Dec. 1, 1942. Y. PEYCHES 2,304,016

SALT BATH FURNACE

Filed April 8, 1939

Fig. 1.

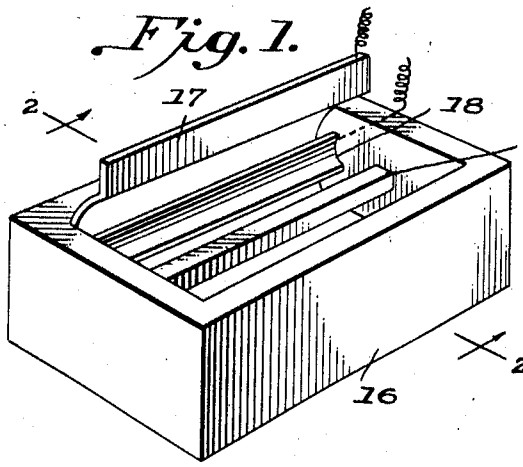


Fig. 2.

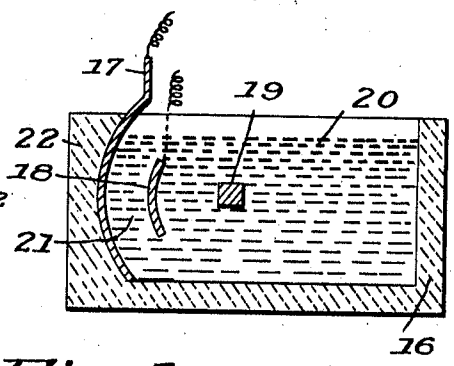


Fig. 3.

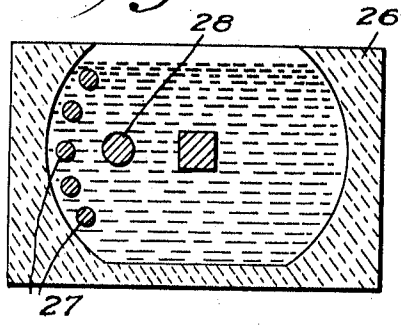


Fig. 5.

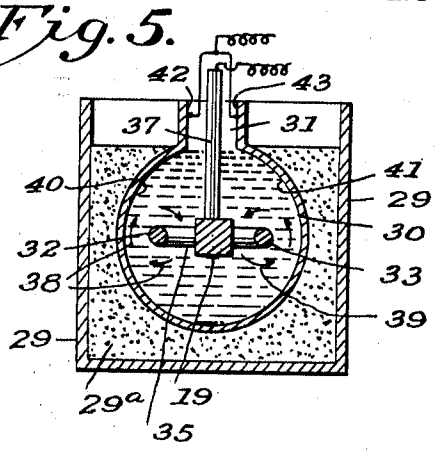


Fig. 4.

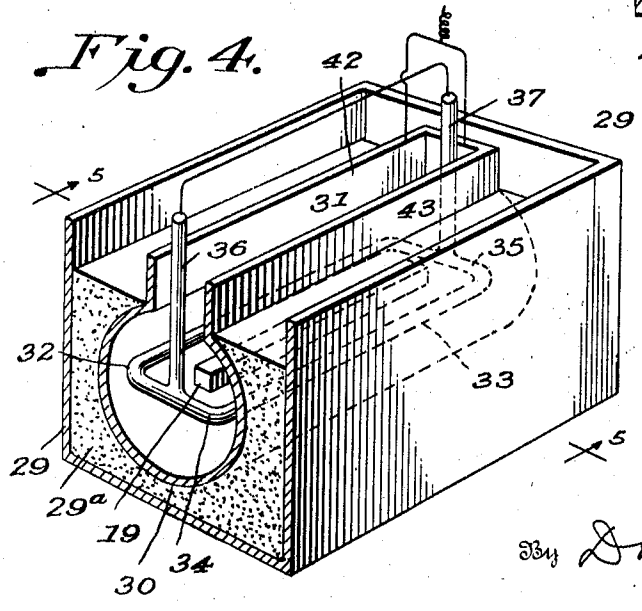
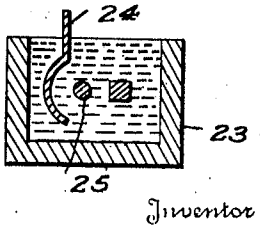


Fig. 2a



Inventor

YVAN PEYCHES

By Drury Colet & Garner

Attorneys

Patented Dec. 1, 1942 2,304,016

UNITED STATES PATENT OFFICE

2,304,016

SALT-BATH FURNACE

Yvan Peyches, Paris, France, assignor to Société Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France

Application April 8, 1939, Serial No. 266,832
In France April 14, 1938

9 Claims. (Cl. 13—23)

This invention relates to salt-bath furnaces for heat treatments, in particular of metals, with a view to tempering, cementation, cyaniding, annealing and the like operations.

Since the baths utilized are conductors, advantage has been taken from the start of that porperty in order to heat these baths electrically by Joule effect in the mass. However, the majority of the practical arrangements have been such that the articles to be treated, when they were introduced into the bath and placed in the path of the lines of current, modified the distribution of these lines of current. Thus metallic articles, much more conductive than the surrounding medium, concentrated the lines of current about them, in such a way that greater energy was expended in the vicinity of the portions of the articles facing towards the electrodes. In the case of articles made of material such as glass, less conductive than the surrounding medium, the inverse phenomenon was produced, that is to say less energy was expended in the vicinity of the portions of the articles facing towards the electrodes than in the other portions. The drawback of these arrangements was, therefore, that the articles did not undergo uniform heating.

In attempting to avoid this drawback it has already been proposed to arrange the electrodes in such a way that the article to be treated is located outside the space comprised between the electrodes, that is to say outside the portion of the bath traversed by the lines of current. The current flows between electrodes, heating the portion of the bath comprised between them; the remaining mass of the bath in which is located the article to be treated is then heated by the convection currents which originate in the zone heated directly by the passage of the current and stir up continually the whole of the bath.

In practice, the applications which have been made of this type of furnace have led to imperfect results in this sense that the temperature of the bath in the vicinity of the article is not the same at all points of the latter.

The present invention has for its object certain improvements hereafter indicated by means of which it is possible to obtain a remarkably uniform heating of the articles to be treated.

The principal improvement consists in the fact that the electrodes are arranged in such a way that the hot zone or zones produced by the passage of the current in the bath will extend horizontally and that the portion of the bath occupied by the article to be heated is itself horizontal and practically parallel to the said hot zone or zones. In this way, the convection currents which are established between the hot zone and the zone containing the article to be heated have their starting points upon a horizontal line of the hot zone and their terminal points upon a horizontal line substantially parallel to the first; these currents are practically contained in planes distinct from one another and perpendicular to the common direction of the hot zone and the zone to be heated, and the different currents follow practically similar paths. In these conditions, each point along the zone to be heated is practically heated by a particular current coming from a distinct point of the hot zone. Practically the isotherms in the active portion of the bath are straight lines parallel to the common direction of the generating lines of the hot zone and of the zone containing the article to be heated, which is equivalent to saying that there is obtained very easily a uniform temperature along the zone to be heated. In order to obtain these results it is in fact sufficient in principle to maintain the temperature uniform along the hot zone.

If, moreover, it is desired to heat further a portion of the zone to be heated, for example the extremities of this horizontal zone, the invention allows that result to be easily attained since it suffices to control in the same sense the corresponding portions of the hot zone, that is to say, in the case considered, the extremities of this hot zone.

In certain of the examples of arrangements which are described hereafter there are indicated methods of carrying out this regulation of temperature along the hot zone and in consequence along the zone to be heated.

In order to produce the hot zone, which is the source of the convection currents, the invention provides various arrangements of electrodes. In some of these, the electrodes are constituted by elements in the form of bars arranged horizontally. In others, the electrodes are constituted by a plurality of elements, which can be vertical or inclined, sufficient in number and sufficiently close together and arranged in such a way that the zone traversed by the electric current shall be a practically continuous and horizontal zone. In either case the essential point is that the portion of the bath in which the Joule effect is developed between the electrodes shall extend horizontally, as has already been stated.

According to one form of carrying out the invention, the circulation of the convection cur-

rents between the hot zone and the zone containing the article to be heated is facilitated by arranging, in the path of the convection currents and in particular in the upward path starting from the hot zone, obstacles which divert these currents so as to direct them towards the zone to be heated. These obstacles can with advantage be constituted by the walls of the furnace or by the electrodes themselves. In order to facilitate the localisation of the convection currents in vertical planes perpendicular to the direction common to the hot zone and to the zone to be heated, the invention provides that screens preferably made of non-conductive material can be arranged in vertical planes perpendicular to that direction, particularly in the portion of the bath situated outside the portion occupied by the article to be heated.

Other features of the invention will appear from the following description which relates to various forms of construction given by way of example. In this description reference is made to the accompanying diagrammatic drawing.

In the drawing:

Figure 1 is a perspective view, illustrating diagrammatically a salt bath furnace constructed in accordance with the principles of the present invention;

Figure 2 is a vertical section along the line 2—2 of Figure 1;

Figure 2*a* is a vertical section through a furnace of a somewhat different type;

Figure 3 is a cross-section through a differently constructed furnace;

Figure 4 is a perspective and diagrammatic view of a different modification, and

Figure 5 is a vertical section along the line 5—5 of Figure 4.

The furnace **16** shown in Figures 1 and 2 comprises an outer electrode **17** and an inner electrode **18**. The article **19** to be heated is situated in a salt bath **20** outside of that portion of the bath which extends between the two electrodes. The electrodes **17** and **18** extend horizontally and parallel to each other. When these electrodes are connected to any suitable source of electrical energy not shown in the drawing they will provide an electrical current which will flow through the portion **21** of the bath which is situated between the electrodes **17** and **18**. The portion **21** of the bath will then be heated by the Joule effect and will create convection currents in the bath which will flow from the portion **21** of the bath to the portions situated outside of the electrodes. Since the article **19** to be heated extends parallel to the electrodes **17** and **18**, it will be heated uniformly along its entire length by the convection currents.

Both electrodes **17** and **18** have cylindrical surfaces with horizontally extending generating lines. In cross-section the electrode **17** has the form of a concave line, such as a circular one, the concavity of the electrode **17** being directed or turned toward the electrode **18** and the object **19**. The inner electrode **18** is also concave, and its concavity is also directed toward the object **19**. The electrode **17** may constitute a lining of the enclosing wall **22** of the furnace **16**.

In accordance with the present invention, the portions of the electrodes **17** and **18** which have their concavity directed toward the interior of the furnace, serve as obstacles placed in the path of the convection currents which cause the convection currents to be directed toward the article **19**.

In the device shown in Figure 2*a*, the furnace **23** comprises an electrode **24** which does not constitute a part of the wall of the furnace but is situated at a distance therefrom. The inner electrode **25** has the form of a single rod. This construction has the advantage that the electrical lines of current between the electrodes **24** and **25** are concentrated in the neighborhood of the electrode **25**, with the result that a zone of substantially high temperature is provided in the portion of the bath adjacent the electrode **25**. This high temperature zone is particularly advantageous for the creation of convection currents.

In the furnace **26** shown in Figure 3, the outer electrode **27** consists of a number of horizontal rods which are disposed in the form of a squirrel cage, while the inner electrode **28** is constituted by a single rod.

The furnace shown in Figures 4 and 5 is provided with an outer casing **29** and an inner cylindrical container **30** having horizontal generating lines and provided with an upper opening **31**. The cylindrical container **30** is preferably made of a conductive material, such as iron, and constitutes the outer electrode. The space between the outer casing **29** and the container **30** is filled with an insulating material **29***a*. The inner electrode comprises two horizontal rods **32** and **33** which are joined by transverse rods **34** and **35** and are carried by the vertical rods **36** and **37**. Due to this construction, the entire furnace and the electrodes thereof are symmetrical in relation to a vertical plane passing through the middle of the furnace and through the article **19** to be heated. Thus the heating of the article **19** itself may be symmetrical in relation to this vertical plane.

The path of convection currents is shown by arrows **38** and **39** in Figure 5. The cylindrical surfaces **40** and **41** of the outer electrode **30** are particularly effective in directing the convection currents towards the article **19**.

Electrical energy may be supplied to the outer electrode **30** through its upper surfaces **42** and **43**. The inner electrode may be connected to that source by the vertical rods **36** and **37** which may be soldered or welded to the lower bent portions of the electrodes forming a frame work **32—35**. This frame-like inner electrode functions as a cage enclosing a central zone of the bath and preventing the passage of the electrical current to that central zone.

It is apparent that the specific illustrations shown above have been given by way of illustration and not by way of limitation, and that the structures above described are subject to wide variation and modification without departing from the scope or intent of the invention. For example, it is possible to provide in a single furnace two or more hot zones which are used for heating one or several objects. The electrodes producing the hot zones may be supplied by single phase or polyphase electrical current. While the illustrated structures were intended primarily for the heating of substantially straight articles, the present invention is equally applicable to furnaces used for the heating of articles of any desired form, for example, bent or crank-shaped articles, crank shafts and the like. In order to carry this into effect, it is merely necessary that the hot zone be given a form which corresponds approximately to that of the article to be heated. Furthermore, the present invention is applicable not only to salt

bath furnaces used for the treatment of articles consisting of conducting materials, but also for materials which are poor conductors of electricity or do not conduct electricity at all. For example, the present invention is applicable to the treatment of glass articles. All of these and other modifications and variations are to be included within the scope of the present invention.

What is claimed is:

1. In a salt bath furnace, a pair of rectilinearly extending electrodes contacting the salt bath and located to provide a hot zone extending horizontally between the electrodes, parallel to the zone containing the article to be heated and outside this last mentioned zone, and means connected with said electrodes to supply electrical current thereto to heat the first-mentioned zone by the Joule effect of said current, whereby the last-mentioned zone is heated by convection currents created in the first-mentioned zone, at least one of said electrodes having a contour of cylindrical form with horizontally extending generating lines, the concavity of this surface being directed toward the zone containing the article to be heated.

2. In a fused salt bath furnace, an outer electrode extending rectilinearly at least near the side wall of the furnace, and an inner electrode extending rectilinearly in parallel relationship thereto and spaced interiorly from said outer electrode in said furnace, said electrodes being immersed in the salt bath and located to provide a hot zone of substantial depth extending horizontally between the electrodes and parallel to the zone into which the object to be heated is adapted to be immersed and outside of said last-mentioned zone, said electrodes adapted to be connected to a source of electrical current to heat the first-mentioned zone by the Joule effect of said current, whereby said last-mentioned zone is heated by convection currents created in said first-mentioned zone, said outer electrode comprising a plurality of bars arranged in the form of a squirrel-cage portion, extending horizontally and curved concavely in vertical section relative to said last-mentioned zone to induce a smooth flow of the convection currents from the hot zone to the other zone.

3. In a salt bath furnace, furnace walls consisting of a current-conducting material and having the form of a cylinder having horizontally extending generating lines and an open top portion, said walls constituting an outer electrode, and an inner electrode having the form of a horizontal frame and situated within said cylinder to provide hot zones extending horizontally between the electrodes and parallel to the zone containing the article to be heated which is situated inside of the frame, and means connected with said electrodes to supply electrical current thereto to heat the first-mentioned zone by the Joule effect of said current, whereby the last-mentioned zone may be heated by convection currents created in the first-mentioned zone.

4. In a liquid bath furnace containing a fused salt, a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, and at least the electrode farther from the second zone having a concave outline in a vertical plane normal to the extension of the electrode and facing the second zone for directing the convection currents induced in said hot zone between the electrodes towards the second zone containing the article.

5. In a liquid bath furnace containing a fused salt, a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, said pair of electrodes having at least parts of similar concave curvature in a vertical plane normal to the extension of the electrodes and facing the second zone to direct the convection currents induced in said hot zone between said electrodes towards the second zone containing the article.

6. In a liquid bath furnace containing a fused salt, a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, said pair of electrodes having a congruous concave curvature in a vertical plane normal to the extension of the electrodes and facing the second zone to direct the convection currents induced in said hot zone between said electrodes towards the second zone containing the article.

7. A liquid bath furnace comprising a wall and containing a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, one of the electrodes adjacent to the wall of the furnace being concavely curved in a vertical plane normal to the extension of the electrode and facing the second zone to direct the convection currents in-

duced in said hot zone between the electrodes towards the second zone containing the article.

8. A liquid bath furnace comprising a wall and containing a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, one of the electrodes adjacent to the wall of the furnace being concavely curved in a vertical plane normal to the extension of the electrode and facing the second zone to direct the convection currents induced in said hot zone between the electrodes towards the second zone containing the article, said one electrode being formed of a plurality of horizontally extending spaced bars.

9. A liquid bath furnace comprising a wall and containing a pair of electrodes extending alongside of each other longitudinally of and within said fused salt bath, means connected with said electrodes to supply electrical current thereto in order to heat the zone of the bath comprised between said electrodes by the Joule effect of the electrical current flowing from one electrode to the other and inducing by the outline of the electrodes the flow of the fused salt having a vertical component towards a second zone in said furnace on the side of said first zone which is adapted to receive an article of an elongated shape horizontally and in parallel to the electrodes to be heated by the convection currents originating from the hot zone of the bath, one of the electrodes being formed as an inside wall of the furnace and being concavely curved in a vertical plane normal to the extension of the electrode and facing the second zone to direct the convection currents induced in said hot zone between the electrodes towards the second zone containing the article.

YVAN PEYCHES.