United States Patent

Nölting

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[54] **MELTING FURNACE**

[72] Inventor: **Peter Nölting,** Toging, Germany

[73] Assignee: **Vereinigte Aluminium-Werke Aktiengesellschaft,** Bonn, Germany

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[51] **Int. Cl.**..**C21b 7/02**

[58] **Field of Search**.........266/33, 5 E, 4 E; 13/20, 25

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Primary Examiner—Leonidas Vlachos
Attorney—Michael S. Striker

[57] **ABSTRACT**

A melting furnace comprising a melting chamber in which a plurality of parallel adjacent electric heating resistances are transversely mounted and secured to opposite wall portions of the chamber in the region of the top thereof. The electric heating resistances have major and minor surfaces and are positioned so that their major surfaces extend parallel with the vertical plane of the melting chamber.

18 Claims, 10 Drawing Figures

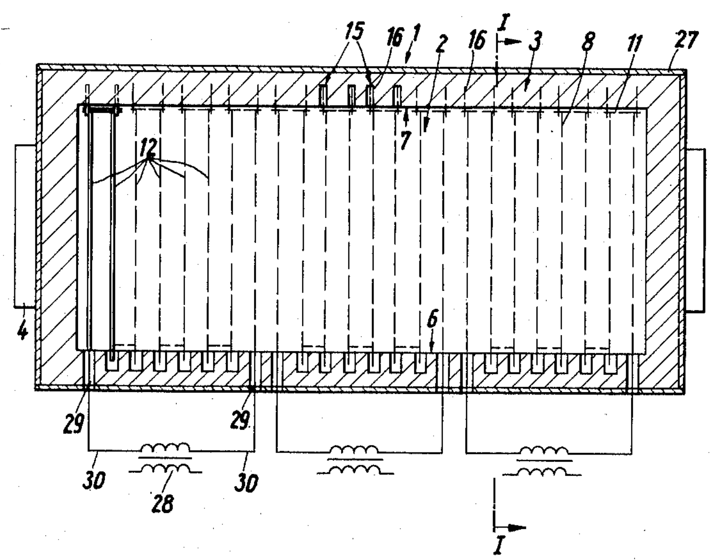


Fig.2

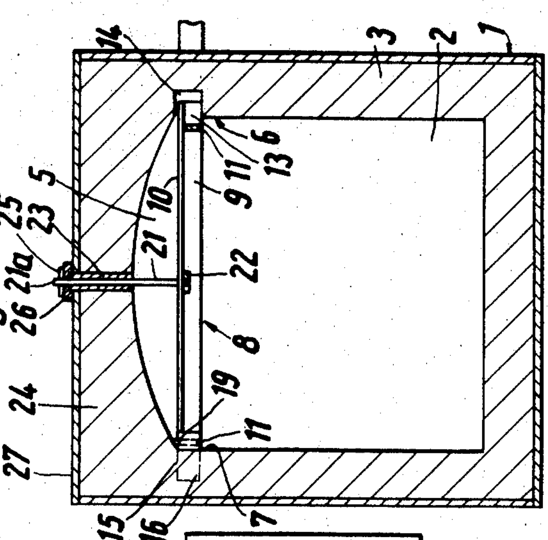


Fig.10

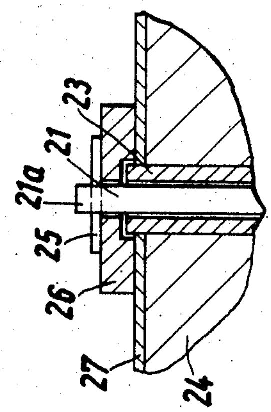
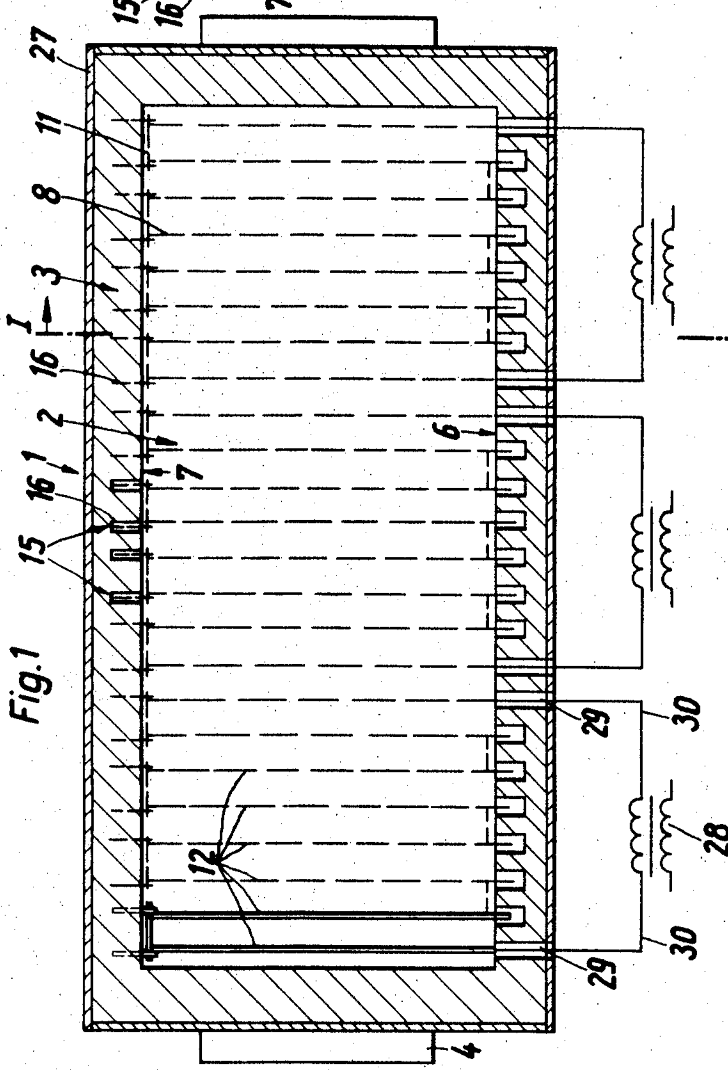
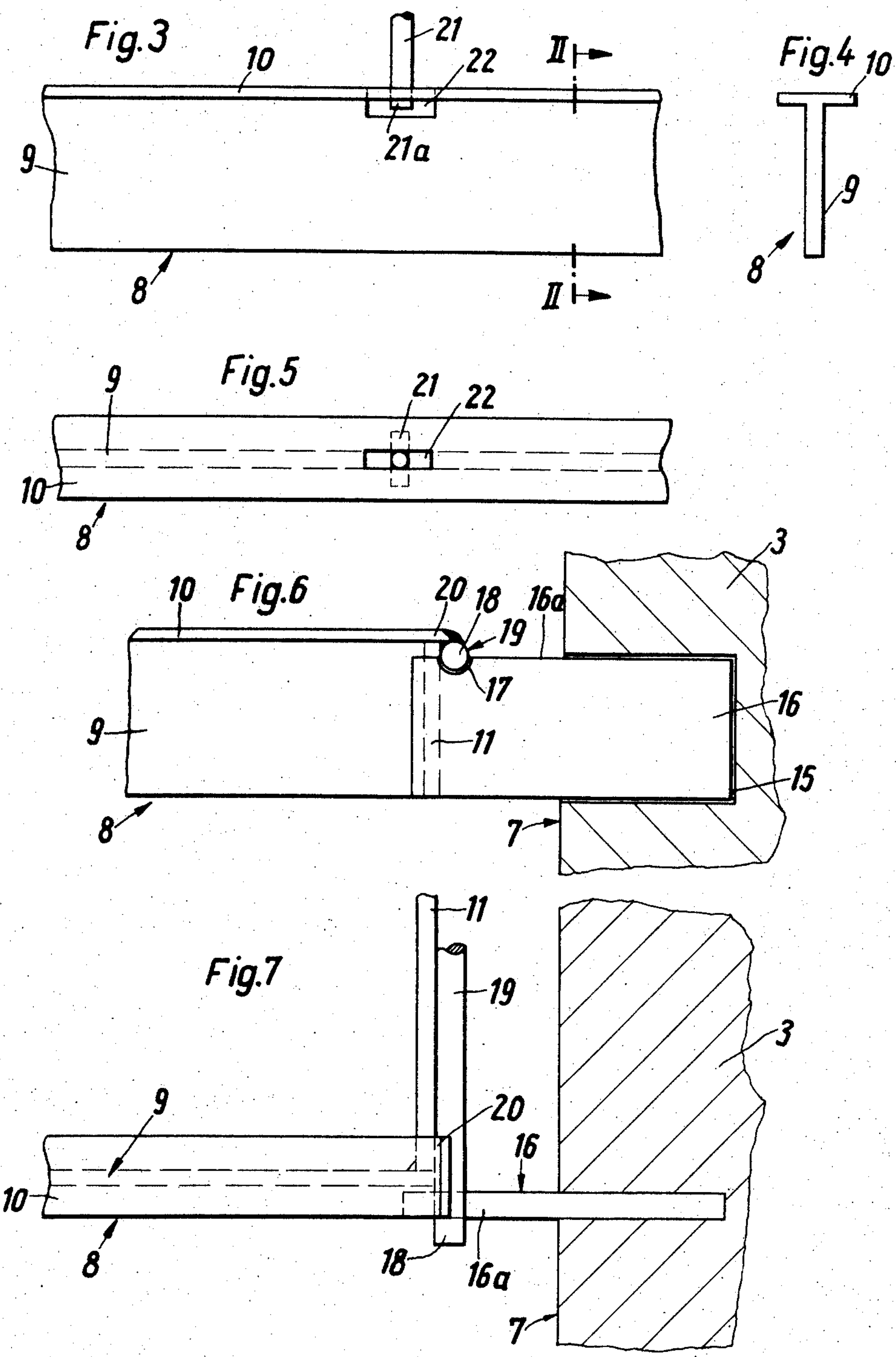


Fig.1



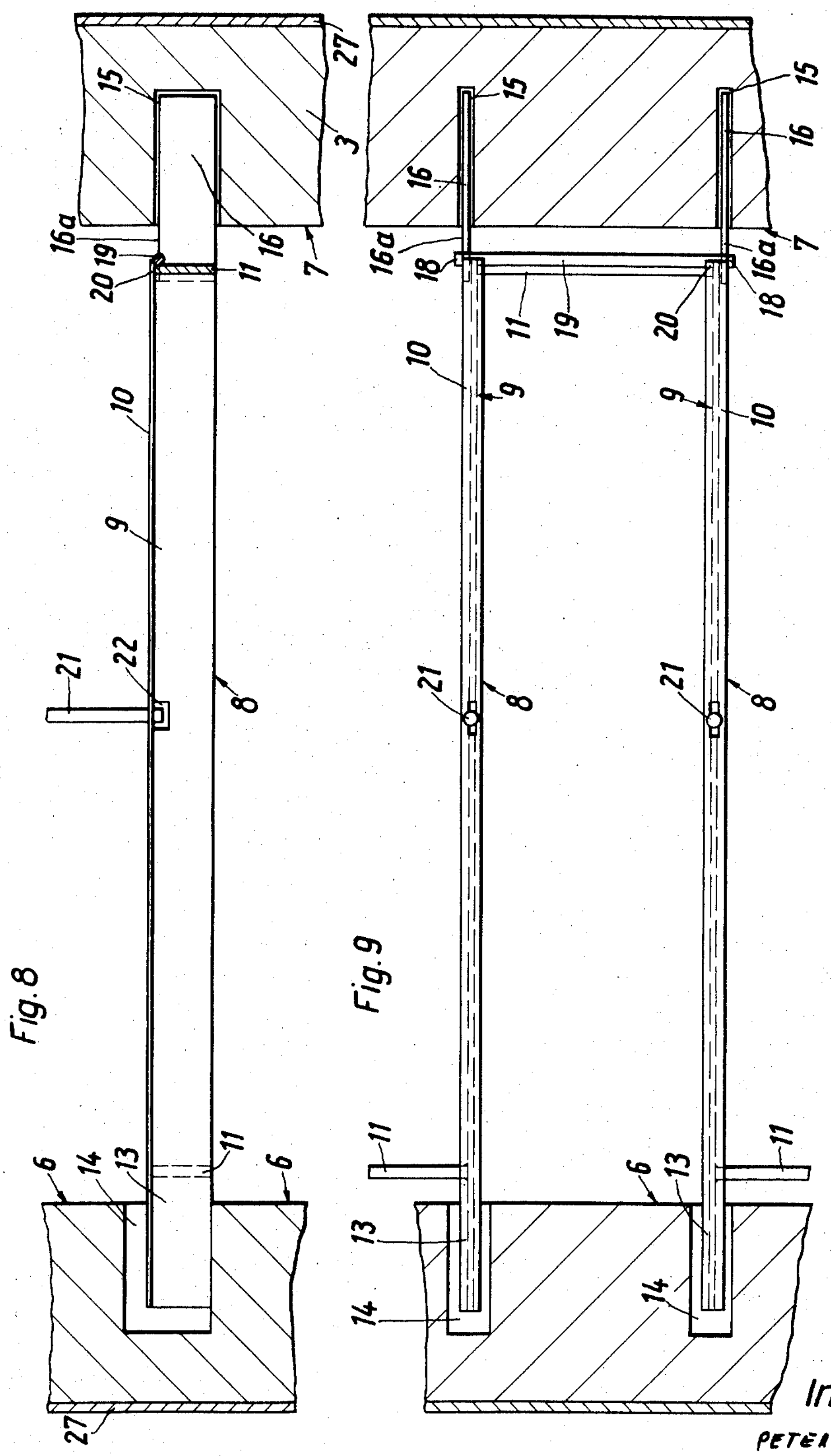
Inventor:

By: Michael S. Striker
Attorney



Inventor:
PETER NÖLTING

By: Michael S. Striker
Attorney



Inventor:
PETER NÖLTING

By: Michael J. Striker
Attorney

MELTING FURNACE

BACKGROUND OF THE INVENTION

The present invention in general relates to a metallurgic resistance furnace and more in particular relates to a smelting furnace of the hearth-type in which the heating resistors are arranged in the melting chamber of the furnace.

Known in the art are hearth-type or reverberatory furnaces in which the heat is produced electrically and which are used for the metallurgic processing of, for example, aluminum or other type metals. It is conventional with such type furnaces that the electric heating elements or resistors are located beneath the hearth and that they transform their energy into heat radiation to which the charge being melted or processed in the furnace is subjected.

Such electric heating elements or resistors are quite costly and the life thereof is determined by two factors:

1 By the operating temperature at which the element or resistor has to operate; and

2 By the amount of splashing of the material processed, especially aluminum, onto the element or resistor.

In the first instance it has been found that the temperature of the element or resistor can be maintained the lower during operation thereof, the better the element or resistor is capable of dissipating its heat to any direction surrounding it.

In the second instance it has been found that due to splashing or spattering of the material processed, a bonding process occurs between this material and the element or resistor so that oftentimes a local disruption of the element or resistor takes place.

Certain known hearth-type furnaces employ heating elements which are freely suspended in the melting chamber of the furnace and consist of double coiled wire resistances. Such type heating elements have a favorable low operating temperature and an acceptable heat dissipation. However, such freely suspended elements, as will be self-evident, are subject to a direct spattering attack by the material which is processed.

Further known hearth-type furnaces utilize zig-zag type heating elements which are inserted in slotted stones. Such type heating elements, however, have a poor mechanical rigidness and are operated at a high temperature which is a disadvantage but, at the same time, such elements are less subjected to spattering of the material processed.

In view of these disadvantages, and since no suitable compromise could be found to overcome the same to ensure an acceptable durability of the heating elements, the only avenue open was to resort to core-type induction furnaces which not only are quite expensive as regards their prime cost, but, moreover, are extremely uneconomical as regards their maintenance.

SUMMARY OF THE INVENTION

Object of the invention is to provide a furnace which positively overcomes the above disadvantages and which is simple as regards its construction and offers a great economy as regards its maintenance.

Such a furnace according to the invention comprises a melting chamber enclosed by a wall and in which a plurality of spaced heating elements are transversely mounted in the upper region thereof, with the elements secured to opposite wall portions of the chamber. The elements have major and minor surfaces and are positioned such that their major surfaces extend substantially parallel with the vertical plane of the melting chamber.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows a top plan view of the melting furnace according to the present invention;

FIG. **2** is a cross-sectional view of the melting furnace taken along the line I—I. of FIG. **1**;

FIG. **3** is a side view of a heating element incorporated in the furnace of FIG. **1** and illustrating, in part, the manner of suspending this element in the furnace;

FIG. **4** is a cross-sectional view of a heating element taken along the line II—II of FIG. **3**;

FIG. **5** is a top view of the arrangement shown in FIG. **3**;

FIG. **6** is a further side view of the heating element of FIG. **3** and illustrating the manner of connecting one end thereof to the inner furnace wall;

FIG. **7** is a top view of the arrangement of FIG. **6**;

FIG. **8** illustrates the heating element of FIG. **3**, mounted in the furnace;

FIG. **9** is a top view of the arrangement of FIG. **8**; and

FIG. **10**, appearing on the sheet incorporating FIGS. **1** and **2**, illustrates, in part, the manner in which the heating element of FIG. **3** is suspended from the top of the furnace.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in detail to the drawings, in which like reference numerals index like parts, FIGS. **1** and **2** illustrate a melting furnace **1** which includes a melting chamber **2** enclosed by a wall **3**. Provided at one end of the furnace **1** is a door arrangement **4** operative to admit material to be processed into the melting chamber **2**.

Horizontally mounted in the upper region **5** of the melting chamber **2** and secured to inner opposite wall portions **6** and **7** thereof, are a plurality of parallel spaced discrete electric heating elements **8**.

The heating elements **8** are substantially straight, and as shown in FIG. **4**, have a T-shaped cross section with major and minor surfaces **9** and **10**, respectively. The height of the major surfaces **9** of the heating elements **8** is substantially greater than the width of the minor surfaces **10** of the elements, and the latter are mounted in such a way in the melting furnace **1**, that their major surfaces **9** extend substantially parallel with the vertical axis of the furnace **1** while their minor surfaces **10** extend substantially parallel with the horizontal axis of the furnace **1**.

Also, as shown in FIG. **1**, the heating elements **8** are positioned transversely relative to the elongation of the melting furnace.

Each two adjacent electric heating elements 8 at their respective outer ends, are pair-wise interconnected by means of band-shaped electric cross connectors 11 and thus formed into an electrically series-wound group 12. Shown in straight lines in FIG. 1, at the left-hand side thereof, is such a pair of interconnected heating elements 8. The rest of these interconnected elements 8 are shown in broken lines.

In the present embodiment and as shown in FIG. 1, the electric heating elements 8 are operated by an AC-current and, in order to constitute a symmetric loading of the three phases R, S, T of the AC-power system, the elements 8 are formed into three electrically series-wound groups 12.

However, also 6 or even 9 groups of series-wound electric heating elements 8 may be used depending on the size of the melting furnace.

The manner of interconnecting the respective series-wound groups 12 with the AC-power system will be explained shortly.

As shown in FIGS. 1, 2, 8 and 9, the cross connectors 11 at one side of the heating elements 8, are slightly spaced from the inner wall portion 6, inwards of the outer ends 13 of the elements 8 such that these outer ends 13 extend beyond the cross connectors 11.

Formed in wall portion 6 are a plurality of recesses 14 in which the outer ends 13 of the heating elements 8 are received.

Likewise as regards the heating elements 8, these recesses 14 in the wall 6 extend parallel and spaced relative to each other and transversely relative to the elongation of the melting chamber 2.

Upon insertion of the outer ends 13 into the recesses 14, the latter are stuffed with insulation stones and mineral wool, not shown, in order to obtain a better thermal insulation.

The opposite wall portion 7 is formed with an equal number of recesses 15 which extend substantially axially with the recesses 14 in wall portion 6.

The recesses 15 are arranged to fixedly mount a plurality of supporting projections 16 whose number equals that of the electric heating elements 8. At their projecting ends, the supporting projections 16, made of a non-scaling material, are formed with indentations 17 at their upper edge 16a, FIG. 6, in which the outer end portions 18, FIG. 7, of cylindrical or round bolts 19 are snugly but removably fitted.

The cylindrical bolts 19 are welded to the end portions 20 of the electric heating elements 3 and are attached thereto in such a way that they replace a portion of the major surfaces 9 at these end portions 20 of the heating elements 8, FIG. 6.

The cross connectors 11, at this side of the heating elements 8, are secured to the end portions 20 thereof, adjacent the bolts 19 and are of such a length that they interfit between each two inner opposing major surfaces 9 of each two adjacent heating elements 8, FIGS. 7 and 9, while the outer end portions 18 are longer than the cross connectors 11 and extend laterally outwardly beyond each two minor surfaces 10 of each two adjacent heating elements 8, FIGS. 7 and 9.

Upon insertion of the supporting projections 16 into the recesses 15, the latter are stuffed with insulation stones to obtain a better thermal insulation and to prevent tilting of the supporting projections 16 therein.

In addition to the above-described manner of laterally supporting the discrete heating elements 8, the latter are futher supported by suspension members 21, FIG. 2.

Depending upon the length of the melting chamber 2, the discrete electric heating elements 8 are preferably suspended in spaced relationship of about 20 inches relative to each other by means of the suspension members 21. This, of course, means that also the recesses 14 and 15 in the walls 6 and 7, respectively, are spaced about 20 inches apart relative to each other. The suspension members 21, made of heat-resisting rods, at their lower ends are flat-forged and are key-wise inserted with these ends into slotted holes 22 arranged centrally in the minor surfaces 10 midway of the heating elements 8, FIGS. 3 and 5, and by rotation through 90° in holes 22, are fittedly secured against removal therefrom.

As shown in FIG. 10, upwardly the suspension members 21 are run through guide tubes 23 which extend through the top 24 of the melting furnace 1. The upper projecting ends 21*a* of the member 21 are locked in position by means of split pins 25 which abut against profrilated bricks 26, supported on the steel housing 27 of the upper furnace surface.

In this manner, the weight of the heating elements is not suspended from the inner surface of the furnace top 24, which has the advantage that a more rigid and reliable suspension is obtained while, in addition, with this manner of suspension, contact between the heating elements 8 and the steel housing 27 is avoided.

It is a basic characteristic of the subject invention to provide the discrete electric heating elements 8 with as great a mechanical section modulus and rigidity as possible so as to keep the suspension, and thereby the number of suspension members 21 for each discrete heating element 8, at a low minimum.

It has been found that as a result of the general configuration of the electric T-shaped heating elements 8, i.e., their large major surfaces 9 and smaller minor surfaces 10, the mechanical section modulus thereof is considerably increased while, simultaneously, and again as a result of their physical configuration, the same are exceptionally non-reactive to splashing or spattering of the material processed in the furnace.

As shown in FIG. 1, each group of series-wound heating elements 12 is connected with the secondary of a transformer 28 via terminal connectors 29 and guide-rails 30 while the primary of the transformer is connected with an AC-power system, not shown.

It will be appreciated that the large cross-sectional area of the discrete electric heating elements effects a low electric resistance per m.m., which enables that the heating elements can be advantageously operated at a low voltage and high amperage.

The electric heating elements 8, the electric cross connectors 11 and the terminal connectors 29 preferably are welded to each other while the terminal connectors 29, the guide-rails 30 and the terminal clamps of the transformers 28 are threadably connected to each other by means of screw members.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

I claim:

1. A wall furnace comprising a bottom wall, side walls and a roof defining a melting chamber of an uninterrupted space between said bottom wall and said roof adapted to receive in a lower part of said space a mass of molten material; heating means in said melting chamber for heating the interior thereof and comprising a plurality of spaced heating elements of uniform cross section throughout their length and extending in an upper region of said space transversely between opposite side walls, each of said heating elements having a T-shaped cross section comprising an upper horizontally extending portion and a narrow web portion extending vertically downwardly midway between opposite ends of said horizontally extending portion and having a height considerably greater than the width of said horizontally extending portion to thus reduce the surface areas of said heating elements which are subjected to spattering of molten material in the lower part of said space while improving the bending resistance of said heating elements; and means securing each of said plurality of heating elements to opposite side walls of said melting furnace.

2. A furnace as defined in claim **1**, wherein said melting chamber is elongated and wherein said heating elements extend substantially parallel relative to each other and substantially transversely relative to the elongation of said hollow melting chamber.

3. A furnace as defined in claim **2** wherein said heating elements are substantially rectilinear.

4. A furnace as defined in claim **1** wherein said plurality of heating elements are connected in series.

5. A furnace as defined in claim **1** wherein said plurality of heating elements are electric resistance elements.

6. A furnace as defined in claim **1** wherein said plurality of heating elements are electric resistance elements and wherein said heating means also includes electric current transformer means interconnected with said electric resistance elements.

7. A furnace as defined in claim **6**, wherein said electric current transformer means are secured to said melting furnace exteriorly of said melting chamber.

8. A furnace as defined in claim **1**, wherein said melting chamber is elongated and said side walls include a first wall and a second wall extending in the direction of elongation of said melting chamber, and wherein said securing means includes a plurality of recesses formed in said first wall and said second wall and operative to connect said T-shaped heating elements at opposite end portions thereof to said first and second walls.

9. A furnace as defined in claim **8**, wherein said T-shaped heating elements with one of said opposite end portions thereof is fixedly mounted in said recesses in said first wall, and wherein said securing means further includes a plurality of supporting members fixedly mounted in said recesses in said second wall and supporting said T-shaped heating elements at the second end portion thereof.

10. A furnace as defined in claim **9**, wherein said recesses in said first and second walls extend substantially parallel and adjacent each other in said direction of elongation of said melting chamber.

11. A furnace as defined in claim **10**, wherein said recesses in said first wall extend substantially axially with said recesses in said second wall.

12. A furnace as defined in claim **4**, wherein said plurality of heating elements connected in series are electric heating elements, and wherein each two adjacent electric heating elements are interconnected by means of electric cross connectors.

13. A furnace as defined in claim **1**, and including suspension members for suspending said plurality of spaced heating elements intermediate the ends thereof in the upper region of said melting chamber.

14. A furnace as defined in claim **13**, wherein said suspension members suspend said plurality of spaced heating elements from said roof.

15. A furnace as defined in claim **14**, wherein said suspension members are rod-shaped and with their upper ends are run through said roof and retained at said upper ends at the upper surface of said roof exteriorly of said furnace.

16. A furnace as defined in claim **15**, wherein said rod-shaped suspension members at the lower end thereof are anchored in said plurality of spaced heating elements to thereby suspend the same.

17. A furnace as defined in claim **16**, wherein each of said spaced heating elements is suspended by at least one of said rod-shaped suspension members.

18. A furnace as defined in claim **15**, wherein said upper ends of said rod-shaped suspension members run through said roof are electrically insulated at said upper exterior surface of said roof.

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