Oct. 9, 1945. W. WILSON ET AL 2,386,529

SALT BATH FURNACE

Filed Oct. 2, 1943

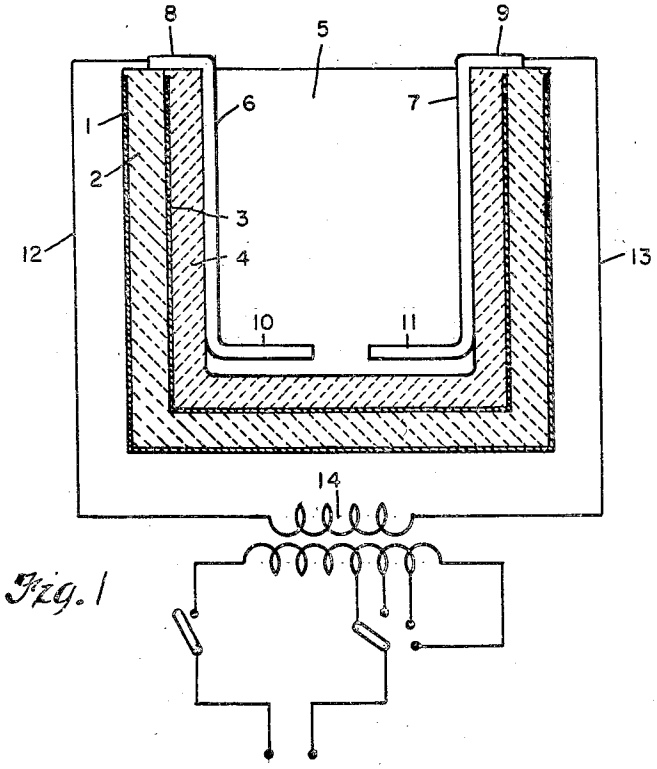


Fig. 1

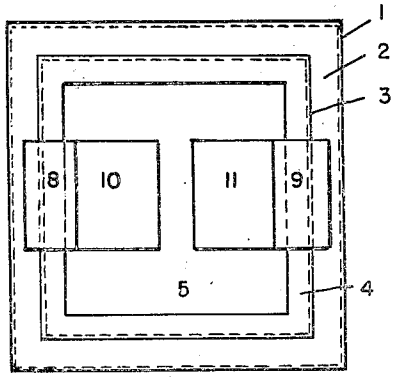


Fig. 2

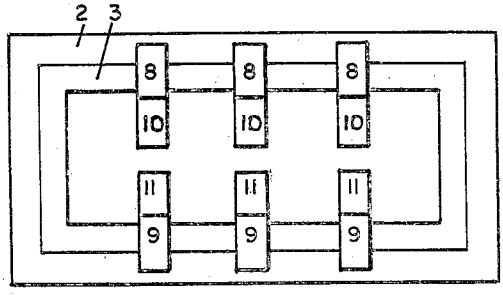


Fig. 3

INVENTORS
WILLIAM WILSON and
JOHN J. BRUTVAN

BY

Oberlin, Limbach & Day.
ATTORNEYS

Patented Oct. 9, 1945 2,386,529

UNITED STATES PATENT OFFICE

2,386,529

SALT BATH FURNACE

William Wilson, Cleveland, and John J. Brutvan, Bedford, Ohio, assignors to The Cleveland Twist Drill Company, Cleveland, Ohio, a corporation of Ohio

Application October 2, 1943, Serial No. 504,688

12 Claims. (Cl. 13—23)

This invention relates as indicated to salt bath furnaces or perhaps more accurately to furnaces of the type which are commonly used in heat treating tools, forgings, machine parts, and the like and which are provided with a well adapted to contain an electrically heated fluid bath of the type which is heated by its own internal electrical resistance. Into this bath, the work such as tools, forgings, or machine parts are suspended for a predetermined length of time in order to bring them to the desired temperature.

In the design of furnaces of this character it has sometimes been the practice to have a metallic lining of the well constitute one electrode and to place another electrode at some location within the well. It has also sometimes been common practice to place two electrodes at opposite sides of a refractory lined well. These are sometimes vertical and sometimes sloping towards each other at the bottom. It has also been a well-known practice to place a closely spaced pair of electrodes on one side of the well. All of these methods of the prior art have certain difficulties of operation. If the electrodes are so spaced that a major portion of the current flows through the working space, tools in this space may short circuit the current causing them to be locally overheated. If the electrodes are closely spaced on one side of the well, a local hot spot may develop in spite of the stirring action of the bath. Or in all of the above cases, difficulty may be encountered with cold or frozen bottoms of the well which sometimes require a long time to melt and become fluid; or to be heated to the temperature of the body of the bath.

One of the most important requirements to be met by a fluid bath heated internally by the passage of electric current therethrough is that the temperature be uniform throughout the bath. The common practice of inserting two straight electrodes vertically in the bath and parallel to each other has the disadvantage of producing a higher temperature at the top of the bath than at the bottom. This undesirable condition develops from the fact that the hotter portions of the bath rise as they are heated, allowing the electrical current to pass mostly through the hotter upper portion which has a lower electrical resistance than does the colder bottom portion. Baths which are excessively hot at the top surface result in non-uniform heating of the articles being processed and have the additional disadvantage of causing excessive erosion of the electrodes at the bath surface.

Attempts have been made in the prior art to overcome this tendency of internally heated fluid baths to become hotter at the top than at the bottom. One method has been to insert the electrodes into a bath which is much larger in cross-section at the top than at the bottom so that the electrodes slope towards each other at the bottom. This method, while producing a more uniform temperature distribution from top to bottom of the bath, entails certain other disadvantages because of the excessive amount of exposed bath surface. Some of such disadvantages are: (*a*) The excessive heat radiated from the larger bath surface causes severe discomfort to the furnace operator; (*b*) Excessive oxidation of electrodes at the bath surface; (*c*) Control instruments are subject to excessive temperatures if near enough to the furnace to be convenient for the operator; and (*d*) The useful working space in the bath is decreased because the walls of the well slope towards each other at the bottom, so that there is danger of shorting long tools against the electrodes in the lower portions of the bath.

All of the foregoing objections to the prior art are met in the present invention which has the advantages enumerated below.

It eliminates the hot top, cold bottom type of bath temperature distribution obtained with parallel vertical electrodes.

It eliminates the excessive surface heat losses associated with baths of the same work capacity which have a large cross-sectional area at the surface and taper to a smaller cross-sectional area at the bottom. In comparison with the latter type it allows more work space in the bath so that there is less danger of shorting the work across the electrodes near the bottom.

When furnaces of this character are placed in operation, and this occurs at regular intervals during their normal use in industry, it becomes necessary to first melt a small amount of the "salt" between the electrodes in order that it may become a conductor and establish a path of current flow between the electrodes. This pool of fluid salt then acts as a heating medium for the purpose of melting the remaining portions of the bath as they are added. When the electrodes are relatively widely spaced in the well, it becomes necessary in "starting" the bath to employ auxiliary resistance units such as for example those illustrated in Bellis Patent No. 1,864,885 or to employ other auxiliary heating means such as an oxy-acetylene flame.

It is a principal object of our invention to

provide a furnace of the character described in which the electrodes are so arranged as to obviate or improve all of the above mentioned difficulties.

Other objects of our invention will appear as the description proceeds.

To the accomplisnment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a vertical transverse sectional view of one form of furnace embodying the principles of our invention; and

Fig. 2 is a plan view of the same; and

Fig. 3 is a plan view showing an alternative form of construction.

Referring now more specifically to the drawing, the furnace here illustrated comprises a metallic outer shell 1 encasing a thick layer of insulating material 2, and an inner metallic lining 3 to act as a container for any portion of the fluid bath which might leak through the inner refractory lining 4. The refractory lining 4 is commonly formed of a dense, durable material which will withstand the action of the highly heated bath which is maintained in the well 5.

The construction of the furnace itself, that is, the bottom and side walls by which the well 5 is provided, are entirely conventional, and form no part of the present invention.

Our invention is concerned with the location, size, and arrangement of the electrodes such as 6 and 7 respectively which, in the preferred embodiment of our invention, hang into the well 5 closely adjacent to opposite sides thereof. The upper terminals 8 and 9 of these electrodes are rebent to rest on the refractory upper portion of the furnace adjacent the well 5, and in this fashion, support the hanging portions of the electrodes in the well. The refractory materials serve both as effective electrical and thermal insulators.

At their lower ends the electrodes 6 and 7 are provided with rebent portions or toes 10 and 11 respectively, which extend toward each other in a plane slightly above the floor of the well.

As illustrative of relative sizes and proportions of the various parts, it may be pointed out that in a commercial installation which has proven highly successful, the width of the well as viewed in Fig. 1 is about 10 inches. The length of the toes 10 and 11 are such as to leave a space of about one inch therebetween. For best operation such space may vary from about ½ inch to about 6 inches.

The toes 10 and 11 are arranged at a distance of about one inch above the floor of the well. In the previously identified commercial installation the width of each electrode or series of electrodes on one side of the well as shown in Fig. 2 is equal to at least one-third the width of the well.

The sizes and proportions given above are those which have been found to be desirable in a commercial construction of the character and size above identified. As the size of the furnace is changed, the illustrative sizes and proportions given above will also be changed, although not necessarily in direct proportion to the change in the size of the furnace itself. The dimensions which will be found most critical are the relative distances between the vertical portions of the electrodes and the distance between the toes of the electrodes.

The relationship between these dimensions should be such as to insure that at least the major proportion of the current flow in the bath between the electrodes is in that area of the bath between the toes of the electrodes. Accordingly, the distance between the vertical portions of the electrodes should be substantially greater than the distance between the toes of the electrodes. The resistance in the bath between the vertical portions of the electrodes will then be greater than the resistance of the current path in the bath between the toes of the electrodes. The major proportion of the current will consequently flow between the toes of the electrodes. There are several factors which enter into the final determination of these relative distances in any commercial construction. Such factors are the width of the bath, the depth to which the vertical portions of the electrodes extend into the bath, the surface area of the electrodes, and other factors which will be apparent to those skilled in the art.

In general, the "effective" distance between the vertical portions of the electrodes should be greater than the effective distance between the toes of the electrodes. The "effective" distance between the electrodes in any area may be defined as the total distance minus the amount of such area which is normally occupied by work when the furnace is in use. It is well known that the electrical resistance through the metallic work piece is generally less than through an equivalent volume of bath.

At this point it will be observed that one of the advantages of our improved construction over prior art structures, in which the electrodes slope toward each other from the top to the bottom of the bath, is that the useful working space in the bath is increased, and the danger of short-circuiting tools against the electrodes is decreased.

To the electrodes 8 and 9 there are connected electrical power leads 12 and 13 respectively, the same for convenience of illustration in the drawing being shown connected to a suitable source of controllable electrical energy 14.

In the embodiment of our invention shown in Figs. 1 and 2 of the drawing one pair of electrodes has been illustrated. Considerations of cost, size of furnace, and facility of manufacture may, however, make it more expedient to employ a plurality of pairs of electrodes as illustrated in Fig. 3. Each such pair is constructed, arranged and energized like the single pair previously illustrated and described.

A furnace constructed in accordance with our invention may be conveniently "started" by merely heaping enough salt on the floor of the well so as to bridge the ends of the electrodes. A small rectangular steel bar may then be inserted between the ends of the electrodes. This loose connection strikes an arc generating locally an intense heat. Immediately a small pool of the salt will be melted and then the same serves as a resistance medium for the generation of sufficient heat to progressively melt the additional quantities of the bath which may then be progressively added to the well. After the pool has been established, the small steel bar should be removed.

When the electrodes are arranged in the manner illustrated and described, the major portion of the current flowing between the electrodes will pass through that small section of the bath lying between the electrode toes 10 and 11. This highly heated portion of the bath will, by convection and electrical stirring, cause an even distribution of heat throughout the entire bath so that there are none of the local "hot" areas which have characterized many of the prior art structures.

A still further and perhaps more important factor responsible for the successful operation of our furnace is the greatly reduced or almost total absence of current flow through that portion of the bath occupied by the metal articles undergoing treatment.

Hence, there is no danger of locally overheating the work by accidentally shorting it across the electrodes. Most important of all, the generation of most of the heat in the center of the bottom of the bath produces a uniform temperature distribution throughout the bath and tends to prevent warping and distortion of the work.

All of the foregoing advantages of our improved construction are secured by an arrangement of electrodes such that they may be removed or replaced without disturbing the remaining structure of the furnace, and accordingly when repairing, removing, or replacing the electrodes in our construction, it is neither necessary to cool the bath nor empty the bath. Because the electrodes do not pass through the wall of the furnace below the level of the bath, there is no possibility of leakage of the bath through the furnace wall around the electrodes.

We have accordingly provided an extremely simple structure which, as indicated, obviates the difficulties of the prior art.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

We therefore particularly point out and distinctly claim as our invention:

1. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes so arranged in said well that the major proportion of the heating current passes horizontally therebetween and is concentrated in an area of the bath closely overlying the bottom of the well.

2. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes extending into said well at opposite sides thereof, hanging vertically and parallel to each other from the top of the well to within a short distance of the bottom and extending horizontally toward each other near the bottom of the well whereby the major proportion of the heating current passing therebetween is concentrated in an area of the bath closely overlying the bottom of the well.

3. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance and in which metallic articles to be heat-treated may be suspended, of heating electrodes extending downwardly into said well closely adjacent opposite sides thereof to a plane below the area normally occupied by the work in said well and then horizontally toward each other for a distance sufficient so that during normal operation of the bath substantially all of the heating current flowing between said electrode passes horizontally through that area of the bath below the space occupied by the work.

4. A structure in accordance with claim 3 which is further characterized in that said electrodes are at least ⅓ as wide as the well sides with which they are associated.

5. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes so arranged in said well that the major proportion of the current flow horizontally through the bath is in an area in the center of and closely adjacent to the bottom of the well.

6. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes extending into said well at opposite sides thereof, hanging vertically and substantially parallel to each other from the top of the well to within a short distance of the bottom and extending horizontally toward each other near the bottom of the well, the distance between the portions thus extending toward each other being sufficiently smaller than the distance between the vertical portions so that the major proportion of the heating current passing between the electrodes will be concentrated in the shorter horizontal path which accordingly has the lower electrical resistance.

7. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes so arranged in said well that the ends thereof approach each other across the bottom of the well to a horizontal distance within the limits of ½ inch to 6 inches.

8. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of heating electrodes so arranged in said well that the ends thereof approach each other across the bottom of the well to a horizontal distance of approximately 1 inch.

9. The combination with a heating furnace provided with a well adapted to contain a fluid bath heated by its own internal electrical resistance, of a pair of heating electrodes respectively arranged to enter the bath at opposite sides of the surface, extend downwardly along the side walls of the well, then approach each other across the bottom of the well leaving a gap between the toes in the center of the bottom of the bath through which is concentrated the major portion of the current flow through the molten bath.

10. The method of heating a heat-treating bath of the character which may be heated by its own internal electrical resistance, which comprises concentrating the major portion of the heating current horizontally in a local area in the center of the bottom of the bath.

11. An electric salt bath furnace comprising a plurality of electrodes for passing current through the bath and adapted to be connected to a source of current supply, said electrodes having portions extending downwardly toward the bottom of the bath and having portions connected to said first portions and extending in a single plane substantially parallel to the bottom of the bath, said last named portions being positioned with their ad-

jacent edges relatively close to generate large currents and produce vigorous thermal circulation.

12. An electric salt bath furnace comprising a plurality of electrodes for passing current through the bath and adapted to be connected to a source of current supply, said electrodes having portions extending downwardly toward the bottom of the bath and having portions connected to said first portions and extending in laterally spaced relation relatively close to the bottom of the bath, said last named portions being positioned with their adjacent edges relatively close as compared with the distance between said downwardly extending portions.

WILLIAM WILSON.
JOHN J. BRUTVAN.