Jan. 4, 1938. B. COUSTEIX 2,104,555

ELECTRICAL FURNACE

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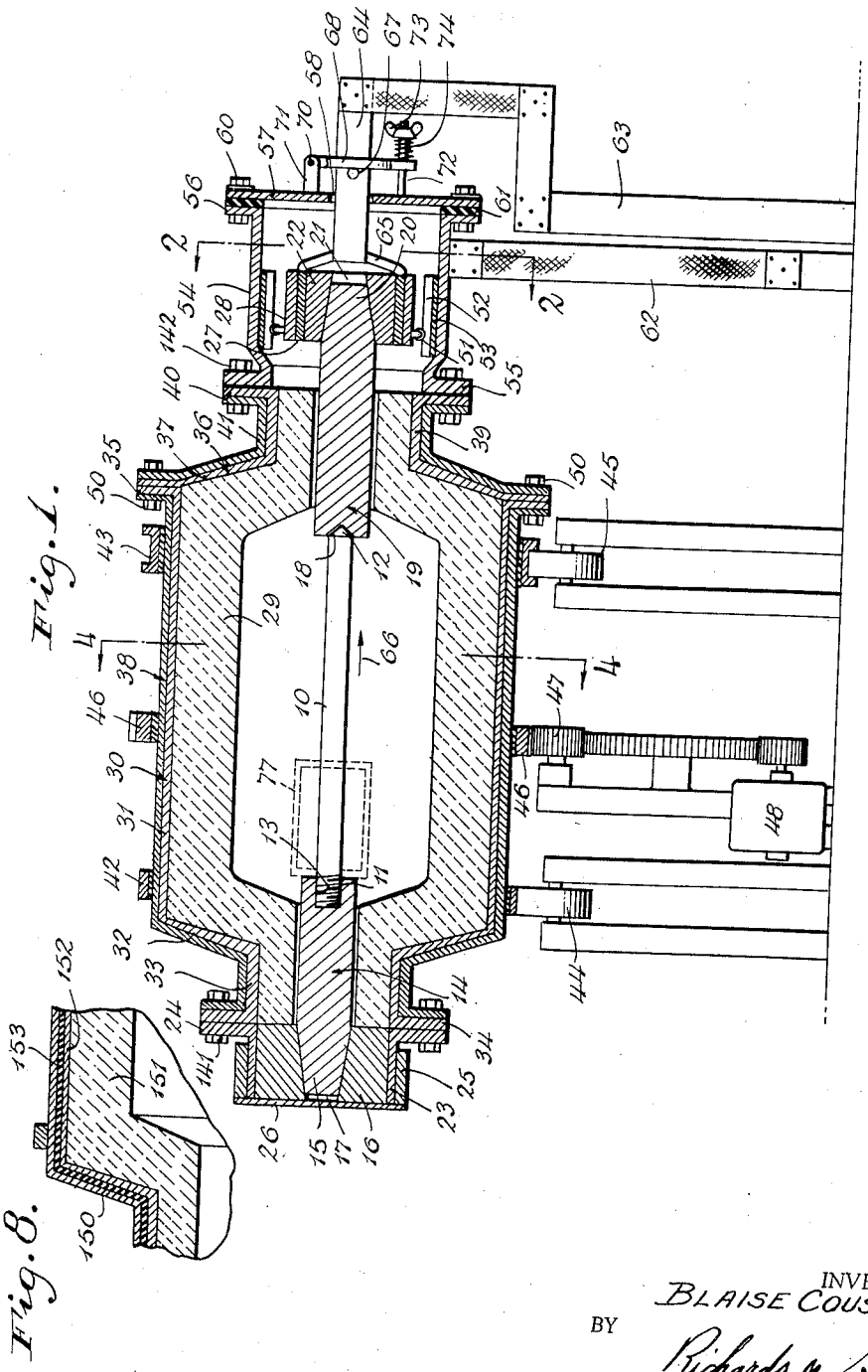


Fig. 1.

Fig. 8.

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ELECTRICAL FURNACE

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Fig. 2.

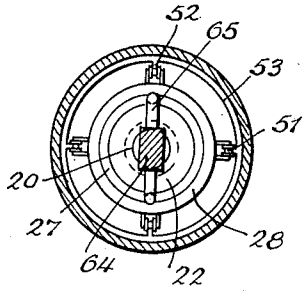


Fig. 3.

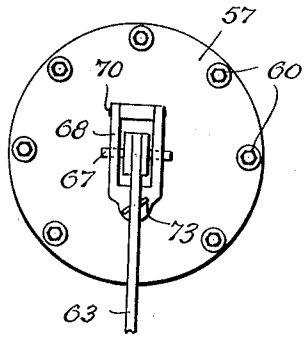


Fig. 7.

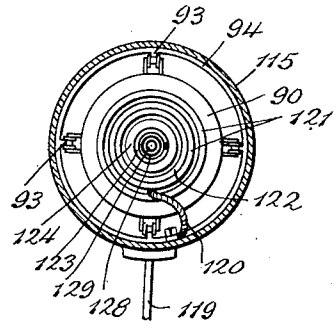


Fig. 4.

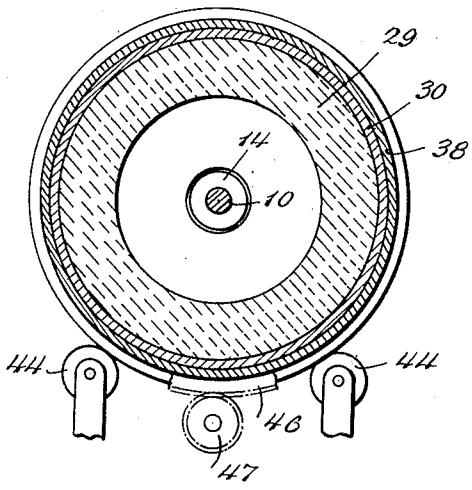


Fig. 6.

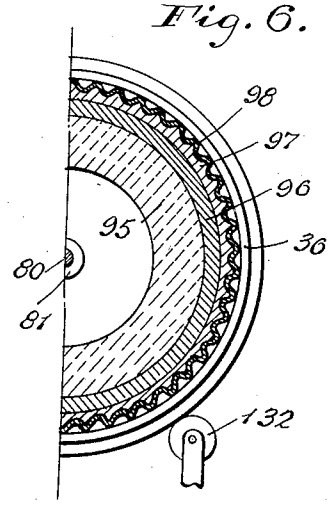
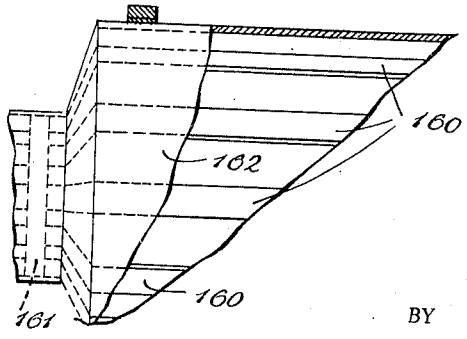


Fig. 9.



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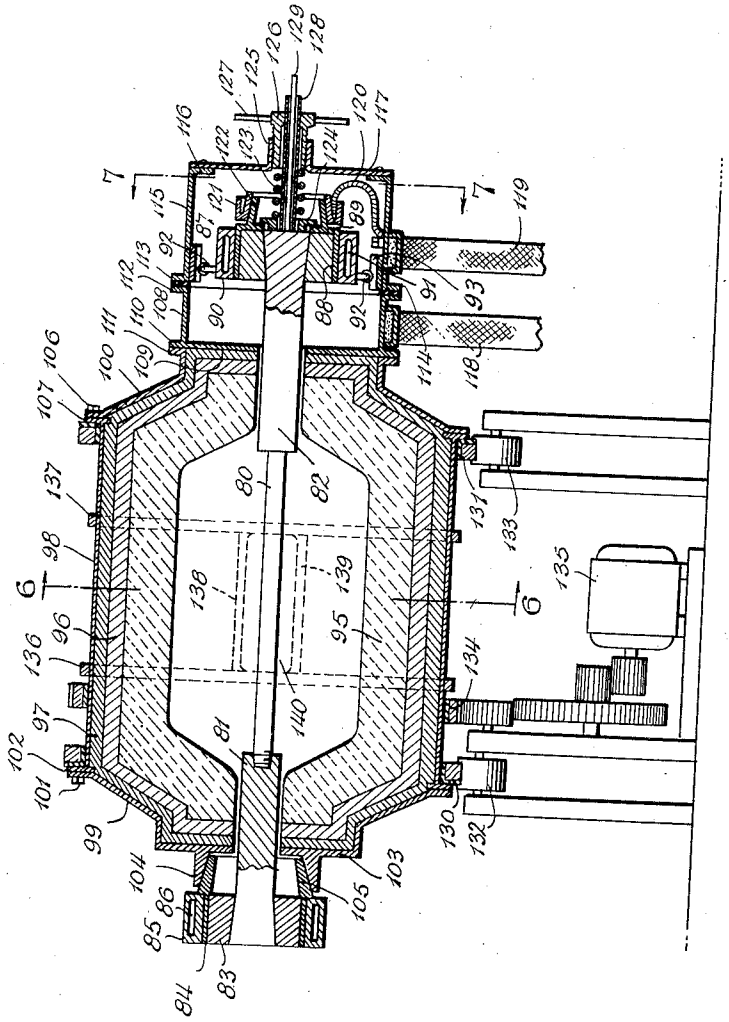
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Fig. 5.



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UNITED STATES PATENT OFFICE

2,104,555

ELECTRICAL FURNACE

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Application January 13, 1936, Serial No. 58,890
In France January 16, 1935

8 Claims. (Cl. 13—21)

This invention refers to electrical furnaces for heating, melting and/or casting various substances, such as quartz or metals, having a high melting point. The invention relates more particularly to single-phase furnaces employing one or more electrical resistances which radiate heat upon the substance to be treated.

In furnaces of this type the heating element has usually the form of one or more rods extending throughout the length of the furnace and connected to a source of electrical energy by conducting elements situated at two opposite ends of the furnace.

Practical experience has shown that the electrical current flowing through the heating element causes the formation of a magnetic field creating eddy currents in certain parts of the furnace which absorb a considerable portion of the electrical energy and thus diminish the output of the furnace.

Another drawback of prior art furnaces consists in the loss of energy caused by inductance resulting from the form and arrangement of the conducting elements supplying the electrical energy to the heating element situated within the furnace.

An object of the present invention is the provision of an electrical furnace of such construction that the energy losses caused by inductance and eddy currents are reduced to a minimum or eliminated entirely.

Another object is the provision of an electrical furnace of greater efficiency than furnaces known heretofore.

A further object is the provision of an electrical furnace comprising simple and effective means for eliminating eddy currents and inductance and for preventing their formation.

The above and other objects of the present invention may be realized by causing the return flow of the heating current through the furnace itself, for instance, by providing an outer furnace casing which consists of a non-magnetic metal conductively connected with the heating element situated within the furnace, so that the electrical current supplied by a source of electrical energy flows consecutively through the heating element and the metallic casing; the conducting elements which connect said source with said element and said metallic casing being situated next to each other at the same end of the furnace.

The metallic casing may consist either totally or in part of copper or other non-magnetic metal and may be situated within the steel cylinder which ordinarily forms the external covering of the furnace. The metallic casing may consist of perforated or non-perforated sheets of metal or of a net of interconnected metallic rods or strips.

According to a modification of the inventive idea, the outer steel covering of the furnace may be eliminated altogether and may be substituted by a casing consisting of a non-magnetic metal. In rotary furnaces of comparatively large dimensions the metallic sheets which may be reinforced or corrugated can be maintained in place by rings supporting the rotary furnace and causing it to rotate around a central longitudinal axis.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings, showing by way of example, preferred embodiments of the inventive idea.

In the drawings:—

Figure 1 is a longitudinal section through an electrical furnace constructed in accordance with the principles of the present invention;

Figure 2 is a section along the line 2—2 of Figure 1;

Figure 3 is an end elevation of the furnace illustrated in Figures 1 and 2;

Figure 4 is a section along the line 4—4 of Figure 1;

Figure 5 is a longitudinal section through a furnace of a somewhat different construction;

Figure 6 is a section along the line 6—6 of Figure 5;

Figure 7 is a section along the line 7—7 of Figure 5;

Figures 8 and 9 illustrate further modifications of the inventive idea.

The electrical rotary furnace illustrated in Figures 1 to 4 of the drawings comprises an inner resistance or heating element 10 having the form of a rod which is situated within the furnace and the longitudinal axis of which substantially coincides with the axis of rotation of the furnace.

The end portion 11 of the heating rod 10 is provided with screw threads, while the opposite end 12 of the rod has the shape of a cone. The end 11 of the rod 10 is screwed into a suitable opening 13 of a support 14, the opening 13 being provided with inner screw threads corresponding to the outer screw threads of the end portion 11.

The support 14 which is made of a conducting material comprises a main substantially cylindrical portion and a conical end portion 15 which is supported by a conducting sleeve or block 16. As shown in Figure 1, the block 16 has a central conical opening 17. The end portion 15 of the

support 14 fits into the opening 17 of the block 16.

While the end 11 of the heating rod 10 is firmly screwed into the support 14, the opposite end 12 of the rod 10 is free and is supported merely by surface contact. The end 12 of the rod 10 fits into a conical opening 18 which is formed in one end of a second support 19.

The support 19 is situated opposite the support 14 at the other end of the furnace and is provided with a conical portion 20 fitting into a conical central opening 21 formed in a sleeve or block 22. As indicated in Figure 1 of the drawings, the block 22 is situated further away from the rod 10 than the support 14, so that the support 19 is somewhat longer than the support 14. On the other hand, in the example illustrated, the block 22 is smaller than the block 16. The support 19 and the block 22 are both made of a conducting material.

The block 16 is surrounded by a casing 23 which is made of a non-magnetic metal, such as copper, and is provided with an annular flange 24. The casing 23 is held in place upon the block 16 by a metallic sleeve or casing 25, which may be made of steel. A disk 26 which is used as a closure for this end of the furnace is connected with the casing 25.

The block 22 situated at the opposite end of the furnace is surrounded by a casing 27 made of a non-magnetic metal such as copper. The casing 27 is surrounded and held in place by a metallic casing 28, which may be made of steel or the like.

The main body of the furnace comprises a furnace lining 29 consisting of refractory material surrounded by suitable heat-insulating layers. As shown in Figure 1, the lining 29 comprises a central cylindrical portion surrounding the interior of the furnace and two end portions forming a continuation of the central portion and surrounding at least a part of the supports 14 and 19, respectively.

The lining 29 is supported and enclosed by two concentric casings. The first casing 30 consists of a non-magnetic metal, such as copper, and comprises a central cylindrical portion 31, a conical end portion 32, a cylindrical end portion 33 and a flange 34 which is situated opposite the above-described flange 24 and connected by bolts 141. The opposite end of the casing 30 has the form of a flange 35.

A separate casing 36 which is also made of a non-magnetic metal comprises a conical portion 37, a cylindrical end portion 39 and a flange 40.

Another casing 38 surrounds the casing 30 and is concentric therewith. The casing 38 is made of an ordinary magnetic metal, such as steel, and is similar in form to the casing 30. Similarly, the casing 36 is surrounded by a casing 41 which is made of a magnetic metal, and which is concentric in relation to the casing 36. The casing 41 is substantially similar in form to the casing 36.

Bolts 50 connect the casings 36 and 41 with the casings 30 and 38.

In the example illustrated, the casing 38 is directly in contact with the casing 30, while the casing 41 is directly in contact with the casing 36. Due to this arrangement, the casings consisting of a non-magnetic metal, and the casings consisting of a magnetic metal are both serving as conductors for the return flow of the electrical current.

Rings 42 and 43 are carried by the casing 38 and are situated upon the outer periphery of said casing. However, these rings are insulated in relation to the casing 38. The rotatable elements of the electrical furnace are supported by rollers 44 and 45 which are in engagement with the rings 42 and 43, respectively. The furnace is also provided with an insulated toothed ring 46 engaging a gear wheel 47, which is driven through the medium of a suitable transmission gear by an electro-motor 48. Due to this arrangement, the furnace may be oscillated about its longitudinal axis which, in the example illustrated, coincides substantially with the longitudinal axis of the heating rod 10.

The casing 28 is provided with several rollers 51 which roll upon guides 52. The guides 52 are insulated by pieces of insulation material 53 from an outer casing 54 which consists of a non-magnetic metal such as copper and which comprises a main cylindrical portion and flanges 55 and 56, the flange 55 being situated opposite the flange 40 of the casing 36 and connected to it by bolts 142. This end of the furnace is closed by a disk or cover 57 having a central opening 58 and attached to the flange 56 of the casing 54 by the bolts 60. Insulation pieces 61 are situated between the cover 57 and the flange 56 of the casing 54.

One end of a conducting cable 62 is connected to a source of electrical energy not shown in the drawings. The opposite free end of the cable 62 is attached to the cylindrical portion of the casing 54, as shown in Figure 1.

Another cable 63 connected to the same source of electrical energy is attached to one end of the conducting rod or plate 64 extending through the opening 58 formed in the cover 57. The opposite end of the rod 64 is provided with arms 65 which are in contact with the casing 27 made of a non-magnetic metal.

Due to the described arrangement, the heating rod 10 can expand freely while it is being heated.

While the end 11 of the heating rod 10 is firmly attached to the support 14, the opposite end 12 of the rod 10 is free, so that it can expand in the direction of the arrow 66 shown in Figure 1. Such expansion will cause a movement of the support 19 in the direction of the arrow 66 along with the block 22, the casing 27 and the sleeve 28. The sleeve 28 will roll upon the rollers 51 along the guides 52 in the direction of the arrow 66, as soon as the heating rod begins to expand.

In order to prevent the heating rod 10 from losing contact with the support 19 during contraction of the rod 10, the rod 64 carries a suitable pin 67 which is in engagement with a lever 68. One end of the lever 68 is pivotally mounted at 70 upon a support 71 carried by the cover 57. The opposite end of the lever 68 is provided with an opening through which extends a bolt 72 carried by the cover 57. The free threaded end of the bolt 72 carries a winged nut 73. A coiled spring 74 is situated between the nut 73 and the lever 68 and surrounds the bolt 72.

The pin 67 moves along with the rod 64 and the arms 65, when the non-magnetic metallic casing 27 is moved in the direction of the arrow 66 by the expansion of the heating rod 10, thereby swinging the lever 68 and compressing the spring 74. When the heating rod 10 begins to contract, the spring 74 will press upon the lever 68 which in its turn will move the pin 67 and the rod 64 carrying this pin in a direction opposite to the direction of the arrow 66. Then the rod 64

will cause the casing 28 to roll backwards upon the guides 52. Therefore, as the heating rod 10 contracts, the support 19 will move in a direction toward the rod 10, so that the surfaces of the opening 18 will always remain in contact with the conical surfaces of the end portion 12 of the rod 10.

The electrical current sent by the source of energy not shown in the drawings will flow through the cable 63 and the rod 64 and will be transmitted by the arms 65 to the casing 27 consisting of a non-magnetic metal. Thence the current will flow through the block 22 and the support 19 toward the resistance 10. The current leaving the resistance 10 will flow through the support 14 and the block 16 to the casing 23 consisting of a non-magnetic metal. The current will be transmitted through the flanges 24 of the casing 23 and the flanges 34 of the casing 30 to the last-mentioned casing and will flow through the same, as well as through the casing 36. The current will pass through the flange 40 of the casing 36 and the flange 55 of the casing 54 and will leave the furnace through the cable 62 attached to the casing 54. Metal, quartz, or any other material which is to be treated in the furnace is introduced into its interior through a suitable door 77. Then the current is switched on and the furnace is caused to oscillate by the motor 48. The treated material is removed through the same door, by taking the furnace apart, or by any other suitable means.

It is obvious that due to this arrangement the magnetic field and the eddy currents are eliminated entirely in the steel casings of the furnace. Furthermore, due to the provision of the described means for supplying the current to the furnace, no losses through inductance can occur.

The electrical rotary furnace illustrated in Figures 5 to 7 of the drawings has no steel casing. This furnace comprises a central heating rod or resistance 80, one end of which is screwed into a support 81. The opposite end of the resistance 80 is carried by a support 82 and is situated within a suitable opening formed in the support. The support 81 comprises a conical portion surrounded by a sleeve or a block 83. The supports 81 and 82 and the sleeve 83 are made of a conducting material.

The sleeve 83 is surrounded by a casing 84 made of a non-magnetic metal, such as copper. An outer sleeve or casing 85 surrounds the casing 84 and is provided with an annular chamber 86 used for the circulation of a cooling medium such as water. The chamber 86 is connected with any suitable means for introducing the water and for removing the same.

The support 82 situated at the opposite end of the furnace comprises a conical end portion surrounded by a conducting sleeve or block 87. A casing 88 surrounds the block 87 and is provided with a flange portion 89 covering the outer side surface of the block 87. The casing 88 is made of a non-magnetic metal, such as copper. A sleeve or casing 90 made of steel or the like surrounds the casing 88 and is provided with an annular chamber 91 used for the circulation of the cooling water. The casing 90 is supported by rollers 92 which are movable along guides 93 carried by insulation pieces 94.

The resistance 80 is surrounded by a layer of refractory material 95 which constitutes the lining of the furnace. The lining 95 surrounds the inner heating chamber of the electrical furnace and also surrounds the major portions of the supports 81 and 82. Two layers 96 and 97 consisting of a heat-resisting and heat-insulating material surround the lining 95. The lining 95 and the layers 96 and 97 are enclosed by a casing made of a non-magnetic metal such as copper, and comprising a central cylindrical portion 98 and two covers 99 and 100.

The cover 99 is connected by bolts 101 to the flange 102 of the cylindrical casing 98 and comprises an end portion 103 having the form of a disk and carrying an annular flange 104. The flange 104 is in electrical contact with a sleeve 105 which is also made of a non-magnetic metal and which is connected with the casing 84.

The cover 100 is attached by bolts 106 to the flange 107 of the casing 98.

A separate casing 108 which is made of a non-magnetic conducting metal is situated close to the cover 100 and comprises a disk 109 closing this end of the furnace and a flange 110 which is situated opposite the flange 111 of the cover 100. The opposite end of the casing 108 is open and is provided with a flange 112 which is separated by insulation 113 from the flange 114 of a casing 115.

The casing 115 is also made of a non-magnetic metal and it supports the insulation pieces 94 which carry the guides 93. The casing 115 is provided with an outer flange 116 which carries a disk 117 constituting a closure for this end of the casing.

The electrical current is supplied from a source of energy not shown in the drawings through a cable 119 which is attached to the outer surface of the casing 115. Another cable 118 causing the return flow of the electrical current to the source of electrical energy is attached to an outer surface of the casing 108.

A conducting cable 120 has an end which is attached to an inner surface of the casing 115 adjacent the cable 119. The cable 120 is situated within the casing 115 and the opposite end of the cable 120 is attached to a sleeve 121 made of a non-magnetic metal and mounted upon a flange 122. The annular flange 122 is carried by the bent portion 89 of the casing 88 and constitutes a part of this casing.

A coiled spring 123 is situated within the casing 115. One end of the spring 123 presses against a supporting piece 124 which is in contact with the adjacent end of the support 82. The supporting piece 124 is surrounded by the flange 122 and is in contact with the edges of the flange 89.

The closure disk 117 comprises a central annular opening which is surrounded by a tubular portion 125. A hollow bolt 126 is screwed into the flange 125 and is provided with a suitable handle 127.

One end of the coiled spring 123 is in engagement with the supporting member 124, while the opposite end of the spring is in contact with the bolt 126.

Cooling water is supplied to the chamber 91 of the casing 90 through two tubes 128 and 129 situated concentrically one within the other. The interior of these tubes is connected by suitable passages with the chamber 91. The cooling water may be supplied through the annular interior of the tube 128 and removed through the interior of the tube 129, or vice versa.

The electrical current supplied by the source of electrical energy flows through the cable 119, the casing 115 and the cable 120 to the sleeve 121. Since the sleeve 121 is conductively con-

nected with the flange 122, the electrical current will flow through the flange 122, the casing 86, the block 87, the support 82 and the heating rod 80. The current leaving the heating rod 80 will flow through the support 81, the block 83, the casing 84, the sleeve 105, the flange 104, the cover 96, and the casing 98. The current will leave the furnace through the cover 100, the casing 103 and the cable 113.

As shown more clearly in Figure 6 of the drawings, the casing 98 consists of corrugated metallic sheets held in place by rings 130 and 131 which are insulated in relation to the casing 98. These rings are supported by several rollers 132 and 133 which carry the central portion of the furnace. The furnace is oscillated by an annular toothed ring 134 which is insulated in relation to the casing 98 and which is driven by an electromotor 135 through the medium of a suitable transmission gear.

The casing 98 is also surrounded by rings 136 and 137. Transverse beams 138 and 139 interconnect the rings 136 and 137 and serve as a framework for a door 140 which is used for inserting the material to be treated into the interior of the furnace and for removing such material after it has been treated.

Figure 8 illustrates a furnace having an outer casing 150 which consists of a magnetic metal such as steel. The lining 151 of the furnace consists of the usual refractory material and is surrounded by a casing 152 which consists of a non-magnetic metal such as copper. The copper casing 152 and the outer steel casing 150 are separated from each other by an insulating layer 153. This construction is similar in all other respects to the one illustrated in Figs. 1 to 4 of the drawings. Due to the provision of the insulating layer 153, the electrical current flowing through the casing 152 will not be transmitted to the outer casing 150, which is entirely insulated from the inner casing.

In the furnace illustrated in Figure 9 of the drawings, the non-magnetic metallic casing consists of a series of conductors, such as conducting rods or strips 160 which are connected in parallel with each other by rings 161, one of which is shown in the drawings. The conductors 160 and the rings 161 are all made of copper or other non-magnetic metal and are covered by a casing 162 consisting of steel or the like.

In the hereinabove described examples for the realization of furnaces according to the present invention, the displacement of the furnace around its axis is an oscillation. This displacement is possible due to the flexibility and the sufficient length of the cables, but it is obvious that the displacement around the axis of the furnace may be also a complete rotating motion. Convenient known means such as brushes or sliding contacts may be used for this purpose.

What is claimed is:

1. An electrical furnace, comprising a heating resistance, a casing for the material to be treated, said casing surrounding said resistance and comprising an envelope consisting of a nonmagnetic conducting metal, another metallic envelope surrounding the first-mentioned casing and conductively connected therewith, and means firmly interconnecting the two envelopes, means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the casing, and means conductively connecting the other end of the casing with said source of electrical energy, whereby the casing is connected in series with said resistance and constitutes a part of the electrical circuit which includes said source of electrical energy and said resistance.

2. An electrical furnace, comprising a heating resistance, a casing for the material to be treated, said casing surrounding said resistance and comprising an envelope consisting of a non-magnetic conducting metal, another metallic envelope surrounding the first-mentioned envelope, an insulating layer separating the first mentioned envelope from the second-mentioned envelope, and means firmly interconnecting the two envelopes, means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the first-mentioned envelope, and means conductively connecting the other end of the first-mentioned envelope with said source of electrical energy, whereby the first-mentioned envelope is connected in series with said resistance and constitutes a part of the electrical circuit which includes said source of electrical energy and said resistance.

3. An electrical furnace, comprising a heating resistance, a casing for the material to be treated, said casing surrounding said resistance and comprising an envelope consisting of a plurality of interconnected rods of a non-magnetic conducting metal, another metallic envelope surrounding the first mentioned envelope, and means firmly interconnecting the two envelopes, means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the first-mentioned envelope, and means conductively connecting the other end of the first-mentioned envelope with said source of electrical energy, whereby the first-mentioned envelope is connected in series with said resistance and constitutes a part of the electrical circuit which includes said source of electrical energy and said resistance.

4. An electrical furnace, comprising in combination a heating resistance, a casing comprising a cylindrical furnace lining adapted to contain the material to be treated and surrounding said resistance, an envelope of a non-magnetic conducting metal containing said furnace lining, and another metallic envelope surrounding the first-mentioned envelope and conductively connected therewith; means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the casing, and means conductively connecting the other end of the casing with said source of electrical energy, whereby the casing is connected in series with said resistance and constitutes a part of the electrical circuit which includes said source of electrical energy and said resistance.

5. An electrical furnace, comprising in combination a heating resistance, a casing comprising a cylindrical furnace lining adapted to contain the material to be treated and surrounding said resistance, an envelope of a non-magnetic conducting metal containing said furnace lining, another metallic envelope surrounding the first-mentioned envelope, an insulating layer separating the first-mentioned envelope from the sec-

ond-mentioned envelope, and means firmly interconnecting the two envelopes and the lining, means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the first-mentioned envelope, and means conductively connecting the other end of the first-mentioned envelope with said source of electrical energy, whereby the first-mentioned envelope is connected in series with said resistance and constitutes a part of the electrical circuit which includes said source of electrical energy and said resistance.

6. An electrical furnace, comprising a heating resistance having the form of an elongated rod a conducting support firmly holding one end of said rod, another conducting support carrying the opposite end of said rod, conducting means connected with the second-mentioned support for permitting a movement of the second-mentioned support in a predetermined direction when said rod is expanded, conducting means connected with the first-mentioned means for moving the second-mentioned support on the opposite direction when said rod is contracted, means conductively connecting the second-mentioned means with a source of electrical energy a casing surrounding said rod and comprising an envelope consisting of a non-magnetic conducting metal, another envelope surrounding the first-mentioned envelope and consisting of a magnetic metal, means conductively connecting the first-mentioned support with the first-mentioned enevelope, another casing supporting the first mentioned means and insulated therefrom, the second-mentioned casing being conductively connected with the first-mentioned envelope, means conductively connecting the second-mentioned casing with said source of electrical energy, and means connected with the second-mentioned envelope for turning the first-mentioned casing about the axis of said rod.

7. An electrical furnace, comprising a heating resistance having the form of an elongated rod, a conducting support firmly holding one end of said rod, another conducting support carrying the opposite end of said rod, conducting means connected with the second-mentioned support for permitting a movement of the second-mentioned support in a predetermined direction when said rod is expanded, conducting means engaging the second-mentioned support for moving the same in the opposite direction when said rod is contracted, a casing surrounding said rod and comprising an envelope consisting of a non-magnetic conducting metal, and another envelope consisting of a non-magnetic conducting metal and conductively connected with the first-mentioned envelope, another casing supporting the first-mentioned means and conductively connected therewith, means conductively connecting the first-mentioned casing with the first-mentioned support, means conductively connecting a source of electrical energy with the second-mentioned envelope, means conductively connecting the second-mentioned casing with said source of electrical energy, and means connected with the first-mentioned envelope for turning the first-mentioned casing about the axis of said rod.

8. A rotary electrical furnace, comprising a substantially horizontal heating resistance, a substantially horizontal casing for the material to be treated, said casing surrounding said resistance and comprising an envelope consisting of a non-magnetic conducting metal, another metallic envelope surrounding the first-mentioned envelope and conductively connected therewith, and means interconnecting the two envelopes; means conductively connecting one end of said resistance to a source of electrical energy, means conductively connecting the opposite end of said resistance with the adjacent end of the casing, means conductively connecting the other end of the casing with said source of electrical energy, and insulated means engaging said casing for rotating it around said resistance.

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