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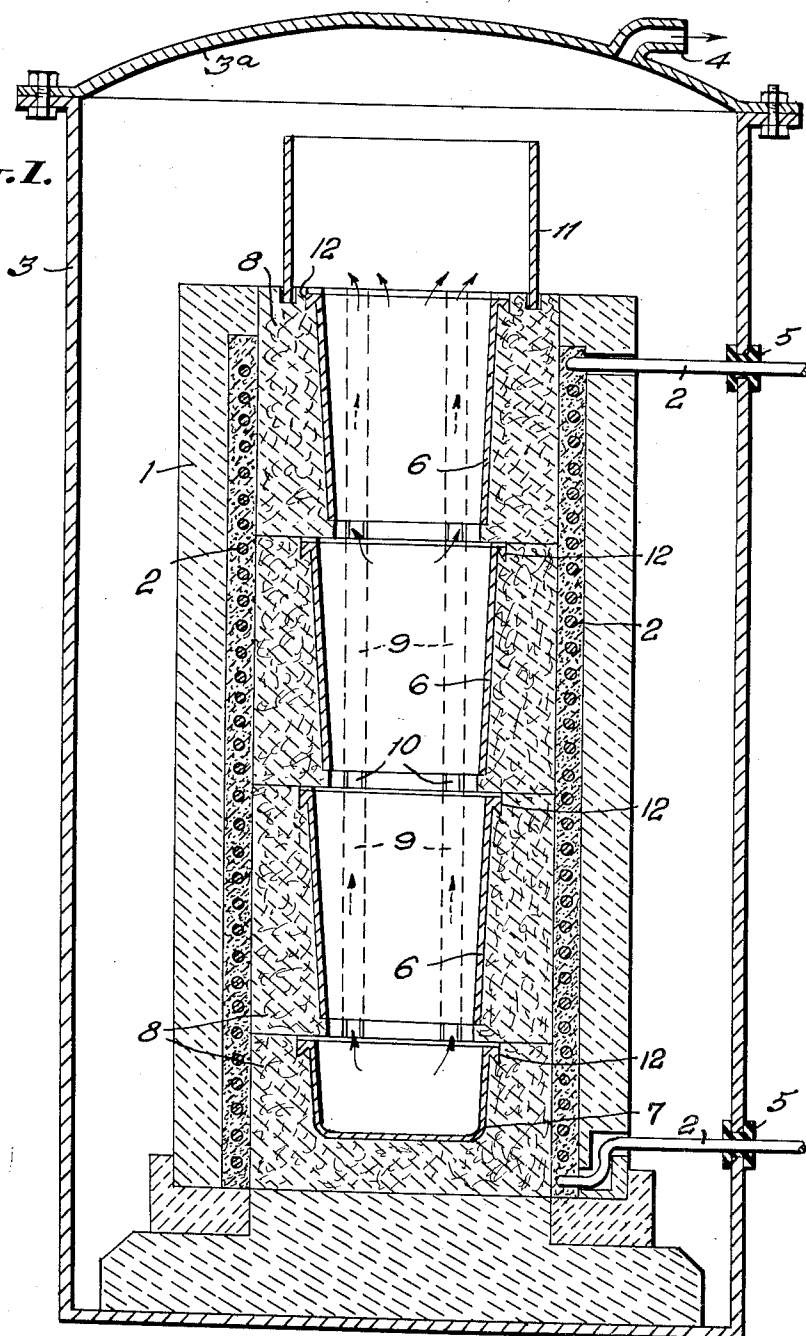
2,661,386

RETORT TYPE SECTIONAL HIGH-FREQUENCY FURNACE

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2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

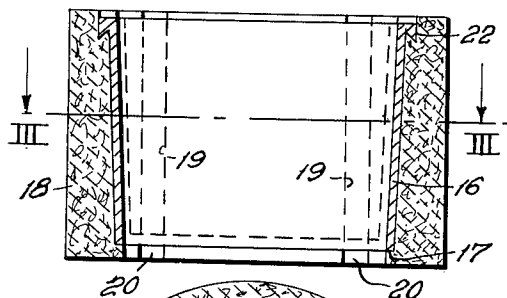


Fig. 3.

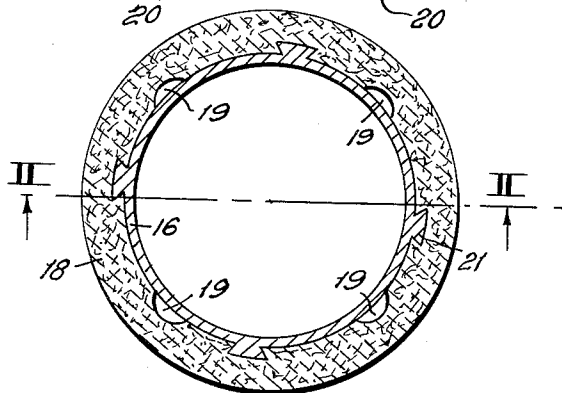


Fig. 4.

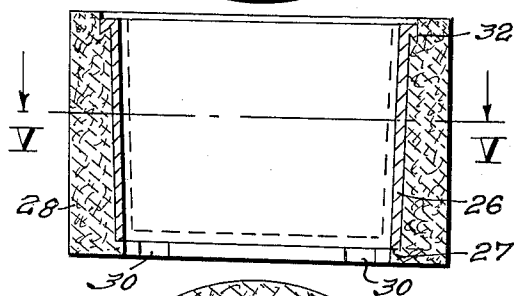
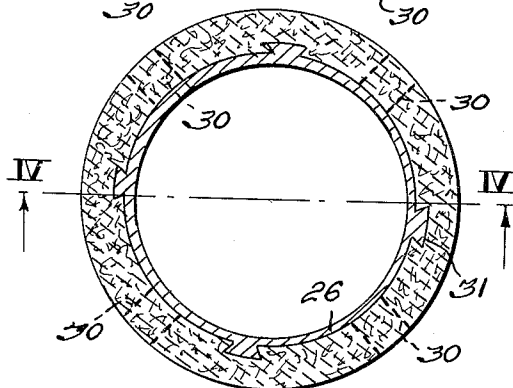


Fig. 5.



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RETORT TYPE SECTIONAL HIGH-FREQUENCY FURNACE

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5 Claims. (Cl. 13—26)

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The present invention concerns high frequency furnaces of the retort type, especially for carrying out metallurgical processes, for example, the production of metals, alloys and the like, for heat treatment of electrically non-conductive material and similar purposes, and more particularly for thermally recovering magnesium, calcium and similar metals from their compounds by reduction and distillation in vacuum.

The process of heating electrically non-conductive material in high frequency furnaces by mixing electrically conductive material in pieces of suitable size with the non-conductive material of the charge, whereby the electrically conductive particles are heated by the induction currents set up and serve as heating elements in the charge is well known. The method whereby electric conductors are placed in a charge which only possesses a low conductivity in such a way that the latter serves as a dielectric in a condenser and is then heated up as a result of the heat generated is also familiar. Furthermore, the employment of the inductive effect in heating electrically conductive charges in the melting of steel and similar processes is known in a number of different variations.

In the first-mentioned process which is based on the inductive effect, the obtaining of a satisfactory result is naturally dependent to a very great extent upon the possibility of employing a conductive material which does not exert a detrimental influence upon the process and which can preferably be used over again in a subsequent operation. The conditions are the same in the case of electric conductors when heating the charge with the help of the heat of resistance. Moreover, if the charge is to be heated for instance in a retort, the introduction of the electric conductors may give rise to difficulties in many instances.

The disadvantages referred to above are obviated in the high frequency furnace which is the subject of the present invention and in which the heating of the charge is carried out indirectly without employing electric conductors introduced into the charge or the container. The high frequency furnace according to the invention is mainly characterized by the employment as heating element for indirect heating of the charge, of a reaction container divided in the vertical direction into several different sections, and manufactured of a metal such as iron, steel or other metal or metal alloy, which is heated by means of the induction currents set up in the furnace to high temperature, said container sec-

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tions being surrounded by a supporting layer of non-conductive, for instance ceramic, material.

In the experimental investigations on which the present invention is based, it has been proved that there are great difficulties in carrying out reactions of the kind indicated above in high retort furnaces with metal containers for the charge at high temperatures and under vacuum. Under said conditions the metal reaction container is subjected to considerable strains and stresses which at some places may be compressive strains, at other places simultaneously tensile strains. The metal container, the strength of which is considerably decreased at the high temperature, cannot endure and withstand said strains, even when the walls are of comparatively great thickness, without deformation or destruction.

The above-mentioned difficulties are removed by the present invention. By means of the division of the metal container or retort in sections in accordance with the invention it is possible to build up retorts of a considerable height, for example, up to 3 meters or more, and to carry out the treatment in these retorts at very high temperature, notwithstanding the great stresses in the form of tensile stresses and compressive stresses hereby occurring, since these stresses are apportioned on a plurality of sections, each being a unit per se, without direct connection with other units. In addition, by providing a supporting layer of suitable thickness and strength, said layer can be caused to provide a reinforcement for the walls of the reaction chamber, thus obviating the danger of the deformation of the latter even in case of relatively thin walls.

According to a preferred form of the invention the retort sections are made in the form of tubes or tube sleeves of cylindrical or, preferably, slightly conical form, and tapering downwards in order to obtain better contact against the supporting layer. These tubular parts are further preferably provided with suitable supporting means which at the same time serve as reinforcements, for example outwardly directed collars and beads, running from above downwards and preferably tapering downwards, which rest in corresponding recesses or on corresponding projections in the surrounding supporting layer.

The supporting and reinforcing layer or wall of electrically non-conductive material may be produced by tamping and sintering ceramic material around the retort sections in the furnace itself, or it may consist of already sintered material which is built up round the retort sections

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or is cast in suitable pieces in accordance with the shape of the retort sections, for example in sections in the form of rings made of ceramic material. By this means the dimensions of mating parts of the retort sections and the supporting wall are so chosen that the former at the working temperature of the furnace fits closely to the latter.

According to one embodiment of the invention gas channels are arranged in the supporting wall which by means of vertical intermediate spaces between the retort sections are in communication with the interior of the furnace, thus allowing the escape of gases formed in the processes taking place in the furnace.

The invention will now be described further by way of example with reference to the accompanying drawings in which two examples of the arrangement are illustrated.

Fig. 1 shows, in vertical section, a high frequency furnace arranged according to the invention and intended to work under vacuum.

Figs. 2 and 3 show cross-sections through a single reaction container with a supporting layer, and

Figs. 4 and 5 show similar cross-sections through a somewhat different embodiment.

In Fig. 1 the furnace is generally indicated by 1 and the high frequency coil of the furnace by 2. The furnace is enclosed in a vacuum-tight outer container 3 with cover 3a, which may be evacuated through a socket 4 in the cover. The feeder connections for the high frequency coil 2 are inserted through vacuum-tight nipples 5 in the wall of the container 3. In the furnace 1 the retort proper is formed from a plurality of vertically spaced apart retort sections in the form of slightly conical tubes or tube sleeves 6, supported independently one above the other, as well as a bottom-bowl 7, suitably of high temperature resistant steel, and these are surrounded by a refractory supporting layer 8, preferably of ceramic material. This supporting layer may be tamped into the furnace and sintered on the spot or constructed of previously manufactured rings. The mutual dimensions of the retort sections 6 and the supporting layer are so chosen as already mentioned, that the tubular parts after heating to the working temperature of the furnace will be in close contact with the supporting layer, as will be seen from the drawing, which shows the furnace at working temperature. Outside the tubular sections 6 are, in the supporting layer 8, arranged vertical channels 9 which at 10 through small vertical intermediate spaces between the retort sections 6 are in connection with the interior of the retort, so that gases which may be formed during the treatment in the furnace may escape therethrough and finally escape into a condensation zone which in the drawing is shown as a casing 11, but which may also be arranged in any other way. Each retort section 6 is at its upper edge provided with an outwardly directed peripheral flange or collar 12 resting in a corresponding recess in the supporting layer 8. These parts form cooperative means serving to support the retort sections in spaced apart relationship and to provide for independent expansion and contraction of the retort sections during heating and cooling thereof.

In Figs. 2 and 3, 16 is the tubular retort section which at its upper edge is provided with the peripheral flange or collar 22 resting in a corresponding recess in the supporting layer 18 which in this case is supposed to be a previously sintered

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ring of ceramic material. The retort section 16 is so dimensioned that only on attainment of the working temperature of the furnace will it fit tightly against the reinforcing layer 18 and be supported thereby, this being illustrated by indicating the cold, i. e. shrunken lining, i. e. the retort section, by broken lines in Fig. 2. The lower edge of the retort section similarly rests against an annular supporting bracket or flange 17 on the ring of the fireproof material 18 only at the working temperature. Gas channels 19 are arranged in the supporting layer and 21 are vertical reinforcing ribs arranged on the outside of the retort section.

Figs. 4 and 5 show a corresponding arrangement with a tubular retort section 26 with a supporting layer 28, the section 26 being by means of a flange or collar 32 suspended in a corresponding recess in the supporting layer and resting below against the annular supporting bracket or flange 27 in the supporting layer. The reinforcing ribs are here indicated at 31, while 30 are gas channels which in this case are arranged in the horizontal direction straight through the supporting layer to collecting channels outside the latter (not shown).

It is obvious that in the embodiments shown different modifications and alterations may be made within the scope of the invention. Thus, all of the retort sections may have the same height and diameter, or else the parts may be made with a diameter increasing upwards in the direction of the height of the furnace, for example, and be of the same or different height. The sections may either be arranged with similar intermediate spaces, as is shown in Fig. 1, or also in such a way that they nearly are in contact with each other when the furnace is heated to the working temperature. Instead of a single reaction chamber or retort, as shown in Fig. 1, the retort furnace may also contain several such retorts formed by tubular sleeves 6, in which case said retorts may be heated by means of one and the same or several high frequency coils, the retorts being in the latter case suitably arranged in circles concentrically with the coils. Obviously, several furnaces may be enclosed in one vacuum-tight container 3, and they may be connected with a common gas condensation zone. Instead of using a retort with a metal bottom, as shown in Fig. 1, it may in many cases be more advantageous to employ retorts without a metal bottom. For the rest, the retort sections in respect to the form and the thickness of the wall, are made to suit the thermal and electrical conditions prevailing in the furnace.

I claim:

1. A high frequency electric furnace of the retort type for the treatment of charges for metallurgical and similar purposes, which comprises in combination a metal retort formed in a plurality of tubular sections which are spaced apart vertically one above the other, independently supported and insulated from each other, said retort sections having thin metal walls of low strength incapable, if unsupported, to withstand the stresses occurring in the furnace, a self-supporting non-conducting refractory wall closely surrounding said retort sections, holding them in spaced apart relationship and constituting their sole support, an induction coil surrounding said retort adapted when energized to heat the retort sections and thereby to heat the furnace; and cooperative means between the retort sections and the refractory wall to support the re-

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tort sections in spaced apart relationship and to provide for independent expansion and contraction of the retort sections during heating and cooling thereof.

2. In a high frequency furnace of the retort type for the treatment of charges for metallurgical and similar purposes, the combination of a reaction chamber, a metal lining in said chamber, said lining comprising a plurality of vertically spaced, separate tubular sections, a supporting, insulating wall structure surrounding said chamber and supporting said spaced lining sections at vertical intervals, an induction coil surrounding said wall structure for causing when fed with a high frequency current, said lining sections to become heated and to heat the charge in said reaction chamber, and gas channels in said wall structure opening into said reaction chamber at spaced levels and through said intermediate spaces between all said lining sections to allow the escape of gases formed during the treatment of the charge.

3. A high frequency furnace of the retort type for the treatment of material in vacuum, comprising in combination a central reaction chamber for receiving the material to be treated, a metal lining in said chamber, said metal lining being divided in a plurality of vertically spaced downwardly tapering tubular sections, a wall structure of a non-conductive material surrounding and supporting said metal lining sections, vertical gas channels in said wall structure opening into said reaction chamber through the uncovered parts of the wall structure between said spaced lining sections, a condenser located at the top of the furnace and connected with said gas channels, an induction coil surrounding said wall structure for inducing a heating current in said metal lining sections to cause said sections to heat the charge in said reaction chamber, and a vacuum-tight outer shell enclosing the entire furnace.

4. A high frequency furnace of the retort type for the treatment of charges for metallurgical and similar purposes, which comprises in combination a metal retort formed in a plurality of sections of frusto-conical shape slightly tapered downwardly and spaced apart vertically one above the other, said retort sections having thin

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metal walls of low strength incapable, if unsupported, to withstand the stresses occurring in the furnace, a self-supporting non-conducting refractory wall closely surrounding and correspondingly tapered to fit said retort sections and supporting them in spaced apart relationship, an induction coil surrounding said retort adapted when energized to heat the retort sections and thereby to heat the furnace, and cooperative means between the retort sections and the refractory wall to support the retort sections in spaced apart relationship and to provide for independent expansion and contraction of the retort sections during heating and cooling thereof.

5. A high frequency furnace of the retort type for the treatment of charges for metallurgical and similar purposes, which comprises in combination a metal retort formed in a plurality of tubular sections which are spaced apart vertically one above the other, vertical ribs provided on the outside of each of said retort sections, said retort sections having thin metal walls of low strength incapable, if unsupported, to withstand the stresses occurring in the furnace, a self-supporting non-conducting refractory wall closely surrounding said retort sections, provided with recesses to receive the ribs of said retort sections and supporting said retort sections in spaced apart relationship, an induction coil surrounding said retort adapted when energized to heat the retort sections and thereby to heat the furnace, and cooperative means between the retort sections and the refractory wall to support the retort sections in spaced apart relationship and to provide for independent expansion and contraction of the retort sections during heating and cooling thereof.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
858,621	Petersson	July 2, 1907
1,292,582	Coulson	Jan. 28, 1919
2,122,241	Arnold	June 28, 1938
2,291,532	Clark	July 28, 1942
2,297,747	Clark	Oct. 6, 1942
2,322,618	De Mare	June 22, 1943