March 18, 1930. C. L. IPSEN 1,751,408

ELECTRIC FURNACE

Filed Oct. 23, 1924

Fig. 1.

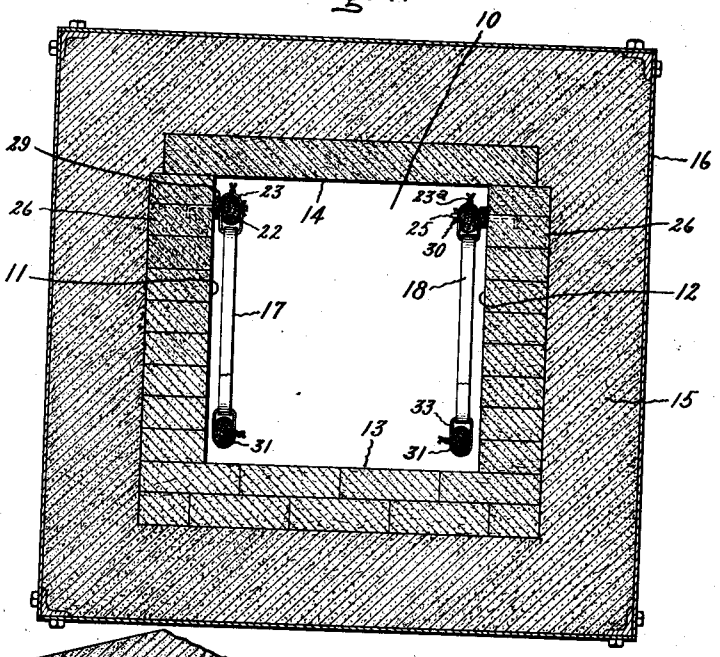


Fig. 2.

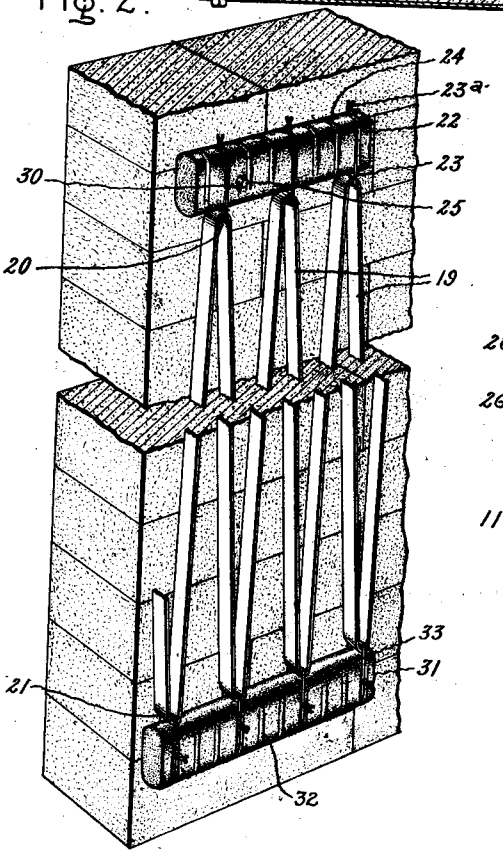
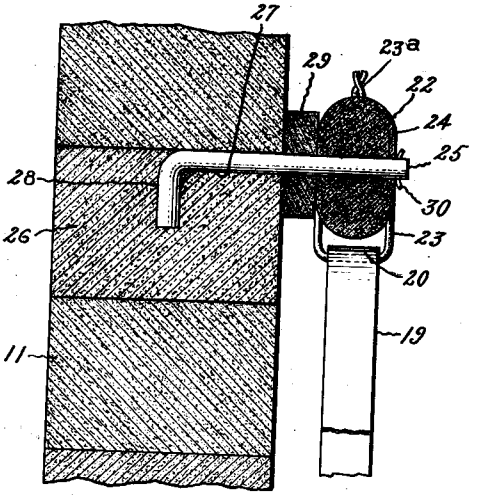


Fig. 3.



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UNITED STATES PATENT OFFICE

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ELECTRIC FURNACE

Application filed October 23, 1924. Serial No. 745,511.

My invention relates to electric furnaces, more particularly to electric resistance furnaces, and has for its object provision of improved means for supporting the heating resistor.

More specifically my invention has reference to electric resistor furnaces which operate at comparatively high temperatures, such that the margin of temperature difference is very small between the normal operating temperature of the furnace and the temperature at which oxidation of the heating resistor takes place. With a resistor made of a nickel-chromium alloy this maximum operating temperature is approximately 1000° to 1100° C., due to the limitations imposed by the resistor. Such furnaces are used in the heat treating, annealing, etc. of metals.

In order to obtain the highest possible safe operating temperature without injury to the heating resistor, the temperature difference between the heating resistor and the interior of the furnace chamber is made as small as possible. A reduction of this temperature difference makes a corresponding increase in the safe operating temperature of the furnace. A low temperature difference is most readily obtained by mounting the resistor directly in the heating chamber so that heat is radiated freely from the resistor to the charge. Such a furnace is sometimes termed a "direct heat" furnace to distinguish it from a muffle type furnace in which the resistor is placed behind muffles through which the heat must be conducted to the furnace chamber. With the direct heat furnace the charge is heated evenly by radiation and once the heating-up period is over there is but little temperature difference between the resistor and the furnace chamber.

One method of supporting the resistor in the direct heat furnace is to hang the resistor on suitable insulators which are secured to the furnace wall. In some cases these supporting insulators constitute extensions on the bricks forming a part of the furnace wall. In shape, the resistor has taken the form of a series of depending loops which are hung on the supporting insulators along the side walls of the furnace. The depending loops sometimes hang free and sometimes pass around and under another set of insulators.

When the resistor is hung on insulators in direct contact with the insulators or is in any manner brought in direct contact with the insulators, I have found that the resistor operates at higher temperatures at the points of contact with the insulators. This is due to the fact that radiation and conduction of heat from the resistor is obstructed at these points by the insulators which are very poor heat conductors. The resistor in some instances has failed at these points of support or engagement with the insulators due to overheating and excessive oxidation, while the remaining portions of the resistor forming a preponderance of its length showed little or no oxidation. It is thus apparent that the safe operating temperature of the furnace is very materially reduced by the higher operating temperature of the resistor at these points. Furthermore, when the loops depend or hang entirely free there is a tendency for them to become distorted upon repeated heating and cooling so that they may engage each other, causing short-circuits. Moreover, the use of supporting insulators built into the wall or permanently secured to the wall makes it difficult or impossible to change the spacing of the loops for the purpose of varying the amount of heat generated in a particular part of the furnace chamber.

In carrying out my invention I support the resistor directly on members having good heat conductivity and also having a very small area of contact with the resistor. This form of support offers the least possible impediment to the radiation and conduction of heat from the resistor at the points of support. The resistor is therefore maintained at a uniform temperature. In one form of my invention these metallic supports may take the form of ring-like metallic members which pass around an insulating bar secured to the furnace wall. The spacing of the convolutions or loops of the resistor may be varied readily by varying the spacing of the supporting members on the bar. I have also provided means for spacing the lower ends of the loops apart while at the same time allow-

ing the resistor to freely expand and contract as a whole in heating and cooling.

For a more complete understanding of my invention reference should be had to the accompanying drawing in which Fig. 1 is a sectional elevation view of an electric furnace embodying my invention; Fig. 2 is an enlarged fragmentary view in perspective showing the supports for the resistor; Fig. 3 is an enlarged fragmentary sectional view showing details of construction.

Referring to the drawing, I have shown my invention in one form as applied to a furnace having a horizontal heating chamber 10 of rectangular cross section which is defined by side walls 11 and 12 and the floor wall 13 constructed of heat refractory bricks. The top wall 14 is formed of suitable heat refractory material, such as bricks or a large slab as shown. These walls may in turn be enclosed by suitable heat insulating material 15, the whole being surrounded by a metallic casing 16. The end walls of the furnace are also constructed of heat refractory material, one or both being removable to afford access to the heating chamber.

The furnace chamber is heated by means of resistors hung along its walls, two resistors 17 and 18 hung adjacent the side walls being shown. These resistors are preferably formed from a ribbon of nickel-chromium alloy or other suitable resistance heating material, which ribbon is bent in zig-zag conformation into a series of convolutions comprising a plurality of vertically extending straight length 19 joined by upper bends 20 and lower bends 21. Obviously, however, the resistor may be cast to have the desired conformation. Each resistor is secured to a bar 22 made of a suitable heat refractory electrically insulating material, such as aluminum oxide. This bar is secured to the wall of the furnaces near the top of the wall, and the resistor is secured to the bar, so as to hang therefrom, by means of metallic ring shaped members or loops 23, forming supports for the resistor, passing around the bar and under the upper bends 20 of the resistor. These loops are made from a suitable heat resisting material having good heat conductivity which may be the same as the material of the resistor. To facilitate assembly the loops may be formed from U-shaped lengths of wire the ends of which are joined over the upper edge of the bar by twisting them together, as indicated at 23^a. Suitable grooves 24 are provided in the upper edge and sides of the bar in which the supporting loops 23 are seated and by means of which the loops are secured in proper spaced relation on the bar, and the convolutions of the resistor thereby properly spaced. Preferably these grooves 24 are provided on the bar at relatively short intervals, so that the spacing of the convolutions of the resistor may be varied at any time by adjusting the supporting loops 23 on the bar. In making this adjustment the loops may be loosened by untwisting the ends. The loops may also be made large enough to be lifted out of the grooves and slipped along the bar as desired.

The bar 22 is secured to the wall of the furnace by means of metallic pins 25 which are secured in specially constructed bricks 26 forming a part of the furnace wall. For the purpose of securing or anchoring the pins 25 in the bricks 26, the inner ends of the pins may be bent at right angles and seated in suitable recesses in the bricks. For example, a groove 27 is formed in the top of each brick 26 together with a recess 28 at the inner end of the groove. When the bricks 26 are laid into the wall, the pins 25 are slipped in place in the groove and recess and secured therein by the next tier of bricks. The pins 25 are made of a suitable heat resisting material which may be the same as the material of the resistor. Suitable spacing electrical insulators 29, preferably washer shaped, are placed on the pins 25 between the bar 22 and the wall whereby the bar is spaced away from the wall, and the resistor consequently hung in spaced relation to the wall. The object in hanging the resistor in spaced relation to the wall is to prevent obstruction by the wall of the free radiation of heat from the resistor. Apertures may be provided in the bar through which the pins 25 extend when the bar is placed thereon. The bar may be secured on the pins, for example, by means of cotter pins 30 in the ends of the pins.

If desirable the bar 22 may be substantially equal in length to the length of the heating chamber, or a plurality of short bars may be provided and secured to the furnace wall in end to end relation. This latter construction has certain advantages since each short bar may be supported by a single brick 26, for example, by means of two pins 25 secured to the brick. With this construction the spacing of the pins can be more easily made to correspond with the spacing of the holes in the bar.

The lower ends of the convolutions of each resistor are attached to a second insulating bar 31 which is similar in construction to the bar 22. It is, however, turned so that the grooves 32 are on its sides and lower edge. Metallic loops 33 similar to loops 23 pass around the bar and over the lower bends 21 of the resistor, i. e., through the convolutions, whereby the bar 33 is hung from the convolutions of the resistor. This lower bar 31 is not secured in any way to the furnace wall and therefore the resistor is free to expand and contract as a whole upon changes in temperature. The lower ends of the convolutions of the resistor, however, are spaced apart by the bar 31 and are thus prevented from twisting and curling and thereby form-

ing short circuits around sections of the resistor. Also, the weight of the lower bar 31 keeps the lengths 19 of the resistor straight. The loops 33 may be adjusted along the length of the bar 31 to vary the spacing of the lower ends of the convolutions of the resistor in the manner described with reference to loops 23.

I have found that during use a marked permanent growth or increase in length of the resistor occurs which is much greater than the normal increase in length when the resistor is heated. The lower bar 31 is therefore spaced above the floor of the furnace a distance greater than the normal increase in length of the resistor due to heating to prevent the bar from coming to rest on the bottom of the furnace when this growth of the resistor takes place. To give the lower bar greater freedom, the twisted ends of the loops 33 may be arranged on the side of the bar as shown in Fig. 2.

By means of this construction the resistor is supported in a spaced relation with respect to all heat and electrically insulating parts. The only parts actually in engagement with the resistor are the supporting loops 23 and the lower loops 33 which are made of a material having good heat conductivity. Consequently any appreciable rise in temperature due to obstruction of heat radiation is prevented at the points of engagement between the loops and the resistor. Moreover, by means of this construction the area of contact between the resistor and the parts in engagement with it is made very small and therefore the actual obstruction of heat radiation from the resistor is reduced to a minimum. The result is a resistor which is supported with the smallest possible contact with other parts of the furnace and which has heat conducted rapidly away from these small points of contact. The resistor therefore operates at a uniform temperature throughout its entire length.

It will be observed that while the resistor as a whole hangs free and can expand and contract independently of its supports, the various convolutions forming the resistor do not depend or hang free.

While I have described my invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electric furnace comprising a wall forming a heating chamber, an elongated heat refractory, electrically insulating member secured to said wall, a plurality of supports securing said member to said wall in spaced relation therewith at intervals along the length of said member, a sinuous heating resistor in said chamber, and members having good heat conductivity engaging and supporting said resistor and attached to said elongated member so that said resistor is hung therefrom in spaced relation to said elongated member and said wall so as to provide for free radiation of heat from said resistor whereby hot spots are prevented when operating close to temperatures producing oxidation of the resistor material.

2. An electric furnace comprising a heat refractory wall forming a heating chamber, a heat refractory bar, a plurality of supports for securing said bar to said refractory wall in spaced relation therewith at intervals along the length of said bar, a heating resistor formed of a plurality of vertically arranged loops, a second heat refractory bar substantially parallel with said first bar, metallic members securing the upper ends of said loops to said first bar so that said resistor is hung therefrom and metallic members securing said second bar to the lower ends of said loops so as to suspend said second bar, said metallic members providing for free radiation of heat from said resistor whereby hot spots are prevented when operating close to temperatures producing oxidation of the resistor material.

3. An electric furnace comprising a heat refractory wall forming a heating chamber, an elongated member made of electrically insulating material secured to said wall in spaced relation thereto, a resistor shaped in a plurality of substantially straight lengths joined at their adjacent ends by bends to form a continuous conductor, and metallic members connecting said bends to said elongated members so as to suspend said resistor in spaced relation with said elongated member and said furnace wall to provide for free radiation of heat from said resistor whereby hot spots are prevented when operating close to the temperatures producing oxidation of the resistor material.

4. An electric furnace comprising a heat refractory wall forming a heating chamber, an elongated member made of electrically insulating material structurally independent of said wall secured to said wall in spaced relation thereto, a metallic resistor comprising a series of convolutions joined by bends, and metallic members cooperating with said bends forming mechanical connections between said resistor and said member whereby said resistor is hung from said member in spaced relation to said member and said wall, so as to provide for free radiation of heat from said resistor said metallic members being adjustable so that the spacing of said convolutions may be varied, and means for adjust-

ably spacing the lower ends of said convolutions.

5. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material secured to said wall in spaced relation thereto, a resistor constituting a series of spaced convolutions, and members carried by said bar for securing said resistor thereto, said members being adjustable on said bar to vary the spacing of said convolutions.

6. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material secured to said wall in spaced relation thereto, a resistor constituting a series of spaced convolutions, and metallic ring shaped members encircling said bar for securing said resistor thereto, said members being adjustable longitudinally of said bar to vary the spacing of said convolutions.

7. An electric furnace comprising a heat refractory wall forming a heating chamber, a pair of elongated members made of electrically insulating material in said chamber structurally independent of said wall, a heating resistor comprising a series of convolutions, connecting members made of a material having a high heat conductivity securing the convolutions of said resistor to said members to provide for free radiation of heat from said resistor whereby hot spots are prevented when operating close to the temperatures producing oxidation of the resistor material, and a mechanical connection between one of said members and said wall whereby said resistor and said other member are hung therefrom.

8. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material in said chamber secured horizontally to said wall in spaced relation thereto, a resistor comprising a plurality of vertically extending lengths joined at their adjacents ends to form a continuous conductor, supporting connections between said bar and said resistor comprising metallic members connecting said resistor to said bar at the junctions between the upper ends of said lengths so as to suspend said resistor in spaced relation with said bar and said furnace wall to provide for free radiation of heat from said resistor whereby hot spots are prevented, a second bar made of electrically insulating material and metallic connecting members securing said second bar to said resistor at the junctions between the lower ends of said lengths to provide for free radiation of heat from said resistor, said resistor and said second bar being hung from said first bar.

9. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material extending longitudinally of said chamber, connections between said bar and said wall whereby said bar is supported in spaced relation to said wall, a heating resistor shaped into a plurality of upright spaced convolutions, connecting members made of a material having good heat conductivity forming mechanical connections between said resistor and said bar at the upper junctions between said convolutions whereby said resistor is hung from said bar in spaced relation to said wall, a second bar made of electrically insulating material, and connecting members made of a material having a high heat conductivity connecting said second bar to the lower ends of the said convolutions at the junctions thereof.

10. An electric furnace comprising a heat refractory wall forming a heating chamber, upper and lower bars made of electrically insulating material in said chamber, a heating resistor in said chamber comprising a plurality of vertically extending lengths joined by bends, metallic supporting members connecting said resistor to said upper bar at the upper bends of said resistor, metallic members connecting said lower bar to the lower bends of said resistor so that said lower bar is supported by said resistor both sets of said metallic members being longitudinally adjustable on said bars, and a plurality of spaced metallic pins forming a mechanical connection between said upper bar and said wall whereby said resistor and said lower bar are hung from said upper bar.

11. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material secured to said wall in spaced relation thereto, a resistor constituting a series of spaced convolutions, metallic members securing the convolutions of said resistor to said bar so that said resistor is hung from said bar, a second bar made of electrically insulating material, and metallic members securing said second bar to said convolutions so that said bar is hung from said resistor, said metallic members being adjustable on said bars to vary the spacing of said convolutions.

12. An electric furnace comprising a heat refractory wall forming a heating chamber, a bar made of electrically insulating material secured to said wall in spaced relation thereto, a resistor constituting a series of spaced convolutions, metallic ring shaped members encircling said bar for securing the convolutions of said resistor thereto, a second bar made of electrically insulating material, and metallic ring shaped members encircling said second bar and interlinking said convolutions whereby said second bar is hung on said resistor, said ring shaped members being adjustable on said bars to vary the spacing of said convolutions.

13. An electric furnace comprising a heat refractory wall forming a heating chamber,

metallic pins secured in said wall projecting into said chamber, a bar made of electrically insulating material carried by said pins in spaced relation to said wall, a resistor formed into a series of convolutions, and metallic members made of a material similar to said resistor securing said resistor to said bar so that said resistor is hung from said bar in spaced relation to said bar and said wall.

In witness whereof, I have hereunto set my hand this 22nd day of October, 1924.

CARL L. IPSEN.