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(54) **REFRACTORY TILE SYSTEM FOR BOILER TUBE/HEAT EXCHANGER PROTECTION**
FEUERFESTE ZIEGEL ZUM SCHÜTZEN VON KESSELROHREN
SYSTEME DE TUILES REFRACTAIRES DESTINE A LA PROTECTION D'UN TUBE DE
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(56) References cited:
EP-A- 0 656 508 **EP-A- 0 854 321**
EP-A- 0 895 028 **CH-A- 336 151**
DE-U- 9 016 206 **US-A- 3 828 735**
US-A- 5 431 020

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EP 1 226 390 B1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention is directed to a boiler, particularly to refractory tube blocks which protect metallic waterwall tubes from hot and highly corrosive furnace gases, while at the same time maintaining good heat conductivity.

2. Background Information

[0002] Refractory tiles have long been used for the protection of boiler walls in waste incinerators and other heat exchanger applications. The primary function of the tiles has been to shield the steel alloy boiler walls, which typically include waterwall tubes and membranes or webs disposed therebetween, from the temperature, erosion, and corrosion by acid vapor attack associated with boiler operation. These conditions are generated by the combustion process occurring within the boiler. For example, municipal solid waste (MSW) facilities incinerate trash and garbage in furnaces at temperatures of up to about 1400°C. In order to recover the valuable energy produced in these MSW plants, water is passed through metallic waterwall tubes adjacent to the furnace and converted to steam by the high temperatures. The steam produced in the tube assembly is then used to power a turbine-driven electric generator. However, the MSW plant also produces gaseous products which, if allowed to contact the metal wall, would chemically attack the walls. The purpose of the refractory tiles has been to prevent direct attack of the walls by gaseous products and still allow the tubes to be sufficiently heated to efficiently generate steam. The primary purpose of the tiles is thus to extend tube wall lifetime expectancy.

[0003] Refractory tiles for boiler tube protection have traditionally been fabricated from a material such as silicon carbide (SiC). These tiles typically are provided with a substantially planar face with a contoured back surface sized and shaped to match the contour of the tube wall. Such tiles generally have been fabricated as a variant of one of three configurations, namely bolted tiles; hanging tiles, such as disclosed in U.S. Patent No. 4,768,447 to Roumeguere; and modified hanging tiles also known as slotted or T-slotted tiles such as disclosed in U.S. Patent No. 5,243,801 to Aiken, et al. and in WO 97/09577 to Zampell Advanced Refractory Technologies, Inc. The U.S. 4,768,447, U.S. 5,243,801 and WO 97/09577 references are fully incorporated by reference herein.

[0004] As shown in Figs. 1 and 2, bolted tiles 10 are generally provided with a square or rectangular face 12 adapted for orientation towards an interior of the boiler. A hole penetrates through the thickness of the tile in the

approximate center of the face 12. A countersunk region 34 typically exists within the hole or bore 30 to act as a seat for a nut 26. In a typical installation, a stud or threaded bolt 24 is welded to a membrane region 16 between two tubes 18 in the boiler wall 62. The contoured back surface 14 of the tile 10 includes accurate portions 20 sized and shaped to receiveably match the profile of the tube wall 19 and allow for close contact therewith.

[0005] The tile is installed by fitting the stud through the hole and securing the tile in position with a washer 28 and nut 26 threaded onto the stud. A cap (not shown) is then typically mortared in place over the hole to minimize the amount of gas that can flow through clearance between the standard hole to the backside of the tile. A layer of mortar (not shown) is typically applied between the tile and the wall 62, and between adjacent tiles, to form a rigid structure which serves to help secure the tile in position and to substantially prevent gas from flowing between and/or behind the tiles.

[0006] An advantage of using a bolted tile configuration is that the tiles are relatively easy to install and may be installed on substantially any surface of the boiler, including vertical and overhanging surfaces.

[0007] A disadvantage of such bolted tiles is associated with tile failures. These tiles usually have a 2 to 4 year life expectancy due to stud failure. When the studs fail, the tiles tend to fall off of the walls, leaving the boiler tubes exposed to the incinerator atmosphere. The cause of failure in the studs was previously believed to have been due to high temperature acid corrosion. In particular, it was believed that the acids penetrated the tile through the stud hole to attack the stud. The corrosion was believed to be severe on the stud due to its high operating temperature (believed to be 1000°C or more). Also, cracking of the tiles was a common occurrence, and believed to have been generated by over-stressing the stud.

[0008] One attempt to address the disadvantages associated with bolted tile systems has included the use of hanging tiles. As shown in Figs. 3 and 4, hanging tiles 45 typically utilize an anchor/hook or short stud 37 to hang the tile on the membrane 16 of the boiler wall 62, with gravity utilized to maintain the tile in close proximity to the boiler wall 62 for good heat transfer. This tile 45 is a modification of the bolted tile in that one or more holes 30' project from the back surface 14' of the tile toward the hot face 12, but do not fully penetrate the hot face. This provides the tile with a closed face, to theoretically improve acid corrosion resistance. A layer of mortar (not shown) is typically installed between the tile 45 and the boiler wall 62, as well as between adjacent tiles to form a rigid, substantially gas and ash impermeable structure.

[0009] A variation of this hanging tile arrangement utilizes the tiles 45 in conjunction with an air sweep system. In this variation, no mortar is installed behind the tiles to leave a gap between the tiles and the boiler wall. A flow of air is fed through this gap to help minimize acid cor-

rosion of the wall.

[0010] An advantage of hanging tiles in general is the relative ease of installation and replacement. A disadvantage of such hanging tile arrangements is that the tiles generally cannot be installed on non-vertical walls, as the tiles tend to fall off their anchors.

Also, tiles have been known to lift off of their anchors during operation due to thermal expansion, etc. Moreover, the above described air sweep system tends to disadvantageously increase the expense of the tile system relative to configurations utilizing mortar. Heat transfer between the tiles and wall also may be disadvantageously reduced due to the insulative (i.e., relatively low thermal conductivity) characteristic of air layers.

[0011] Turning to Fig. 5, modified hanging tiles 50 have been developed in an attempt to address the drawbacks associated with the hanging tiles becoming dislodged from their anchors or hooks. Examples of such modified configurations are commonly known as mushroom bolt, tube-welded fin anchor, and T-slot tiles. These tiles 50 are typically hybrids of bolted tiles and hanging tiles, incorporating a closed tile face 12' with an anchor 52 that has a substantially T-shaped profile, to effectively capture the tiles and allow them to be installed on both vertical and overhanging surfaces.

[0012] These tiles 50 are generally installed with a layer of mortar between the tile and the boiler wall, as well as between adjacent tiles. The purpose of the mortar is to help secure the tiles by providing a rigid attachment and to provide a barrier to resist penetration of ash and corrosive gas between and behind the tiles.

[0013] An advantage of these modified tiles 50 is that they may be installed on nominally any boiler surface. Disadvantages of the tiles 50 include difficulty of manufacture since they incorporate a blind (i.e., discontinuous) slot 54 projecting laterally into the tile from an edge thereof. Also, the tiles may be physically weaker due to the complexity of the blind slots 54. Moreover, individual tiles generally cannot be replaced without removing a entire row of tiles.

[0014] An additional approach intended to address the drawbacks of the above-described configurations has included use of the hanging tiles 45 in combination with a resilient material 48 installed between opposed recesses or grooves 49 as shown in Figs. 3 and 4. This approach tends to facilitate installation and replacement of the tiles relative to tile systems utilizing conventional rigid mortar. While this approach may operate satisfactorily in some applications, the resilient material 48 disadvantageously provides little resistance to corrosive gas flow and thus tends to be undesirable for use in particularly corrosive environments such as found in MSW boilers.

[0015] Still further, many of the approaches discussed hereinabove utilize a fibrous compressible material or mortar at periodic tile intervals to serve as expansion joints. For example, such material may be used every 7 to 15 tiles in a manner familiar to those skilled in the art

of masonry (i.e., such as commonly utilized in fabrication of concrete sidewalks, etc.) These joints however, tend to disadvantageously permit the passage of acids and other corrosive materials therethrough, to enable corrosion of the underlying boiler wall.

Additionally, the useful life of tile systems having such expansion joints have not been shown to be appreciably greater than similar tile configurations not having such expansion joints.

[0016] EP-A-0 854 321 describes a boiler water pipe protecting refractory structure comprising a refractory interposed between a boiler water pipe and a combustion gas. The water pipe protecting refractory structure is provided as a refractory structure capable of reducing thermal stress without increasing the wall thickness of refractory blocks, and improving the durability of mounting members by preventing the occurrence of high-temperature corrosion thereof, and has a high heat transfer efficiency. The characteristics of this structure reside in that the structure is provided with a refractory block, which has an arcuate portion and a connecting portion engaged at inner circumferences thereof with the boiler water pipe, and a locking recess and a locking projection formed on the boiler water pipe, respectively, as fixing means for detachably engaging the refractory block and boiler water pipe with each other.

[0017] EP-A-0 656 508 refers to a protective wall structure for protecting boiler tubing in facilities using refuse as a fuel source to produce steam for electrical power generation. The protective wall shall structure includes an array of shielding tiles, heat transfer bonding material, and elongated compressible material. The shielding tiles include a front surface facing the interior combustion zone of the facility, a rear surface facing the boiler tubes, and a plurality of sidewall surfaces. The heat transfer bonding material is positioned between the boiler tubes and the rear surfaces of the shielding tiles to permit heat transfer and create a bond between the boiler tubes and the shielding tiles. The elongated compressible material is positioned between the sidewall perimeter surfaces of adjacent shielding tiles to provide an expansion joint. This permits relative expansion between adjacent shielding tiles without cracking upon an increase in temperature in the interior combustion zone.

[0018] Thus, a need exists for an improved refractory tile system that addresses drawbacks associated with the prior art.

SUMMARY

[0019] The present invention refers to a boiler according to independent claim 1 as well as to a method for assembling a refractory tile system for use on a wall of a boiler.

[0020] A significant aspect of the present invention is the recognition of the problem responsible for many of the failures of the prior art systems. It was recognized that these failures were generated by both bowing of in-

dividual tiles (as used herein, "micro-scale" bowing) and collective bowing of multiple tiles (as used herein, "networked" or "macro-scale" bowing) as shown in Fig. 8. Referring to Fig. 9, micro-scale bowing generates forces F which transfer through the rigid mortar (not shown) to adjacent tiles to thus generate a macro-scale bowing effect. The macro-scale bowing applies sufficient tensile stress to the studs to cause failure. In this regard, it was heretofore believed that any significant dimensional instability of the tiles was primarily limited to thermal expansion generated by exposure to elevated boiler temperatures. Moreover, it was believed that any bowing was limited to individual tiles.

[0021] Contrariwise, the present invention is based on the recognition that thermal gradients experienced by individual tiles during boiler operation (i.e., the difference between the temperature at the hot face 112' and the back 114' as shown, for example, in Fig. 7) were greater than previously suspected, and exerted a greater influence on the dimensional instability of the tiles than the aforementioned thermal expansion. It was then realized that bowing generated by the thermal gradient tended to transfer stresses through the rigid mortar disposed between adjacent tiles to effectively magnify the effects of individual tile bowing as a function of the square of the length of the tile network. This phenomenon is described by the following equation:

$$\delta = \alpha L^2 \Delta T / (8t)$$

where δ = cumulative deflection, α = the coefficient of thermal expansion, L is the length of the tile array, ΔT is the difference between temperatures at opposite faces of the tiles and t is the tile thickness.

[0022] It has also been discovered that oxidation on the hot face on the tiles occurring over time creates "hot spots" which tend to exacerbate the temperature gradient across the tile to further contribute to the micro-scale bowing effect. In this regard, it has been found that the macro-scale bowing serves to accelerate the oxidation, thus initiating a self-perpetuating cycle that serves to accelerate the decay of the tiles. For example, optimum operating temperature of the hot face of SiC tiles may be approximately 500 to 600 degrees C. Oxidation at this temperature has been found to be minimal and to not substantially affect tile life. However, it has been found that oxidation progresses rapidly in the event the hot face reaches or exceeds about 750 degrees C and continues to accelerate rapidly as the temperature increases further. An aspect of the present invention was thus the recognition that the macro-scale bowing serves to separate the tiles from the boiler wall, forming an air gap which generally reduces the heat transfer from the back of the tile to the wall. This decrease in heat transfer effectively increases the temperature at the hot face beyond the preferred operating temperature range. The macro-scale bowing eventually has the effect of raising

the hot face temperature to the oxidation promoting temperature of 750 degrees C or more. The oxidation in turn, tends to further increase the temperature gradient which as discussed hereinabove, tends to further exacerbate the macro-scale bowing, thus forming a self-perpetuating, deleterious cycle.

[0023] Thus, as prior art tile configurations have been developed to minimize acid penetration (i.e., the blind hole mounting of hanging and modified tiles 45 and 50), they have neither identified, nor addressed the aforementioned bowing condition. These prior configurations continue to make use of rigid mortar around the tiles, to thus permit macro-scale bowing to occur.

[0024] It was similarly realized that the failure of the above-referenced expansion joints to generate any substantial benefit was due in part to the failure to recognize the networked bowing phenomena and rather attempt to compensate only for relatively benign thermal expansion effect. This failure is indicated not only by the relative paucity or infrequency of the expansion joints (i.e., utilized only once every 7-15 tiles), but also by the frequent use of conventional mortar disposed within at least a portion of the expansion joint.

[0025] Initial steps in developing the present invention included completion of a first finite element model (FEM) of a conventional 18cm x 18cm bolted tile to assess the cause of cracking in the tiles during operation. This analysis revealed the presence of stresses in the tile due to thermal gradients. It also revealed that the individual tiles bow as a function of the thermal gradients. The initial result of this analysis was to increase the thickness of the tile to increase the tile strength.

[0026] After this first analysis was completed, a second finite element model was completed to predict the thermal profiles through the tile thickness and along the length of the stud. At an assumed incinerator operating temperature of 1370°C, this model predicted that the studs were operating at temperatures above 800°C, which is the maximum use temperature for most stainless steel.

[0027] Failed studs were then retrieved from an incinerator. Analysis of the studs revealed that they had been stretched approximately 6mm prior to failure. This indicated that the studs were placed under a tensile load, and thus were not failing by acid corrosion alone, but rather by stress-corrosion. It was thus determined to examine the cause of the stress on the studs.

[0028] Moreover, during retrieval of the failed studs, it was observed that blistered areas of tiles existed. These blisters were approximately 10 tiles by 10 tiles in area, and were displaced into the boiler.

[0029] A third finite element model was initiated to study the phenomenon of tile bowing and tensile stress. As previously mentioned, the first FEM indicated that bowing of individual tiles, or micro-scale bowing, occurred due to thermal gradients. This bowing, however, was of insufficient magnitude (0.3 mm) to have caused the 6mm deformation observed in the studs.

[0030] In the third FEM, a 7 by 7 array of tiles was modeled, assuming that the mortar would act as a rigid material. The results of the analysis indicated a networking effect among the tiles which generated a significant bow of over 25mm. Additionally, stress analysis indicated that the networked (macro-scale) bowing applied sufficient tensile force to the studs to cause them to stretch to the fracture point.

[0031] To confirm the finite element model, a test panel of instrumented tiles was installed in an incinerator. Data collected from the test panel indicated that the tiles bow on a macro-scale during operation, with the magnitude of the bow being approximately 4mm after 1 year in service. Extrapolation of the rate of bowing indicates that the tile will displace 8mm (the displacement assumed to be necessary for stud failure) approximately 2.5 years from the start of the test. This corresponds well with the previous service lifetime observations from bolted tiles.

[0032] Thus, according to this invention, a refractory tile system for use on a wall of a boiler includes a plurality of tiles having a floating fastener system engagable with the wall to maintain the tiles in spaced, movable relation to one another as well as in spaced movable relation to the wall. The tiles are sized and shaped to provide a gap between adjacent ones of the tiles, the gap being sufficient to accommodate dimensional changes of the tiles exhibited during exposure to operational temperatures of the boiler. A corrosion barrier is disposed between the tiles and the wall. Moreover, the corrosion barrier is a coating applied to the tube wall and the coating is adapted to adhere to the wall to be free from adherence the tiles.

[0033] A refractory tile system for use on a wall of a boiler includes a plurality of tiles disposed on the wall in spaced, movable relation to one another. The tiles are sized and shaped to provide a gap between adjacent ones of the tiles, the gap being sufficient to substantially prevent macro-scale bowing of the tiles during exposure to operational temperatures of the boiler. A corrosion barrier is disposed between the tiles and the wall to substantially prevent corrosion of the wall.

[0034] In a further aspect of the subject invention, a method is provided for increasing the useful life of a wall of a boiler. The method includes the steps of:

- (a) providing a plurality of tiles having a floating fastener system engagable with the wall to maintain the tiles in spaced, movable relation to one another as well as in spaced movable relation to the wall;
- (b) sizing and shaping the tiles to provide a gap between adjacently wall-mounted ones of the tiles, the gap being sufficient to accommodate dimensional changes of the tiles exhibited during exposure to operational temperatures of the boiler;
- (c) disposing a corrosion barrier on the wall which corrosion barrier is a coating adhering to the wall while being free from adherence to the tiles; and

(d) engaging the floating fastener system with the wall, wherein the tiles are superposed with the wall with the corrosion barrier disposed therebetween.

[0035] The above and other features and advantages of this invention will be more readily apparent from a reading of the following detailed description of various aspects of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

FIG. 1 is a plan view of a bolted refractory tile of the prior art;

FIG. 2 is a cross-sectional view taken along 2-2 of the refractory tile of Fig. 1;

FIG. 3 is a side elevational cross-sectional view of a hanging refractory tile of the prior art;

FIG. 4 is a top elevational cross-sectional view of the hanging refractory tile of Fig. 3;

FIG. 5 is a perspective, partially exploded view, with portions broken away, of a modified refractory tile of the prior art, disposed for engagement with a boiler wall;

FIG. 6 is a view similar to that of Fig. 2, including a top elevational view of an embodiment of the refractory tile system of the present invention;

FIG. 7 is a view similar to that of Fig. 6, of another embodiment of the refractory tile system of the present invention;

FIG. 8 is a perspective view of an array of prior art refractory tiles bowed on a macro-scale as identified pursuant to the present invention;

FIG. 9 is a schematic cross-sectional view similar to that of Fig. 2, of a portions of a pair of adjacent refractory tiles of the prior art, with portions shown in phantom to indicate improvement due to bowing;

FIG. 10 is a view similar to that of Figs. 6 and 7, of still another embodiment of the refractory tile system of the present invention;

FIG. 11 is a side elevational exploded view of portions of the refractory tile system of FIG. 11;

FIGS. 12-15 are perspective views of the refractory tile system of FIGS. 10 and 11, of various steps taken during installation of a refractory tile according to the present invention;

FIG. 16 is an elevational schematic representation of a series of conventional bolted tiles of Figs. 1 and 2 installed in a boiler for test;

FIG. 17 is a graphical representation of test results generated by bolted tiles of FIG. 16; and

FIG. 18 is a graphical representation similar to that of FIG. 17, of test results generated by tiles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Referring to the figures set forth in the accompanying Drawings, the illustrative embodiments of the present invention will be described in detail hereinbelow. For clarity of exposition, like features shown in the accompanying drawings shall be indicated with like reference numerals and similar features as shown in alternate embodiments in the Drawings shall be indicated with similar reference numerals.

[0038] Where used in this disclosure, the term "axial" when used in connection with an element described herein, shall refer to a direction relative to the element, which is substantially parallel to the central axis a of tube 18 (i.e., Fig. 7) when the element is disposed in engagement with a tube 18 as shown in Figs. 6, 7, 10 and 14. The term "transverse" refers to a direction substantially orthogonal to the axial direction.

[0039] Turning now to Fig. 6, in one embodiment of the present invention, a refractory tile system 60 includes a barrier layer coating 61 applied to the wall 62 (i.e., membrane 16 and tube wall 19) of a boiler of an incinerator or heat exchanger. The barrier layer 61 is adapted to provide acid and salt corrosion resistance at the normal operating temperatures of the boiler. An example of such a coating is a phosphate bonded SiC barrier layer such as PC-1022™ available from Norton Company of Worcester, Massachusetts. Advantageously, this material provides relatively good corrosion resistance and thermal conductivity. Refractory tiles 66 are then fastened to the tube wall 62 in superposed relation with the wall 62 utilizing a floating attachment mechanism 68. The tiles 66 are fabricated from any suitable refractory material known to those skilled in the art, such as, for example silicon carbide (SiC) or other ceramic materials capable of withstanding the temperatures (as high as approximately 1400°C) experienced within the boiler of a MSW incinerator/heat exchanger, and the like.

[0040] The floating attachment mechanism 68 provides the tiles 66 with a relatively high degree of freedom of movement relative to the tube wall 62 to accommodate micro-scale bowing of the tile. As discussed hereinabove, the micro-scale bowing has been found to be generated by the relatively large temperature gradient (typically about 200 to 600°C or more) experienced by such tiles. As also discussed, this temperature gradient has been found to have a substantially greater effect on the dimensional instability of the tiles than the elevated temperature per se, particularly in light of the networking effect in which bowing increases as a square of length of the tile array. Each tile 66 is effectively isolated from adjacent tiles by providing a predetermined gap 70 therebetween of sufficient size to effectively prevent macro-scale bowing which has been found to be generated by networking. As shown in Fig. 9, this networking phenomena is generated by the pressure or force F exerted by

the tiles upon one another through the rigid mortar (not shown) when micro-scale bowed.

[0041] Turning back to Fig. 6, the gap 70 is preferably formed by contoured peripheral edges 72 which are sized and shaped to form a spaced, shiplapped joint between adjacent tiles 66. This shiplapped configuration advantageously serves to provide an obstructed line-of-sight between the tiles to inhibit penetration of ash or other contaminants through the gap 70 during operation of the boiler. Moreover, a compressible fibrous mortar (not shown) may be disposed in the gap or channel 70 between each adjacent tile to further inhibit ash or other contaminant penetration. An example of such a suitable compressible fibrous mortar is known as Topcoat 2600™ available from Unifrax Corporation of Niagara Falls, New York. In the event such a compressible mortar is used, the gaps 70 are sized in combination with the known compressibility of the particular compressible mortar selected, so as to maintain any force transfer between tiles at a magnitude low enough to substantially prevent the occurrence of macro-scaled bowing when the individual tiles are disposed in their maximum micro-scale bowed condition. For example, tiles shaped substantially as shown in Fig. 7 having a rectangular face 112' extending approximately 30cm x 20cm, should have gaps 70' extending at least approximately 6mm from adjacent tiles.

[0042] In the embodiment shown, floating attachment mechanism 68 includes rails 74 having a plurality of flexible arms 76 with convex terminal ends 78 adapted to engage similarly sized recesses 80 disposed in the tiles 66. Arms 76 are thus biased into releasable engagement with tile 66 to facilitate installation and removal thereof. Moreover, the resiliency of the arms 76 serves to fasten the tile 66 to the wall 62 in a manner which permits the tile 66 to move or "float" relative to the wall 62 in response to dimensional changes of the tile 66 generated by thermal gradients and elevated mean temperatures. In this regard, the floating attachment mechanism 68 enables the tile 66 to move with at least three degrees of freedom (i.e., along three mutually orthogonal axes x, y and z, as shown) relative to the wall 62. Moreover, in addition to translation along the x, y and z axes, the tile may rotate around a tube 18 and/or bow towards or away from a tube 18. The rail 74, including arm 76 and convex terminal end 78 are preferably fabricated from a flexible, corrosion resistant material, such as stainless steel.

[0043] As also shown, the face 112 of the tile 66 may be provided with a contoured geometry which substantially matches the contour of the wall 62 to provide the tile with a relatively uniform thickness t.

[0044] Turning now to Fig. 7, an alternate embodiment of the present invention is shown as tile system 60'. This embodiment is substantially similar to the tile system 60 shown in Fig. 6, while utilizing a substantially planar face 112' and an alternate floating engagement mechanism 68'. As shown, this fastener system 68' is in

many respects similar to fastener system 68 of Fig. 6, though utilizing approximately 50 percent fewer arms 76'.

[0045] Although embodiments of floating mechanism 68 and 60' have been shown, it should be recognized by those skilled in the art that substantially any mounting mechanism capable of securing a tile to a wall 62 of a boiler in a manner which permits the tile to expand and/or bow on a micro-scale without generating the macro-bowing effect as set forth hereinabove, may be utilized without departing from the spirit and scope of the present invention. In this regard, for example, a rigid mounting arrangement may be used in lieu of the flexible arms 76 and 76', as long as sufficient clearance is provided between the mounting hardware and the tile to enable the aforementioned dimensional changes to occur nominally without applying excessive force or stress to the mounting hardware and/or adjacent tiles.

[0046] One example of such an alternate arrangement may include provision of one or more pins 82 (shown in phantom) fabricated from stainless steel or the like, which are insertable into substantially oversized bores 84 (shown in phantom) disposed within in the tile and which extend substantially parallel to the tile face 112. The pin 82 is in turn, secured to the wall 62 in any convenient manner known to those skilled in the art, (not shown). In this manner, the tile may be secured to the wall 62 with sufficient clearance to effectively "float" relative to the wall as discussed hereinabove.

[0047] Turning now to Figs. 10 and 11, an additional embodiment of the present invention is shown as tile system 60". This tile system 60" is substantially similar to the tile systems 60 and 60' shown in Figs. 6 and 7, while using an alternate floating engagement mechanism 68". As shown, this fastener system 68" is in many respects similar to fastener system 68' of Fig. 7, though the arms 76" are substantially "C" shaped for engagement with substantially semi-cylindrical slots or recesses 80" of the tile 66" as shown.

[0048] Referring to Fig. 11, the slots 80" of tile 66" include upper slots 81 and lower slots 83, which extend axially inward from upper and lower edges 116 and 118, respectively, of tile 66". The upper slot 81 preferably extends an axial distance d1 from upper edge 116 that is greater than axial distance d2 of lower slot 83, to facilitate installation of the tile 66" as discussed hereinbelow. As also shown, the upper and lower surfaces 116 and 118 are chamfered, preferably at an angle α of approximately 30 to 60 degrees, at their intersection with the slots 81 and 83 to further facilitate installation of the tiles 66" as discussed below. In a preferred embodiment, angle α is approximately 45 degrees as shown.

[0049] Turning now to Figs. 12-15, the method of installing a tile 66" is shown. Referring to Fig. 12, a tile 66" is installed by placing the upper surface 116 of the tile between the upper and lower arms 76", in substantial axial alignment therewith. This orientation may be accomplished by disposing a portion of the upper surface

116 in surface-to-surface engagement with the tubes 18 as shown. Turning to Fig. 13, the surface 116 of tile 66" is moved axially upwards as indicated by arrow a, while the lower surface 118 is pivoted closer to the tubes 18 as shown by arrow b. This action serves to slide the upper slot 81 (Fig. 11) into receiving engagement with one set of (i.e., the uppermost) arms 76" as shown. This movement is continued until the tile clears the lower arms 76" to permit the tile 66" to be moved into substantially parallel alignment with the tubes 18 as shown in Fig. 14. The tile then may be translated axially towards an adjacent pre-installed tile 66" (i.e., in direction c) to receivably engage lower arms 76" within lower slots 83 (Fig. 11). This translation preferably continues until the lower arms 76" engage the proximal end 120 (Fig. 11) of the slots 83. At this point, the adjacent tiles 66" will be disposed in their desired spaced, shiplapped orientation as shown in Fig. 15, to complete the installation. Additional tiles 66" (not shown) then may be installed in a similar manner.

[0050] The following illustrative examples are intended to demonstrate certain aspects of the present invention. It is to be understood that these examples should not be construed as limiting.

EXAMPLES

Example 1 - Comparison

[0051] A series of conventional bolted tiles of the general type shown in Figs. 1 and 2 were installed in a furnace in a pattern as shown in Fig. 16. Tiles labeled A, B, C, and D were instrumented with LVDTs (linear variable-displacement transducers) to measure the displacement of these tiles away from the tube walls during normal furnace operation. As shown, tiles B and D were located in a tile array portion that included a conventional flexible mortar (the above-referenced Topcoat 2600™) between adjacent tiles. Turning to Fig. 17, the output of the LVDTs indicate that the instrumented tiles were displaced nearly simultaneously with one another, providing evidence that macroscale bowing was taking place. (The differences in displacement magnitude indicated by the plots were apparently due to variations in location of the LVDTs within the tiles.) Note, LVDT 5 located on Tile B malfunctioned and thus is not shown in Fig. 17.

Example 2

[0052] An array of tiles of the present invention was mounted in a boiler for test. The tiles were configured and mounted in the boiler in a manner substantially as shown and described hereinabove with respect to Fig. 7, including use of a barrier material between the boiler wall and the tiles, and Topcoat 2600™ between adjacent tiles. Selected tiles indicated as A, B, C, D, E, and G were instrumented with LVDTs in the manner described

in Example 1. As shown in Fig. 17, the output of these LVDTs show that the tiles were displaced independently from one another, in a manner contrary to that shown in Example 1. These test results thus indicate that these tiles of the present invention accommodated individual (micro-scale) bowing, without generating macroscale bowing.

[0053] Although the attachment mechanisms 68, 68' and 68" enable the tiles 66, 66' and 66" to move or "float" relative to the wall 62, the skilled artisan will recognize that the mechanisms 68, 68' and 68" preferably maintain the tile 66 as close as possible to the surface of the tube 18 to maximize heat transfer through the tile 66 to the tube.

[0054] Moreover, the aforementioned hanging tile and modified hanging tile systems discussed hereinabove may be utilized in combination with the present invention. Furthermore, a conventional bolted tile fastener arrangement as also discussed hereinabove may be modified to provide additional clearance between the stud and bore to permit the tile to float relative to the wall to thus be usable in combination with the corrosion barrier and the gap between adjacent tiles of the present invention.

[0055] The foregoing description is intended primarily for 10 purposes of illustration. Although the invention has been shown and described with respect to an exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions, and additions in the form and detail thereof may be made therein without departing from the and scope of the invention as defined in the claims.

Claims

1. A boiler, comprising:

a wall (62);
a plurality of tiles (66; 66'; 66") having a floating fastener system (68; 68'; 68") engagable with the wall (62) to maintain said tiles (66; 66'; 66") in spaced, movable relation to one another, and wherein said fastener system (68; 68'; 68") maintains said tiles (66; 66'; 66") in spaced, movable relation to the wall (62);
said tiles (66; 66'; 66") being sized and shaped to provide a gap (70; 70') between adjacent ones of said tiles (66; 66'; 66"), said gap (70; 70') being sufficient to accommodate dimensional changes of said tiles (66; 66'; 66") exhibited during exposure to operational temperatures of the boiler; and
a corrosion barrier disposed between said tiles (66; 66'; 66") and said wall (62),

characterized in that

said corrosion barrier is a coating (61) applied to the tube wall (62) and the coating (61) is adapted to adhere to the wall (62) and to be free from adherence to said tiles (66; 66'; 66").

2. The boiler of claim 1, wherein said tiles (66; 66'; 66") are sized and shaped to provide a gap between at least a portion of said tiles (66; 66'; 66") and the tube wall (62) sufficient to accommodate said dimensional changes.
3. The boiler of claim 1, wherein said gaps (70; 70') are sufficient to accommodate dimensional changes of said tiles (66; 66'; 66") due to exposure to a mean temperature gradient experienced during operation of the boiler.
4. The boiler of claim 3, wherein said temperature gradient is within a range of about 500 to 1400 degrees C.
5. The boiler of claim 4, wherein said tiles (66; 66'; 66") are maintained close enough to the wall (62) of the boiler to maintain said temperature gradient within said range of about 200-600 degrees C.
6. The boiler of claim 5, wherein at least a portion of said tiles (66; 66'; 66") is maintained in superimposed contact with at least a portion of said corrosion barrier, and said corrosion barrier is maintained in superimposed contact with at least a portion of the wall (62).
7. The boiler of claim 1, wherein said floating fastener system (68; 68'; 68") comprises a tab disposed on one of said wall (62) and said tiles (66; 66'; 66"), and a receptacle disposed on an other of said wall (62) and said tiles (66; 66'; 66"), said member and said receptacle being adapted for mutual engagement with sufficient clearance to maintain said tiles (66; 66'; 66") in said movable relation.
8. The boiler of claim 7, wherein said floating fastener system (68; 68'; 68") comprises a hanging tile system.
9. The boiler of claim 7, wherein said floating fastener system (68; 68'; 68") comprises a T-slotted tile system.
10. The boiler of claim 1, wherein said floating fastener system (68; 68'; 68") comprises a tab disposed on one of said wall (62) and said tiles (66; 66'; 66"), and a receptacle disposed on an other of said wall (62) and said tiles (66; 66'; 66"), said member and said receptacle being adapted for mutual engagement with sufficient resiliency to maintain said tiles (66; 66'; 66") in said movable relation.

11. The boiler of claim 1, wherein said receptacle comprises at least one slot (81, 83), said at least of slot (81, 83) extending in an axial direction.
12. The boiler of claim 11, wherein said at least one slot (81, 83) extends inwardly from an edge of said tile (66"), said edge being chamfered relative to the edge of said tile (66").
13. The boiler of claim 12, wherein said at least one slot comprises first and second slots extending inwardly from opposite edges of said tile, said first slot extending approximately twice as far as said second slot from respective opposite edges.
14. The boiler of claim 12, wherein said chamfer extends approximately 30 to 60 degrees relative to a transverse direction.
15. The boiler of claim 1, wherein said floating fastener system (68; 68'; 68") provides said tiles (66; 66'; 66") with at least one degree of freedom of movement relative to the wall (62).
16. The boiler of claim 15, wherein said floating fastener system (68; 68'; 68") provides said tiles (66; 66'; 66") with at least two degrees of freedom of movement relative to the wall (62).
17. The boiler of claim 15, wherein said floating fastener system (68; 68'; 68") provides said tiles (66; 66'; 66") with at least three degrees of freedom of movement relative to the wall (62).
18. The boiler of claim 1, further comprising a compressible material disposed in said gap (70; 70').
19. The boiler of claim 18, wherein said compressible material inhibits passage of contaminants into said gap (70; 70').
20. The boiler of claim 19, wherein said compressible material comprises a fibrous mortar.
21. The boiler of claim 1, wherein said coating comprises a membrane (61).
22. The boiler of claim 21, wherein said coating (61) comprises phosphate bonded silicon carbide (SiC).
23. The boiler of claim 1, wherein said tiles (66; 66'; 66") further comprise peripheral surfaces sized and shaped to form a spaced, shiplapped joint between said adjacent ones of said tiles (66; 66'; 66").
24. The boiler of claim 4, wherein said mean temperature is within a range of about 750 to 1200 degrees C.

25. A method for assembling a refractory tile system (60; 60'; 60") for use on a wall (62) of a boiler, said method comprising the steps of:

- (a) providing a plurality of tiles (66; 66'; 66") having a floating fastener system (68; 68'; 68") engagable with the wall (62) to maintain said tiles (66; 66'; 66") in spaced, movable relation to one another, and wherein said fastener system (68; 68'; 68") maintains said tiles (66; 66'; 66") in spaced, movable relation to the wall (62);
- (b) sizing and shaping said tiles (66; 66'; 66") to provide a gap (70; 70') between adjacent ones of said tiles (66; 66'; 66"), said gap (70; 70') being sufficient to accommodate dimensional changes of said tiles (66; 66'; 66") exhibited during exposure to operational temperatures of the boiler;

characterized by the further steps

- (c) disposing a corrosion barrier on the wall (62), which corrosion barrier is a coating (61) adhering to the wall (62) while being free from adherence to the tiles (66; 66'; 66"); and
- (d) engaging the floating fastener system (68; 68'; 68") with the wall (62), wherein the tiles (66; 66'; 66") are superposed with the wall (62) and the corrosion barrier is disposed therebetween.

Patentansprüche

1. Kessel, mit:

einer Wand (62);
einer Mehrzahl von Fliesen (66; 66'; 66") mit einem mit der Wand (62) in Eingriff bringbaren, flexiblen Befestigungssystem (68; 68'; 68"), um die Fliesen (66; 66'; 66") in beabstandeter, bewegbarer Beziehung zueinander zu halten, und wobei das Befestigungssystem (68; 68'; 68") die Fliesen (66; 66'; 66") in beabstandeter, bewegbarer Beziehung zu der Wand (62) hält;

wobei die Fliesen (66; 66'; 66") eine Größe und Form aufweisen, um eine Lücke (70; 70') zwischen benachbarten Fliesen (66; 66'; 66") zu bilden, wobei die Lücke (70; 70') ausreichend ist, um für Dimensionsänderungen der Fliesen (66; 66'; 66"), die während dem Ausgesetztsein gegenüber den Betriebstemperaturen des Kessels auftreten, Platz zu lassen; und

einer zwischen den Fliesen (66; 66'; 66") und der Wand (62) angeordneten Korrosionssperrschicht,

dadurch gekennzeichnet, daß

- die Korrosionssperrschicht eine Beschichtung (61) ist, die auf die Röhrenwand (62) aufgebracht ist und die Beschichtung (61) ausgebildet ist, um an der Wand (62) anzuhaften und frei zu sein von Anhaftung an den Fliesen (66; 66'; 66'').
2. Kessel nach Anspruch 1, wobei die Fliesen (66; 66'; 66'') eine Größe und Form aufweisen, um eine Lücke zwischen zumindest einem Teil der Fliesen (66; 66'; 66'') und der Röhrenwand (62) zu bilden, um für die Dimensionsänderungen ausreichend Platz zu lassen.
 3. Kessel nach Anspruch 1, wobei die Lücken (70; 70') ausreichend sind, um Platz zu lassen für Dimensionsänderungen der Fliesen (66; 66'; 66'') aufgrund des Ausgesetztseins gegenüber einem mittleren Temperaturgradienten, wie er während des Betriebs des Kessels durchlaufen wird.
 4. Kessel nach Anspruch 3, wobei der Temperaturgradient in einem Bereich von etwa 500 bis 1400 Grad C liegt.
 5. Kessel nach Anspruch 4, wobei die Fliesen (66; 66'; 66'') nahe genug an der Wand (62) des Kessels gehalten werden, um den Temperaturgradienten in dem Bereich von etwa 200 - 600 Grad C zu halten.
 6. Kessel nach Anspruch 5, wobei zumindest ein Teil der Fliesen (66; 66'; 66'') mit zumindest einem Teil der Korrosionssperrschicht in übereinanderliegendem Kontakt gehalten ist, und die Korrosionssperrschicht in übereinanderliegendem Kontakt mit zumindest einem Teil der Wand (62) gehalten ist.
 7. Kessel nach Anspruch 1, wobei das flexible Befestigungssystem (68; 68'; 68'') einen entweder an der Wand (62) oder an den Fliesen (66; 66'; 66'') angebrachten Vorsprung und eine an dem jeweils anderen Element Wand (62) oder Fliesen (66; 66'; 66'') angebrachte Aufnahmeeinrichtung aufweist, wobei das Bauteil und die Aufnahmeeinrichtung zum gegenseitigen Ineingriffbringen mit ausreichendem Abstand ausgestattet sind, um die Fliesen (66; 66'; 66'') in der bewegbaren Beziehung zu halten.
 8. Kessel nach Anspruch 7, wobei das flexible Befestigungssystem (68; 68'; 68'') ein System mit hängenden Fliesen umfaßt.
 9. Kessel nach Anspruch 7, wobei das flexible Befestigungssystem (68; 68'; 68'') ein System mit T-geschlitzten Fliesen umfaßt.
 10. Kessel nach Anspruch 1, wobei das flexible Befestigungssystem (68; 68'; 68'') einen entweder an der Wand (62) oder an den Fliesen (66; 66'; 66'') angebrachten Vorsprung und eine an dem jeweils anderen Element Wand (62) oder Fliesen (66; 66'; 66'') angebrachte Aufnahmeeinrichtung aufweist, wobei das Bauteil und die Aufnahmeeinrichtung zum gegenseitigen Ineingriffbringen mit ausreichender Rückstellkraft ausgestattet sind, um die Fliesen (66; 66'; 66'') in der bewegbaren Beziehung zu halten.
 11. Kessel nach Anspruch 1, wobei die Aufnahmeeinrichtung mindestens einen Schlitz (81, 83) aufweist, wobei der Schlitz (81, 83) sich in axialer Richtung erstreckt.
 12. Kessel nach Anspruch 11, wobei sich der mindestens eine Schlitz (81, 83) von einer Kante der Fliese (66'') nach innen erstreckt, wobei die Kante relativ zur Kante der Fliese (66'') abgeschrägt ist.
 13. Kessel nach Anspruch 12, wobei der zumindest eine Schlitz einen ersten und einen zweiten Schlitz umfaßt, die sich von gegenüberliegenden Kanten der Fliese nach innen erstrecken, wobei sich der erste Schlitz etwa doppelt so weit wie der zweite Schlitz von den entsprechenden gegenüberliegenden Kanten erstreckt.
 14. Kessel nach Anspruch 12, wobei sich die Abschrägung zwischen etwa 30 bis 60 Grad relativ zu einer transversalen Richtung erstreckt.
 15. Kessel nach Anspruch 1, wobei das bewegliche Befestigungssystem (68; 68'; 68'') den Fliesen (66; 66'; 66'') mindestens einen Bewegungsfreiheitsgrad relativ zu der Wand (62) gewährleistet.
 16. Kessel nach Anspruch 15, wobei das flexible Befestigungssystem (68; 68'; 68'') den Fliesen (66; 66'; 66'') mindestens zwei Bewegungsfreiheitsgrade relativ zu der Wand (62) gewährleistet.
 17. Kessel nach Anspruch 15, wobei das flexible Befestigungssystem (68; 68'; 68'') den Fliesen (66; 66'; 66'') mindestens drei Bewegungsfreiheitsgrade relativ zu der Wand (62) gewährleistet.
 18. Kessel nach Anspruch 1, der weiterhin ein zusammendrückbares Material, das in der Lücke (70; 70') angeordnet ist, enthält.
 19. Kessel nach Anspruch 18, wobei das zusammendrückbare Material den Durchgang von verunreinigenden Stoffen in die Lücke (70; 70') hemmt.
 20. Kessel nach Anspruch 19, wobei das zusammendrückbare Material einen Fasermörtel enthält.

21. Kessel nach Anspruch 1, wobei die Beschichtung (61) eine Membran enthält.
22. Kessel nach Anspruch 21, wobei die Beschichtung (61) ein phosphatgebundenes Siliciumcarbid (SiC) enthält. 5
23. Kessel nach Anspruch 1, wobei die Fliesen (66; 66'; 66'') des weiteren periphere Oberflächen enthalten, die eine derartige Größe und Form aufweisen, um eine beabstandete, überfaltete Verbindung zwischen benachbarten Fliesen (66; 66'; 66'') zu bilden. 10
24. Kessel nach Anspruch 4, wobei die mittlere Temperatur in einem Bereich von etwa 750 bis 1200 Grad C liegt. 15
25. Verfahren zum Zusammensetzen eines feuerfesten Fliesensystems (60; 60'; 60'') zur Verwendung an der Wand (62) eines Kessels, wobei das Verfahren die Schritte umfaßt: 20

- (a) Zurverfügungstellen einer Mehrzahl von Fliesen (66; 66'; 66'') mit einem flexiblen Befestigungssystem (68; 68'; 68''), das mit der Wand (62) in Eingriff bringbar ist, um die Fliesen (66; 66'; 66'') in beabstandeter, bewegbarer Beziehung zueinander zu halten, und wobei das Befestigungssystem (68; 68'; 68'') die Fliesen (66; 66'; 66'') in beabstandeter, bewegbarer Beziehung zur Wand (62) hält; 25
- (b) Sortieren und Formen der Fliesen (66; 66'; 66''), um eine Lücke (70; 70') zwischen benachbarten Fliesen (66; 66'; 66'') zu gewährleisten, wobei die Lücke (70; 70') ausreicht, um für Dimensionsänderungen der Fliesen (66; 66'; 66''), die während dem Ausgesetztsein gegenüber den Betriebstemperaturen des Kessels auftreten, Platz zu lassen; 30 35 40

gekennzeichnet durch die weiteren Schritte

- (c) Anbringen einer Korrosionssperrschicht auf der Wand (62), wobei die Korrosionssperrschicht eine Beschichtung (61) ist, die an der Wand (62) anhaftet, während sie frei von Anhaften an den Fliesen (66; 66'; 66'') ist; und 45
- (d) Ineingriffbringen des flexiblen Befestigungssystems (68; 68'; 68'') mit der Wand (62), wobei die Fliesen (66; 66'; 66'') mit der Wand (62) überlagert sind und die Korrosionssperrschicht dazwischen angeordnet ist. 50

Revendications

1. Chaudière comprenant :

une paroi (62) ;
 une pluralité de tuiles (66; 66'; 66'') ayant un système de fixation flottant (68; 68'; 68'') susceptibles de venir en prise avec la paroi (62) pour maintenir lesdites tuiles (66; 66'; 66'') en relation espacée et mobile l'une par rapport à l'autre, et dans laquelle ledit système de fixation (68; 68'; 68'') maintient lesdites tuiles (66; 66'; 66'') en une relation espacée et mobile par rapport à la paroi (62) ;
 lesdites tuiles (66; 66'; 66'') étant dimensionnées et conformées pour réaliser un espace (70; 70') entre tuiles (66; 66'; 66'') adjacentes, ledit espace (70; 70') étant suffisant pour accepter les variations dimensionnelles desdites tuiles (66; 66'; 66'') qui se manifestent au cours de l'exposition aux températures de fonctionnement de la chaudière ; et
 une barrière à la corrosion disposée entre lesdites tuiles (66; 66'; 66'') et ladite paroi (62),

caractérisée en ce que

ladite barrière à la corrosion est un revêtement (61) appliqué à la paroi (62) de tube et le revêtement (61) est adapté à adhérer à la paroi (62) et à être dépourvu d'adhérence vis-à-vis desdites tuiles (66; 66'; 66'').

2. Chaudière selon la revendication 1, dans laquelle lesdites tuiles (66; 66'; 66'') sont dimensionnées et conformées pour ménager un espace entre au moins une portion desdites tuiles (66; 66'; 66'') et la paroi de tube (62), suffisant pour accepter lesdites variations dimensionnelles.
3. Chaudière selon la revendication 1, dans laquelle lesdits espaces (70; 70') sont suffisants pour accepter les variations dimensionnelles desdites tuiles (66; 66'; 66'') dus à l'exposition à un gradient de température moyen rencontré au cours du fonctionnement de la chaudière.
4. Chaudière selon la revendication 3, dans laquelle ledit gradient de température est compris dans une gamme allant d'environ 500 à 1400°C.
5. Chaudière selon la revendication 4, dans laquelle lesdites tuiles (66; 66'; 66'') sont maintenues suffisamment proches de la paroi (62) de la chaudière pour maintenir ledit gradient de température au sein de ladite gamme d'environ 200-600°C.
6. Chaudière selon la revendication 5, dans laquelle au moins une portion desdites tuiles (66; 66'; 66'') est maintenue en contact de superposition avec au moins une portion de ladite barrière à la corrosion, et la barrière à la corrosion est maintenue

en contact de superposition avec au moins une partie de la paroi (62).

7. Chaudière selon la revendication 1, dans laquelle ledit système de fixation flottant (68; 68'; 68'') comprend une patte disposée sur l'une de ladite paroi (62) et desdites tuiles (66; 66'; 66''), et un réceptacle disposé sur l'autre de ladite paroi (62) et desdites tuiles (66; 66'; 66''), ledit élément et ledit réceptacle étant adaptés à venir en prise mutuelle avec un jeu suffisant pour maintenir lesdites tuiles (66; 66'; 66'') selon ladite relation mobile. 5
8. Chaudière selon la revendication 7, dans laquelle ledit système de fixation flottant (68; 68'; 68'') comprend un système de suspension des tuiles. 10
9. Chaudière selon la revendication 7, dans laquelle ledit système de fixation flottant (68; 68'; 68'') comprend un système de tuiles fendues en T. 20
10. Chaudière selon la revendication 1, dans laquelle ledit système de fixation flottant (68; 68'; 68'') comprend une patte disposée sur l'une de ladite paroi (62) et desdites tuiles (66; 66'; 66''), et un réceptacle disposé sur l'autre de ladite paroi (62) et desdites tuiles (66; 66'; 66''), ledit élément et ledit réceptacle étant adaptés à venir en prise mutuelle avec une résilience suffisante pour maintenir lesdites tuiles (66; 66'; 66'') selon ladite relation mobile. 25
11. Chaudière selon la revendication 1, dans laquelle ledit réceptacle comprend au moins une fente (81; 83), ladite au moins une fente (81; 83) s'étendant dans une direction axiale. 30
12. Chaudière selon la revendication 11, dans laquelle ladite au moins une fente (81; 83) s'étend vers l'intérieur depuis un bord de ladite tuile (66''), ledit bord étant chanfreiné par rapport au bord de ladite tuile (66''). 35
13. Chaudière selon la revendication 12, dans laquelle ladite au moins une fente comprend une première et une seconde fentes s'étendant vers l'intérieur depuis des bords opposés de ladite tuile, ladite première fente s'étendant approximativement sur une longueur double de celle de la seconde fente à partir des bords opposés respectifs. 40
14. Chaudière selon la revendication 12, dans laquelle ledit chanfrein s'étend sur approximativement 30 à 60° par rapport à une direction transversale. 45
15. Chaudière selon la revendication 1, dans laquelle ledit système de fixation flottant (68; 68'; 68'') pourvoit lesdites tuiles (66; 66'; 66'') d'au moins un degré de liberté de mouvement par rapport à la paroi (62). 50

16. Chaudière selon la revendication 15, dans laquelle ledit système de fixation flottant (68; 68'; 68'') pourvoit lesdites tuiles (66; 66'; 66'') d'au moins deux degrés de liberté de mouvement par rapport à la paroi (62).

17. Chaudière selon la revendication 15, dans laquelle ledit système de fixation flottant (68; 68'; 68'') pourvoit lesdites tuiles (66; 66'; 66'') d'au moins trois degrés de liberté de mouvement par rapport à la paroi (62).

18. Chaudière selon la revendication 1, comprenant en outre un matériau compressible disposé dans ledit espace (70; 70').

19. Chaudière selon la revendication 18, dans laquelle ledit matériau compressible empêche le passage de contaminants dans ledit espace (70; 70').

20. Chaudière selon la revendication 19, dans laquelle ledit matériau compressible comprend un mortier fibreux.

21. Chaudière selon la revendication 1, dans laquelle ledit revêtement (61) comprend une membrane.

22. Chaudière selon la revendication 21, dans laquelle ledit revêtement (61) comprend du carbure de silicium (SiC) lié au phosphate.

23. Chaudière selon la revendication 1, dans laquelle lesdites tuiles (66; 66'; 66'') comprennent en outre des surfaces périphériques dimensionnées et conformées pour réaliser un joint à feuillure, espacé, entre tuiles (66; 66'; 66'') adjacentes.

24. Chaudière selon la revendication 4, dans laquelle ladite température moyenne est comprise dans une gamme allant d'environ 750 à 1200°C.

25. Procédé d'assemblage d'un système de tuiles réfractaires (66; 66'; 66'') pour utilisation sur une paroi (62) d'une chaudière, ledit procédé comprenant les étapes suivantes :

- (a) la fourniture d'une pluralité de tuiles (66; 66'; 66'') ayant un système de fixation flottant (68; 68'; 68'') susceptible de venir en prise avec la paroi (62) pour maintenir lesdites tuiles (66; 66'; 66'') selon une relation espacée et mobile les unes par rapport aux autres, ledit système de fixation (68; 68'; 68'') maintenant lesdites tuiles (66; 66'; 66'') en une relation espacée et mobile par rapport à la paroi (62) ;
- (b) le dimensionnement et la conformation desdites tuiles (66; 66'; 66'') pour réaliser un espace (70; 70') entre tuiles (66; 66'; 66'') adjacentes.

tes, ledit espace (70; 70') étant suffisant pour accepter les variations dimensionnelles desdites tuiles (66; 66'; 66") manifestées au cours de l'exposition aux températures de fonctionnement de la chaudière,

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caractérisé par les autres étapes ci-après :

(c) la disposition d'une barrière à la corrosion sur la paroi (62), laquelle barrière à la corrosion est un revêtement (61) adhérent à la paroi (62) tout en étant dépourvu d'adhérence vis-à-vis des tuiles (66; 66'; 66") ; et

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(d) la mise en prise du système de fixation flottant (68; 68'; 68") avec la paroi (62), les tuiles (66; 66'; 66") étant superposées à la paroi (62) et la barrière à la corrosion étant disposée entre elles.

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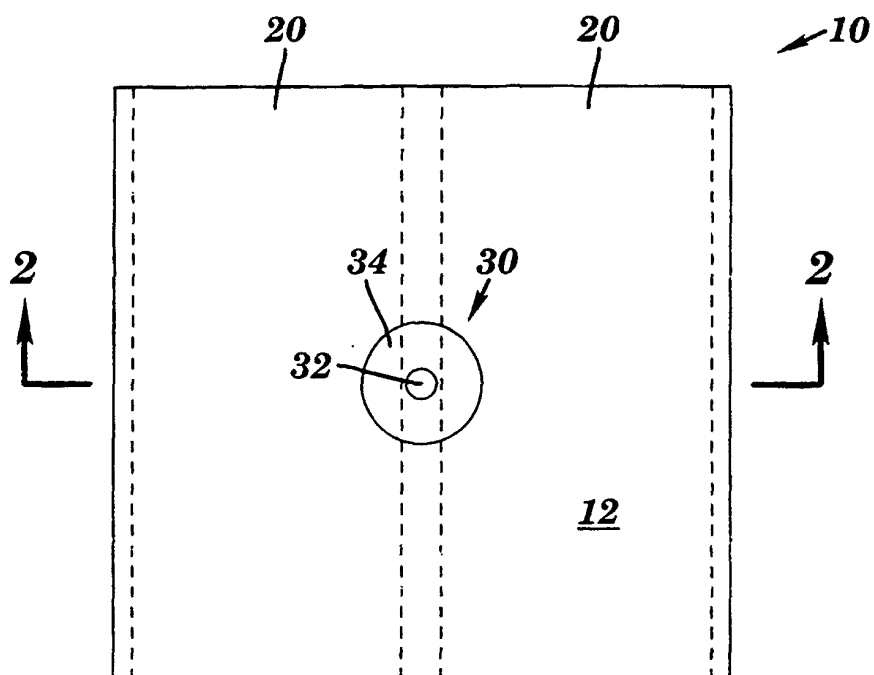


FIG. 1
PRIOR ART

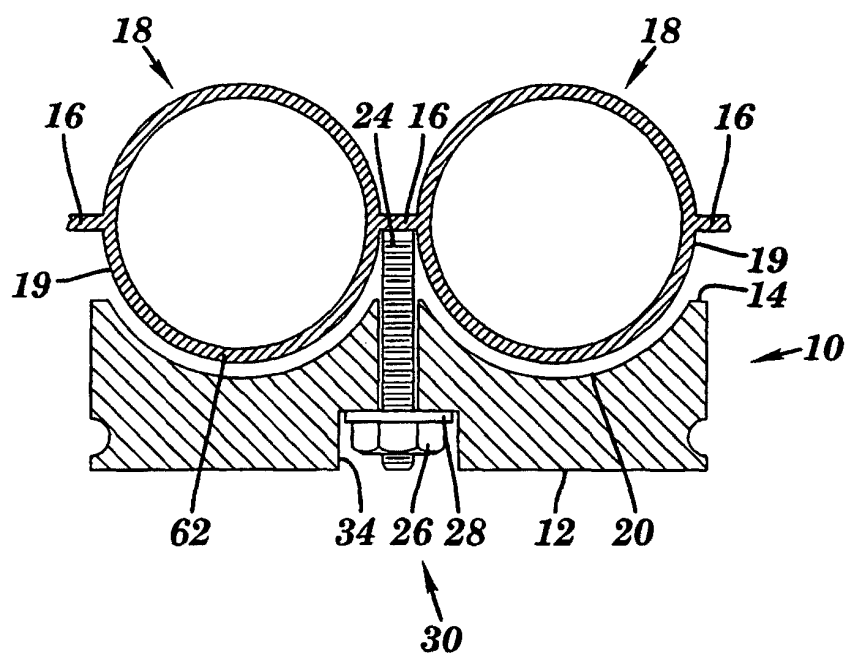


FIG. 2
PRIOR ART

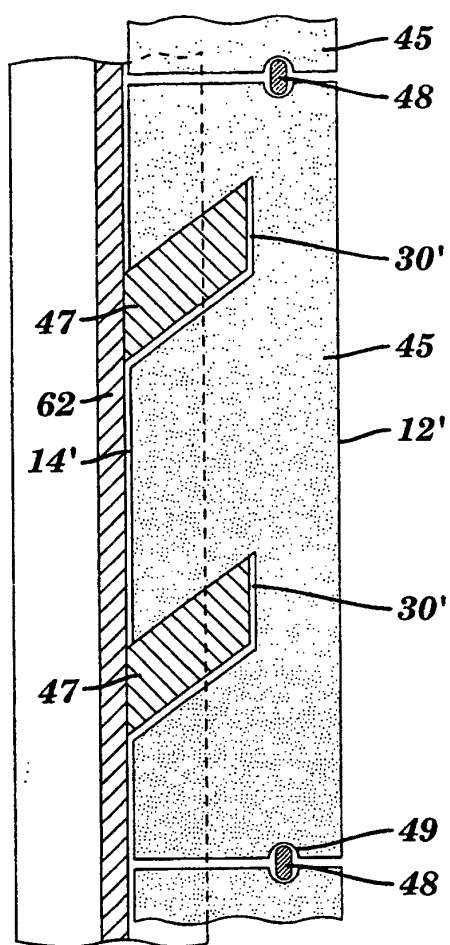


FIG. 3
PRIOR ART

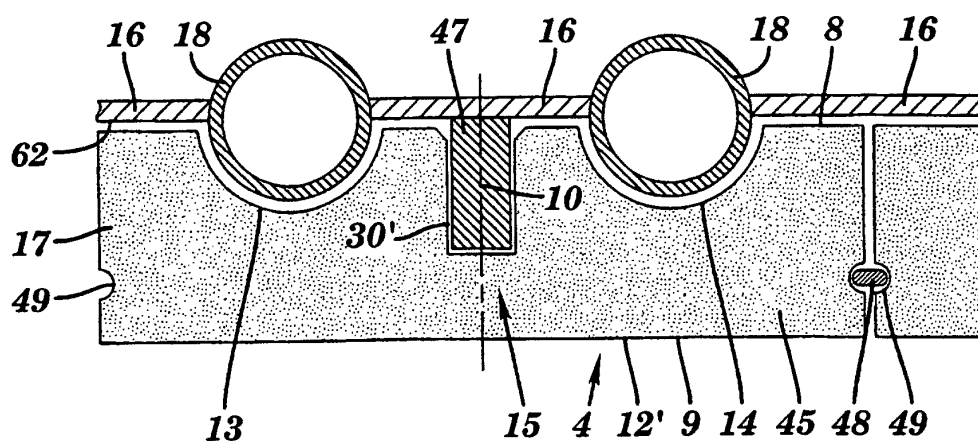


FIG. 4
PRIOR ART

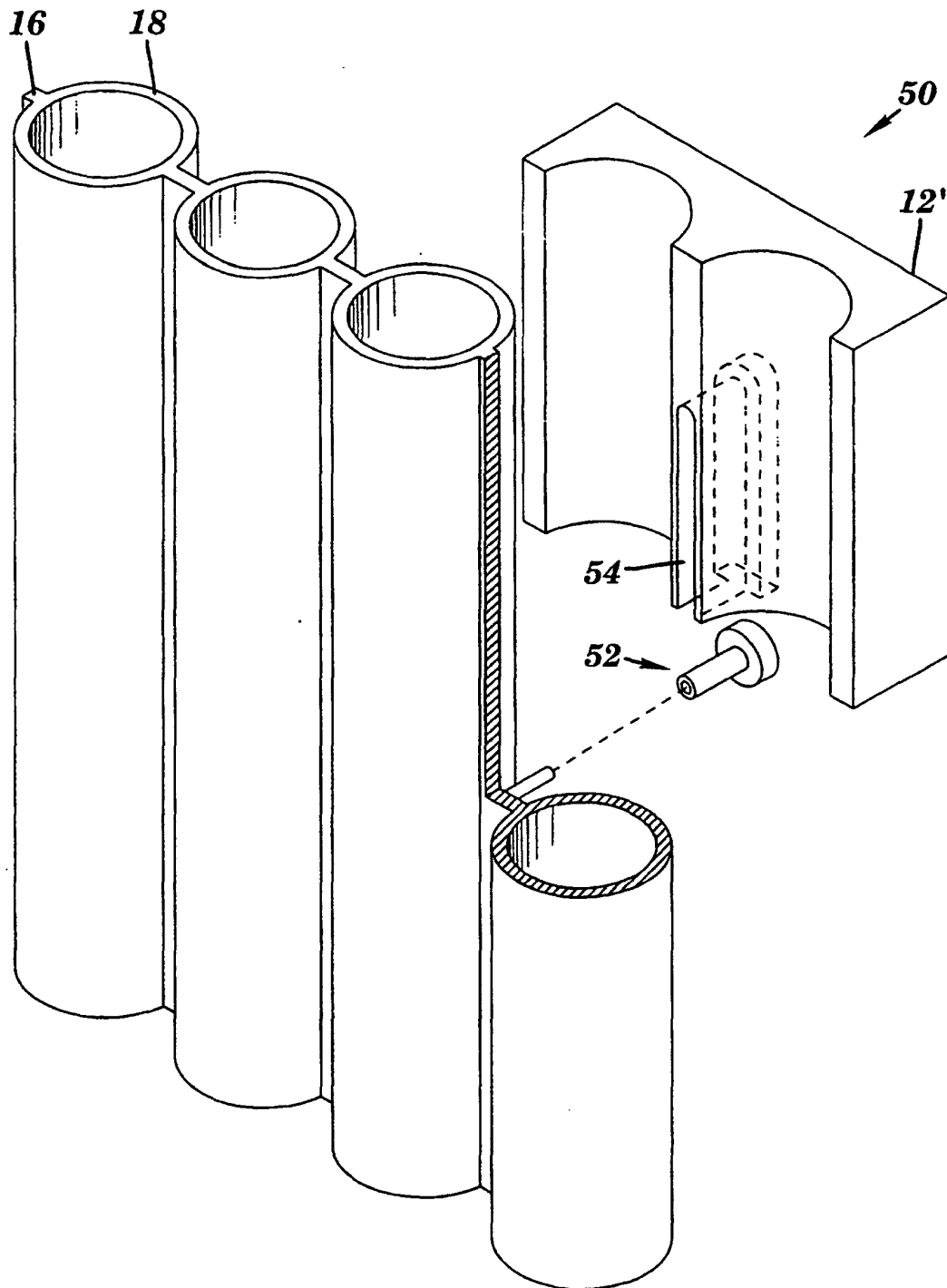


FIG. 5
PRIOR ART

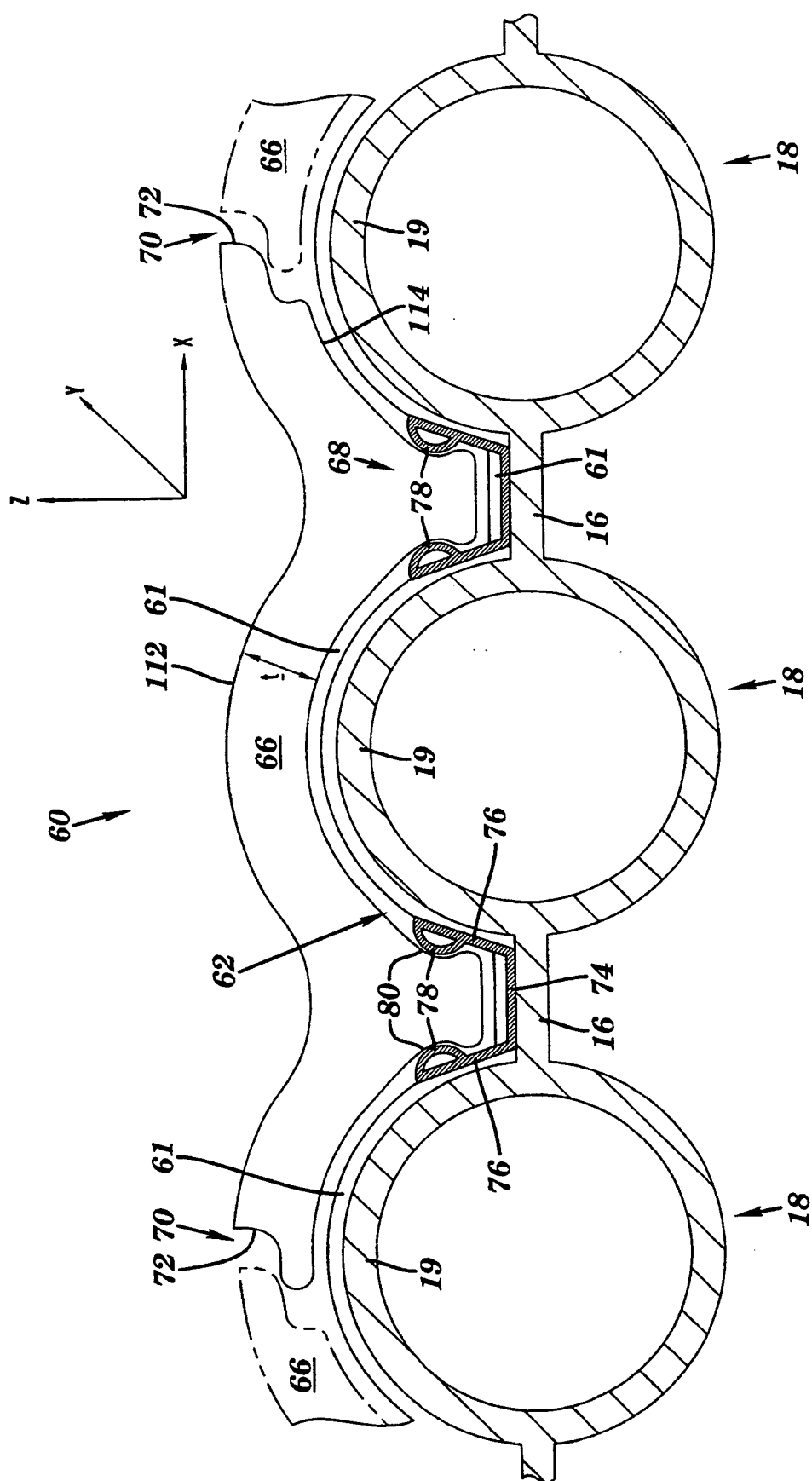


FIG. 6

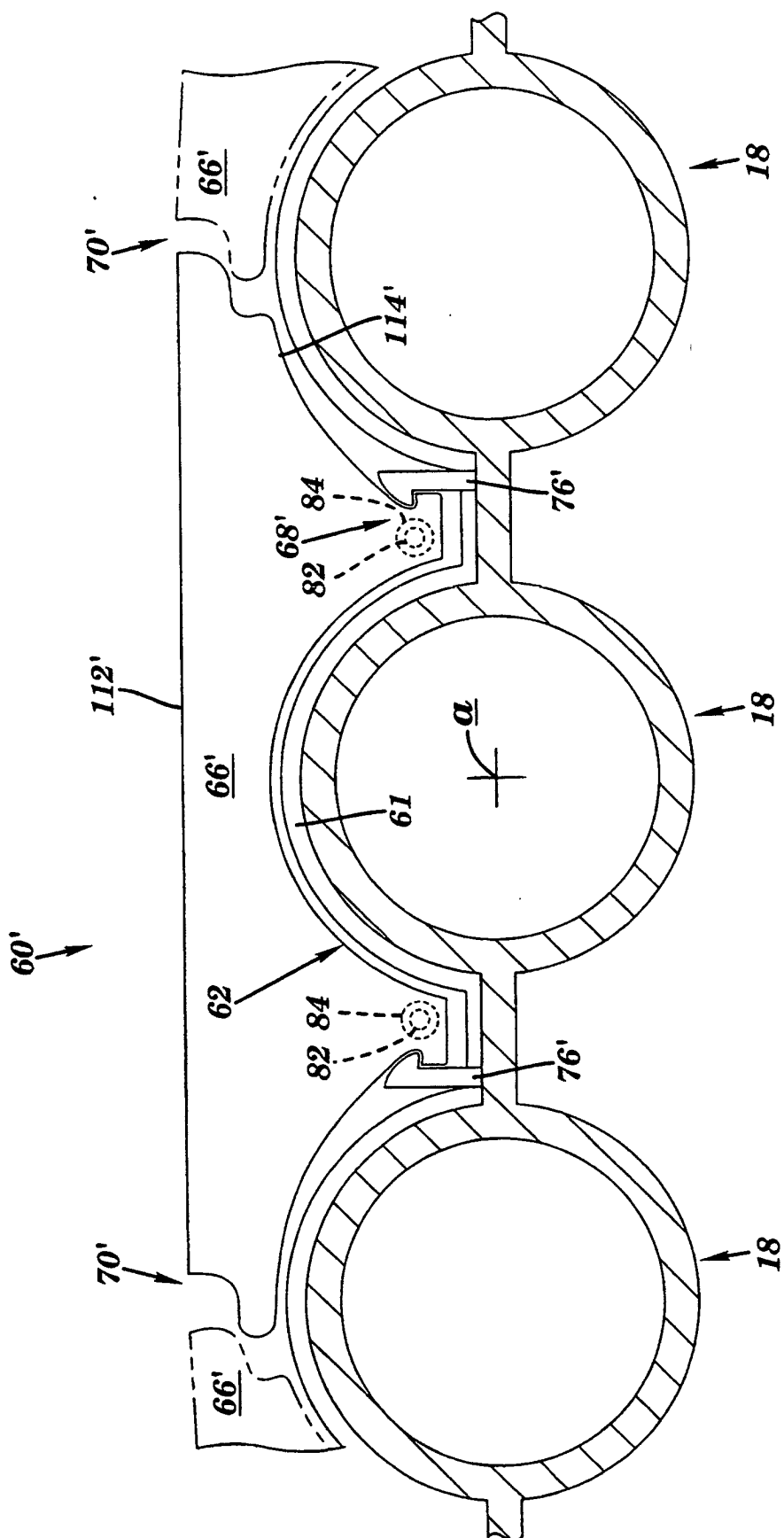
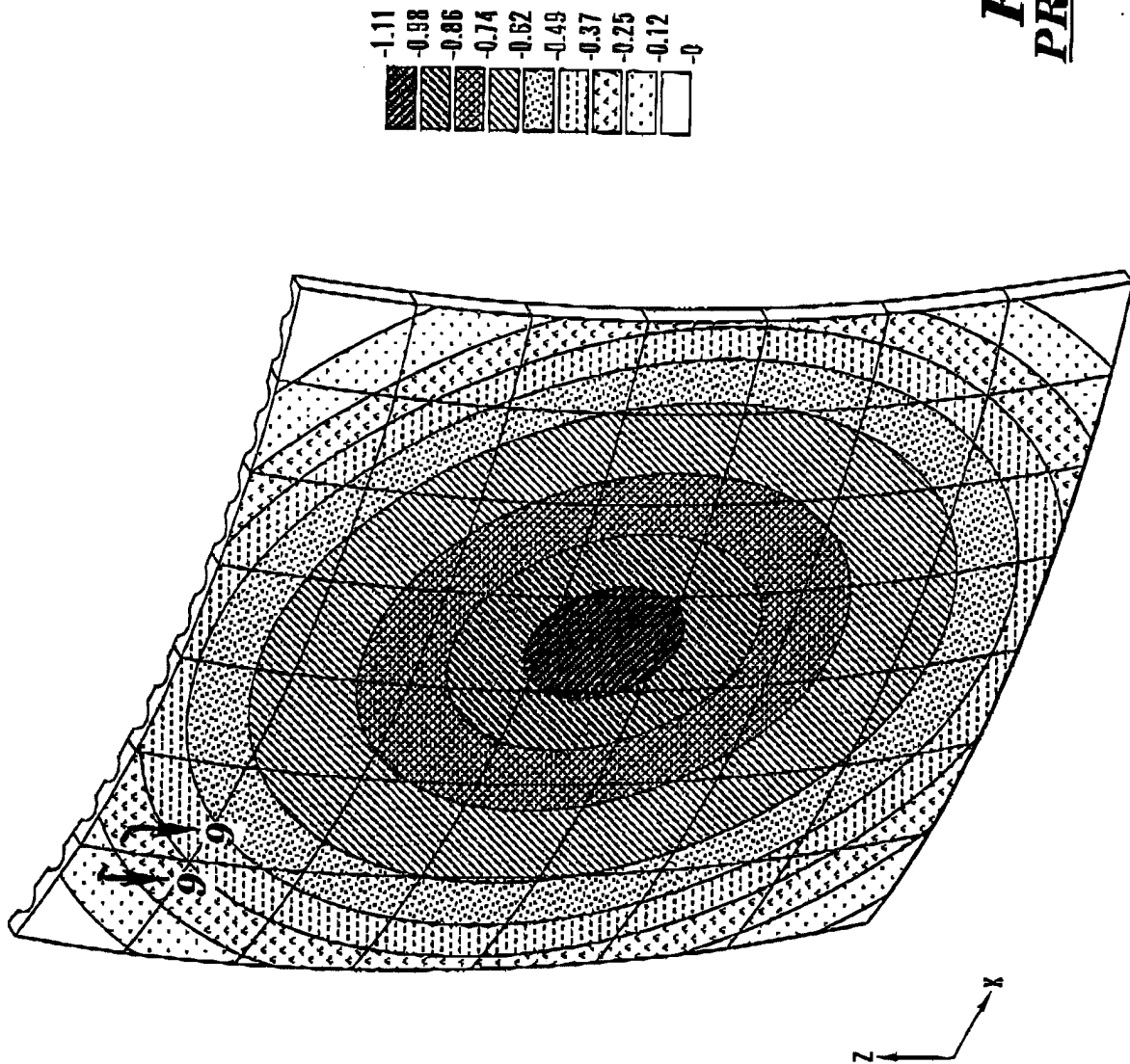


FIG. 7

FIG. 8
PRIOR ART



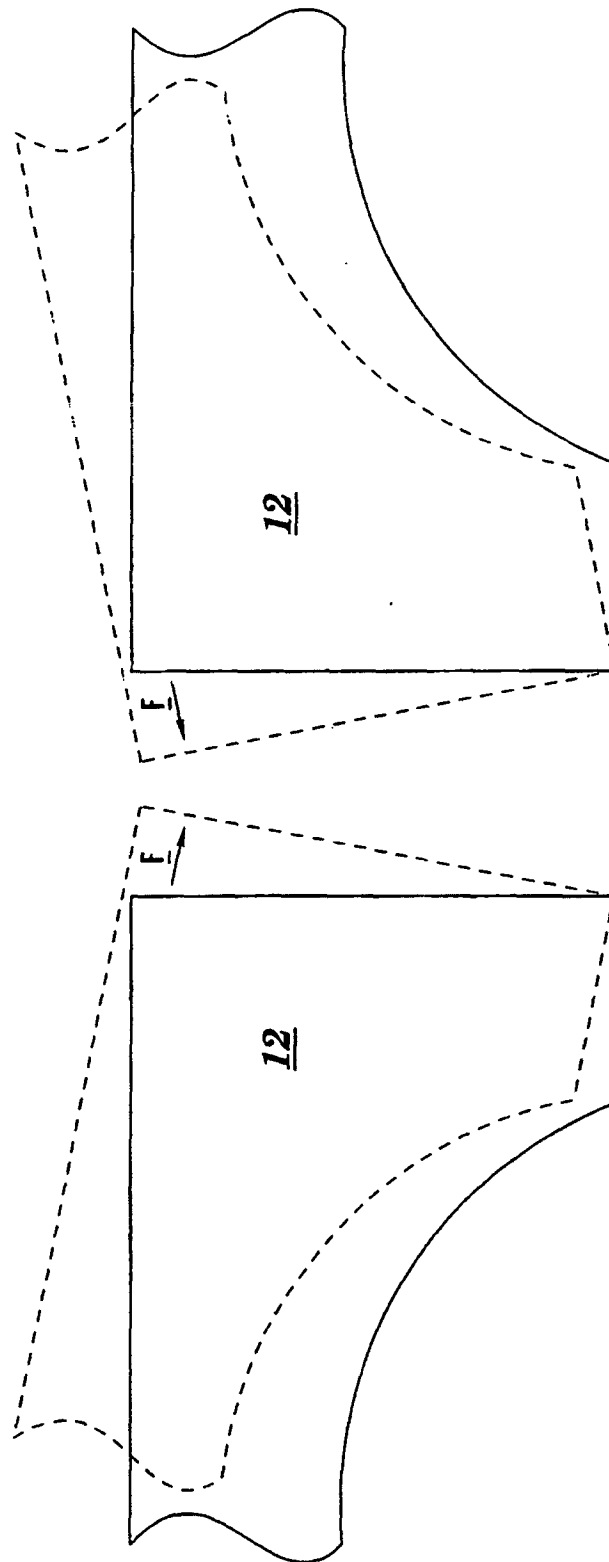


FIG. 9
PRIOR ART

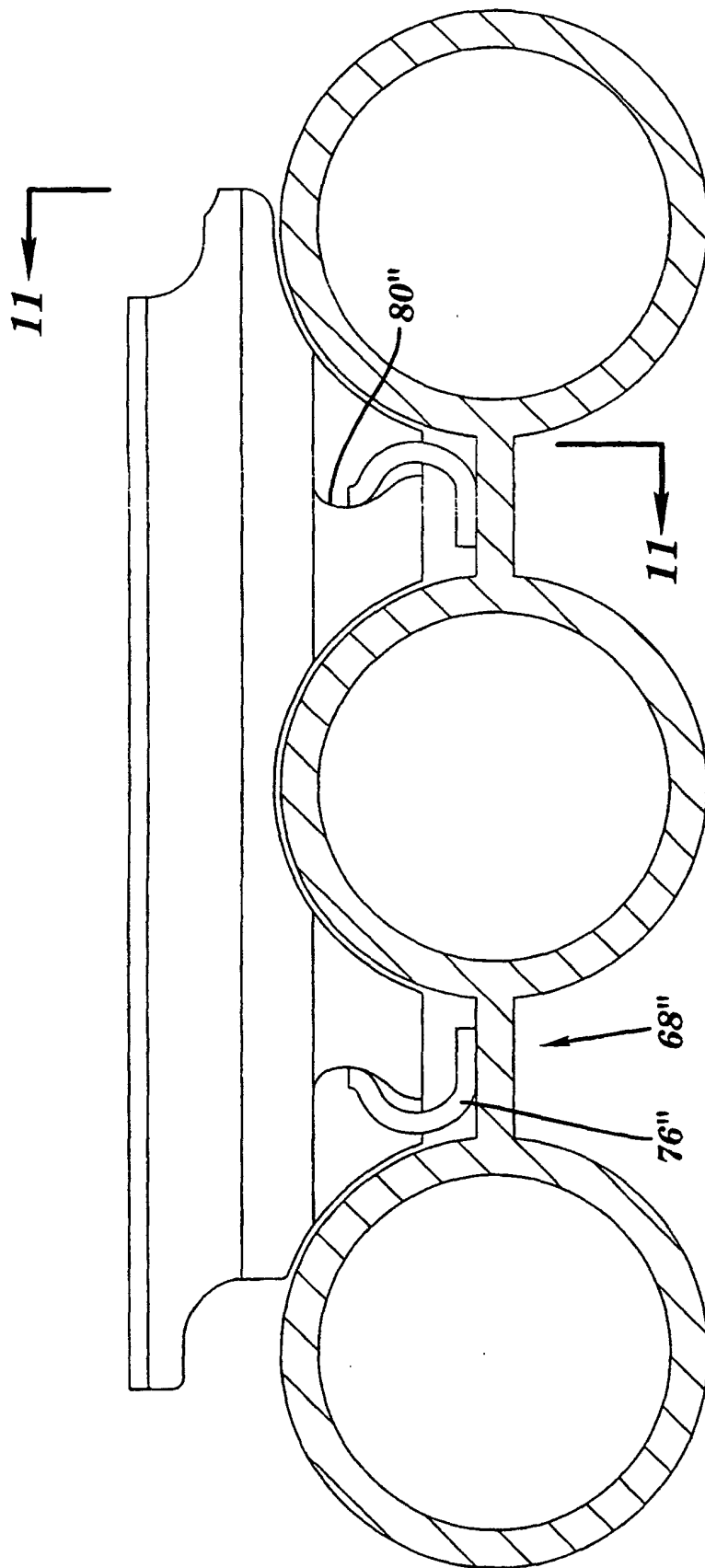


FIG. 10

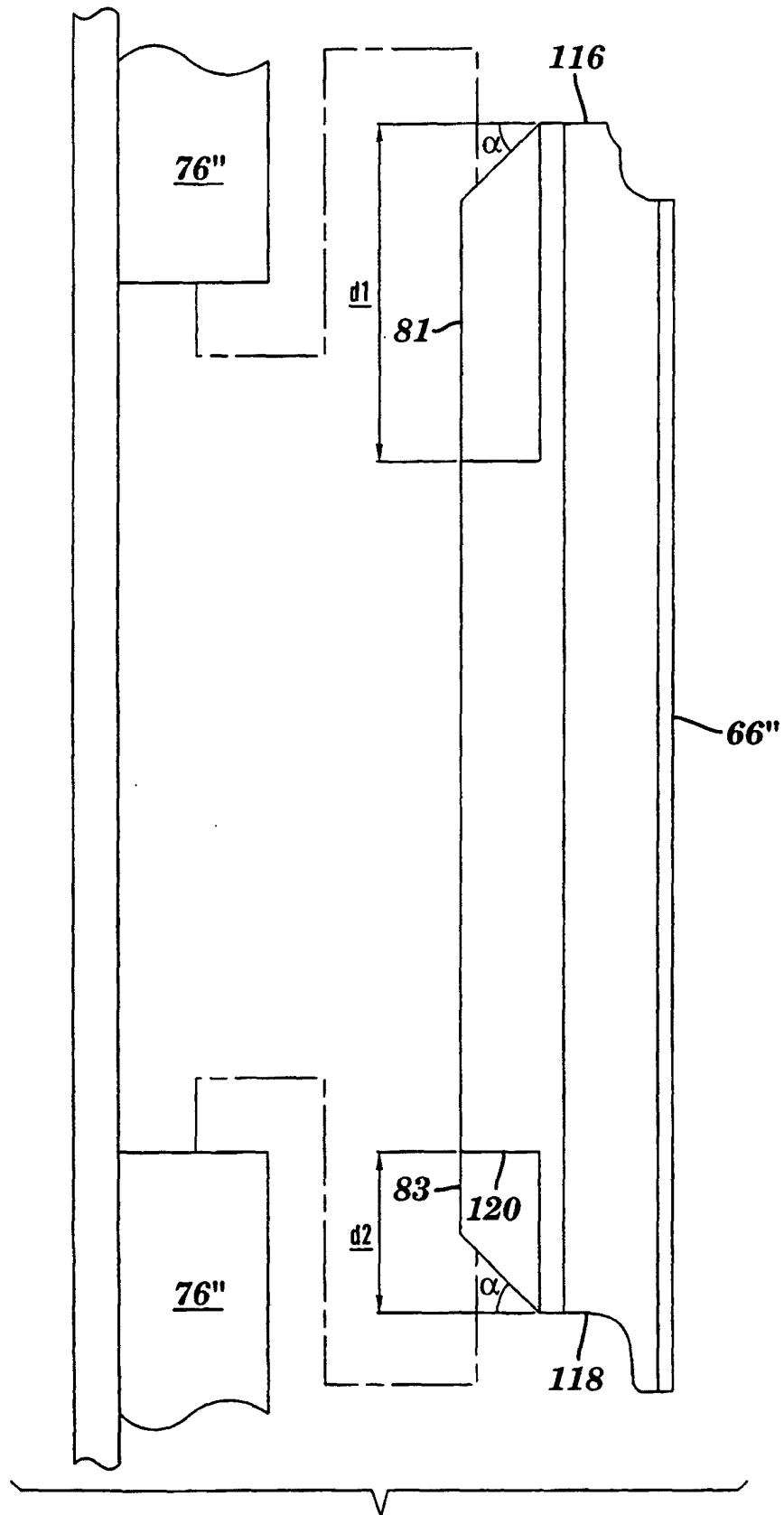


FIG. 11

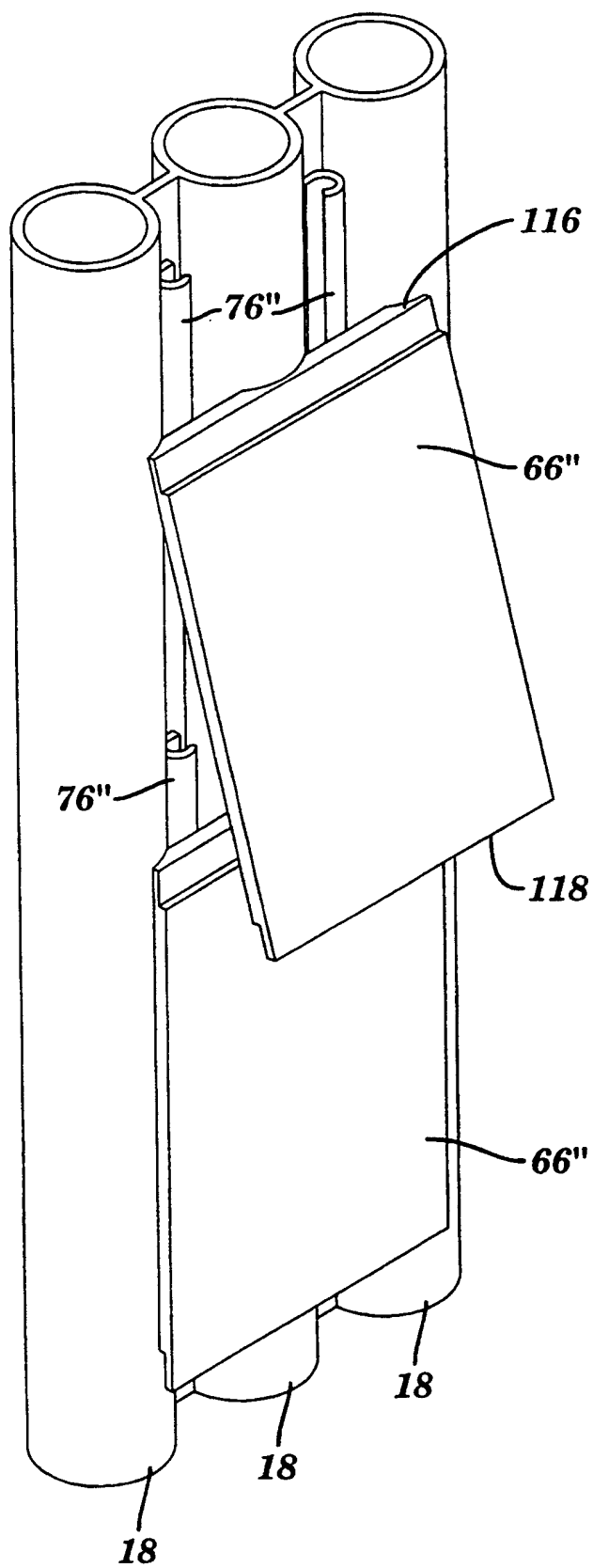


FIG. 12

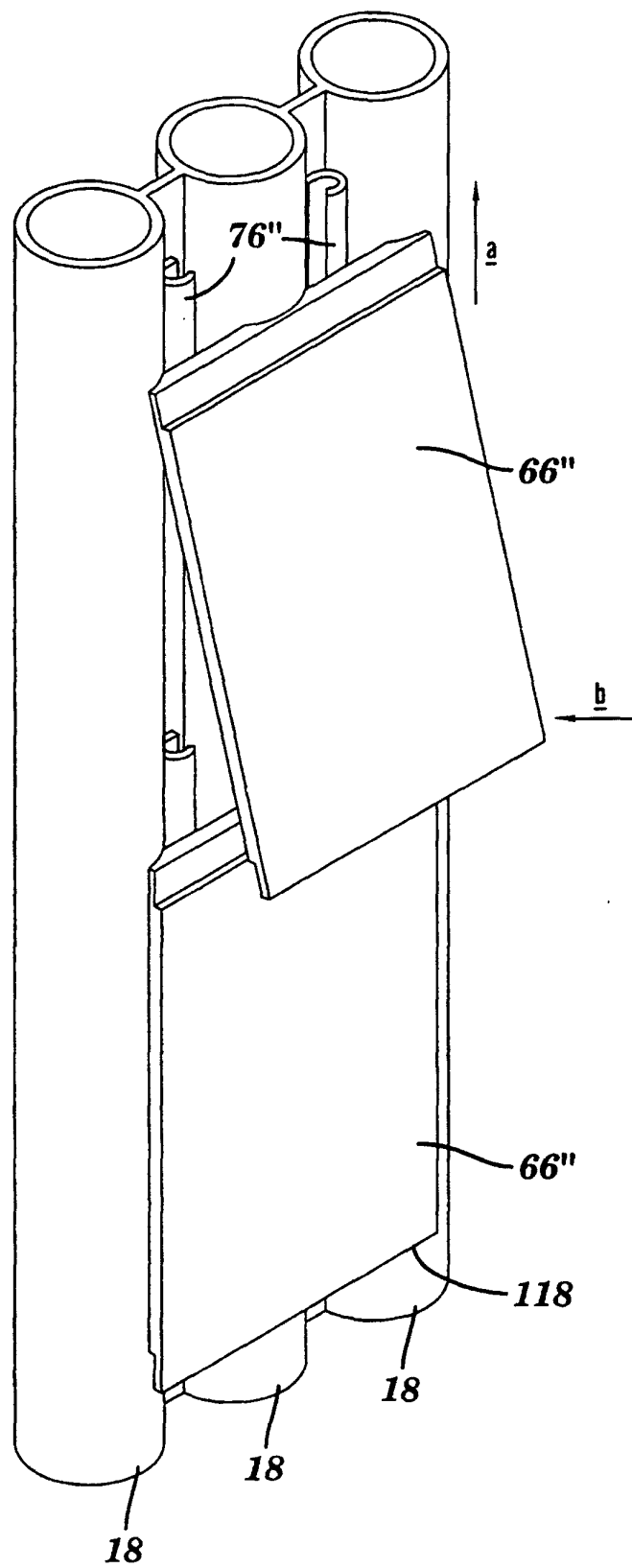


FIG. 13

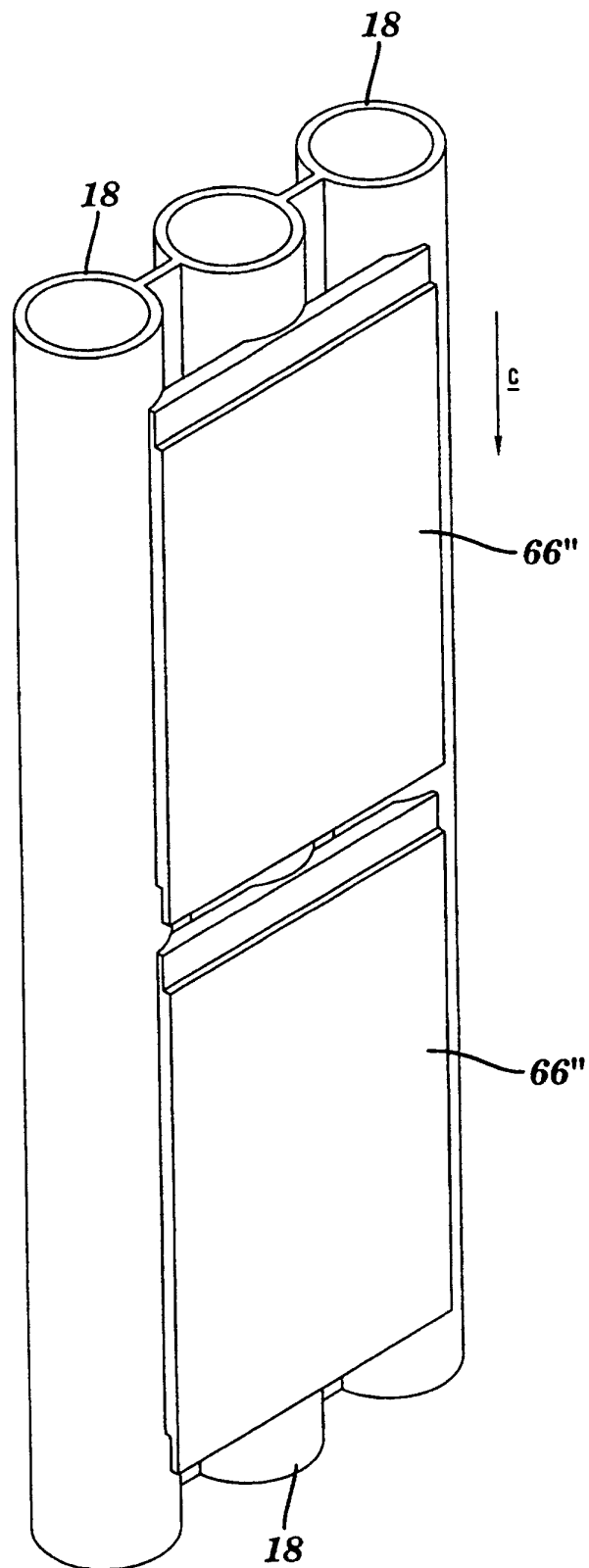


FIG. 14

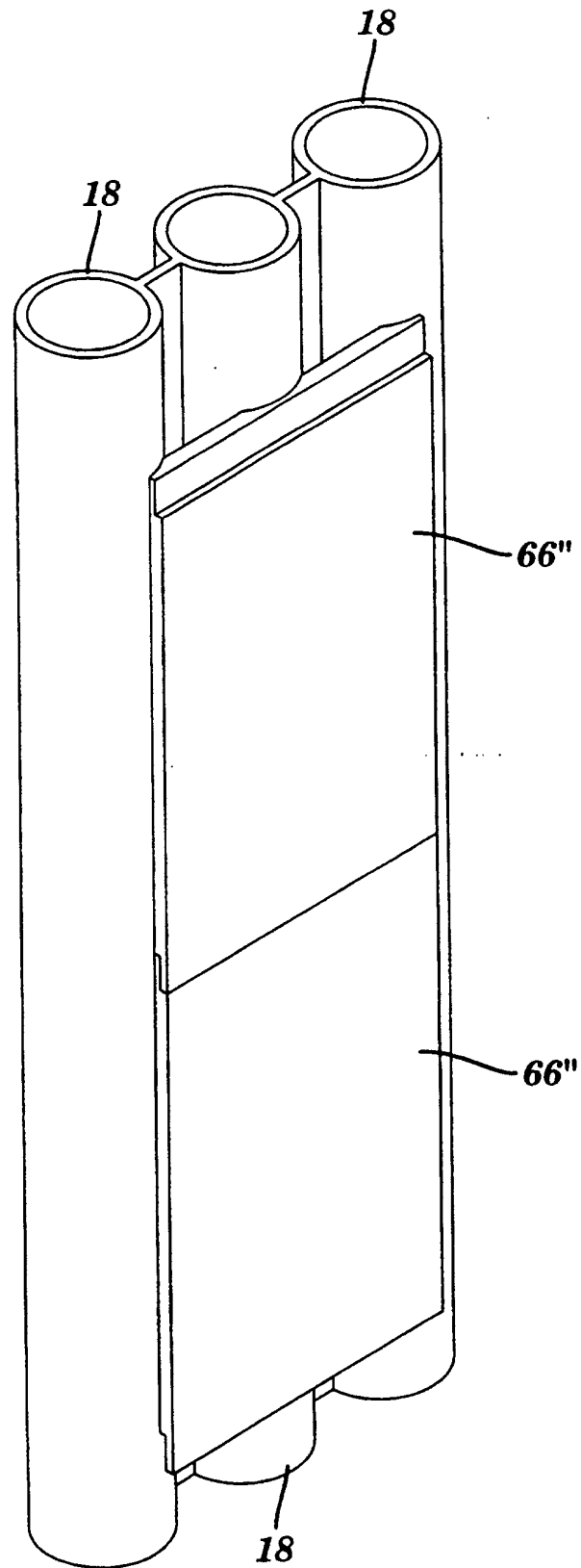


FIG. 15

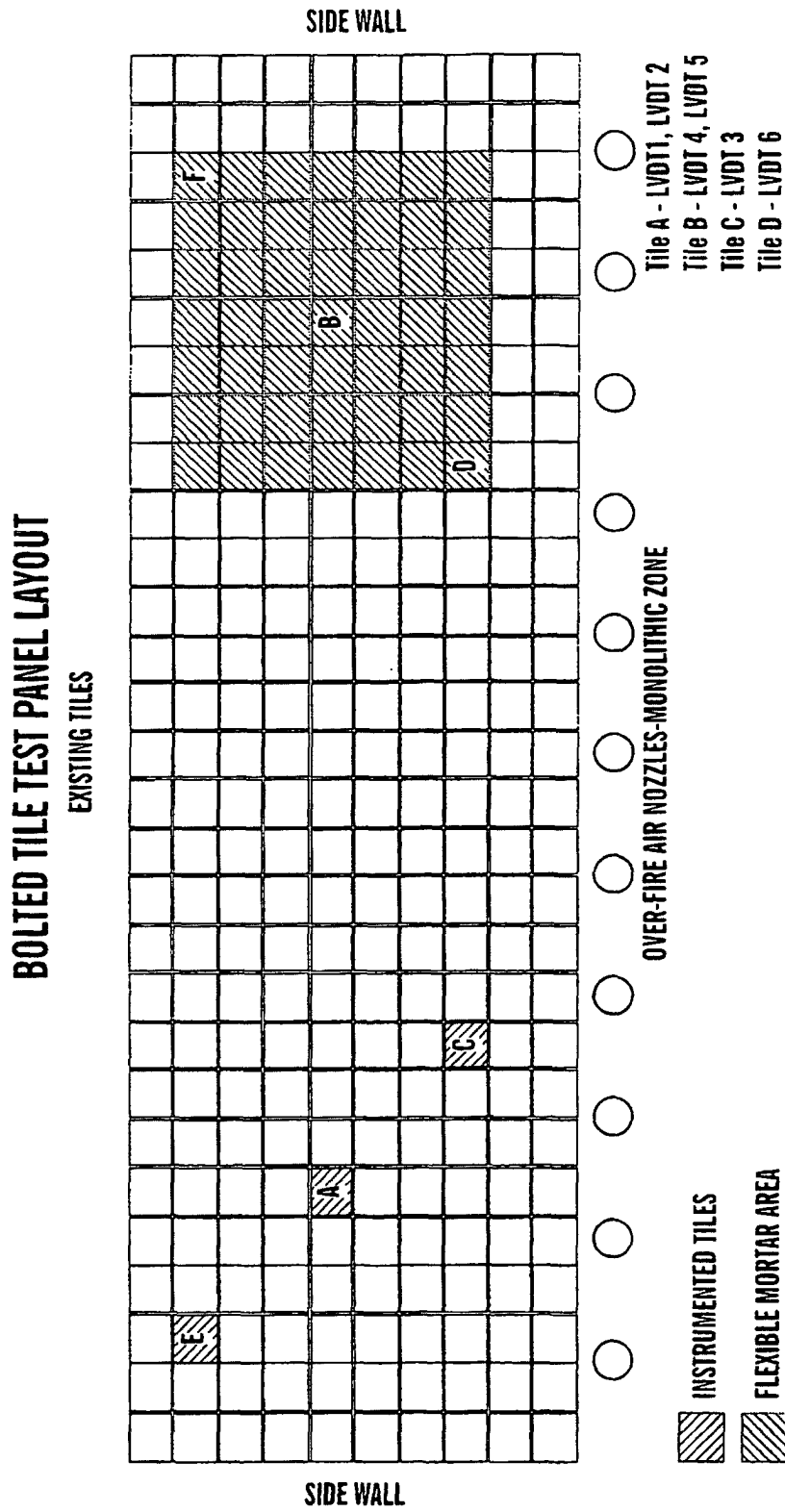


FIG. 16

BOLTED TILE DISPLACEMENT DATA
Bolted Tile Networked Displacement
FIG. 17

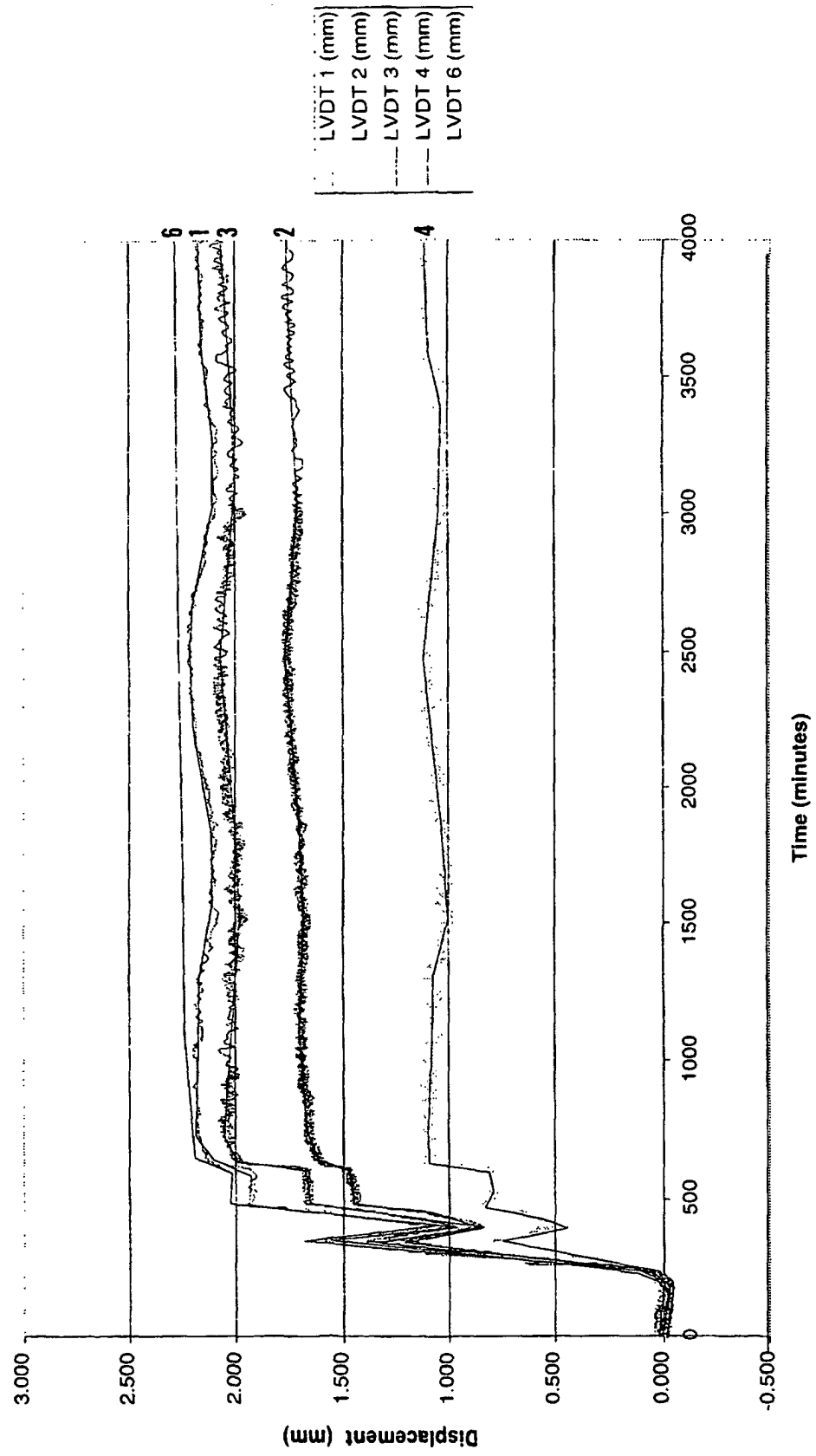


FIG. 18

NEW TILE DISPLACEMENT DATA

Side Wall Displacement Data - Post Maintenance

