall but permits relative free vertical movement of the tubes connected with different support members.

2. In a furnace, a vertical wall having its inner surface lined with a plurality of coplanar parallel connected tubes in juxtaposed relation, with the tubes extending vertically down the wall from the upper portion, being reversely bent in internested fashion at the lower end of the wall and extending vertically up the wall to the upper portion thereof, thereby forming in effect two adjacent intermediate interconnected tubular panels, support mechanism disposed above said tubes connected with the upper portion of the vertical runs thereof so that they hang from their upper portion, said mechanism including a first horizontally disposed structural member hung from above and connected with at least several of the tubes in one of the panels that are nearest the other panel but being vertically movable relative to the corresponding tubes in said other panel, a second horizontally disposed structural member independent of the first and connected to said corresponding tubes in said other panel, and spring means operative to resiliently support said second member from above permitting limited vertical movement thereof, guiding and stiffener buckstay assemblies at vertically spaced intervals extending across the inner wall surface that is comprised of said tubes at the outer side thereof and connected therewith in a manner that retains the tubes in the plane of the wall but permits relative free vertical movement of the tubes connected with said structural members.

3. In an organization of the type described a vertical furnace wall having coplanar tubes lining the inner surface thereof with said tubes being in parallel side by side relation and disposed so they extend up and down the wall and are reversely bent in unison at the upper and lower portions of the wall thereby forming a plurality of side by side tubular panels that are serially interconnected, means supporting said panels from above, said support means including means that permit vertical movement of the tubes of one panel relative to the tubes of another panel to which they are interconnected at their lower end by a return bend that is too short to accommodate such relative movement, said tubes being divided into a number of circuits with each circuit being comprised of a number of adjacent tubes and with each circuit having a separate inlet header, alignment and stiffener means extending horizontally across the wall at vertically spaced locations, each of said alignment and stiffener means being fixedly connected with the tubes in a pair of panels that are horizontally spaced sufficiently that this means can bend as required to accommodate limited relative vertical movement between these tubes and with said alignment and stiffener means being fixedly connected with only the tubes of one circuit in this pair of panels, and means interconnecting each of the other tubes in these panels and the other panels with the alignment and stiffener means in a manner permitting relative horizontal and vertical movement therebetween while keeping the tubes aligned in the plane of the wall.

4. In an organization of the type described a vertical furnace wall having coplanar tubes lining the inner surface thereof with said tubes being in parallel side by side relation and disposed so they extend up and down the wall and are reversely bent in unison at the upper and lower portions of the wall thereby forming a plurality of side by side tubular panels that are serially interconnected, means supporting said panels from above, said support means including means that permits vertical movement of the tubes of one panel relative to the tubes of another panel to which they are interconnected at their lower end by a return bend that is too short to accommodate such relative movement, alignment buckstay assemblies extend horizontally across the wall in overlying relation with the tubes of the panels and at spaced vertical locations, said assemblies being fixedly secured to some of the tubes of panels that are spaced sufficiently and with the assemblies being sufficiently flexible to bend sufficiently between these locations of fixed connection to accommodate appreciable relative vertical movement between the tubes at these locations, means holding the other tubes in the wall against the buckstay assembly while permitting relative vertical movement between them and the assembly.

5. In a furnace wall the combination of coplanar tubes lining the inner surface thereof with said tubes being in parallel adjacent relation and disposed so they extend up and down the wall and are reversely bent in unison at the upper and lower portions of the wall with the vertical runs thereby forming adjacent panels that are serially interconnected, means for supporting said tubes and said wall from the upper portion of the panels and including a pair of vertically spaced buckstay assemblies at said upper portion, each assembly comprising a pair of vertically spaced horizontally disposed elongated angle members having one leg in flat overlying relation with the tubes and with said one leg of the two angle members being directed toward each other, a lug rigidly interconnecting said angle members at horizontally spaced locations, a channel member disposed outwardly of said angle members and effectively connected thereto through some of said lugs, the angle members of one of the buckstay assemblies being welded to the tubes of one of the panels of a pair of panels that are interconnected at their lower end and which tubes are interconnected with the tubes in the other panel of the pair by return bends that are too short to accommodate any substantial relative vertical movement between the tubes, the channels of the other buckstay assembly being welded to the corresponding tubes of the other panel of this pair, each of the buckstay assemblies being free to move vertically with respect to these tubes in the panel of the pair of panels to which the other buckstay assembly is connected, a stationary support frame, at least one of the buckstay assemblies being resiliently supported from said frame at the location of the connection of the assembly with these tubes so that it may move vertically, the other buckstay assembly being supported from said frame at the location of its connection with these tubes.

6. The organization of claim 5 wherein there are alignment buckstay assemblies constructed similar to said pair of assemblies and extending across the wall at vertically spaced locations to retain the tubes in alignment, each of said assemblies having its angle members welded to some of the tubes in panels that are spaced horizontally a sufficient distance relative to the rigidity of the buckstay assembly so that the assembly may flex sufficiently to accommodate the required differential vertical movement of these tubes, and means connecting the other tubes in the panels of the wall with these buckstay assemblies in a manner that permits limited vertical movement between the tubes and the buckstay assembly but prevents the tubes from moving laterally relative to the wall.

7. The organization of claim 6 wherein the last mentioned means comprises a T-lug welded to each tube

and slidingly received over and in back of the flanges of the spaced angle members overlying the tubes.

8. The organization of claim 6 wherein each panel is comprised of a number of groups of adjacent tubes with there being a separate inlet header for each group of tubes and with each alignment buckstay assembly being secured to only one group of tubes in any one panel.

9. In a vertical furnace wall the combination of a plurality of tubes in side by side relation extending up and down a predetermined lower portion of the wall in sinuous fashion with the tubes being bent in unison and internested at the upper and lower extremities of said predetermined lower portion, the remainder of the wall being lined with another group of side by side tubes adapted to operate at a different temperature than the first mentioned tubes and also extending up and down the wall in sinuous fashion and being bent in unison and internested at the upper and lower extremities of this other wall portion, with the lower end of said other group of tubes being juxtaposed to the upper end of said first mentioned tubes, means for hanging the first mentioned tubes and said other group of tubes independently from above and from spring means so as to permit limited vertical movement of them, means interconnecting said juxtaposed ends preventing them from moving vertically apart and a baffle means operative to prevent furnace radiation escaping between said juxtaposed ends.

10. In a furnace wall the combination of tubes lining the inner surface thereof with said tubes being in parallel adjacent relation and disposed so they extend up and down the wall and are reversely bent in unison at the upper and lower portions of the wall with the vertical runs thereby forming adjacent panels that are serially interconnected, means for supporting said tubes and said wall from the upper portion of the panels, said support means including a stationary support frame from which the tubes are supported, vertically movable means resiliently supported from the support frame and operative to support the tubes of one panel of each pair of panels that are interconnected at their lower ends by return bends that are too short to accommodate any substantial relative movement between the tubes with this resiliently supported movable means permitting the lower ends of these tubes of said one panel of each pair to move while carrying the load of the said tubes of said one panel from said upper end, guiding and stiffener buckstay assemblies at vertically spaced intervals extending across the inner wall surface that is comprised of said tubes at the outer side thereof and connected therewith in a manner that retains the tubes in the plane of the wall but permits relative free vertical movement between these tubes of each pair that are interconnected by return bends that are too short to accommodate any substantial relative movement between the tubes.

11. In a furnace wall the combination of a plurality of parallel tube members disposed in side by side coplanar relation and comprising the inner surface of said wall with some of said tube members being adapted to move longitudinally relative to others, guiding and stiffener buckstay assemblies continuously extending across said inner wall surface on the outer side thereof and transversely of the longitudinal disposition of the tube members and at spaced intervals longitudinally of the tube members each of said assemblies including an elongated member continuously extending across the wall, said assemblies being fixedly connected with said inner tubular wall surface at widely spaced locations longitudinally of the assemblies and slidably connecting means interconnecting said assemblies with said tubes intermediate said locations, said connecting means preventing said tubes from moving out of the plane of the wall but permitting universal movement within said plane.

12. In a furnace wall the combination of a plurality of parallel tube members disposed in side-by-side coplanar relation and comprising the inner surface of said wall with some of said tube members being adapted to move longitudinally relative to others, guiding and stiffening buckstay assemblies continuously extending across said inner wall surface on the outer side thereof and transversely of the longitudinal disposition of the tube members and at spaced intervals longitudinally of the tube members, said assemblies including a pair of elongated, laterally spaced angular members opened towards each other with said members extending transversely of the tube members and having one flange overlying said tube members, said angular members being effectively rigidly connected with the inner tubular wall surface at widely spaced locations longitudinally of the assemblies but being free thereof intermediate said locations, lugs connected with the tubes intermediate said locations and having a portion slidingly received in back of said overlying flange so as to prevent said tubes from moving out of the plane of the wall but permitting universal movement within said plane.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,030,937 April 24, 1962

Ernest C. Witzke

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, line 26, strike out "intermediate".

Signed and sealed this 2nd day of October 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents