

[54] **BOILER TUBE SHIELDING WALL**

2,705,476 4/1955 Hardgrove 122/6

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[51] Int. Cl. **F23m 9/10**

[58] Field of Search **122/6 R, 6 A; 110/98 R,
110/1 A**

[56]

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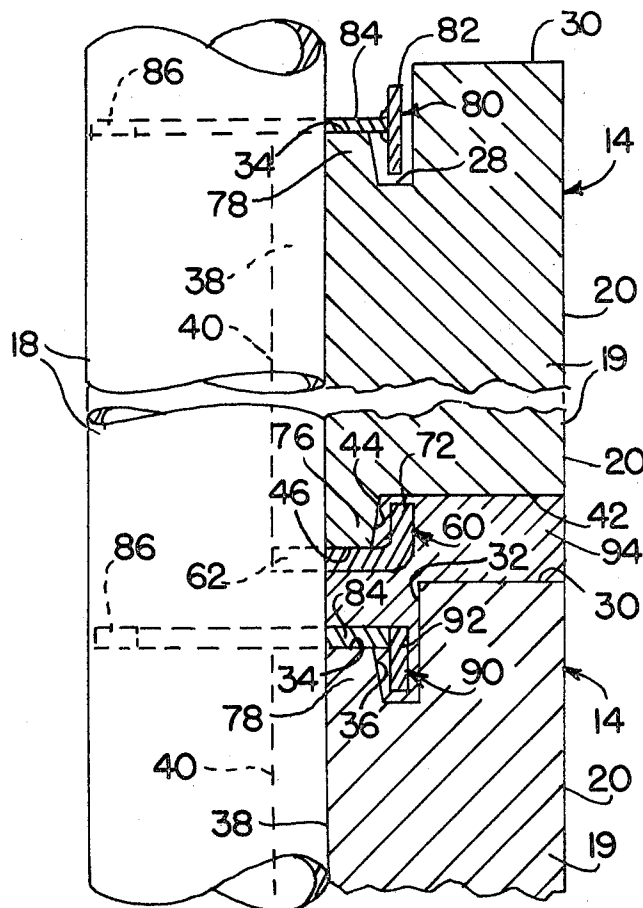
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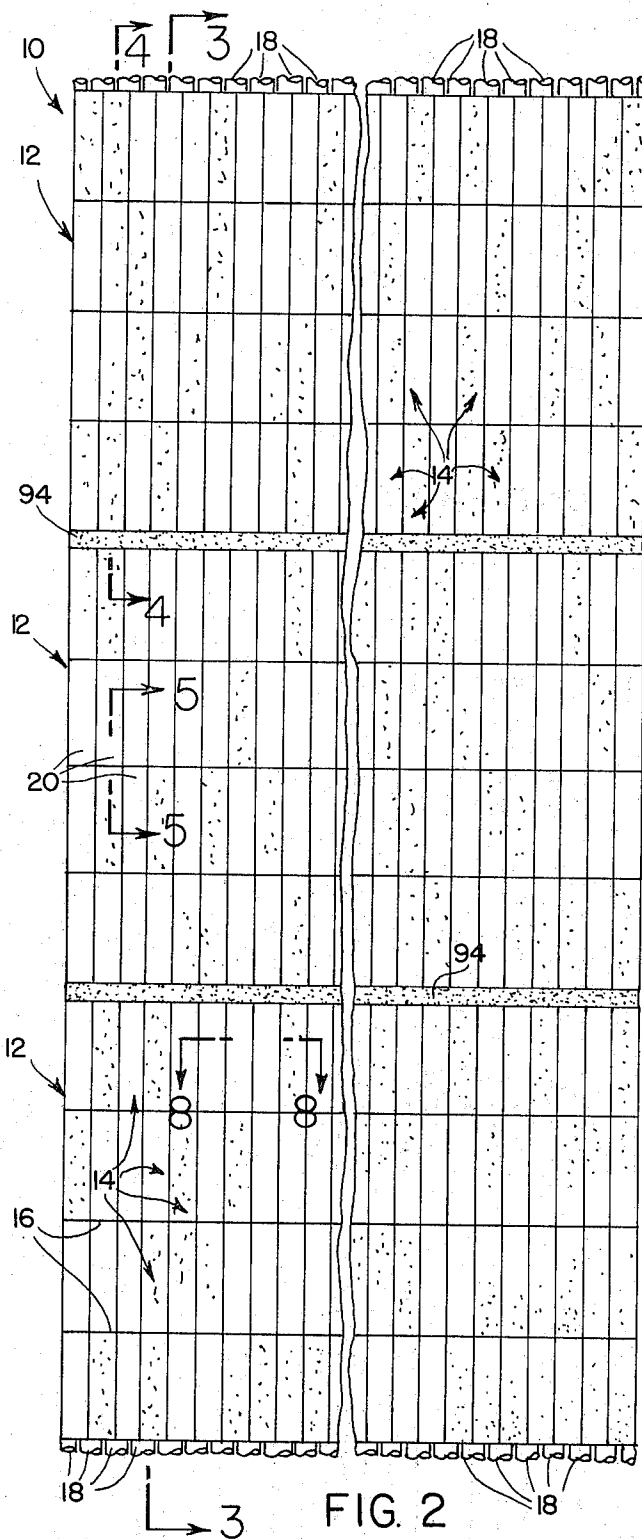
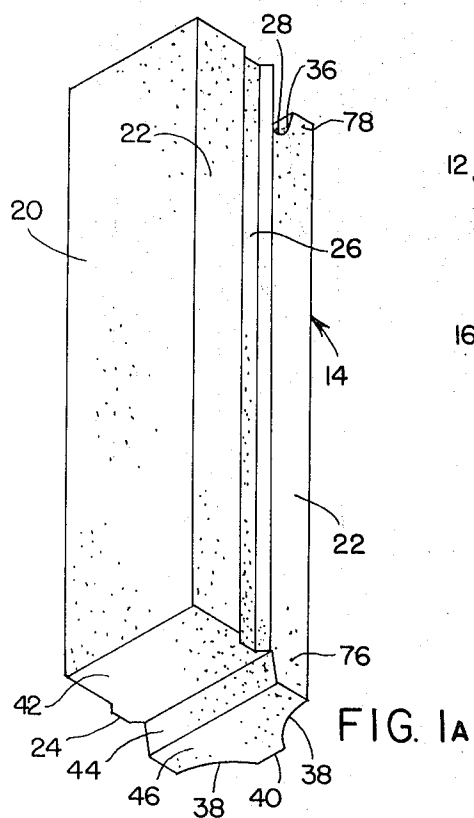
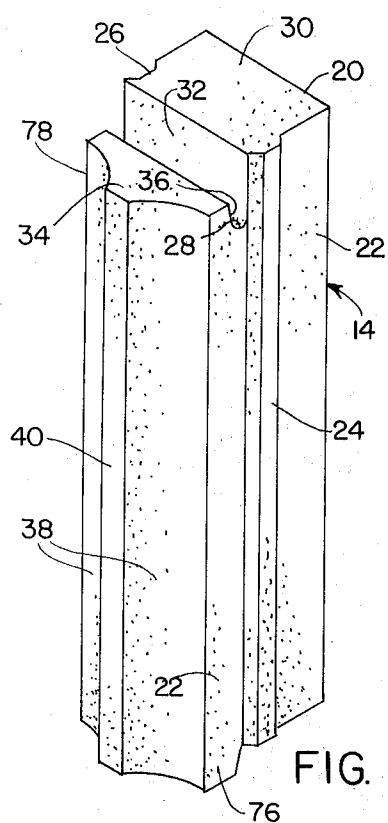
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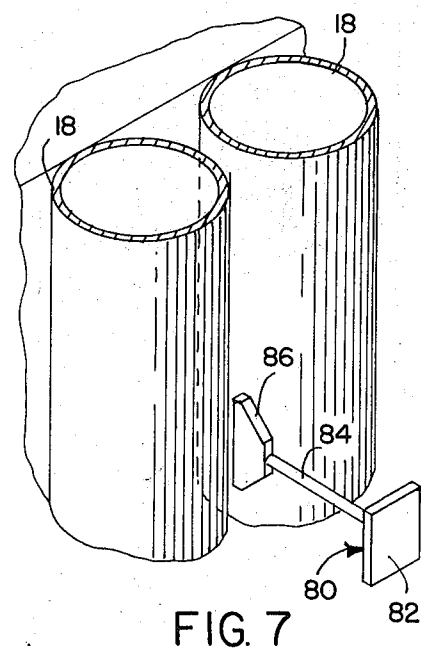
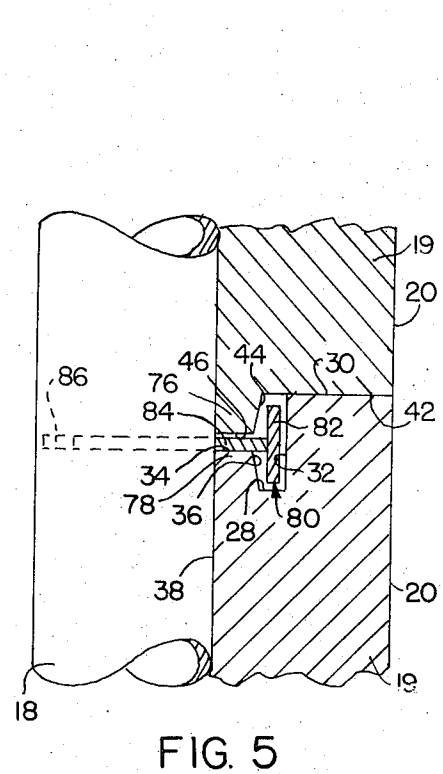
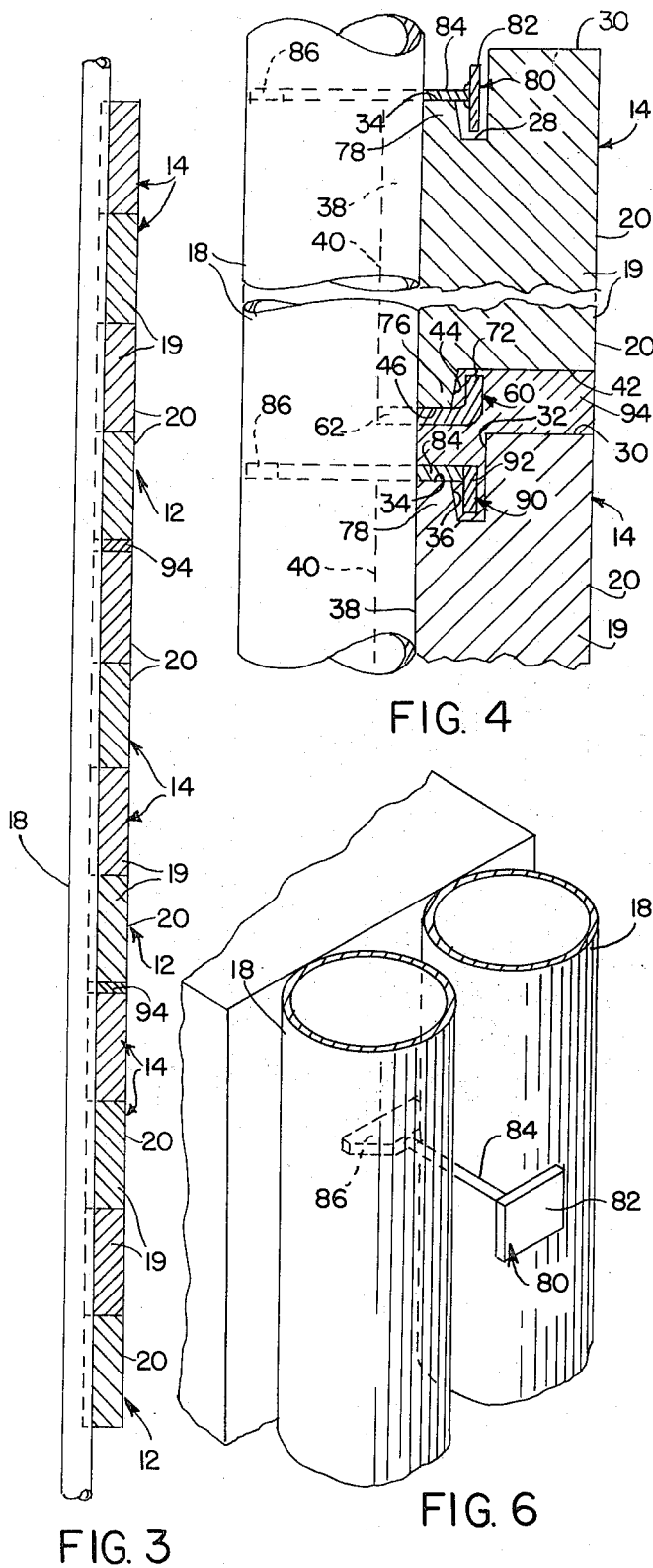
[57] **ABSTRACT**

A shielding or insulating wall of discrete tiles is removably secured in front of the impingement surfaces of boiler tubes in the burner region of the boiler furnace chamber for shielding the lower regions of the boiler tubes against excessive heating in order to force combustion gases to rise into the superheat and reheat regions of the boiler to develop and maintain required higher temperatures in such latter regions, or to protect the boiler tubes from direct impingement of burner flames which tend to generate and accelerate their premature deterioration. The shielding wall of tile is free-floating with the expansion and contraction of the boiler tubes, whose load and temperature variation in the burner region of the furnace area normally results in cracking and decay of a fixed continuous shielding wall material as currently practiced.

56 Claims, 26 Drawing Figures







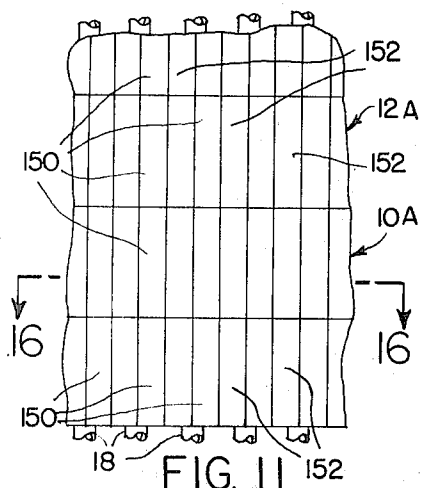


FIG. 11

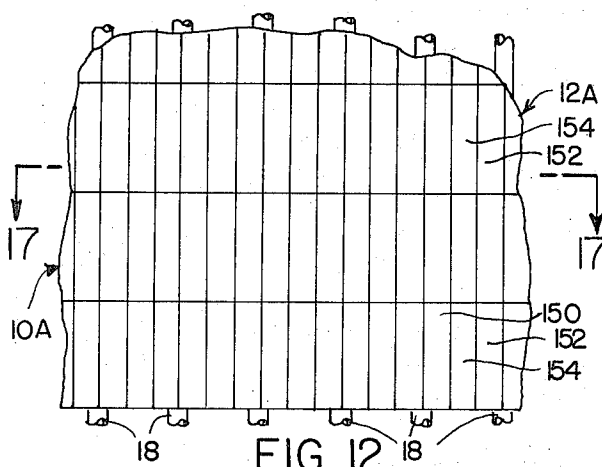


FIG. 12

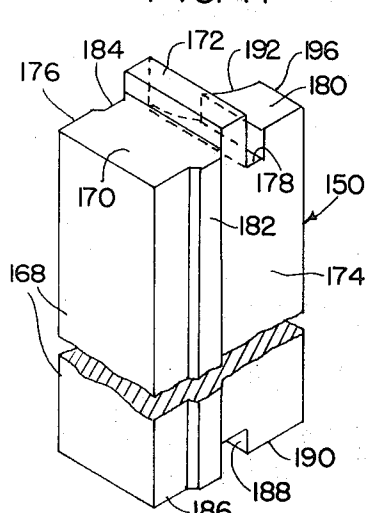


FIG. 13

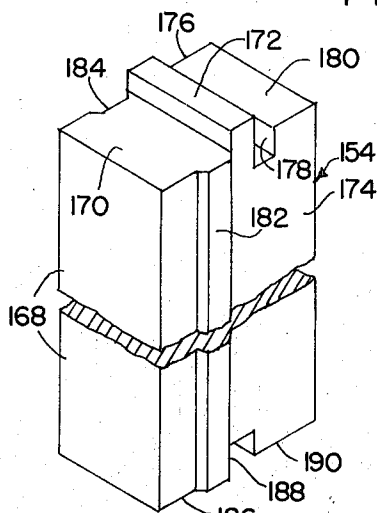


FIG. 14

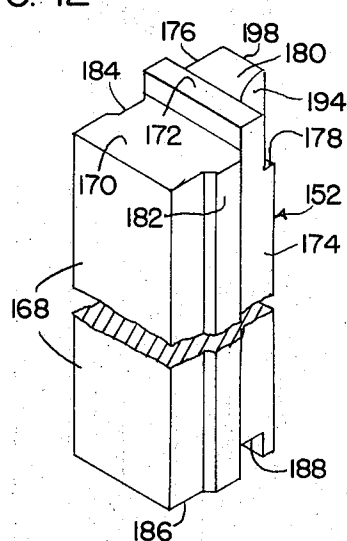


FIG. 15

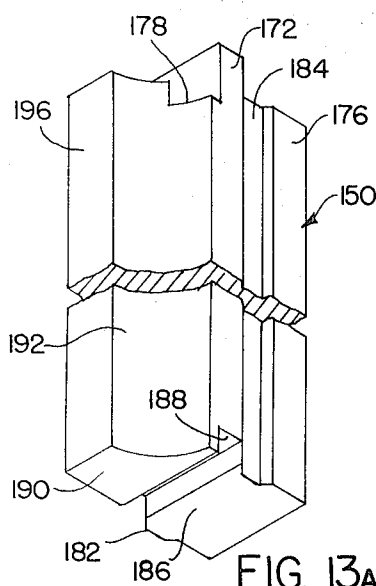


FIG. 13A

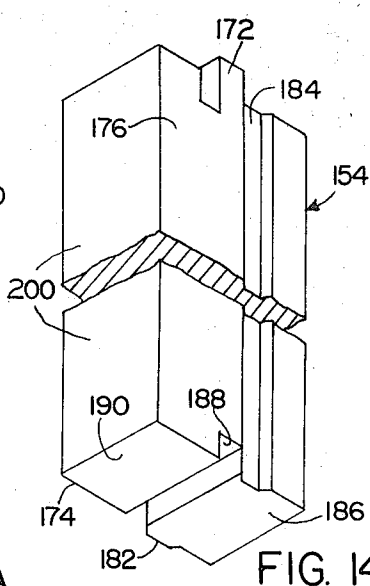


FIG. 14A

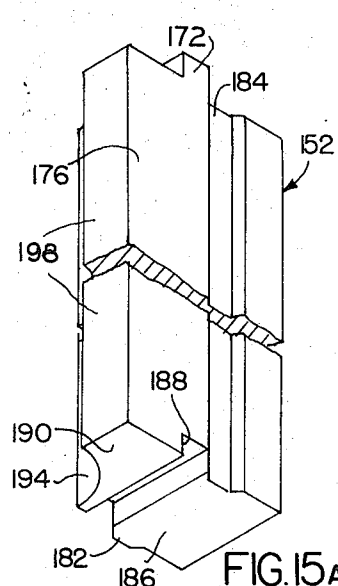


FIG. 15A

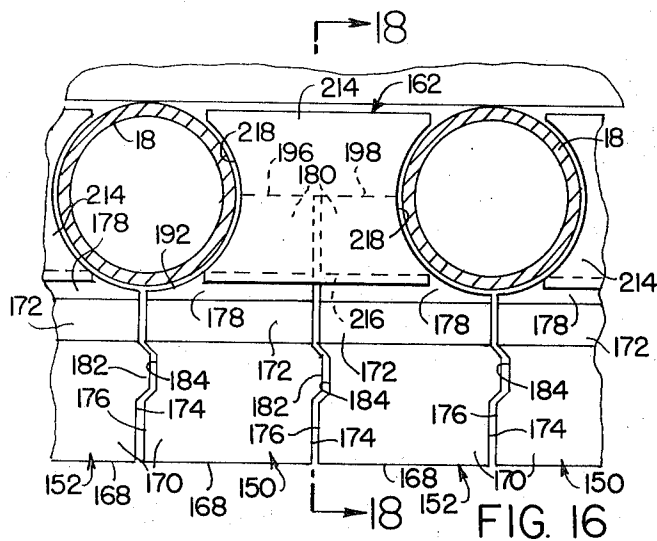


FIG. 16

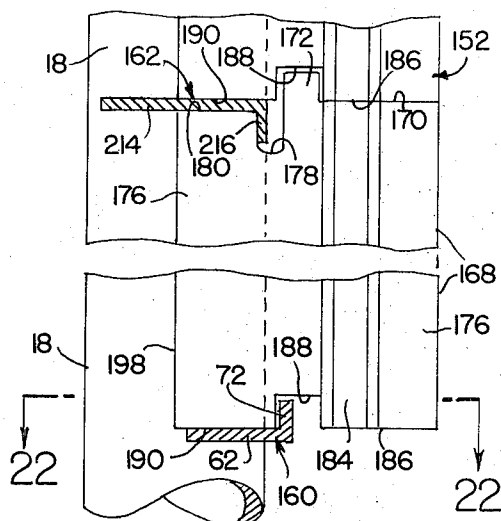


FIG. 18

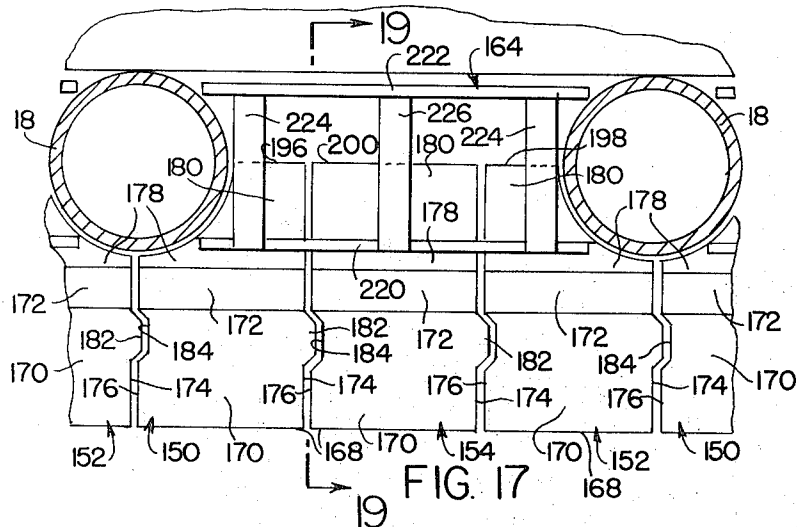


FIG. 17

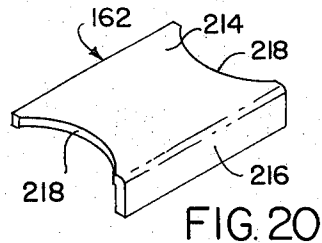


FIG. 20

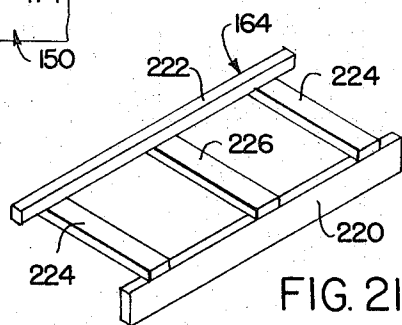


FIG. 21

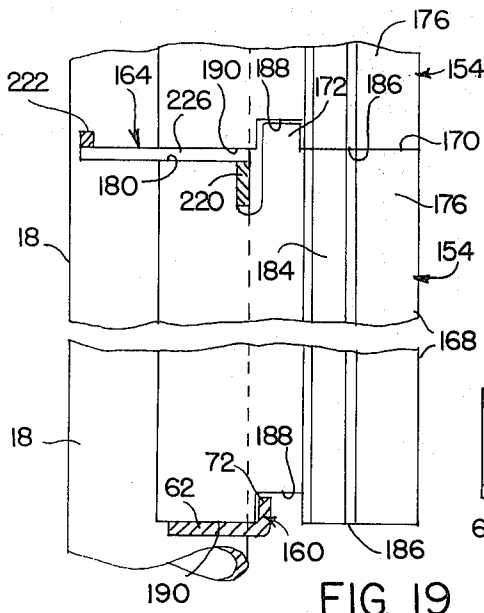


FIG. 19

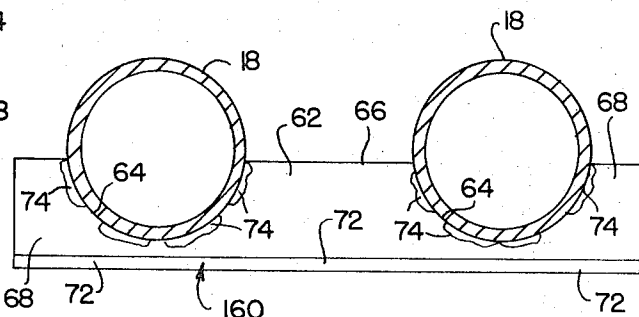


FIG. 22

BOILER TUBE SHIELDING WALL

BACKGROUND OF THE INVENTION

The invention pertains to a heat shielding wall tile and system for securing such tile in a free-floating relationship to boiler tubes in a boiler tube furnace which has been converted from coal firing to oil firing burners. Most utility boiler tube furnace structures were originally designed for and operated over a long period of time with coal-fired burners. Because of the distinctive nature of coal firing, the character and distribution of its flame and combustion gases, the relatively moderate volumes of excess air utilized by these burners, the design and organization of the lower regions and the upper superheat and reheat regions of the boiler tubes, such utility furnaces developed superheat temperatures and pressures adequate to meet specified output requirements. However, today, in view of the ecological and environmental need to reduce air pollution as an important if not a vital operating factor, utility companies have been gradually converting their coal-fired burners to oil-fired burners. Such conversions have unfortunately also been attended by a consequent reduction in the necessary specified elevated temperatures in the superheat regions of the boiler unless substantial additional excess air is provided to the oil-fired burners. As a result, operating costs for such boiler tube furnaces have increased markedly due to accelerated corrosion of the boiler tubes and the quantity of input oil fuel required in comparison with previously used lower cost coal. More frequent down-time and inspections have also occurred, adding to the cost factor.

In evaluating the problem of such conversion to oil-firing burners, it was found that spray coating the lower regions of the boiler tubes with a wall of a suitable insulating shielding ceramic material, operating as an insulating wall while still transmitting a required amount of heat to the boiler tubes in such lower region, caused a deflection upwardly into the superheat and reheat regions of the boiler of the combustion gases sufficient to maintain the required elevated temperatures in the latter regions. But the difficulty with such a continuous sprayed wall coating upon the heat impinging surfaces of the boiler tubes was an expected cracking, separation and decay of such coating material because of the variation in temperatures in various regions of the coated tubes due to load variations and expansion and contraction characteristics, whether such coating material was anchored by mechanical means to the boiler tubes or not so anchored. The load variation in the impingement area of the oil-fired flame and combustion gases resulted directly in thermal variations which occasioned the destructive cracking, separation and decay of the continuous sprayed-on wall coating material. Once cracking and separation were initiated, the wall crumbled and decayed with consequent loss of shielding to the boiler tubes in their lower regions, a lower temperature in the superheat and reheat regions of the boiler, an increased cost factor, and more frequent shut-down for inspection and repair. The primary difficulty, as observed, appeared to be the variation in thermal expansion and contraction of the boiler tubes.

BRIEF GENERAL DESCRIPTION OF THE INVENTION

The invention herein disclosed provides for a shielding wall of discrete ceramic tiles which moves and floats relatively freely with the boiler tubes and thus avoids the primary difficulties occasioned by the expansion and contraction factors of the tubes in continuous substantially solid wall surfacing. Individual tiles of a suitable high temperature resistant ceramic material are shaped and designed to dovetail with adjacent lateral, superior and inferior tiles to form a shielding wall of relative insulation for the lower regions of the boiler tubes against impinging oil-fired flames and combustion gases. The lowest course of such tiles is supported upon metallic clips permanently secured to a pair of adjacent boiler tubes, and a plurality of horizontal courses of these tiles are laid against the tubes and secured thereto by free-floating retaining members that hold the tiles to the boiler tubes while allowing the tubes to expand and contract without disturbing the relationship of the courses of tile resting freely against the tubes. A second superior bank of such tiles can be secured above the first bank and separated slightly therefrom by a second course of permanently attached clip members supporting the courses of tile forming such second bank. The horizontal gap between the two banks of tiles is filled with a heat insulating type of material such as Kaowool, a readily installed and removable material adapted to shield the boiler tubes in the area of the gap. Where required or desired, third, fourth and additional superior banks of the ceramic tile can be applied to the water wall boiler tubes until the lower region of the boiler tube furnace has been sufficiently shielded to obtain the required temperature distribution from the lower to the upper superheat regions of the boiler unit.

PURPOSES AND OBJECTS OF THE INVENTION

It is therefore an object of the invention to provide a relatively free-floating wall of ceramic tile secured to boiler tubes in an oil-fired boiler tube furnace. Another object is the provision of vertically arranged courses of the ceramic tile supported upon clip members permanently secured to the boiler tubes. A further object is to provide free-floating retainer means anchoring superior courses of the tile to the boiler tubes. Yet another object is to provide, where desired or required, a plurality of banks of such tiles arranged in courses, the banks being spaced slightly vertically apart from each other and the horizontal gap therebetween filled with a suitable readily removable insulating filling material. Still a further object is to provide a shielding wall of ceramic tile secured to the boiler tubes to form a shielding insulating wall for the lower regions of the tubes in order to obtain required elevated temperatures in the superheat and reheat regions of the boiler. Yet a further object is to provide a shielding wall of insulating tile which is free-floating vertically and laterally, the tiles being readily individually removable if necessary for replacement without a major repair of the wall. Still another object is to provide a free-floating bank of tiles to protect the boiler tubes from direct impingement of burner flames and combustion gases, wherein the boiler tubes are in contiguous tangent relationship, or closely adjacent but spaced apart relationship, or widely or substantially widely spaced apart relation-

ship. Still a further object is to maintain and improve high boiler output efficiencies in a boiler tube furnace converted from coal-fired to oil-fired burners, and if possible to effect fuel cost savings.

Various further and more specific objects, features and advantages of the invention will appear from the description given below, taken in connection with the accompanying drawings, illustrating by way of example preferred forms of the invention. Reference is here made to the drawings annexed hereto and forming an integral part of this specification, in which

DRAWINGS

FIGS. 1 and 1a are top and bottom perspective views respectively of a ceramic tile embodying features utilized in the inventive system illustrated in FIG. 2.

FIG. 2 is a front elevational view of heat shielding wall for the lower regions of water-filled boiler tubes in a boiler unit furnace area, embodying a preferred form of the invention.

FIG. 3 is a vertical sectional view taken substantially on the line 3—3 of FIG. 2.

FIGS. 4 and 5 are somewhat enlarged vertical sectional views taken substantially on the lines 4—4 and 5—5 of FIG. 2.

FIG. 6 is a perspective view of a pair of adjacent boiler tubes with the free-floating tile retaining clip illustrated in vertical section in FIG. 5 positioned between and in engaging relationship with the adjacent tubes.

FIG. 7 is a view substantially the same as in FIG. 6, showing the free-floating tile retaining clip disposed adjacent and forward of the boiler tubes before its insertion into the open gap between the tubes.

FIG. 8 is a horizontal sectional view taken substantially on the line 8—8 of FIG. 2.

FIG. 9 is a vertical sectional view similar to that illustrated in FIGS. 4 and 5, showing the supporting clip for the ceramic tile permanently affixed to the boiler tubes.

FIG. 10 is a horizontal vertical sectional view partially in elevation, taken substantially on the line 10-10 of FIG. 9.

FIG. 11 is a front elevational view of a portion of a bank of tiles for boiler tubes which are spaced more widely apart than those illustrated in FIGS. 2, 8 and 10, in which two tiles are required between centers of the boiler tubes, for a modified preferred form of the invention.

FIG. 12 is a front elevational view, similar to that illustrated in FIG. 11, where the boiler tubes are still more widely spaced apart and three tiles are required between boiler tube centers.

FIGS. 13 and 13a are top and bottom perspective views respectively of the left-hand tile illustrated in FIG. 16.

FIGS. 14 and 14a are top and bottom perspective views respectively of the middle tile illustrated in FIG. 17.

FIGS. 15 and 15a are top and bottom perspective views of the right-hand tile illustrated in FIG. 16.

FIG. 16 is a horizontal sectional view taken substantially on the line 16—16 of FIG. 11.

FIG. 17 is a horizontal sectional view, taken substantially on the line 17—17 of FIG. 12.

FIG. 18 is a side vertical sectional view, taken substantially on the line 18—18 of FIG. 16.

FIG. 19 is a side vertical sectional view, similar to that illustrated in FIG. 18, taken substantially on the line 19—19 of FIG. 17.

FIG. 20 is a perspective view of the free-floating tile retaining clip illustrated in FIGS. 16 and 18.

FIG. 21 is a perspective view of the free-floating tile retaining clip illustrated in FIGS. 17 and 18.

FIG. 22 is a horizontal sectional view of the permanently affixed tile supporting clip taken substantially on the line 22—22 of FIG. 18.

SPECIFIC DESCRIPTION

As illustrated particularly in FIGS. 1 through 10 inclusive, for a preferred form of the invention, the heat shielding wall 10 comprises one or more banks 12 of ceramic tiles 14 arranged in horizontal courses 16 one above the other, to shield the boiler tubes 18 therebehind. The water filled tubes 18, at least in the lower region of the boiler furnace area, are disposed in vertical closely adjacent but spaced apart parallel aligned relationship to form a "water wall" against and upon which the combustion gases discharged by the burners would normally impinge to heat the water therewithin to the elevated temperatures required for the generation of steam which rises from these lower tube regions into the superheat and reheat regions of the boiler unit. Because the superheat and reheat regions of the boiler tubes are substantially elevated above the burner portion of the boiler furnace, the rising combustion gases operate to increase the temperature of the steam to superheat temperatures in the upper regions of the boiler tubes due to the shielding effect of the ceramic tile wall 10.

The tiles 14 comprise a heat resistant ceramic fire brick body 19 having a substantially planar distal front "hot face" wall surface 20, adjacent lateral side walls 22,22 extending rearwardly from the wall surface 20 and having a longitudinally extending rib portion 24 on one wall and a complementary recess 26 on the opposite lateral wall, an upper slot 28 extending transversely of the tile from one side edge to the other rearwardly of the rib 24 and recess 26, a first distal top surface 30 intermediate the side walls 22,22 and extending from the front facing wall 20 to the depending wall 32 defining one side of the slot 28, a second proximal top surface 34 extending from inner wall 36 of the slot 28 to the arcuate edges of the longitudinally extending closely adjacent concavely curved wall surfaces 38,38 intermediate the side walls 22,22 and spaced apart from each other by the proximal medial web surface 40, and a first distal bottom surface 42 extending from the front facing wall 20 to a vertically depending stop wall surface 44 and a second proximal bottom surface 46 extending from the latter wall surface 44 to the lower edges of the arcuate wall surfaces 38,38 and the web surface 40 between the lateral walls 22,22, the second bottom surface 46 being disposed substantially parallel to and below the adjacent first bottom surface 42.

The ceramic tile 14 is formed of a fire clay type of material suitable for use in the furnace region of the boiler unit in which substantial elevated temperatures are achieved, often of the order of over 2,000° F. The "hot face" 20 of the ceramic tile is positioned outwardly in front of the boiler tubes 18 against which the

tiles are designed to rest, to receive the impinging effect of the burner flame and combustion gases. The arcuate wall surfaces 38,38 have a curvature complementary to the cylindrical configuration of the water tubes 18 so that substantial optimum contact can be made between such tile surfaces and the tubes against which they rest.

To support the courses 16 of the tiles in each bank 12 upon the boiler tubes and in relatively free-floating relationship thereto, support angle clips 60 and free-floating clips 80 and 90 are used to retain the ceramic tile 14 upon and against the boiler tubes 18.

The permanently affixed support clip 60 comprises a plate portion 62 having arcuate edges 64,64 spaced apart by a medial web edge 66 and intermediate substantially co-planar lateral outer edge portions 68,68 adjacent the lateral sides 70,70 of the plate portion 62, and an upstanding tile retaining flange 72 at its distal edge. The arcuate edges 64,64 have a curvature complementary to the curvature of the cylindrical boiler tubes 18,18 (FIG. 10), to which they are permanently affixed by welding as at 74,74.

The supporting clips 60 are shown positioned in spaced apart substantially horizontal alignment so that the first course 16 of tiles 14 will rest thereon in a substantially straight line, although a less regular arrangement and organization may also be adopted. The depending face 44, bottom face 46, the lower region of the arcuate wall surfaces 38,38 and web face 40 define the proximal lower flange portion 76 of the tile positioned inwardly of the retaining flange 72 of clips 60, the arcuate surfaces 38,38 being adapted to lie closely against or to abut the cylindrical outer wall surface of the adjacent boiler tubes 18,18. The bottom surface 46 of the tile 14 rests directly upon the plate portion 62 of the clip 60 (FIG. 9). The proximal upper flange portion 78 of tile 14 is defined by the wall surface 36 and the lateral walls 22,22, the concavely curved wall surfaces 38,38 and the web surface 40 lying in the horizontal plane of the slot 28.

As shown particularly in FIG. 8, in a single course 16, a single tile 14 rests medially between adjacent boiler tubes 18,18, allowing portions of adjacent lateral tiles 14,14 to rest in part upon lateral portions of the plate portion 62 of a single clip 60, thus distributing the weight of one full tile and portions of two adjacent lateral tiles upon a single supporting clip 60. The adjacent tiles of each course are disposed in slightly spaced apart relationship, with the lateral ribs 24 and recesses 26 of adjacent tiles dovetailing each other in similar spaced relationship.

To secure tiles to the boiler tubes in the higher second and superior courses of the bank 12, floating clips 80 are inserted between adjacent spaced apart boiler tubes 18 to retain vertically adjacent aligned tiles at their adjacent lower and upper ends. The free-floating clips 80 each comprises a distal tile anchoring plate member 82, one end of a stem or post 84 being secured substantially central of and to the rearward side of the plate member 82 and its other end to a retaining member 86 disposed in a plane normal to the plane of the plate member 82 and co-axially of the stem 84. The retaining member 86 is first presented to the boiler tubes in the posture shown in FIG. 7, inserted far enough into the gap between the tubes until it clears them for rotation, and rotated substantially 90° into the posture illustrated in FIG. 6, so that one portion of the distal plate

member 82 lies in the slot 28 of the lower tile 14, stem 84 rests in part upon the proximal flange face 34, and retaining member 86 engages proximal surfaces of the adjacent boiler tubes 18,18 (FIGS. 5 and 6).

The floating clip 80, anchored by the retaining member 86 to the adjacent boiler tubes 18, retains the lower tile 14 by the forward distal plate member 82 which engages the inner wall surface 36 should the tile move forwardly. At the same time, the floating clip 80 retains the superior tile 14, the forward distal plate member 82 engaging the depending surface 44 of the superior tile, the bottom surface 42 of which rests upon the top wall surface 30 of the inferior tile 14, particularly as illustrated in FIG. 5. It should be noted that the floating clip 80 operates as a retaining member to keep the stacked courses of tiles 14 closely adjacent the forwardly facing portions of the outer surfaces of the waterfilled boiler tubes 18, thus serving as a protective heat-shielding wall for the tubes against the impinging flames and combustion gases of the oil-fired burners. It should be noted (FIG. 5) that the bottom surface 46 of the superior tile is spaced slightly from and above the retaining clip stem 84 and the top wall surface 34 of the inferior tile 14, the depending proximal flange portion at the bottom of the tile being slightly shorter than the upstanding distal flange portion at the top of the tile, allowance being made for the thickness of the retaining clip stem 84.

When the most superior course 16 of tiles is installed in each bank 12, a top retaining clip 90 is used in place of the retaining clip 80, particularly as shown in FIG. 4. The clip 90 is substantially the same as the clip 80 except that the distal front plate member 92 is not provided with an upstanding flange portion but only with an offset depending portion, the stem 84 and the rear or proximal boiler tube engaging retaining plate member 86 being the same. The retaining clip 90 is inserted between the boiler tubes 18 in the same manner as is described above for the clip 80 and illustrated in FIGS. 6 and 7, and the clip stem 84 rests upon the proximal top face 34 of the tile in the most superior course of the bank 12.

When the most superior course 16 of a bank 12 is positioned and retained against the boiler tubes 18 by the free-floating clips 90, the next superior bank of tiles is again supported upon permanently affixed clips 60, as illustrated in FIG. 4. The next higher bank of tiles 14 is spaced somewhat above the top surface 30 of the most superior course of tiles in the next lower bank by affixing the clips 60 thereabove a distance sufficient to allow for removal of the retaining clip 90 immediately therebelow in order to release the tiles 14 for removal, replacement or repair as occasion requires. The retaining clips 90 are removed by manually grasping the distal plate member 92, rotating the same and the stem 84 so that the retaining member 86 at its proximal end will pass between and be withdrawn from the adjacent lateral boiler tubes 18. In the horizontal open space provided between vertically adjacent tiles 14 of adjacent banks 12, and intermediate the surfaces 30 and 42, 34 and 46, 36, 32 and 44 (FIG. 4), and the adjacent forwardly facing surfaces of the cylindrical boiler tubes 18, such space is filled with a suitable high temperature insulating packing material 94, such as "Kao wool" ceramic fiber of other equivalent material which is highly resistant to heat and thermal decomposition. "Kao wool" is a trademark identifying a ceramic fiber prod-

uct of the Babcock & Wilcox Company, Refractories Division, Augusta, Ga. Other equivalent materials which can be used in place of the "Kaowool" include high temperature resistant mineral wool fibers in bulk, strip or blanket forms, a fireclay product such as kaolin which can be applied as a cementitious filler or mortar, and other similar materials known in the art. The packing 94 disposed in the gap between adjacent banks 12 of tiles 14 substantially closes the shielding wall 10 to protect the boiler tubes therebehind from burner produced flames and combustion gases.

When the topmost course of tile 14 has been installed in the topmost bank 12, retaining clips 80 are engaged with adjacent boiler tubes 18 and their distal plate members 82 are disposed in slots 28 of each tile of the most superior course, as shown in the upper portion of FIG. 4.

In the event that a tile or tiles 14 require replacement or repair for any reason, the tile retaining clips 80 engaging each tile 14, in the vertical file involved in the removal, repair or replacement, are raised and removed from their slot positions and from between adjacent boiler tubes 18, allowing each tile to be withdrawn from the tile next therebelow until the damaged tile is reached. In the event that the tile requiring removal, replacement or repair lies in an inferior bank of tile, the insulating packing material 94 is first manually removed from between adjacent banks 12, allowing for lifting and removal of the retaining clip 90 to release the uppermost tile 14 in the file leading to the significant tile requiring removal or replacement. Upon making the necessary or desired replacement of the damaged tile, the file of tiles 14 is then built up again in exactly the same fashion as originally installed with the free-floating retaining clips 80 being positioned with their distal plate portions 83 disposed in the slots 28 of each of the tiles as they are again installed.

A FIRST MODIFIED PREFERRED FORM OF THE INVENTION

Boiler constructions have from time to time been varied, according to theories then considered valid or appropriate, in respect to the proper spacing between the parallel boiler tubes in the burner regions of the boiler furnace chamber. In many instances, boiler tubes 18 have been arranged in relatively closely adjacent but spaced apart parallel relationship as above described. In others, the boiler tubes are more widely spaced apart (FIGS. 11-22 inclusive), and in still other boiler constructions, currently common, the boiler tubes are in contiguous or tangent parallel relationship (FIGS. 23-30 inclusive).

Each of these boiler tube arrangements can be provided with a shielding wall of tiles embodying a preferred form of the invention. A first modification, for more widely spaced apart boiler tubes, is illustrated in FIGS. 11-22 inclusive.

In this preferred form of construction, each bank 12a of tiles of the shielding wall 10a comprises horizontal courses of complementary tiles 150 and 152 (FIGS. 11, 13, 15 and 16) where two tiles are used to cover the spatial distance between adjacent boiler tubes center to center, or courses of complementary tiles 150, 154 and 152 (FIGS. 12, 13, 14, 15 and 17), where three or more tiles are required to cover the spatial distance between adjacent boiler tubes center to center, base tile supporting clips 160 permanently affixed to the adjacent

widely spaced apart boiler tubes 18 in a construction and manner similar to that disclosed above for the supporting clip 60 (FIGS. 9 and 10), and free-floating tile retaining clips 162 (FIGS. 16, 18 and 20) or 164 (FIGS. 17, 19 and 21) to retain the tiles at their upper ends in vertical files and horizontal courses upon their supporting clips 160.

The complementary tiles 150 and 152 (FIGS. 13, 13a and 15, 15a) are left hand and right hand tiles respectively and each comprises in common with the other a front facing wall 168, a distal top wall 170, an upstanding transverse flange 172 extending from and to opposite lateral side walls 174, 176, an upper transverse slot 178 adjacent and substantially coextensive with the upper flange 172 and posterior thereto, a posterior or proximal top wall 180 in a plane below that of the distal top wall 170, and a longitudinally extending rib 182 in the side wall 174 to dovetail with the complementary groove 184 in the opposite side wall 176 of an adjacent tile, a distal bottom wall 186, a transverse groove 188 generally complementary to and receptive of the upper flange 172 of an inferior tile, and a posterior or proximal bottom wall 190 substantially in the same plane as the distal bottom wall 186. The left hand tile 150 is further provided with the proximal left-hand longitudinally extending arcuate wall surface 192 complementary to the convex curvature of the adjacent boiler tube 18, and right hand tile 152 is provided with the proximal right-hand longitudinally extending arcuate wall surface 194 complementary to the convex curvature of its adjacent boiler tube 18. The proximal rearwardly facing back walls 196 and 198 of the tiles 150 and 152 respectively abut each other, or at least are closely adjacent each other, when the two tiles are placed in side-by-side relationship in the construction illustrated in FIGS. 11 and 16.

When the three-tile arrangement illustrated in FIGS. 12 and 17 is required, the medial tile 154 is constructed with the same features as above described for the tiles 150 and 152 except that there is no proximal arcuate wall surface posterior the upper flange 172 and bottom groove 188, the lateral side walls extending rearwardly in substantially parallel planes to the proximal rear back wall 200 which is substantially in the same plane as the back walls 196 and 198 of the adjacent complementary tiles 150 and 152 respectively. All features of the medial tile 154 which are common with the same features of the complementary tiles 150 and 152 bear the same reference numerals.

The tile retaining clip 162 is in the form of an angle (FIGS. 16, 18 and 20) and comprises a generally planar body portion 214 and a flange 216 along its distal edge, the lateral sides of the body portion having concavely arcuate edges 218, 218 of a curvature substantially complementary to the convex curvature of the adjacent boiler tubes 18, 18 between which the body portion 214 is positioned upon the proximal upper walls 180, 180 of the adjacent inferior tiles 150 and 152 (FIG. 18). The clip flange 216 depends into the aligned grooves 178 of the tiles, to engage and restrain them from pivoting forwardly away from the boiler tubes 18, 18, the proximal portions of the lateral arcuate edges 218, 218 engaging the boiler tubes.

An alternate tile retaining clip 164 for use with three or more tiles (FIGS. 17, 19 and 21) comprises the parallel bars 220, 220 secured together in spaced apart relationship by the transverse rib members 224, 224 adja-

cent but spaced from the ends of the bars and by one or more intermediate ribs 226. The bars 220 and 222 are longer than the shortest clear free distance between the adjacent boiler tubes 18,18 so that the proximal bar 222 and the distal bar 220 must be positioned on either side of and in engaging relationship with the boiler tubes when the bars lie substantially in a plane, tied together by the transverse rib members 224,224 and 226. The outer rib members 224,224 have an overall distance which is less than the clear free distance between the boiler tubes, so that the free-floating tile retaining clip 164 rests directly upon the proximal upper walls 180 of the tiles 150, 152 and 154. The distal and proximal bar members 220 and 222 are secured to the transverse rib members by welding, into a ladder-like structure. The distal bar member 220 depends from the transverse rib members as a flange so as to hang in the grooves 178 of the tiles.

To insert the free-floating clips 162 or 164 in tile retaining posture, the clip is tilted at an angle sufficient to allow the proximal edge of plate portion 214 of clip 162 or the proximal bar 222 of clip 164 to clear the adjacent boiler tubes 18,18 before placing the clip in a horizontal attitude directly upon the proximal upper walls 180, with its distal depending flange 216 or 220 disposed in the upper slots 178 of the inferior tiles. The next superior course of tiles can then be laid up upon the retained supported inferior course.

ALTERNATE APPLICATION OF THE INVENTION

Although the heat shielding wall described above was designed and developed for the purpose of deflecting heat generated by burner produced combustion gases into the upper superheat and reheat regions of the boiler, there are instances where the wall of tiles can be used to protect the lower regions of boiler tubes against direct burner generated flame impingement while absorbing the heat of the combustion gases to transmit them by conduction, radiation or convection directly to the lower regions of the boiler tubes where that is the desired or required purpose. Because direct flame impingement upon the boiler tubes, particularly in coal-fired furnaces, can result in accelerated deterioration of the boiler tubes, it is most desirable to shield such tubes from direct flames. To effect this result, the tiles 14, 150, 152, 154 can be made of a silicon carbide composition which is a very good ceramic heat conductor. Such tiles will absorb heat generated by the burners and at the same time protect the boiler tubes from direct flame impingement, thereby extending their useful life in the boiler unit.

The tiles 14, 150, 152 and 154 disclosed herein are preferably made of ceramic or equivalent materials according to conventional fire-brick manufacturing practice. The tile supporting clips 60 and 160 are preferably made of sheet stock stainless steel or equivalent alloys such as for example the No. 309 alloy, or they may be cast. The tile retaining clips 80, 162 and 164 are preferably made of sheet, or sheet and rod, or bar stock, or cast stainless steel or equivalent alloys, such for example as the No. 25-12 alloy. The selection of proper and suitable materials for the tiles, clips and bar device will of course vary in some measure according to engineering preference and standards, and in view of particular boiler furnace and tube conditions and the firing equipment being used therein, such selection being well

within the competence of persons skilled in the art and having the foregoing disclosure available to them.

It will be at once observed that the system of this invention, while providing a more satisfactory solution to the problems of heat distribution first above described, also permits a selective replacement, removal or repair of damaged tiles without in any way affecting adjacent portions of the shielding wall 10 not involved in such damage. Thus, the costs in labor and materials to repair any damaged portion of the shielding wall 10 is substantially and materially reduced, by comparison with present day practices referred to generally above. In addition, of course, the advantages of free-floating movement of the shielding wall 10 upon general or localized expansion and contraction of the boiler tubes, varying from region to region in the boiler tube furnace and from portion to portion in the boiler tube, are of paramount importance and should contribute substantially to an improvement in the cost factor.

Although certain particular embodiments of the invention are hereindisclosed for purposes of explanation, further modifications thereof, after study of this specification, may or will become apparent to those skilled in the art to which the invention pertains. Reference should be had to the appended claims in determining the scope of the invention.

We claim:

1. In a wall of ceramic fire brick or tile to shield at least a portion of a water wall of substantially parallel relatively closely adjacent but spaced apart boiler tubes extending vertically upwardly in and from the burner region of a boiler tube furnace area from direct impingement of burner-produced flames and combustion gases upon the facing exposed surfaces of said boiler tubes, and to deflect a significant portion of the heat generated by said flames and combustion gases into the superheat region of the boiler unit thereabove, the improvement combination comprising

at least one pair of said parallel relatively closely adjacent but spaced apart vertically extending boiler tubes, a plurality of shielding tiles for said boiler tubes,

means to support said plurality of shielding tiles in substantially vertical files adjacent the said facing exposed surfaces of said boiler tubes, said support means being fixedly secured to said boiler tubes, and free-floating tile retaining means manually removably engageable with said boiler tubes and with an upper portion of each said tile in said files, to secure each said tile in shielding relationship to said boiler tubes,

each of said tiles comprising a unitary ceramic body having a distal front face, lateral side walls, a proximal rear face, and a top wall surface having a transverse slot therein,

one of said side walls having a longitudinally extending rib portion and the other of said side walls having a longitudinally extending recess complementary to said rib portion,

said rib portion and recess being aligned with each other transversely of said body,

whereby said tiles are relatively free-floating with the expansion and contraction movements of said boiler tubes, and said rib portions and recesses of laterally adjacent tiles dovetail with each other when said tiles are arranged in parallel side-by-side relationship.

2. The structural combination defined in claim 1, wherein
said means to support said plurality of shielding tiles comprises
a plate portion disposed at an angle to the plane of said boiler tubes and fixedly secured to said boiler tubes,
and a tile retaining portion at the distal edge of said plate portion to engage said tile resting upon said plate portion and retain the same thereon.
3. The structural combination defined in claim 2, wherein
said plate portion is provided with a proximal edge substantially complementary to the facing exposed surfaces of said boiler tubes,
portions of said proximal edge being welded to said boiler tube surfaces.
4. The structural combination defined in claim 2, wherein
said plate and tile retaining portions comprise a unitary angle plate.
5. The structural combination defined in claim 3, wherein
said boiler tubes are cylindrical and have convexly curved outer facing surfaces extending axially of said tubes, and
said plate portion proximal edge is provided with concavely arcuate portions complementary to said boiler tube convexly curved outer facing surfaces.
6. The structural combination defined in claim 5, wherein
said arcuate edge portions are at least in part welded to said boiler tube surfaces.
7. The structural combination defined in claim 2, wherein
said plate portion is disposed in a plane substantially normal to the plane of said boiler tubes.
8. The structural combination defined in claim 1, wherein
said transverse slot extends from one side wall to the other.
9. The structural combination defined in claim 1, wherein
said transverse slot is spaced from and extends substantially parallel to said distal front face.
10. The structural combination defined in claim 1, wherein
said tile body further comprises
a distal undercut bottom wall surface extending rearwardly to a depending proximal lower flange portion.
11. The structural combination defined in claim 1, wherein
said rib portion and recess are disposed substantially medially of said side walls.
12. The structural combination defined in claim 1, wherein
said proximal rear face comprises in part a pair of longitudinally extending substantially parallel concavely curved wall surfaces at the proximal corners of said tile.
13. The structural combination defined in claim 12, wherein

- said concavely curved wall surfaces are spaced apart by a medial longitudinally extending web face therebetween.
14. The structural combination defined in claim 12, wherein
said concavely curved wall surfaces have a transverse curvature substantially complementary to the adjacent portions of the outer facing surfaces of said boiler tubes.
15. The structural combination defined in claim 1, wherein
said tile body further comprises a proximal upper flange portion extending rearwardly of said slot and being lower in height than said top wall surface.
16. The structural combination defined in claim 1, wherein
said tile body is generally rectilinear in configuration.
17. The structural combination defined in claim 1, wherein
said manually removably engageable tile retaining means comprises
a distal plate member engageable with at least one said tile in said file,
a stem having one end secured to said distal plate member and extending axially normal to the plane of said plate member,
and a boiler tube engaging member secured to the other or proximal end of said stem, extending rearwardly from and in the plane of said stem and substantially normal to the plane of said distal plate member.
18. The structural combination defined in claim 17, wherein
said one stem end is secured substantially medially and central of said distal plate member.
19. The structural combination defined in claim 17, wherein
said stem is secured substantially to one edge of said distal plate member.
20. The structural combination defined in claim 17, wherein
said stem and said boiler tube engaging member each have a cross-sectional thickness no greater than the free clear distance between said pair of spaced apart adjacent boiler tubes,
and said boiler tube engaging member has a transverse width substantially greater than such free clear distance between said adjacent boiler tubes,
whereby said boiler tube engaging portion and said stem of said tile retaining means are insertable between said boiler tubes and, upon rotation of said stem and boiler tube engaging member, said free-floating tile retaining means is engaged with said boiler tubes at their proximal sides.
21. The structural combination defined in claim 15, wherein
said manually removably engageable tile retaining means comprises
a distal plate member engageable with at least one said tile in said file,
a stem having one end secured to said distal plate member and extending axially normal to the plane of said plate member,
and a boiler tube engaging member secured to the other or proximal end of said stem, extending

rearwardly from and in the plane of said stem and substantially normal to the plane of said distal plate member,
 said stem and boiler tube engaging member each having a cross-sectional thickness no greater than the free clear distance between said pair of spaced apart adjacent boiler tubes,
 said boiler tube engaging member having a transverse width substantially greater than such free clear distance between said adjacent boiler tubes,
 said distal plate member being engageable with said proximal upper flange portion of said tile in said slot when said stem is at rest upon said proximal upper flange portion, the proximal portion and stem of said tile retaining means having been inserted between said boiler tubes and, upon rotation of said stem and boiler tube engaging member,
 said tile retaining means having engaged said boiler tubes at the latter's proximal sides.

22. The structural combination defined in claim 20, wherein said boiler tube engaging member is planar and, when rotated into engagement with said boiler tubes, lies in a plane substantially normal to the plane of said boiler tubes.

23. The structural combination defined in claim 20, wherein

when said proximal boiler tube engaging member and said stem are inserted between said boiler tubes and said engaging member extends inwardly beyond the surfaces of said adjacent boiler tubes, said tile retaining means is manually rotatable upon grasping said distal plate member and rotating the same in a plane substantially parallel to the plane of said boiler tubes.

24. The structural combination defined in claim 1, wherein

said plurality of shielding tiles are arranged in one or more banks of tiles forming said shielding wall, each said bank comprising a plurality of vertical files of tiles supported upon said supporting means,
 said files having their tiles in horizontal parallel alignment with each other to form horizontal courses,

a superior bank of said tiles being spaced vertically above an inferior bank to provide a horizontal gap therebetween for facile manual removal and engagement of the uppermost of said tile retaining means with the most superior tiles of said inferior bank,

and a heat insulating packing material disposed in said gap to close said gap against impingement of burner flames and combustion gases upon the exposed surfaces of said boiler tubes therebehind.

25. The structural combination defined in claim 5, and wherein

said plate portion further comprises
 a web portion intermediate said concavely arcuate edge portions,
 said plate portion being supportive of a plurality of said tiles.

26. The structural combination defined in claim 2, wherein

said tile retaining portion at the distal edge of said plate portion is substantially coextensive in length with said plate portion.

27. The structural combination defined in claim 2, wherein
 said tile retaining portion comprises an upstanding flange.

28. The structural combination defined in claim 1, wherein

said free-floating tile retaining means comprises
 a distal member removably engageable with at least one said tile in said vertical files,
 a stem having one end thereof secured to said distal member and extending axially normal to the plane of said distal member, and
 a boiler tube engaging member secured to the proximal end of said stem, extending rearwardly from and in the plane of said stem and substantially normal to the plane of said distal member.

29. The structural combination defined in claim 1, wherein

each said tile comprises a unitary ceramic body of silicon carbide.

30. The structural combination defined in claim 1, wherein said free-floating tile retaining means each comprises

a plate portion having lateral edges intermediate its distal and proximal edges engageable with said boiler tubes,
 and a distal member engageable with a plurality of tiles at their upper ends.

31. The structural combination defined in claim 30, wherein

said free-floating tile retaining means each comprises substantially an angle plate.

32. The structural combination defined in claim 30, wherein

said lateral edges have arcuate edge portions with a curvature substantially complementary to the convex curvature of said boiler tubes.

33. The structural combination defined in claim 30, wherein

said distal member comprises a depending tile-engaging flange.

34. The structural combination defined in claim 30, wherein

said plate portion is adapted to rest upon the proximal upper top wall surfaces of said tiles.

35. The structural combination defined in claim 31, wherein

said angle plate is adapted to rest upon the proximal upper top wall surfaces of said tiles.

36. The structural combination defined in claim 32, wherein

the root distance between said lateral arcuate edge portions is less than the clear free distance between said boiler tubes.

37. The structural combination defined in claim 30, wherein

said plate portion is adapted to removably engage said boiler tubes and to move relative to said boiler tubes in response to their expansion and contraction movements.

38. The structural combination defined in claim 1, wherein

said free-floating tile retaining means each comprises in combination
 substantially parallel aligned spaced apart distal and proximal bars,

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transverse rib members fixedly secured to said parallel bars adjacent but spaced from the ends of said bars so that said parallel bars project laterally beyond said transverse rib members, the ends of said proximal parallel bar being engageable with said boiler tubes, said distal parallel bar being engageable with a plurality of tiles at their upper ends.

39. The structural combination defined in claim 38, wherein said transverse rib members are adapted to rest upon the proximal upper top wall surfaces of said tiles.

40. The structural combination defined in claim 38, wherein the overall distance between said transverse rib members is less than the clear free distance between said boiler tubes.

41. The structural combination defined in claim 38, wherein said distal parallel bar depends from said transverse rib members in tile engaging posture.

42. The structural combination defined in claim 38, wherein the combination of said conjoined parallel bars and transverse rib members is adapted to removably engage said boiler tubes and to move relative to said boiler tubes in response to their expansion and contraction movements.

43. The structural combination defined in claim 1, wherein said proximal rear face comprises a longitudinally extending concavely curved wall surface forming one corner of said tile at its proximal end and an adjacent proximal wall surface.

44. The structural combination defined in claim 43, wherein said concavely curved wall surface has a transverse curvature substantially complementary to the convex curvature of the boiler tube next thereto adjacent.

45. The structural combination defined in claim 1, wherein said proximal rear face comprises a pair of longitudinally extending notched wall surfaces at its proximal corners, complementary to and adapted to receive portions of the convexly curved wall surface of said boiler tubes therewithin, and an intermediate substantially medial longitudinally extending web portion therebetween.

46. The structural combination defined in claim 1, wherein said proximal rear face comprises a longitudinally extending notched wall surface at one proximal corner, complementary to and

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adapted to receive a portion of the convexly curved wall surface of one said boiler tube therewithin, and an adjacent proximal wall surface.

47. The structural combination defined in claim 1, wherein said tile top wall surface is further provided with a transverse upstanding flange anterior of said transverse slot.

48. The structural combination defined in claim 47, wherein said upstanding flange is disposed adjacent and substantially coextensive with said transverse slot.

49. The structural combination defined in claim 48, wherein said tile top wall surface further comprises a proximal top wall portion posterior of said transverse slot at a plane lower than the plane of said top wall surface anterior of said upstanding flange.

50. The structural combination defined in claim 47, wherein each of said tiles further comprises a bottom wall surface having a transverse slot therein substantially parallel to, aligned and coextensive with said top wall surface upstanding flange.

51. The structural combination defined in claim 50, wherein said bottom wall surfaces on each side of said transverse slot lie in a common plane.

52. The structural combination defined in claim 47, wherein said tile top wall surface upstanding flange extends from side wall to side wall.

53. The structural combination defined in claim 50, wherein said bottom wall surface transverse slot extends from side wall to side wall.

54. The structural combination defined in claim 1, wherein one said tile in a course of said tiles extends substantially across the space between parallel centerlines of and before adjacent boiler tubes.

55. The structural combination defined in claim 1, wherein a pair of said tiles are disposed in side by side relationship in a course of said tiles and extend substantially across the space between parallel centerlines of and before adjacent boiler tubes.

56. The structural combination defined in claim 1, wherein three or more of said tiles are disposed in side by side relationship in a course of said tiles and extend substantially across the space between parallel centerlines of and before adjacent boiler tubes.

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