June 13, 1939. K. ERDMANN 2,161,916

ELECTRIC SHAFT FURNACE

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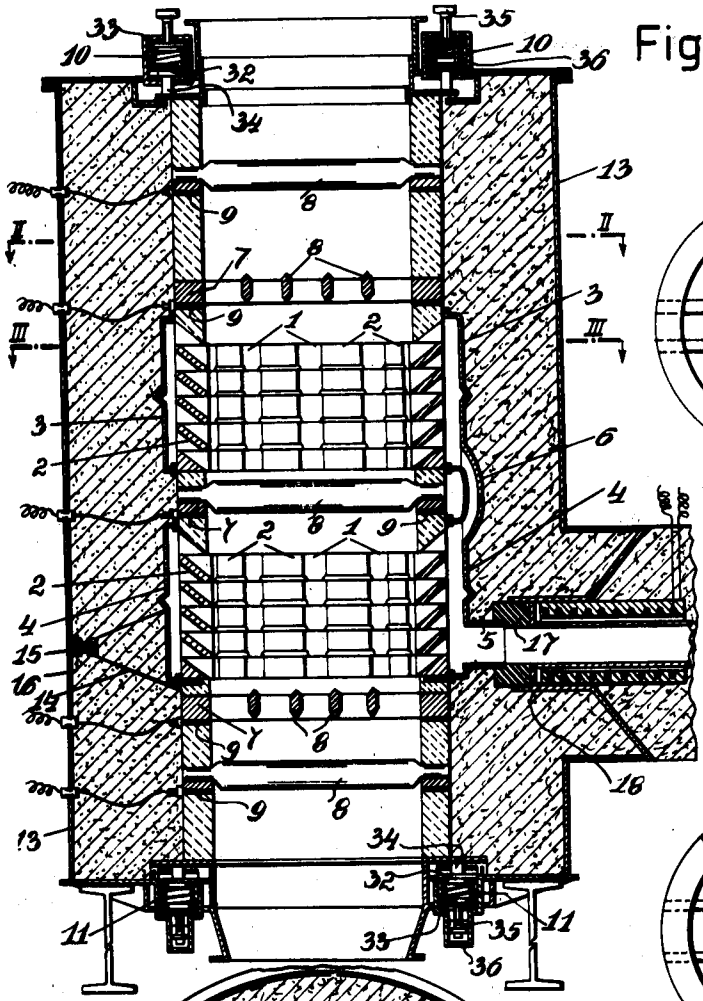


Fig.1

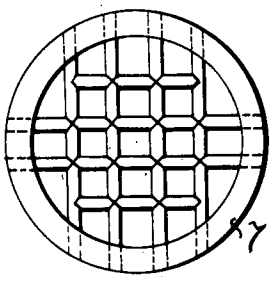


Fig.5

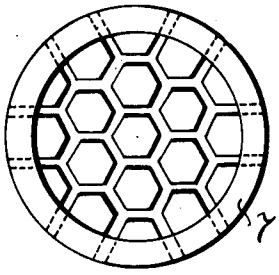


Fig.6

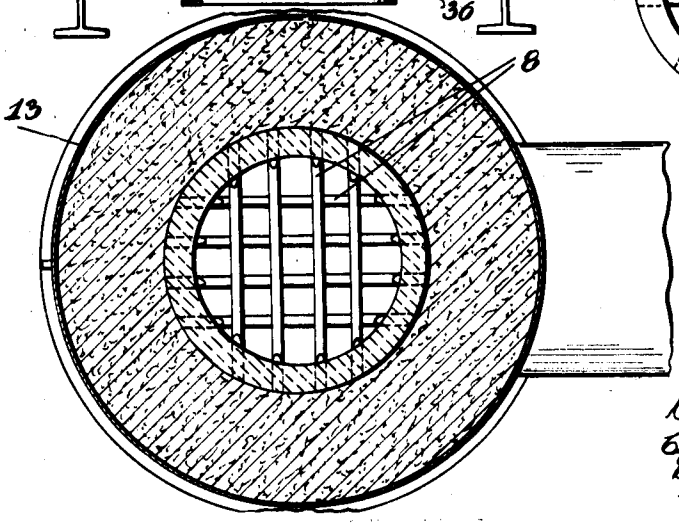


Fig.2

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Fig.3

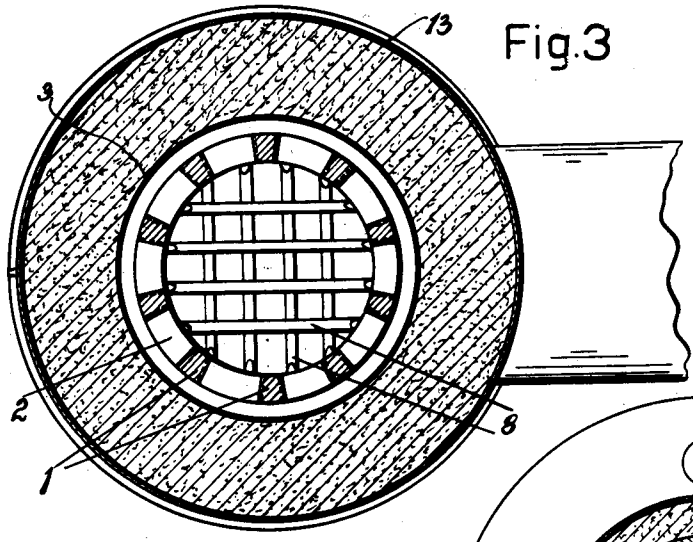


Fig.8

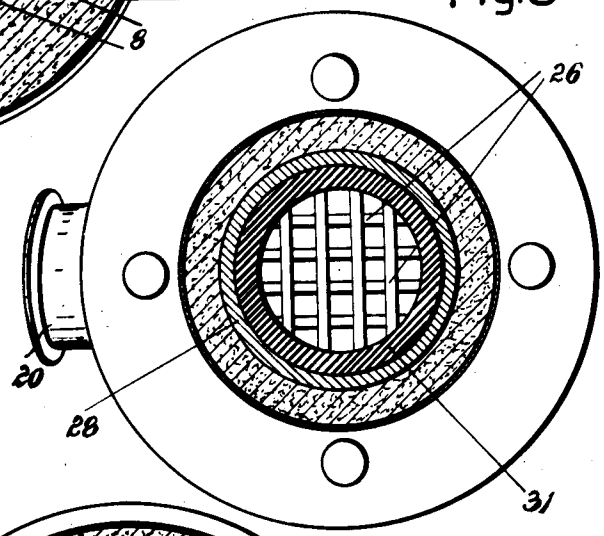
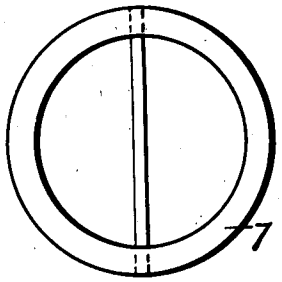


Fig.4



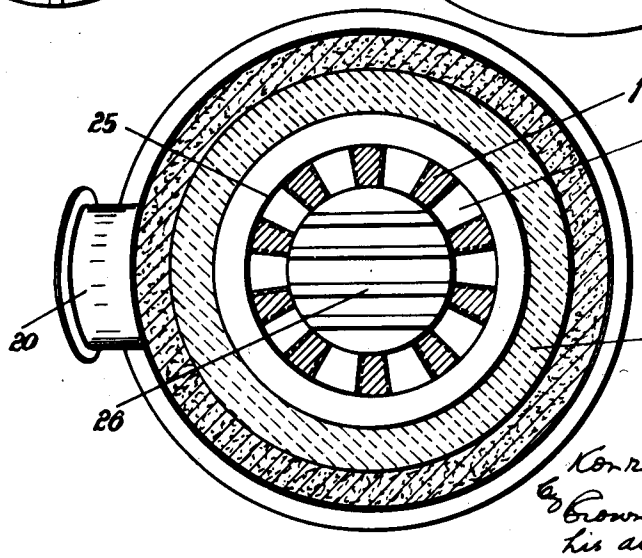


Fig.9

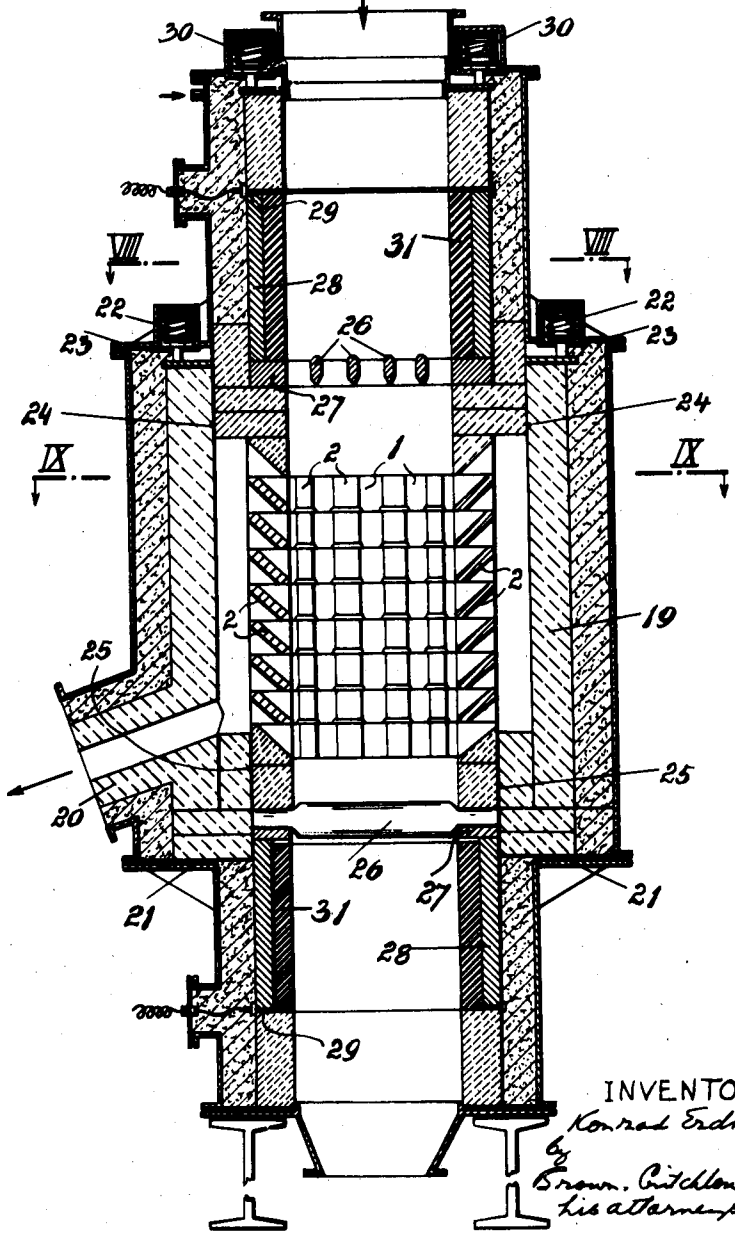
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Fig. 7



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UNITED STATES PATENT OFFICE

2,161,916

ELECTRIC SHAFT FURNACE

Konrad Erdmann, Radenthein, Austria, assignor to American Magnesium Metals Corporation, Pittsburgh, Pa.

Application December 29, 1936, Serial No. 118,078
In Austria January 10, 1936

8 Claims. (Cl. 13—23)

This invention relates to electric shaft furnaces, especially to electric shaft furnaces adapted for direct resistance heating, by passing an electric current through the furnace charge, and intended mainly for the recovery of volatile metal and more particularly magnesium, by distilling it out from mixtures of the metal with non-volatile concomitants, and for the refining of crude metals by distillation, but also for other purposes, for instance for the reduction of compounds of the metal concerned at temperatures above its boiling point.

An object of the invention is to enable vaporizing of the material under treatment to be carried out in an uninterrupted run with the generation of pure vapor, even when the furnace charge is of a nature to give rise to the formation of dust.

Another object of the invention is to provide a refining, by filtration, of the vapor leaving the furnace.

A further object is to provide electrodes so formed that the charge is uniformly heated and thus to prevent overheating of the charge.

A further object is to prevent setting up of strains in the constructional parts of the furnace in consequence of unequal expansion, and thus to avoid the formation of leaks in the shaft wall.

A still further object is to ensure an intimate contact between the elements through which the current is fed to the electrodes.

Other objects and advantages will appear as the description proceeds.

When the distillation chamber in the form of a shaft is connected with the condenser by a directly branched off pipe, for constructional reasons the connecting conduit must be of small internal cross-sectional area. Consequently, when material is treated which tends to form dust, the difficulty arises that the disengaged vapors, which leave the shaft at relatively high velocity, carry over with them dusty constituents of the charge which deteriorate the quality of the condensate or even prevent altogether the formation of a liquid deposit that will set to compact metal.

In electric furnaces for the distillation of zinciferous material it is already known to provide rows of discharge apertures at the distillation zone, and to enclose each of these rows in a separate collecting chamber which is in communication with the condenser. In this manner the velocity of the escaping vapors is, however, not reduced to the extent that is required for ensuring that the carrying over of dust be reliably prevented. If in accordance with the present invention the discharge apertures open into a common chamber surrounding the shaft, from which chamber the connecting pipe to the condenser branches off, the possibility is given to arrange series of discharge apertures immediately adjacent to one another whereby the total cross-sectional area of all the discharge apertures become so great that there is no danger of the vapors becoming contaminated. Moreover, by the arrangement of a common chamber there is also prevented cooling off of the vapors on their way to the condenser.

Preferably the apertures for the distillation products are separated from one another by webs in the form of plate-like elements, arranged in the manner of Venetian blinds, sloping upwards towards the outside wall of the shaft. In this manner there is effected a refining of the escaping vapors and gases, by filtration, since these latter are constrained to pass through the material which becomes heaped up at a natural slope within the apertures of the shaft walls; since this material gradually slides off the inclined plate-like elements or louver boards, and is therefore constantly, though very slowly, renewed the effectiveness of the filtering action is kept up undiminished as long as the furnace is in operation.

If the furnace is to be a direct resistance furnace through which the charge travels in the form of a moving column, the electrodes, which are arranged in a known manner at different levels in the shaft, consist in accordance with the invention of a frame having the same internal width as the shaft, and of one or several bars traversing the frame. The bars may be so disposed that they divide up the area enclosed by the frame into figures of equal or approximately equal area, which may have the shape for example of squares, polygons, or circles, whereby the result is achieved that the electric current traverses the charge travelling between the electrodes, at uniform density, and thus heats the charge uniformly. Overheating of the material, which could lead to vaporization of impurities, can thus easily be avoided. This result can not be achieved with the known electrodes of annular form or of the form of a star after the manner of the spokes of a wheel, since the current density varies greatly in the zones of the charge lying between the electrodes.

It is a matter of great importance that the shaft walls be perfectly vapor-tight, since otherwise magnesium vapors would penetrate into the

cold insulation layer surrounding the shaft, and become deposited on the outside metal jacket. When the shaft is bricked up in the usual manner it is impossible, in view of the difference of expansion between the ceramic material and the metal casing, to prevent the formation of fissures and cracks in the shaft walls. In accordance with the invention the shaft as a whole is gripped top and bottom by means of compressed springs which effect a firmer holding together of the ceramic material and compensate longitudinal expansion, so that the formation of leaks is precluded. On the other hand provision must be made to prevent the gas discharge pipe from becoming subjected to bending strain by the expansion and contraction of the shaft walls. For this purpose in accordance with the invention that intermediate part of the shaft from which this pipe is branched off is firmly anchored, for instance rigidly connected with the metal jacket.

This arrangement at the same time very effectively secures maintenance of an intimate contact between the elements through which the current is fed to the electrodes and the electrodes themselves. Since the current leads must consist of metal, the coefficient of expansion of which is different from that of the electrode material (graphite, carbon blocks) perfect and permanent fitting together of the two materials at the contacting surfaces must be ensured, since otherwise the connection would become loose on heating and cooling off, which would lead to the formation of small arcs between the metal and the electrode and to further deterioration of contact through burning of the material. In accordance with the invention the current leads consist of plates of large bearing area, and preferably of annular discs of the same dimensions as the electrode frames themselves, which plates or discs bear against one or both front walls of the electrode frames, and are pressed against these latter by the force of the springs gripping the shaft.

When the working temperatures are relatively low, or are kept appropriately low by the employment of a suitably high vacuum, the collecting chamber surrounding the basket-like apertured section of the shaft can be enclosed by a metal jacket which, by virtue of its elasticity, can yield to the alterations in length, even when rigidly connected to the shaft. On the other hand if the working temperature reaches such a height that only refractory materials can be used, and if the highly heated shaft were rigidly connected to the far less heated shaft jacket, harmful strains would be set up in the structure of these parts in consequence of unequal expansion.

According to a further development of the invention the occurrence of such strains is avoided by movably guiding the shaft in the jacket made from refractory material. The jacket is preferably gripped by means of compressed springs, as described above for the shaft itself, in order to hold the ceramic material more firmly together. In order not to load the body of the shaft with the weight of the jacket this latter is preferably arranged to rest upon a support the foundation of which is independent of the furnace shaft.

A further modification which the shaft furnace according to the invention must undergo when the distillation is carried out at temperatures which metallic materials will not withstand, relates to the arrangement of the electrodes. In order to prevent high temperatures being brought to bear on the metallic current leads these latter are disposed in non-heated zones above and below the distillation zone, and connected with the electrode frames laid in the hot zone, by means of carbon or graphite cylinders the inner wall of which is lined with refractory and electrically insulating material. These carbon cylinders are kept in engagement with the electrode frames and the metallic current leads by the weight of the shaft walls and by the action of the springs with which these walls are stressed, so that no electric arc formation can occur in consequence of imperfect contact between the elements of the current conducting means employed.

Two forms of construction of the shaft furnace according to the invention are shown, by way of example, in the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a shaft furnace;

Fig. 2, a cross-section on the line II—II, Fig. 1; Fig. 3 a cross-section on the line III—III, Fig. 1; Figs. 4, 5 and 6 are plan views of three modified forms of construction of electrodes; Fig. 7 is a vertical sectional view of a modification of a shaft furnace according to this invention; Fig. 8 a cross-section on the line VIII—VIII, Fig. 7; and Fig. 9 a cross-section on the line IX—IX, Fig. 7.

Like reference characters denote like parts in the several figures of the drawings.

Referring to Figs. 1 to 3, the shaft through which the charge, preferably in the form of granulated material of a grain size between about ¼ of an inch to 1 inch, travels as a moving column, is provided in its middle portion with two basket-like apertured zones which are built up of solid bricks 1 and plate-like elements 2 in the form of sections of a hollow cone. The plates 2 are anchored to the solid bricks, for example in such manner that the edges of the plates engage in grooves in the solid bricks (see Fig. 3). These basket-like apertured zones of the shaft are encased by closely fitting metal jackets 3, 4. The jacket 4, the lower side wall of which is secured to the wall of the shaft, is connected to a discharge pipe 5, and communicates with the space enclosed by the jacket 3 through a conduit 6.

The electrodes disposed at different levels consist, according to Figs. 1 and 2, of rings 7 and a grating or lattice-work of parallel bars 8 having their ends inserted in the rings. The arrangement adopted is preferably such that the bars of consecutive electrodes are displaced 90° relatively to each other (Fig. 1). Instead of several bars 8 one bar inserted in a ring may also be used as electrode (Fig. 4). The grating bars can also be so arranged that the areas therebetween have the shape of a regular figure, for example a square (Fig. 5) or a hexagon (Fig. 6).

The current is fed to the electrodes consisting of graphite or carbon blocks, through annular metal discs 9 which bear against one plane surface of the electrode rings 7.

The shaft is bodily supported top and bottom against compressed springs 10 and 11 respectively. The springs 10, 11 are compressed between two plates 32, 33 that rest on bolts 34, 35, the one 34 of which presses against the wall of the furnace shaft, whereas the other 35 being

provided with a screw thread is screwed into a wall of the casing 36 that houses the springs and plates and is secured to the metal jacket 13 of the furnace. The degree of compression of the springs 10 and 11 may be adjusted by means of the screw bolts 35.

The section of the shaft carrying the discharge pipe 5 is rigidly connected with the metal jacket 13. For the purpose of anchoring this section of the shaft, lugs 14 may for example be welded on to the metal jacket 4 of the collecting chamber, which lugs bear against the metal casing 13. In the constructional example shown in the drawings these lugs are formed at their outer ends to constitute holders for blocks 15 of electrically insulating material which are fitted into holders 16 on the metal jacket. Moreover, the discharge pipe 5 is also included in the system by which the lower section of the shaft is rigidly anchored to the metal jacket, by being socketed into a short length of tube 17 of electrically insulating material which is fitted in a holder 18 connected with the metal jacket.

In the furnace shown by way of example in Figs. 7 to 9 the basket-like apertured zone of the shaft made similarly to the construction of Fig. 1, is surrounded by a walled jacket 19 which constitutes the collecting chamber for the vapors escaping from the middle section of the shaft, and which is connected to the condenser by means of a pipe 20. The masonry of the jacket rests upon brackets 21 and is loaded by springs 22 which are supported against brackets 23 in a manner similar to that described in connection with Fig. 1. Since the masonry jacket 19 is not rigidly connected with the shaft the portions 24 and 25 of the wall of the shaft touching the jacket can slide against the inner walls of the jacket, so that differences in the extent to which these two structural parts expand and contract longitudinally can thus be compensated.

At the upper and lower ends of the section of the shaft enclosed by the jacket 19 there are provided the electrodes of graphite or carbon, consisting of one or several parallel bars 26 the ends of which are inserted in rings 27. The electrode rings are connected to annular current leads 29 of metal by means of suitably long carbon or graphite cylinders 28 which are lined with refractory and electrically insulating material 31 (Fig. 8). Under the pressure exerted by the weight of the masonry and the force of the springs 30 loading the masonry in a similar manner as the springs 10 according to Fig. 1, the metal discs 29, the cylinders 28, and the electrode frames 27 are powerfully pressed together, so that at the joints between these elements no gaps can become formed which would give rise to the generating of electric arcs. For this purpose the insulating cylinders 31 are shorter than the carbon or graphite cylinders 28. In consequence of the interposition of the cylindrical distance pieces 28 between the electrodes 27 and the metal rings 29 the current connection is placed in the pre-heating zone above the distillation zone and in the cooling off zone below the distillation zone, where the shaft walls do not become heated to such high temperatures as to preclude the use of metallic current leads.

According to the provisions of the patent statutes, I have explained the principle and construction of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practised otherwise than as specifically illustrated and described.

I claim:

1. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber opens into a condenser, and springs acting upon the top and bottom of said shaft to apply longitudinal compression forces thereto.

2. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, and opening through a firmly anchored discharge pipe into a condenser, the shaft being rigidly connected with said discharge pipe, and springs acting upon the top and bottom of said shaft to apply longitudinal compression forces thereto.

3. Electric shaft furnace comprising a metal jacket encasing the furnace, a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, and opening into a condenser through a discharge pipe firmly anchored to said metal jacket, the shaft being rigidly connected with said discharge pipe, and springs acting upon the top and bottom of said shaft to apply longitudinal compression forces thereto.

4. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber is provided with a conduit leading to a condenser, the outer wall of said chamber being formed by a jacket of refractory material resting on a support independent of the said jacket and pressed against the same by means of compressed springs, the shaft being movably guided in the said jacket.

5. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber is provided with a conduit leading to a condenser, the outer wall of said chamber being formed by a jacket of refractory material resting on a support and pressed against the same by means of compressed springs, the shaft being movably guided in the said jacket, and springs acting upon the top of the shaft to apply longitudinal compression forces to the shaft.

6. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber opens into a condenser, and electrodes in the form of a grating with a frame of substantially the same inside diameter as the shaft of the furnace and inserted at different levels in the wall of the shaft and adapted to serve as a building

element of the shaft supporting the portion of the shaft disposed above said frame, the bars of said grating dividing the area enclosed by the frame up into areas of approximately equal size.

7. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber opens into a condenser, springs acting on said shaft to apply longitudinal compression forces thereto, and electrodes arranged at different levels which consist of a frame of substantially the same inside diameter as the shaft of the furnace, and of at least one bar traversing the frame and having its ends anchored thereto, said frame being inserted in the wall of the shaft and adapted to serve as a building element of the shaft supporting the portion of the shaft disposed above said frame.

8. Electric shaft furnace comprising a shaft provided at the distillation zone with series of individual apertures discharging the distillation products in the form of vapor, and a common chamber surrounding the shaft in which the distillation products pass through the apertures, which chamber opens into a condenser, springs acting on said shaft to apply longitudinal compression forces thereto, electrodes arranged at different levels which consist of a frame of substantially the same inside diameter as the shaft of the furnace and inserted in the wall of the shaft, and of at least one bar traversing the frame and having its ends anchored thereto, and electric conductive annular discs connected to the current supply and inserted between said frames and the wall of the shaft, the said frames and discs being adapted to serve as building elements of the shaft supporting the portion of the shaft disposed above the same.

KONRAD ERDMANN.