March 14, 1933. F. A. FAHRENWALD 1,901,499

ELECTRIC FURNACE

Original Filed May 19, 1924

Fig. 1

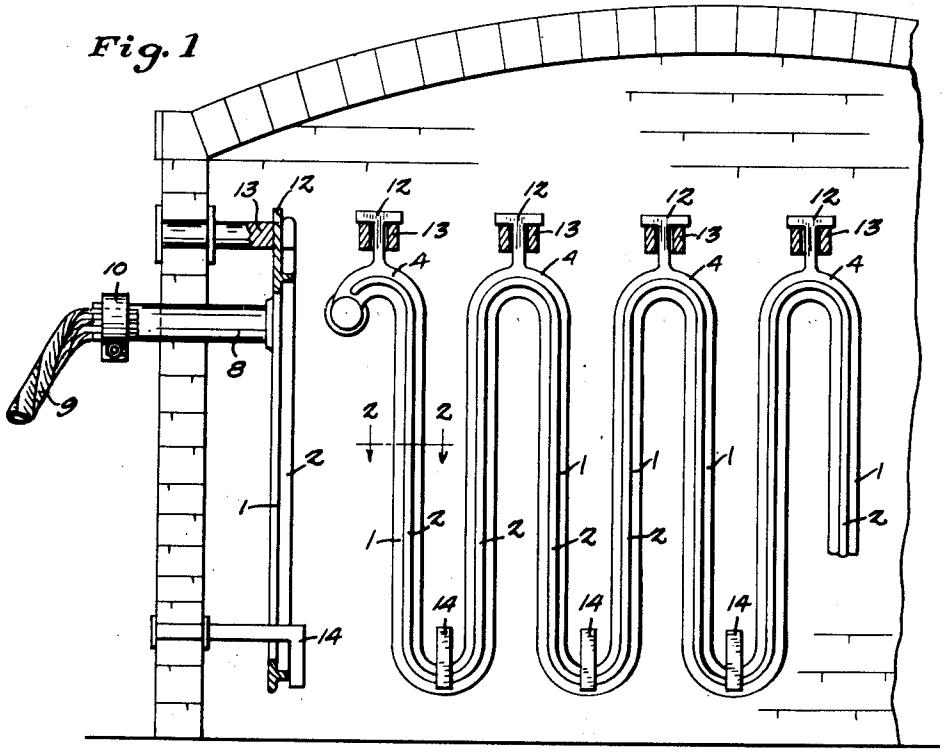


Fig. 2

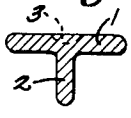


Fig. 3

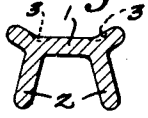


Fig. 4

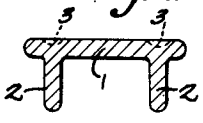


Fig. 5

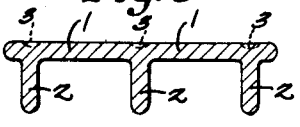


Fig. 6

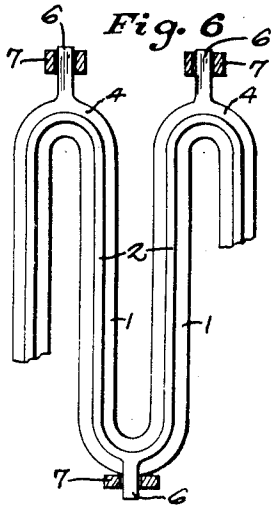


Fig. 7

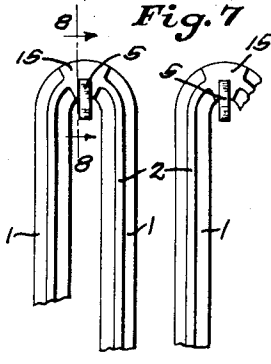
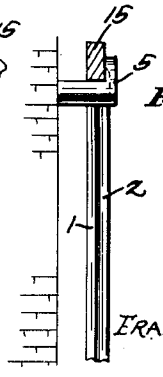


Fig. 8



FRANK A. FAHRENWALD
Inventor

by Smith and Freeman
Attorneys

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UNITED STATES PATENT OFFICE

FRANK A. FAHRENWALD, OF CHICAGO, ILLINOIS

ELECTRIC FURNACE

Original application filed May 19, 1924, Serial No. 714,289. Divided and this application filed March 31, 1930. Serial No. 440,267.

This invention relates to electric furnaces and has for its object the provision of a furnace of the metallic-resistor type which can be cheaply and readily constructed, which shall produce higher working temperatures than heretofore procurable with furnaces of this type, and which shall exhibit a longer life despite these high temperatures; the provision of a new and improved mode of supporting such resistance elements while permitting expansion and contraction between the same and the furnace walls; the provision of resistors characterized by an enhanced rigidity of form thereby enabling the same to be spaced close to each other and to the furnace wall without danger of becoming warped so as to produce short-circuiting contacts; while further objects and advantages of the invention will become apparent as the description proceeds. This application is a division of my copending application filed May 19, 1924, Serial No. 714,289.

In the drawing accompanying and forming a part of this application, I have illustrated certain typical forms in which my inventive idea may be embodied, but without intent to limit myself thereto. Fig. 1 illustrates a portion of a furnace showing two resistance heating elements on adjacent walls thereof, one in elevation and the other in section; Fig. 2 is a cross sectional view of one of the elements corresponding to the line 2—2 of Fig. 1; Figs. 3, 4, and 5 illustrate modified cross-sectional forms; and Figs. 6, 7, and 8 illustrate modified supporting expedients.

In the parent application above identified I have disclosed and claimed the improvement which concerns forming resistance heating elements of certain cross-sectional shapes; the present application is presented to claim and secure those phases of my invention which concern the use of my improved resistor elements for furnace-heating purposes together with certain subsidiary improvements in the mode of supporting such elements inside a furnace chamber.

A device of this character as provided for electric furnace use is necessarily made of some oxidation-resisting alloy of comparatively high melting-point, and while I do not restrict myself to any one composition or alloy, experience shows that practically all substances having these essential qualities have the further property of contracting at the instant of solidification which therefore prevents their filling the mold completely and necessitates a shrinkage area at some point. If it be attempted to cast a resistor of square or rectangular or circular or oval section, the surface portions first become cooled in a substantially uniform manner so that the necessary shrinkage is produced by an internal disintegration. This means that the crystalline structure of the metal is disrupted internally at different points, with the result that the resistance varies from point to point so that it is impossible to employ a long element of this nature as a heating element in a furnace since some parts will burn out before others reach the working temperature.

I have discovered, however, that by making the parts of certain asymmetrical cross sections so as to bring this region of contraction toward one surface of the metal section instead of allowing it to exist at a deeper point, it becomes possible to cast a conductor of such uniform physical condition and also of such uniform electrical conductivity that a conductor of great length will be heated uniformly. My preference is to employ one of the forms shown in Figs. 2, 3, 4, or 5 comprising a base portion 1 together with one or more forwardly projecting ribs or flanges 2. This concentrates the heat of the metal at or near the junction points and causes these to cool more slowly with the result that the point of contraction occurs at 3 opposite each rib or flange while the body of the casting retains a homogeneous structure.

Such a device may be made in form of a long, straight strip if desired, but my preference is to form it in sinuous shape as shown in Fig. 1 having a plurality of spaced limbs (which are generally more or less straight and parallel) connected at alternate ends by curved loops 4, and to support it inside the wall of the furnace by means of these loops. To this end each loop in Fig. 1 is illustrated as

provided with an integral finger 12 of T shape, received in suitable forked-hooks 13. However, I do not restrict myself to this mode of mounting since it is equally permissible to employ fingers 6—6 at each loop, both sets of fingers being received in suitable eye-bolts 7—7 as shown in Fig. 6; this mode is particularly useful in case it be desired to support the heating element in horizontal position at either the top or bottom of the furnace. In Figs. 7 and 8, I have shown the element as supported by two upwardly facing hooks 5—5, projecting through the loops in carrying relation. Other expedients may also be used. To prevent swaying of the resistor away from the furnace wall while at the same time permitting necessary expansion and contraction of the parts I have in Fig. 1 shown down-turned hooks 14 located between adjacent limbs and engaging the lower loops. The terminal 8 consists of a massive bar of metal projecting through the wall of the furnace and welded to the resistor, the usual copper conductor 9 being fastened to this terminal by any suitable clamp 10.

The rib 2 may run from end to end if desired, as shown in Figs. 1 and 6, or it may be discontinued for a short distance at the upper loops as shown at 15 in Figs. 7 and 8, the base portion 1 being thickened at that point to increase the physical strength and electrical conductivity to prevent overheating adjacent supports.

It is my information and belief that no such ribbed-resistor elements and above all no cast-metal resistance heating element was ever successfully employed for furnace heating purposes prior to my invention. Cast-metal resistance grids had been used for motor-control and switch-board or rheostat purpose was to procure a cheap resistance which would have a large surface exposed to the air and so dissipate the heat generated as quickly as possible. Uniformity of resistance from point to point was comparatively unimportant. The material employed was usually, if not always, common cast-iron, which would not withstand furnace temperature, and attempts to adapt those devices to furnace heating purposes by merely casting them from high-temperature alloys were unsuccessful due in part to their excessive warping and in part to the irregular internal structure caused by the internal shrinkage cracks hereinbefore described which gave rise to local hot spots that reduced the material to a lacy condition despite its supposed "high temperature" qualities.

The employment of casting as a mode of producing such heating grids, now that I have discovered how the same may be made of uniform electrical resistance permits the use of alloys having a higher rigidity of form than is compatible with the exigencies of rolling or forging or drawing, and accordingly my improved cast-metal heating grids when applied to furnace use, not only permit the production of higher working temperatures than are consistenly attainable with previous metal elements, but exhibit a longer life and a smaller deformation. It also happens that rolled, wrought or forged alloys generally exhibit a smaller resistance to corrosion than can be secured by cast alloys, added to which the cast-alloys are cheaper.

The hooks, guides and supports used with these resistance heating grids are preferably made of metal which avoid the disadvantages of "slagging" or combining with the hot metal as sometimes occurs when refractory supports are used. Even when located inside the loops as shown in Fig. 6, these hooks can be made substantially narrower than the loops, thus avoiding any electrical shunting; the rigidity of the cast metal is such that the loops retain their shape without sagging.

The ribbed cross section of the heating elements exhibits a substantial advantage in decreasing the tendency of the depending limbs to warp, twist, or bend due to the heating. A plain ribbon element when supported by being looped over spaced supports tends to bend and twist so as to bring adjacent sections into contact unless well separated or carefully guided or both. The laterally projecting portions 1, 1 shown in Figs. 1, 2, 6, 7, and 8 hereof afford a stiffening function which markedly inhibits this action, and enables the limbs of the resistor to be located closer together (in comparison with their length) than would otherwise be feasible.

While I have described my improvements in connection with cast-grids and while my invention arose in connection with grids made by casting, it will be observed that certain of the advantages and benefits of my improvements are obtainable with grids or elements made in other ways. Furthermore the improvements and advantages herein described relate less to the nature and performance of the individual naked element or grid than to its mode of mounting and its performance in connection with a furnace-wall and in company with other grids or elements. Accordingly I assert that I have invented a new and useful improvement in furnaces, as well as a new and useful resistor element, and a new and useful mode of securing such an element to a furnace wall inasmuch as the structures and combinations herein set forth were not known and could not be made prior to my invention; but I do not limit myself to any of the details of construction herein set forth except as required by the prior art and as recited in my several claims which I desire may be construed broadly, each inde-

pendently of limitations contained in other claims.

Having thus described my invention what I claim is:

1. In an electric furnace, the combination with the furnace wall of an electric resistance heating element of serpentine shape cast of high temperature resistant alloy having a plurality of spaced limbs which are longitudinally ribbed on one face only and are connected at alternate ends by curved loops, integral fingers projecting from the top of certain of said loops, and metallic elements carried by the furnace wall having recesses which receive said fingers and thereby support said heating element.

2. In an electric furnace, the combination with the furnace wall of an electric resistance heating element of high temperature resistant alloy made in serpentine shape having a plurality of spaced limbs connected at alternate ends by curved loops, each of said limbs being longitudinally ribbed on one face only whereby the cross section of said limbs is rendered uneven, said element being mounted adjacent to the furnace wall with its plane substantially vertical, integral projections extending upwardly from the upper loops in the plane of said element, and supporting elements carried by the furnace wall above said element, said supporting elements and projections being interconnected one to the other.

3. In an electric furnace, the combination with the furnace wall of an electric resistance heating element of serpentine shape cast of high temperature resistant alloy having a plurality of spaced limbs which are longitudinally ribbed on one face only and are connected at alternate ends by curved loops, said element being mounted adjacent to the furnace wall with its plane substantially vertical, integral T-shaped projections extending upwardly from the upper loops, and forked supporting elements carried by the furnace wall and detachably receiving said T-shaped projections in supporting relation.

4. An electric resistance heating element of serpentine shape having integral T-fingers projecting from certain turns thereof whereby said element may be suspended.

In testimony whereof I hereunto affix my signature.

FRANK A. FAHRENWALD.