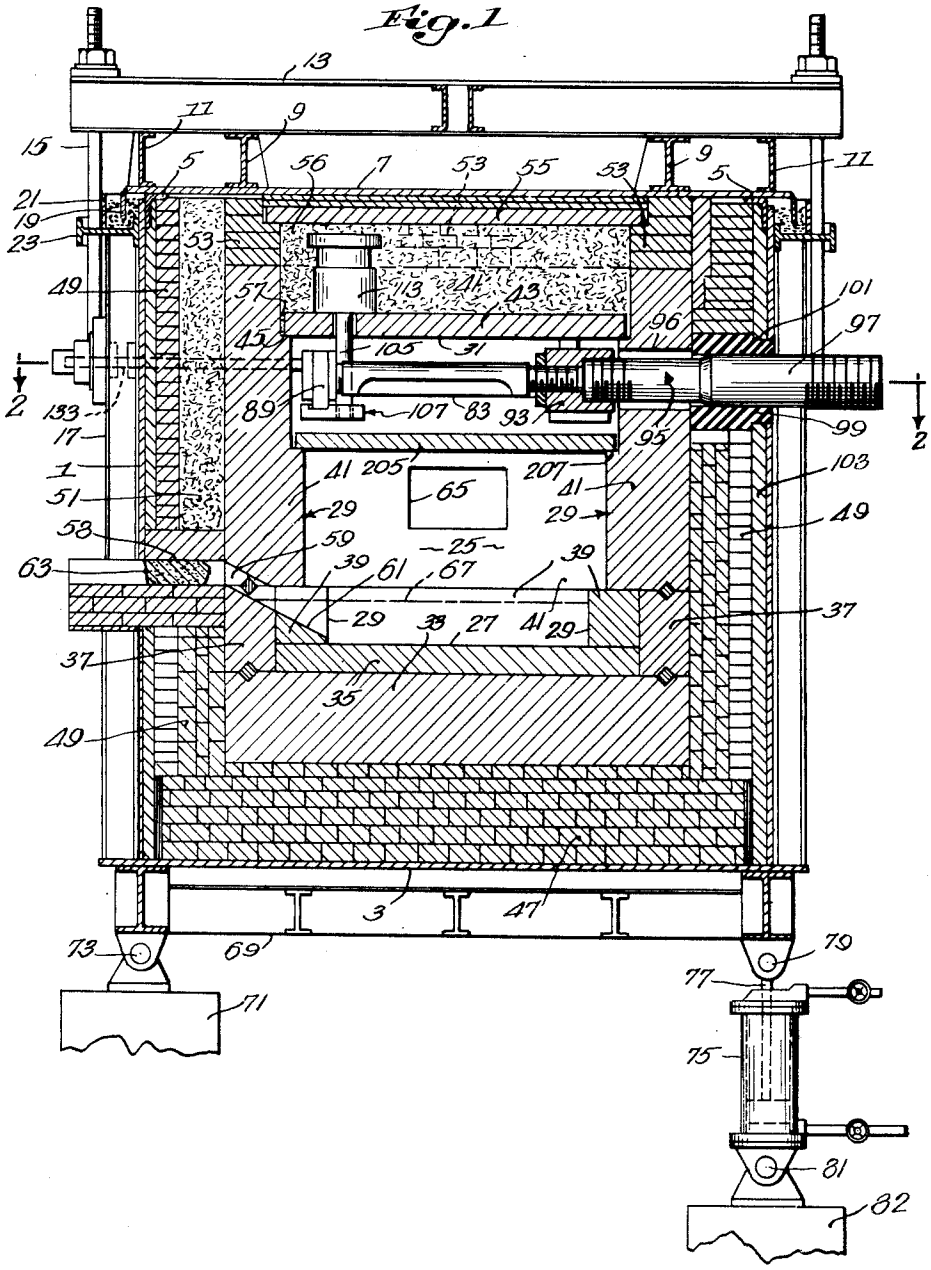
Dec. 14, 1954 F. F. POLAND 2,697,127

ELECTRIC RESISTOR FURNACE

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Fig. 1



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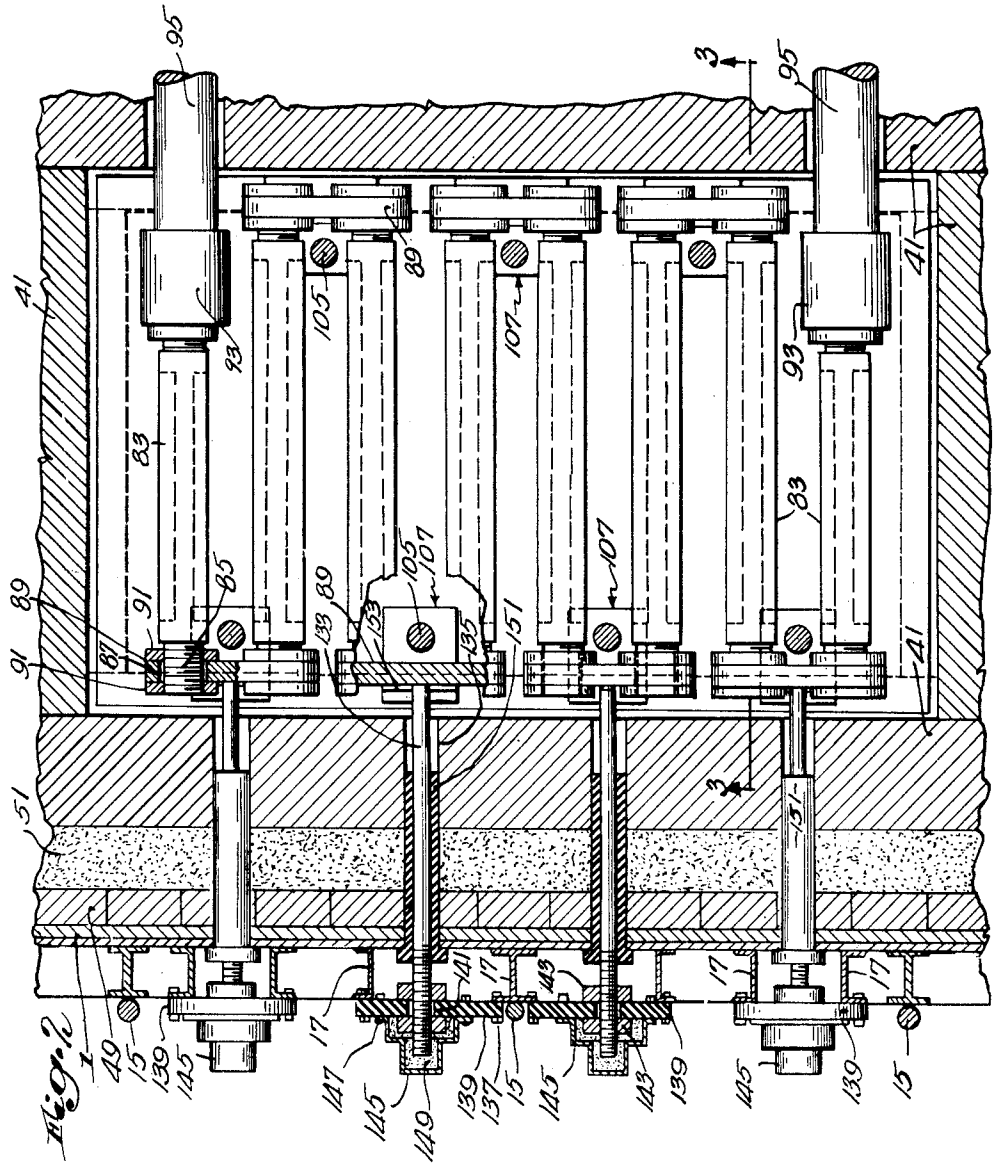


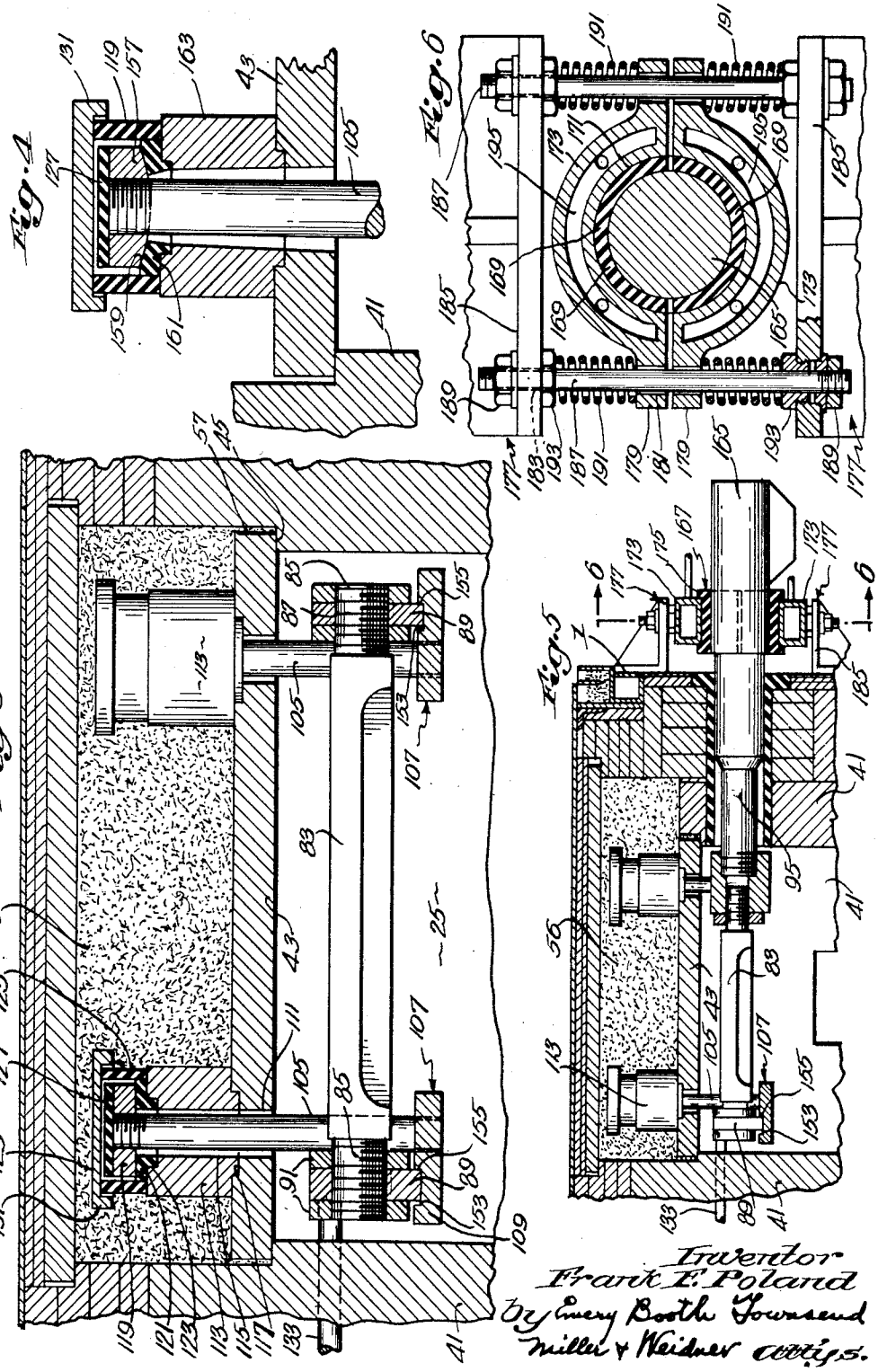
Fig. 2

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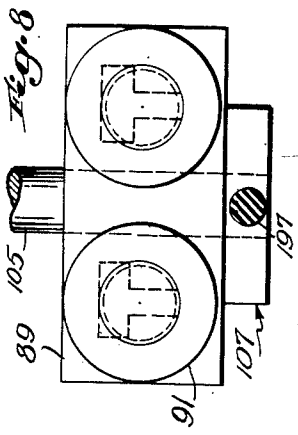


Fig. 8

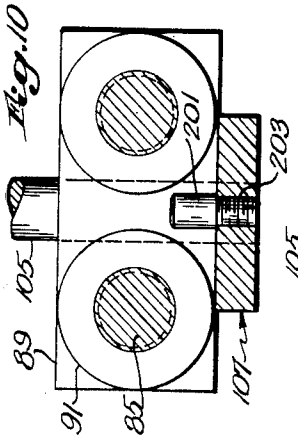


Fig. 10

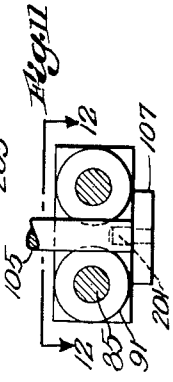


Fig. 11

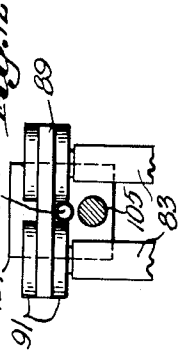


Fig. 12

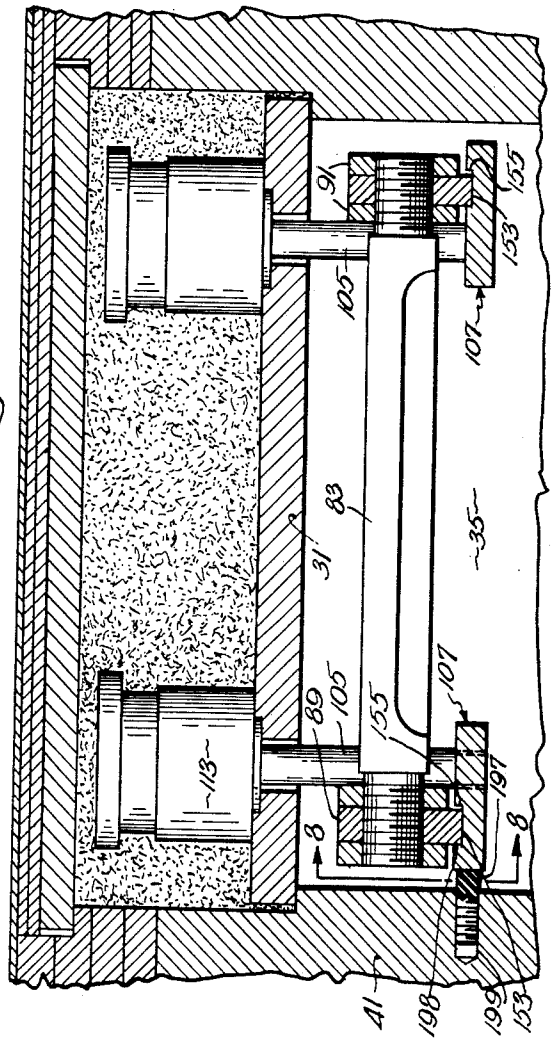


Fig. 7

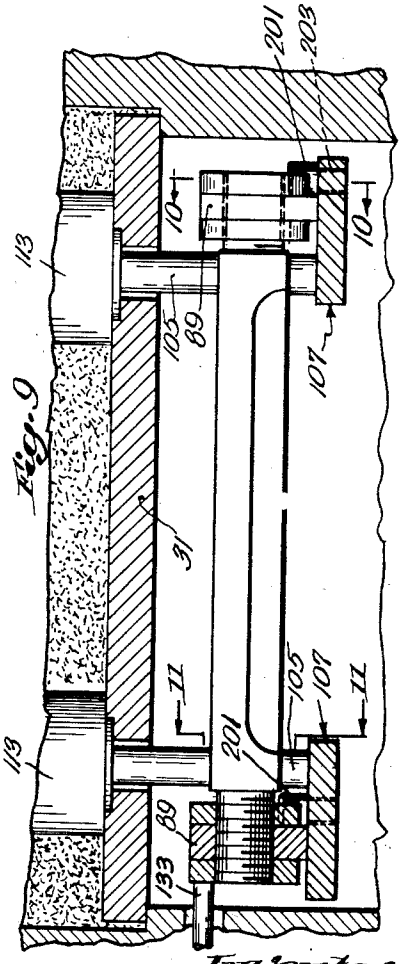


Fig. 9

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United States Patent Office 2,697,127 Patented Dec. 14, 1954

2,697,127

ELECTRIC RESISTOR FURNACE

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Application February 4, 1952, Serial No. 269,824

24 Claims. (Cl. 13—20)

My invention relates to electric resistor furnaces of the tilting type, and is more particularly concerned with a support for the resistors.

The invention, which has among its objects the provision of means for preventing shifting of the resistors when the furnace is tilted to pour it, will be best understood from the following description when read in the light of the accompanying drawings, while the scope of the invention will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a vertical section of a tilting resistor furnace according to the invention, with parts shown in elevation;

Fig. 2 is a section on the line **2—2** of Fig. 1, with parts broken away, and parts in elevation, on an enlarged scale;

Fig. 3 is a section on the line **3—3** of Fig. 2, with parts omitted, parts in elevation, and parts broken away, on an enlarged scale;

Fig. 4 illustrates a detail showing the modification of the resistor suspension of Figs. 1 to 3;

Fig. 5 is a section, corresponding to a fragment of Fig. 1, showing a modification of the means for preventing shifting of the resistors when the furnace is tilted;

Fig. 6 is a section on the line **6—6** of Fig. 5, with parts in elevation, on an enlarged scale;

Fig. 7 is a view, corresponding to Fig. 3, showing a further modification of the means for preventing shifting of the resistors;

Fig. 8 is a section on the line **8—8** of Fig. 7, with parts omitted;

Fig. 9 is a view, corresponding to Fig. 3, showing a still further modification of the means for preventing shifting of the resistors;

Figs. 10 and 11 are, respectively, sections on the lines **10—10** and **11—11** of Fig. 9, with parts omitted, on an enlarged scale; and

Fig. 12 is a section on the line **12—12** of Fig. 11.

The furnace illustrated is generally like that shown by applicant's United States Patents 2,472,612 and 2,472,613, both dated June 7, 1949, and therefore will not be described with any further particularity than necessary to explain the present invention.

As shown, the furnace comprises an open top airtight metallic casing comprising the lateral walls **1** and bottom walls **3**. Resting upon the angle-irons **5** that extend continuously around and are welded to the upper edge portions of the lateral walls of the casing is an airtight cover plate **7**. This cover plate at its upper side carries the reinforcing beams **9** and **11** which extend entirely across it and are welded thereto. Removably resting upon the upper sides of these beams is a frame comprising the beams **13**, the ends of which latter are removably secured by bolt rods **15** to the furnace casing for removably securing the cover plate to that casing, the lower end portions of the bolt rods being welded to vertically extending reinforcing beams **17** welded to the lateral walls of the casing for reinforcing the latter.

As shown, the cover plate **7** at its edges projects laterally beyond the lateral walls **1** of the furnace casing, and, at such edges, is provided with a depending flange **19** extending continuously around it, which flange is welded thereto in a fluidtight manner. This flange is received in the space between the lateral walls of the casing and the flange **21**, which latter extends continuously around the lateral walls of the casing and is welded in a fluidtight manner at its lower edge to I-beams **23**, these beams also extending continuously around the casing and being welded thereto in a fluidtight manner. By filling with oil or sand, or a mixture of the two, the space above the I-beams **23** between the flange **21** and the lateral walls of the casing the joint between the cover plate and the casing is rendered fluidtight.

Interiorly of the casing **1** is a furnace chamber **25** having a bottom or hearth **27**, side or lateral walls **29**, and a top wall **31**. The hearth preferably is formed of a massive slab or block **33** of hard carbon, on which rests a thinner removable "wear" plate in the form of a hard carbon slab **35**. The lateral walls of the furnace chamber adjacent the hearth are shown as formed by outer massive slabs or blocks **37**, preferably of hard carbon, which rest at their lower edges on the slab or block **33**, and by inner removable "wear" plates **39**, also preferably of hard carbon, which rest on the wear plate **35**. The remainder of the lateral walls of the furnace chamber, as shown, are formed by the massive slabs or blocks **41**, of hard carbon, which rest on the slabs or blocks **37** and wear plates **39**. The roof of the furnace chamber is shown as formed of a slab **43**, preferably of graphite, which at its edges rests on upwardly facing ledges **45** formed on the slabs or blocks **41**. As shown, the hearth slab or block **33** rests on a refractory heat insulating layer **47** which is built up of courses of refractory firebricks and the like and rests on the bottom wall **3** of the metallic casing of the furnace. Laterally the slabs or blocks **33** and **37** are backed by similar walls **49** of refractory firebricks and the like, these walls on one side of the furnace extending upward to its top as indicated at the right hand side of Fig. 1, while on the other three sides the walls are so built as to leave a space adjacent the outer sides of the blocks **41** which is filled with a mass **51** of refractory heat insulating material such as carbon beads. The slabs or blocks **41** are continued upward by walls formed of courses of firebricks **53**. Carried by these last mentioned walls adjacent the cover plate **7** is a further slab **55** of graphite or hard carbon, and the space between that slab and the slab **43** is filled with a mass **56** of refractory heat insulating material such as carbon beads which is preferably mixed with broken up charcoal to decrease its angle of repose so as to prevent it from flowing when the furnace is tilted. The slab **43** is shown at its edges in slightly spaced relation to the surrounding walls of the blocks **41**, as indicated at **57**. This space may be filled with a mixture of carbon beads and graphite that may be tamped into the space to prevent the slab from shifting when the furnace is tilted.

As shown, the furnace is provided with a pouring opening **58** extending through one of its lateral walls, this opening having a portion **59** formed by notching the slabs or blocks **37** and **41** and wear plate **39** to provide a downwardly sloping surface **61** extending to adjacent the hearth **27**. The pouring opening is normally closed by a plug **63** of fireclay forced into it, which plug may be broken away when the furnace is to be poured. The furnace may be charged with metal, or other material to be melted or otherwise treated therein, through a charging port **65** in one of the lateral walls of the furnace, which port has a normally closed door (not shown). Metal charged to the hearth in this way may be melted to form a body of molten metal on the hearth having an upper level **67**. By tilting the furnace such molten metal may be poured therefrom through the pouring opening **58**.

For tilting the furnace it is shown as resting on a frame **69** to which the bottom of the furnace casing is welded. This frame, as shown, is mounted on a foundation pier **71** for tilting about a horizontal axis, as indicated at **73**. As illustrated, the furnace may be tilted by use of an air or hydraulic cylinder **75** of usual construction, the piston rod **77** associated with such cylinder being pivotally connected to the frame, as indicated at **79**, at the side thereof opposite the pivotal support **73** of the frame, while the cylinder is pivotally supported at its lower end, as indicated at **81**, on a foundation pier **82**.

Referring particularly to Figs. 1, 2 and 3, the furnace is shown as provided with a resistor heating grid consisting of a row of elongated parallel resistor bars **83**. These bars, as shown, have screw-threaded reduced end portions **85** extending through horizontally elongated

openings 87 in connecter plates 89, nuts 91 screw-threaded on said reduced portions slidably clamping the resistors to the connecter plates in electrical contact therewith. The resistor bars at the ends of the row are shown as connected by sleeves 93 to extensions 95, the adjacent ends of these extensions and resistor bars being screw-threaded into said sleeves causing a rigid connection between the two. As shown in Fig. 1, each extension projects through an opening 96 formed in the adjacent hard carbon block or slab 41 in spaced relation to the walls of said opening so as to be insulated from said block. Each extension has a cylindrical portion 97 which slidably extends through an insulating bushing 99 of heat refractory electric insulating material, preferably fused alumina. This bushing at its inner end abuts against the adjacent block 41, and adjacent its outer end is formed with an annular shoulder 101 which abuts against a slab 103, this slab resting against the inner side of the adjacent lateral wall of the metallic furnace casing and forming part of the heat refractory wall 49. In this way the bushing is secured against longitudinal movement. The terminals for the electric cables for energizing the resistor grid may be connected to those ends of the extension which project outside the furnace, in this way to connect the resistor bars for series flow of electric current through them. The resistor bars 83, connecter plates 89, nuts 91, sleeves 93 and resistor extensions 95 are all preferably formed of graphite which is a substance that may be readily machined.

For suspending the resistor grid from the graphite roof slab 43 are provided vertically disposed rods 105, preferably formed of graphite. Screw-threadedly connected to the lower ends of these rods are shown saddle plates 107, which latter provide portions 109 projecting laterally of the rods on which portions the connecter plates 89 at their lower edges slidably rest. The rods are shown as projecting through openings 111 in the graphite roof slab 43 in out-of-contacting relation to the walls of said openings. Surrounding each rod and resting on the upper side of the roof slab 43 are shown sleeves or blocks 113 having openings 115 in alignment with the adjacent openings 111. As shown, each sleeve 113 at its lower end has a reduced diameter portion 117 which fits into a correspondingly shaped recess in the upper side of the roof slab 43 so as to hold the sleeve from shifting transversely relative to the slab. Screw-threaded on the upper end of each rod 105 is a nut 119, preferably of graphite. These nuts are shown as resting on heat refractory electric insulating washers 121 surrounding the rods, and, at their lower sides, having reduced diameter portions 123 fitting correspondingly shaped recesses in the upper ends of the sleeves 113 so as to hold the washers from shifting transversely relative to said sleeves. Surrounding the nuts 119, and fitted over the peripheries of the washers 121, are sleeves 125 of heat refractory electric insulating material for keeping the electrically conductive mass 56 of carbon beads and charcoal out of contact with said nuts. To the same end a plate 127 of heat refractory electric insulating material is placed on the upper side of each nut 119, while a cap 129 of graphite is placed over the upper edge of each sleeve 125, the peripheral flange 131 of the cap preventing undue shifting of the same relative to the rest of the structure. The rods 105, plates 107 and nuts 119 of the resistor suspensions are, as above described, and like the resistors, preferably formed of graphite, so as to be readily machinable, and because such material is about the only readily commercially available rigid material other than hard carbon that will withstand the high temperatures to which the furnace may be subjected, hard carbon not being readily machinable. The electric insulating washers and other insulating material of the resistor suspensions are preferably formed of fused alumina (Al_2O_3) which is the best readily commercially available electric insulating material of sufficient heat refractory property to withstand very high temperatures. These washers and other insulating parts are placed well above the roof slab 43 so as to have them in a position which is below their softening temperature. The sleeves or blocks 113 are preferably formed of porous carbon which is extremely heat refractory and a relatively poor conductor of heat, with the result that a minimum of heat tending to soften the washers 121 is conducted to them.

It will be observed from Fig. 1 that, when the furnace is tilted to pour it, the resistor grid tends to shift to the left relative to the furnace walls, and the resistor grid suspensions tend to swing to the left, as viewed in said figure. Such shifting and swinging, if not prevented, may cause the resistor grid and its suspensions to contact with the walls of electrically conductive blocks 41 or with the roof slab 43, which would act to ground and short circuit the resistors. Also the stresses tending to cause such shifting and swinging, if means are not provided to counteract them, will place undue stresses on the resistor grid, especially when the resistor extensions 95 are widely spaced apart, and likewise on the suspension rods 105, and tend to rupture them, in which connection it is pointed out that solid graphite, of which these parts are made, although reasonably strong in respect to tensile and shear strengths, is exceedingly brittle, being almost wholly without elasticity at high temperatures. To prevent these damaging effects, in the modification of the invention shown by Figs. 1 to 3 the lateral wall of the furnace having the pouring opening is shown as carrying spaced horizontal rods 133, preferably formed of graphite, which extend from within the furnace chamber to the exterior of the furnace casing through openings 135 in such wall positioned opposite the connecter plates 89. The spaced vertical reinforcing bars 17 at the exterior of the furnace casing are shown as having secured thereto, by bolts 137, plates 139 of heat refractory electric insulating material such as fused alumina. The rods 135 are shown as screw-threaded at their outer end portions, which portions extend through openings 141 in these plates, and screw-threaded on the rods at opposite sides of the plates are nuts 143, preferably formed of graphite, which nuts act rigidly to secure the rods in adjusted positions longitudinally thereof to said plates. Solid graphite is an excellent conductor of heat, and to minimize loss of heat from the furnace by reason of conduction through the rods the ends of the latter are shown as covered by metallic casings 145 secured by bolts 147 to the plates 139, each casing being filled with a mass 149 of heat refractory heat insulating material such as lampblack. For electrically insulating the rods from the metallic casing and electrically conductive walls of the furnace the rods are shown as passing through bushings 151 received in the openings 135. The rods are adjusted longitudinally relative to the insulating plates 139 to bring their inner ends into operative relation to the connecter plates 89 at the left hand side of the resistor grid, as viewed in Figs. 1 and 2, so as to prevent when the furnace is tilted the grid from shifting to the left as viewed in those figures.

As best shown in Figs. 2 and 3, the lower edge portions of the connecter plates 89 are received in grooves 153 formed in the upper sides of the saddle plates 107 of the resistor suspensions, on the bottoms of which grooves the connecter plates slidably rest. The vertical right hand walls 155 of these grooves, as viewed in Fig. 3, serve as abutments on the plates 107 adapted to contact with the connecter plates 89 when the furnace is tilted, such contact acting when the furnace is tilted to restrain the resistor grid suspensions against swinging to the left and thus to relieve the rods 105 of lateral stresses tending to break them.

The arrangements of parts shown in Figs. 1, 2 and 3 and in the figures of the drawings showing the herein subsequently described other modifications of the invention indicate the position of parts when the resistors and furnace are heated and the furnace has been once tilted. The inner ends of the rods 133 may be adjusted to be slightly out of contact with the connecter plates 89 when the furnace is cold, as a result of which longitudinal expansion of the resistors when heated will cause said plates to contact with said rods. The grooves 153 in the plates 107 are so formed that when the furnace is cold the right hand walls 155 of such grooves contact, or about contact, with the connecter plates 89 received by those grooves, the linear expansion of the roof slab 43 and furnace walls substantially maintaining such relation when the furnace is heated. As a result, when the furnace is tilted the resistor grid is held against shifting to the left, as viewed in Fig. 3, and substantial swinging of the suspensions beyond that normally permitted by the lost motion of the parts is effectively prevented. In the appended claims for convenience of terminology such preventing of swinging of the suspension rods or the like and concomitant relieving them of bending stresses

tending to rupture them is referred to as restraining them against lateral shifting.

In large furnaces to minimize the possibility of any substantial lateral stresses being imparted to the graphite rods **105** by reason of expansion of the resistor grid and furnace walls, and by reason of tilting of the furnace, the graphite nuts **157** at the upper ends of those rods may, if desired, be so formed that their lower surfaces **159** are surfaces of a sphere, the upper surfaces of the electric insulating washers **161** on which the nuts rest being of complementary shape. With such construction, and because graphite has high lubricating properties, any tendency of the rods to swing will not result in material bending stresses being applied to those rods. Otherwise the construction of the resistor suspensions may be the same as that heretofore described, except preferably that the aligned openings in the insulating washers **161**, porous carbon blocks **163**, and graphite roof slab **43**, through which aligned openings the rods extend, are tapered or otherwise formed to make such openings of progressively increasing diameter as they extend downward, in this way to prevent any possibility of the rods grounding on said blocks and roof slab.

In the modification of the invention shown by Figs. 5 and 6, which is particularly applicable to furnaces having resistor bars of relatively moderate length, the resistor grid extensions **95** are held against longitudinal movement relative to the furnace wall through which they extend by means positioned exteriorly of the furnace. As a result the resistor grid is held against shifting when the furnace is tilted, and, the grid being so held, the contact of the right hand walls **155** of the grooves **153** in the connecter plates **89** restrains the grid suspension rods **105** against any swinging beyond that normally permitted by the lost motion of the parts.

For holding the resistor extensions **95** against the above mentioned longitudinal movement in the modification shown by Figs. 5 and 6 the enlarged diameter portion **165** of each said extension is shown as surrounded by a split bushing **167** of heat refractory electric insulating material such as fused alumina. As illustrated, this bushing is formed of two approximately semi-circular segments **169** received in a bore **171** formed by the two cooperating approximately semi-circular metallic segments **173**, the insulating segments having arcuate end flanges **175** extending radially outward in contact with the opposite sides of the segments **173** so that the bushing so formed is held against axial movement relative to the segments **173**. As shown, the cooperating segments **173** are positioned between vertically spaced upper and lower brackets **177** welded to the outer side of the adjacent lateral wall **1** of the metallic casing of the furnace. Each segment **173** is formed at each of opposite sides thereof adjacent its horizontal edges with an outwardly projecting flange **179** provided with a perforation **181**. Through the aligned perforations **181**, and aligned perforations **183** formed in the adjacent flanges **185** of the brackets **177**, extend vertical metal rods **187** retained in assembled relation with the brackets by nuts **189** screw-threaded on the outer ends of said rods. Surrounding the rods are compression springs **191** which at one of their ends bear against the flanges **179** of the segements **173** and at their opposite ends bear against washers **193** resting against the flanges **185** of the brackets. These springs, which are under initial compression, act to press the segments **173** toward each other, and therefore to clamp the insulating segments **169** fixedly against the resistor extension portions **165**. As shown, the metal segments **173** are formed with cavities **195** through which cooling water may be circulated for maintaining the insulating segments **169** below their softening temperature.

The rods **133** ordinarily need not be employed in connection with the modification shown by Figs. 5 and 6 if the length of the resistor grid as measured from one resistor extension **95** to the other is small. However when such length is relatively great, as for example in the construction shown by Fig. 2, one or more of such rods may be employed toward the center of the length of the grid to restrain it from buckling when the furnace is tilted. In such case the rods will be so adjusted longitudinally thereof relative to the furnace walls that when the furnace is cold their inner ends are out of contact with the connecter plates **89** but in contact with such plates when the furnace is heated.

Referring particularly to Figs. 7 and 8, in all the modifications of the invention presented by this application pins **197** of electric insulating material may be substituted for the graphite rods **133** when the temperature to which the furnace chamber is heated does not exceed the softening temperature of the material of which said pins are formed. As shown, these pins are screw-threadedly received in screw-threaded perforations **199** formed in the carbon blocks **41** adjacent the left hand side of the resistor grid as viewed in Fig. 7. The pins **197** are adjusted to project into the furnace chamber the requisite distance to secure the same overall results as are secured by the rods **133**. The pins may be positioned to contact either with the saddle plates **107** of the resistor extensions as shown in Fig. 7 or, as shown in Fig. 2 in connection with the rods **133**, with the resistor connecter plates **89**. This is also true of the rods **133**, which likewise may be positioned to contact with either the connecter plates or saddle plates. However, when the pins or rods contact with the saddle plates as is shown in Fig. 7 in connection with the pins, the grooves **153** should be so positioned that when the furnace is heated the connecter plates contact with the left hand walls **198** of the grooves as viewed in Fig. 7 for the reason that in such case the grid suspensions are directly held against swinging by the rods or pins and the suspensions thus act to prevent the grid from shifting. In all these arrangements it will be observed that, considering the grid as one part and the suspension as another part, one part is directly restrained against lateral shifting when the furnace is tilted, and on the two parts are cooperating abutments for causing the part so restrained to restrain the other part also against lateral shifting. As heretofore pointed out, fused alumina is the most heat refractory electric insulating material commercially available. It however softens at temperatures of about 2200° F. and cannot be successfully employed for the pins **197** with higher temperatures.

In all the modifications of the invention upwardly projecting pins exemplified by the pins **201** of Fig. 9 may be substituted for the grooves **153**, one or the other of the sides of which pins form abutments taking the place of the abutments **155** or **198** formed by such grooves. These pins, like the resistor suspension plates **107**, are preferably formed of graphite, so as to resist the high temperatures to which the furnace may be subjected. As shown in Figs. 9 to 12, they are screw-threadedly received at their lower ends in screw-threaded perforations **203** formed in the plates **107**. These pins are so positioned in Figs. 9 to 12 that when the furnace is heated the left hand sides of the pins will just about bear against the resistor connector plates **89** as shown in Fig. 9. The resistor grid being held against shifting by the rods **105** or by the construction shown by Figs. 5 and 6, the resistor suspensions will be restrained by the pins against swinging to the left as viewed in Fig. 9. When the pins **197** of Fig. 9 are employed in conjunction with the pins **201** the latter obviously must be placed at the left hand side of the connector plates **89** as viewed in Figs. 7 and 9.

As shown in Fig. 1, a slab **205** of graphite is placed in the furnace chamber between the resistor grid and the hearth to protect the resistor grid, which is of expensive construction, from corrosive fumes and dusts which may rise from the material being treated in the furnace. This slab **205** however may be omitted in situations where such fumes and dusts are absent. As shown, the blocks **41** are formed to provide a ledge **207** extending continuously about the furnace chamber, on which ledge the edge portions of the slab rest.

It will be understood that within the scope of the appended claims wide deviations may be made from the forms of the invention described without departing from the spirit of the invention.

I claim:

1. An electric furnace comprising walls defining a furnace chamber, a generally horizontal downwardly facing resistor grid in said chamber for radiating heat downward toward the bottom of said chamber, heat refractory means comprising vertically extending rods carried by the roof of said chamber for supporting said grid from said roof, means mounting the furnace for tilting, and heat refractory means carried by said walls engaging said grid for restraining the latter against lateral shifting when said furnace is tilted.

2. An electric furnace formed to provide a furnace chamber having a hearth, and lateral and top walls, said top wall and adjacent portions of said lateral walls exposed to said chamber being of electric conductive material; a first means comprising a resistor grid of exposed electric conductive material in said chamber at such portions of said lateral walls; a second means suspending said grid from said top wall comprising electric insulating material for electrically insulating said second means from said top wall; means mounting the furnace for tilting; means in electric insulated relation to said lateral walls carried thereby and projecting into said chamber for engagement with one of said first and second means for restraining the means so engaged against shifting laterally of said chamber when said furnace is so tilted, and cooperating abutment means on said first and second means for causing the means so restrained to restrain the other of said first and second means also against lateral shifting when the furnace is tilted.

3. An electric furnace formed to provide a furnace chamber having a hearth and lateral and top walls, said top wall and adjacent portions of said lateral walls exposed to said chamber being of electric conductive material, a resistor grid of exposed electric conductive material in said chamber at such portions of said lateral walls; means mounting the furnace for tilting; a suspension for said grid comprising an elongated rod or the like of electrically conductive material carried by said top wall at its upper side in electrically insulated relation thereto and extending through an opening formed in said top wall to its under side, said suspension also comprising a portion carried by said rod within said chamber on which portion said grid slidably rests; means carried by said lateral walls of said chamber for engagement with said grid for restraining it against lateral shifting when said furnace is tilted, and means providing an abutment carried by said suspension for cooperation with said grid for restraining said rod against lateral shifting when said furnace is so tilted.

4. An electric furnace according to claim 3 in which the portion of the grid suspension on which the grid slidably rests is formed with a groove receiving said grid, a lateral wall of such groove forming the abutment carried by the suspension for restraining the grid against lateral shifting.

5. An electric furnace according to claim 3 in which the portion of the grid suspension on which the grid slidably rests is provided with an upwardly projecting lug forming the abutment carried by the suspension for restraining the grid against shifting.

6. An electric furnace according to claim 3 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more members carried by said walls in electricaliy insulated relation thereto, which members project into the furnace chamber for contact with the grid.

7. An electric furnace according to claim 3 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more members of heat refractory electric insulating material projecting into the furnace chamber for contact with the grid.

8. An electric furnace according to claim 3 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods of heat refractory electrically conductive material carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid, said rods extending through heat refractory electric insulating bushings received in openings formed in said lateral walls for electrically insulating them from such walls.

9. An electric furnace according to claim 3 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods of heat refractory electrically conductive material carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid, said rods extending through heat refractory electric insulating bushings received in openings formed in said lateral walls for electrically insulating them from such walls, the rods extending to the exterior of the furnace, and means at such exterior in electrically insulated relation to said walls for holding the rods against longitudinal movement.

10. An electric furnace according to claim 3 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods of heat refractory electrically conductive material carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid, said rods extending through heat refractory electric insulating bushings received in openings formed in said lateral walls for electrically insulating them from such walls, the rods extending to the exterior of the furnace, means at such exterior in electrically insulated relation to said walls, and means cooperating with said rods and last mentioned means having provision for adjusting the rods longitudinally and holding them against longitudinal movement when in their adjusted positions.

11. An electric furnace formed to provide a furnace chamber having a hearth and lateral and top walls, a resistor grid in said chamber, means mounting the furnace for tilting, a suspension for said grid comprising an elongated rod or the like carried by said top wall and extending downward into the furnace chamber, said suspension also comprising a portion carried by said rod within the furnace chamber on which portion said grid slidably rests, means carried by said lateral walls for engagement with said grid for restraining it against lateral shifting when said furnace is tilted, and means providing an abutment carried by said suspension for cooperation with said grid for restraining said rod against shifting when said furnace is tilted.

12. An electric furnace according to claim 11 in which the portion of the grid suspension on which the grid slidably rests is formed with a groove receiving said grid, a lateral wall of such groove forming the abutment carried by the suspension for restraining the grid against lateral shifting.

13. An electric furnace according to claim 11 in which the portion of the grid suspension on which the grid slidably rests is provided with an upwardly projecting lug forming the abutment carried by the suspension for restraining the grid against shifting.

14. An electric furnace according to claim 11 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more members carried by said walls and projecting into the furnace chamber for contact with said grid.

15. An electric furnace according to claim 11 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid.

16. An electric furnace according to claim 11 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid, said rods extending to the exterior of the furnace, and means at such exterior holding said rods against longitudinal movement.

17. An electric furnace according to claim 11 in which the means carried by the lateral walls of the furnace for restraining the grid against lateral shifting comprises one or more elongated rods carried by the lateral walls of the furnace and projecting into the furnace chamber for contact with the grid, said rods extending to the exterior of the furnace, and means at such exterior holding said rods against longitudinal movement, which means has provision for adjusting the rods longitudinally relative thereto.

18. An electric furnace formed to provide a furnace chamber having a hearth and lateral and top walls, a resistor grid in said chamber, means mounting the furnace for tilting, a suspension for said grid comprising an elongated rod or the like carried by said top wall and extending downward into the furnace chamber, said suspension also comprising a portion carried by said rod within the furnace chamber on which portion said grid slidably rests, means carried by said lateral walls for engagement with said suspension for restraining it against lateral shifting when said furnace is tilted, and means providing cooperating abutments on said grid and suspension for causing said suspension when so restraining to restrain said grid also against lateral shifting.

19. An electric furnace formed to provide a furnace chamber, a generally horizontal resistor grid in said cham-

ber for radiating heat downward toward its bottom, means suspending said grid comprising suspension members extending downward from the top of said chamber and having portions on which said grid slidably rests, means mounting said furnace for tilting, means carried by the furnace walls for restraining the grid against lateral shifting when the furnace is tilted, and cooperating abutment means on said grid and suspension members for restraining said members against lateral shifting when said furnace is tilted and said grid is so restrained.

20. An electric furnace according to claim 19 in which the grid has spaced extensions projecting through the lateral walls of the furnace, the means for restraining the grid against lateral shifting comprising means for securing said extensions to such walls.

21. An electric furnace according to claim 19 in which the grid has spaced extensions projecting through the lateral walls of the furnace, the means for restraining the grid against lateral shifting comprising means at the exterior of the furnace for securing said extensions to such walls, the grid suspension members comprising elongated rods carrying adjacent their lower ends the portions on which the grid slidably rests, said rods being supported adjacent their upper ends for free swinging movement relative to the furnace chamber walls.

22. An electric furnace according to claim 19 in which the grid has spaced extensions projecting through the lateral walls of the furnace, the means for restraining the grid against lateral shifting comprising means at the exterior of the furnace for securing said extensions to such walls, the grid suspension members comprising elongated rods carrying adjacent their lower ends the portions on which the grid slidably rests, the rods extending upwardly through the top of the furnace chamber and being supported above said chamber for freee swinging movement relative to the furnace chamber walls.

23. An electric furnace according to claim 19 in which the grid has spaced extensions projecting through the lateral walls of the furnace, the means for restraining the grid against lateral shifting comprising means at the exterior of the furnace for securing said extensions to such walls, the grid suspension members comprising elongated rods carrying adjacent their lower ends the portions on which the grid slidably rests, said rods being supported adjacent their upper ends for free swinging movement in all directions relative to the furnace chamber walls.

24. An electric furnace according to claim 19, in which the grid has spaced extensions projecting through the lateral walls of the furnace, the means for restraining the grid against lateral shifting comprising means at the exterior of the furnace for securing said extensions to such walls, the grid suspension members comprising elongated rods carrying adjacent their lower ends the portions on which the grid slidably rests, the rods extending upwardly through the top of the furnace chamber and being supported above said chamber for free swinging movement in all directions relative to the furnace chamber walls.

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