

June 20, 1950

A. F. HOLDEN ET AL
ELECTRIC SALT BATH FURNACE

2,512,206

Filed Sept. 9, 1947

4 Sheets-Sheet 1

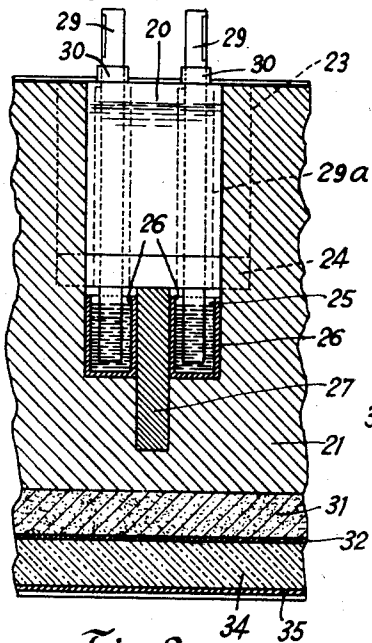


Fig. 2

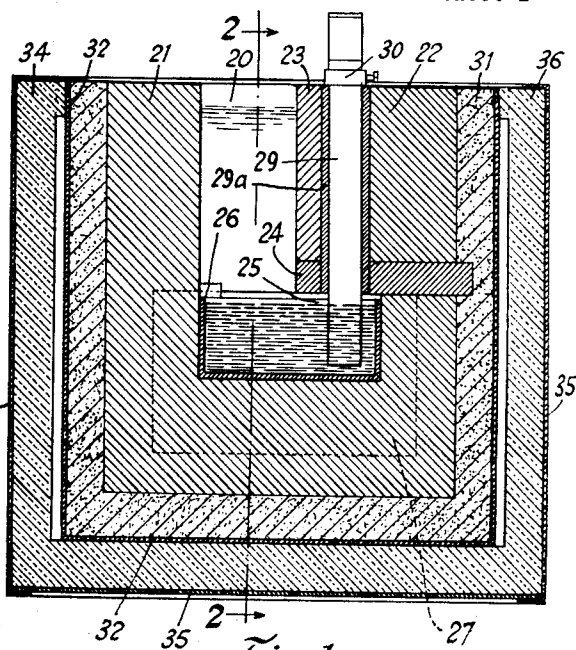


Fig. 1

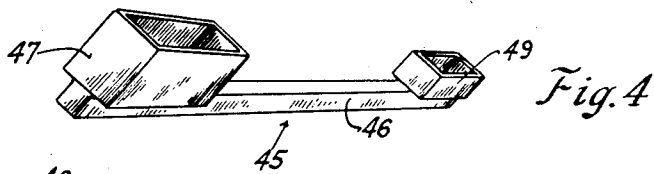


Fig. 4

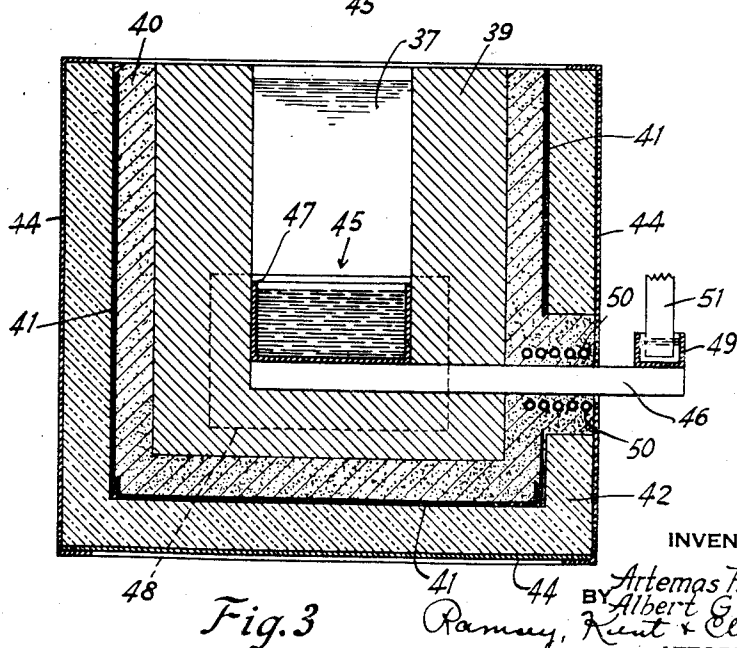


Fig. 3

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4 Sheets-Sheet 2

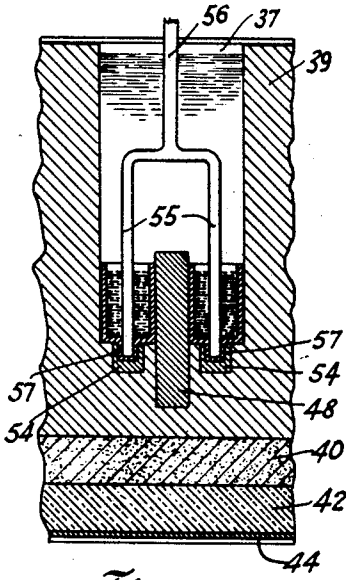


Fig. 6

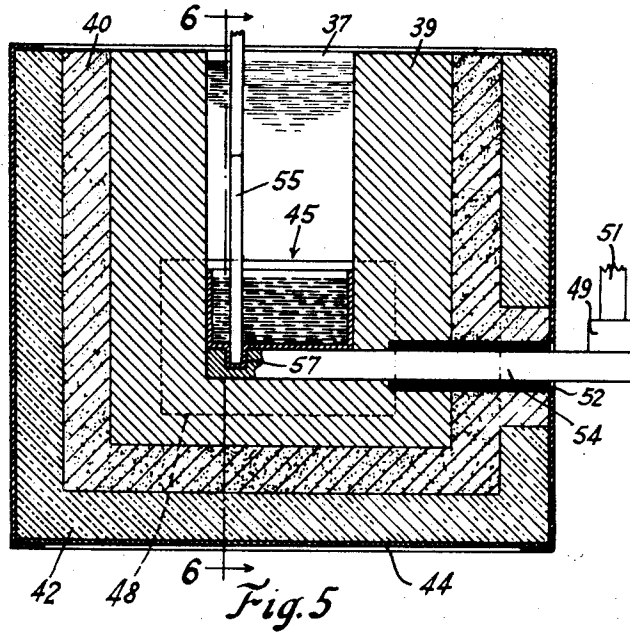


Fig. 5

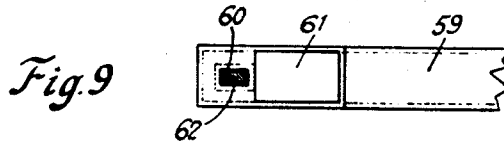


Fig. 9

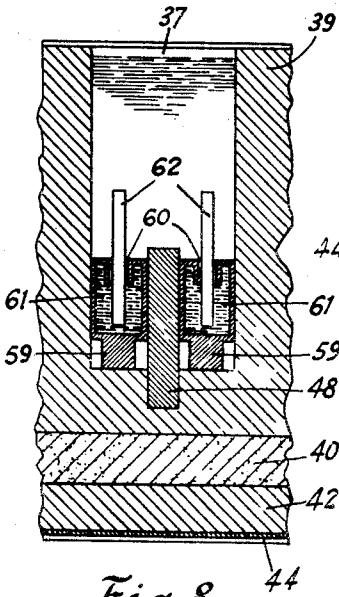


Fig. 8

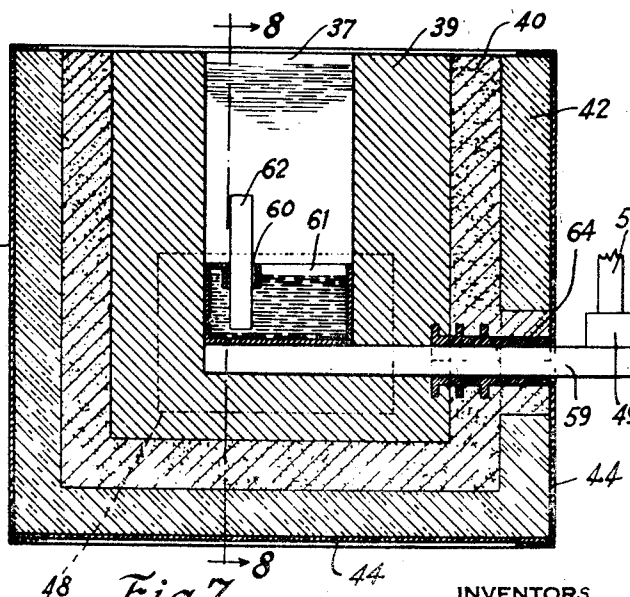


Fig. 7

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4 Sheets-Sheet 3

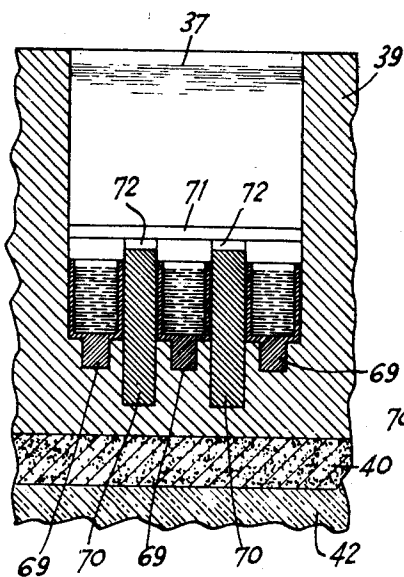


Fig. 11

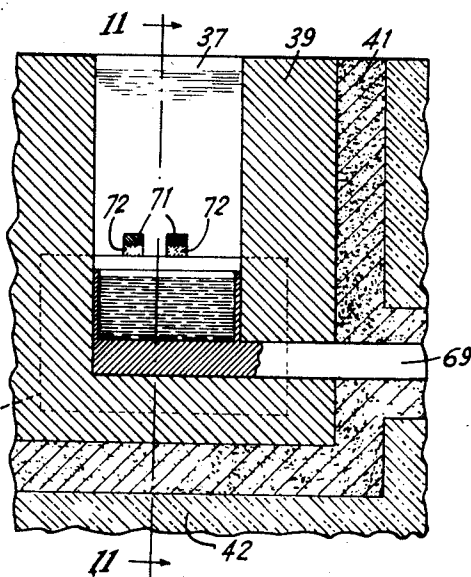


Fig. 10

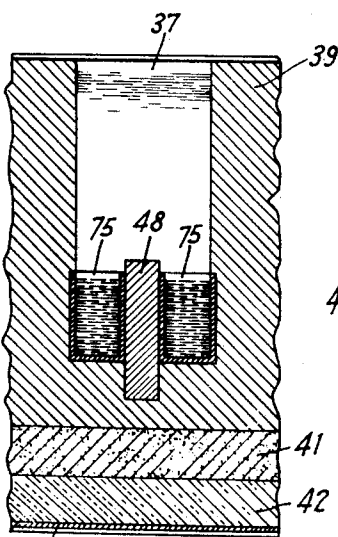


Fig. 13

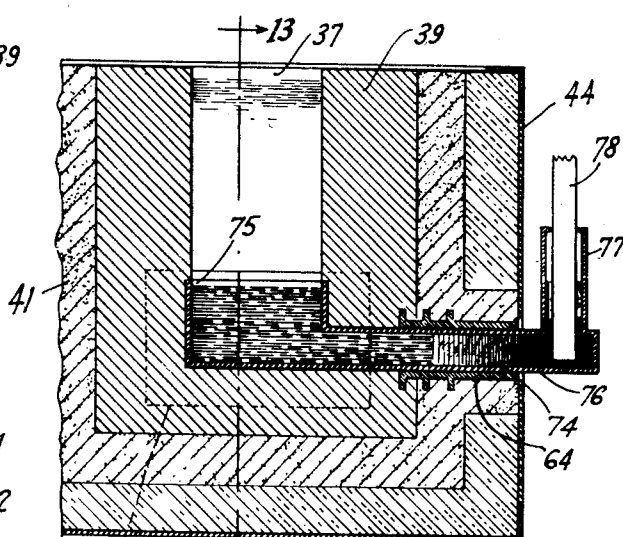


Fig. 12

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4 Sheets-Sheet 4

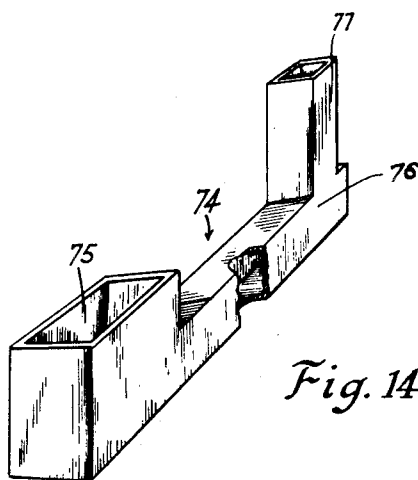


Fig. 14

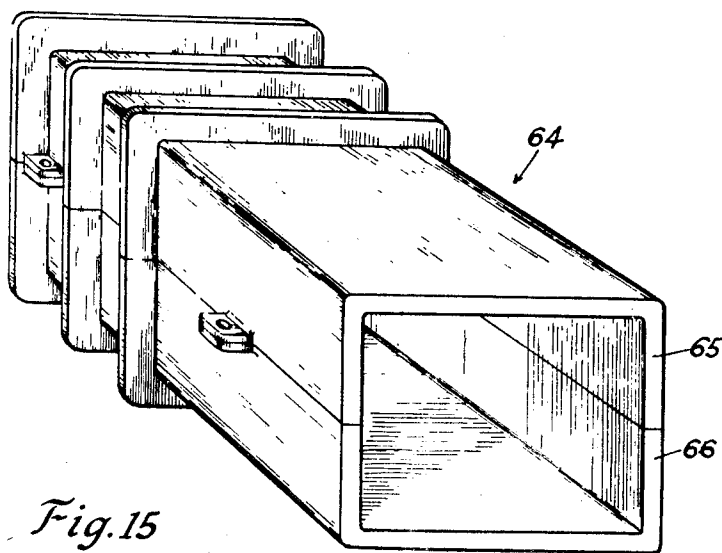


Fig. 15

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ELECTRIC SALT BATH FURNACE

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Application September 9, 1947, Serial No. 772,950

9 Claims. (Cl. 13—23)

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This invention relates to electrical salt bath furnaces in which a liquid salt bath is heated by electrodes in contact therewith, the electric current passing through the bath. One feature of the present invention is that the bath contacting portions of the electrodes are formed principally of a conductor, preferably a heavy metal, such as lead or lead alloy, which is in liquid phase at the operating temperature of the furnace.

This construction has as its principal purpose the introduction of the electrical current into the salt bath with a minimum of electric power loss, so that the heating effect of the current will occur principally in the salt bath where the heat is desired rather than in the electrodes where the heat is not desired and is in some respects detrimental to furnace operation and life of electrodes.

The power loss experienced in such a construction is held to a minimum by the inherent self-cleaning properties of a liquid metal electrode in contact with a liquid salt bath. By the very nature of the electrode, any insulating film, such as an oxide coating, formed on the bath contacting surface of the electrode will be non-adherent and discontinuous and carried as a sludge on the surface of the liquid electrodes. In this respect, such electrodes may be regarded as self-cleaning, a good electrical contact being maintained between the electrodes and the bath at all times.

In the case of conventional solid metal electrodes, the scale or film forming on the electrodes is usually composed of oxides and silicates and is very adherent to the electrodes. This scale has a high electrical resistance. There is no known practicable way to remove this scale or prevent its formation. Upon the passage of current into and through the salt bath, a considerable heating effect of the electric current is concentrated in this oxide layer on the surface of the electrodes, the electrodes operating at a temperature hotter than the salt bath temperature. This is in contrast with the operating temperature of the "liquid" electrodes of the present invention, wherein the electrodes are of somewhat lower temperature than the bath temperature due to the lack of scale separating the electrodes from the bath. In addition to the "liquid" electrode construction, the electrode surfaces are separated to give a larger zone of heating of the salt bath than occurs when conventional electrodes are closely spaced in parallel relation. The effect of increasing the heating zone is to reduce the temperature to which the salt bath within the heating zone is heated. This effect is en-

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hanced by the fact that the electrodes are cooler than the bath temperature and are therefore not additionally heating the bath by heat transfer therefrom. Heat is produced by passage of current through the bath rather than by heat generated at the electrode surfaces.

Since the heating zone of the bath is larger and cooler than in conventional construction, breakdown of the salts due to excessive temperatures within this hot zone and adjacent to the electrodes is reduced to a minimum, contributing to long bath life and lessening requirements of replenishing and rectifying the bath.

In addition, erosion of the ceramic wall of the pot is reduced due to reduction of thermal circulation of the bath, arising from its more uniform temperature. At higher operating temperatures, refractory furnace linings are subject to attack at the ceramic grain boundaries, this attack being a function of the velocity of flow of the bath. By maintaining the temperature within the enlarged heating zone of the bath nearer to the temperature of the remainder of the bath, velocity of circulatory flow of the bath is reduced.

In the present furnace the fact that the electrodes are in the bottom of the salt chamber, and the further fact that the conductors for the electrical current do not descend through the salt chamber, leaves the entire chamber clear for the suspension of work to be treated.

A further result of the electrodes being located in the bottom of the salt chamber is that the lower portion of the salt bath a short distance above the electrodes becomes the hottest portion of the bath, and since the top of the bath in contact with air is the coolest portion the final result is a vertical thermal circulation in the salt bath which passes the hot salt bath around work suspended in the bath and thus produces uniform heating of the work.

The foregoing liquid electrode construction facilitates the use of a metallic electrical resistance or starting fork which may be placed in position bridging between the electrodes after closing down the furnace and before the salt bath solidifies. Upon restarting the furnace, the current will pass through the starting fork, the frozen salt bath being a very poor conductor of electricity. The starting fork acts as a resistance heater, being heated by the passage of electrical current and in turn heating and fusing the adjacent salt bath. After a sufficient portion of the salt bath has been heated in this fashion, the starting fork is removed and the bath continues to heat in the usual manner.

More specifically, the objects of the present in-

vention are to provide an improved electrode and furnace construction such that the salt bath will be heated more efficiently and uniformly, and the electrodes will operate at a lower temperature; to lessen contamination of the salt bath by the electrodes; to facilitate starting up of the furnace and fusion of the salt; to facilitate removal of sludge and scale from the bath; to provide electrodes which are adjustable for various operating voltages; and to generally improve the construction of salt bath furnaces.

Further objects and improvements relating to details of structure and economies of manufacture will more definitely appear from the following description.

Our invention is clearly defined in the appended claims. In the claims, as well as in the description, parts are at times identified by specific names for clarity and convenience, but such nomenclature is to be understood as having the broadest meaning consistent with the context and with the concept of our invention as distinguished from the pertinent prior art. The best form in which we have contemplated applying our invention is illustrated in the accompanying drawings forming part of this specification, in which:

Fig. 1 is a vertical section of a salt bath furnace embodying the present invention.

Fig. 2 is a fragmentary vertical section of the furnace shown in Fig. 1, taken on the line 2—2 thereof.

Fig. 3 is a vertical section similar to Fig. 1 of a modified furnace.

Fig. 4 is a perspective view of one of the electrodes of the furnace shown in Fig. 3.

Fig. 5 is a vertical section similar to Fig. 1 of a still further modified form of furnace, a starting fork being shown positioned within the furnace.

Fig. 6 is a fragmentary vertical section of the furnace shown in Fig. 5, taken on the line 6—6 thereof.

Fig. 7 is a vertical section of a still further modified form of furnace.

Fig. 8 is a fragmentary vertical section of the furnace shown in Fig. 7, taken on the line 8—8 thereof.

Fig. 9 is a fragmentary top plan view of one of the electrodes of the furnace shown in Figs. 7 and 8.

Fig. 10 is a fragmentary vertical section of a still further modified form of furnace.

Fig. 11 is a fragmentary vertical section of the furnace shown in Fig. 10, taken on the line 11—11 thereof.

Fig. 12 is a fragmentary vertical section of a still further modified form of furnace.

Fig. 13 is a fragmentary vertical section of the furnace shown in Fig. 12, taken on the line 13—13 thereof.

Fig. 14 is a perspective view of the electrode incorporated in the furnace shown in Figs. 12 and 13.

Fig. 15 is an enlarged perspective view of the electrode cooling jacket incorporated in the furnace shown in Figs. 12 and 13.

Referring now to the drawings and particularly to Figs. 1 and 2, the electrode type electric furnace is formed for the most part of conventional materials. A furnace pot 20 is formed of block refractory material 21 which is built up to form the sides and bottom of the pot.

The refractory material 21 on one side of the pot is built out to form an overhanging ledge 22 which may be supported by a refractory slab 24, leaving an enlarged chamber 25 at the bottom of

the pot 20, the ledge being faced with another refractory slab 23.

The chamber 25 receives a pair of containers 26, 26, open at the top, which are preferably formed of heat-resistant metal, such as a nickel iron or chrome iron alloy, and may completely fill the chamber 25 with the exception of a space between the containers which is filled by a refractory slab 27. The refractory slab 27 is of such size as to extend slightly above the containers 26, 26 and into the block refractory 21 forming the sides and bottom of the furnace pot for some distance, as indicated in Fig. 1, the reasons for this construction being hereinafter explained.

The refractory materials forming the furnace pot are selected from those which do not conduct electric current to any appreciable extent and which are substantially nonreactive with the salt bath to be employed.

The containers 26, 26 each receives the end of an electrode or conductor 29 extending from the top of the furnace downwardly through the overhanging ledge 22. The conductors 29, 29 are provided with collars or clamps 30, 30 at their upper ends to better support the conductors in the pot wall. To facilitate removal of the conductors 29, 29, they are received within metal sleeves 29a, 29a of a rectangular cross section, set within the refractory pot wall.

The sides and bottom of the block refractory 21 are surrounded by a layer of rammed refractory 31 which is contained within a metallic receptacle 32, formed of heavy gauge iron or alloy steel. The receptacle 32 is contained within a layer of insulating material 34 customarily used in electric furnace construction which is in turn contained within a second or outer receptacle 35 formed of sheet metal and serving as a frame for the furnace. A ceramic seal 36 may be placed around the upper margin of the insulating material 34 to protect this material against damage.

For operation of this furnace, the containers 26, 26 are substantially filled with material, preferably a metal or metal alloy, which is considerably denser than the salt bath to be employed, which is liquid at the operating temperature of the furnace, and is a good conductor of electricity in both its solid and liquid phases. In addition, this material must be non-volatile and non-fuming at furnace operating temperature and substantially non-reactive with the furnace bath salts. We have found that lead and alloys of lead meet these requirements and are relatively inexpensive although silver and other metals could be employed. This metal forms the principal bath-contacting portion of the electrodes for conducting the electric current into and from the salt bath.

The balance of pot 20 is filled with any desired salt bath which is selected in accordance with the operating temperature of the furnace, the heat treatment desired, and other considerations, as is well-known in the art.

In the operation of this furnace the transformer connections, not shown, are clamped to the upper ends of the conductors 29, 29 in the customary manner, thus conducting current into the pools of metal within the recesses of containers 26, 26. The current will flow through this molten metal and into the salt bath, establishing an electrical field or heating zone, the current passing above the ceramic slab 27 and heating the salt bath in the normal manner. There will, undoubtedly, be some current passing directly from the conductors 29, 29 through the salt bath and

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from the containers 26, 26 into the salt bath but this flow of current will be relatively slight and will not substantially affect the operation of the furnace.

The advantages of the foregoing construction are manifold. By removing the conductors 29, 29 from the pot 28 and enclosing them within the refractory material forming the pot wall, they are insulated somewhat from the heat of the molten salts. Further, these conductors serve only to conduct the electric current to the liquid metal within the containers 26, 26, there being no substantial area of the conductors in contact with the salt bath. Accordingly, no extended layer of scale forms on these conductors so as to heat the conductors to a temperature above that of the salt bath. The result is that there is substantially no power loss between the transformer and the liquid metal electrodes within the containers 26, 26.

As above described, the bath-contacting surface of the liquid metal within the containers 26, 26 is to a large degree self-cleaning, it being impossible for any continuous adherent scale to form on the surface. Accordingly, there is no power loss as current passes between the electrodes and the salt bath, and, therefore, no heating of the surface of the electrodes and consequent overheating and breakdown of the salt bath as in conventional constructions. Further, due to the non-scaling properties of such electrodes, electrode current densities far higher than practicable with conventional solid electrodes may be employed. It has been found that whereas conventional electrodes often operate at a temperature up to 200° hotter than the temperature of the salt bath, the temperature of the liquid metal electrodes may be as much as 200° below the temperature of the salt bath.

Normal furnace sludge and oxide scale from the work which may tend to accumulate on the surface of the liquid metal electrodes may be scooped off from time to time to maintain good electrical contact between the electrodes and the bath.

While the lead comprising the liquid metal electrodes may be slowly oxidized even though protected from the atmosphere by the salt bath, the lead oxide or litharge so produced will have a beneficial rather than a harmful effect on the bath. This material will enter the salt bath and tend to reduce oxides of the work being treated (which is often found to be present in small quantities in the bath) thus lessening the hazard of decarburizing steel parts treated within the bath. Due to oxidation, the lead may be slowly consumed but can be replenished from time to time without closing down the furnace by adding solid or molten lead or lead alloy to the electrodes as required.

By separating the electrodes, the heating zone of the salt bath is enlarged, and, therefore, the temperature of the heating zone is decreased, resulting in a more uniform bath temperature. A more uniform bath temperature has two effects; first, it reduces erosion of the ceramic walls of the pot which occurs due to inter-granular attack of the ceramic, and second, it decreases the rate of breakdown of the salts, adding materially to the bath life and decreasing the frequency of bath replenishing or rectification.

The temperature of the conductors 29, 29 of the electrodes decreases from their point of contact with the liquid metal of the electrodes to the exterior of the furnace, no special cooling of the

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conductors being required in order to prevent heating of the transformer.

The metallic containers 26, 26 have a relatively long life, but may eventually crack from the heat of the bath, failing to retain the liquid metal portion of the electrodes, after which they must be replaced. The refractory slab 27 between the metallic receptacles 26, 26, which extends well within the block refractory material 21 to prevent any lead from either container contacting the other container and short-circuiting the furnace, is likewise long-lived. The upper edge of this slab may become somewhat eroded due to the elevated temperature of the salt bath, but this occurs only slowly over a considerable period of time.

The first modified form of furnace shown in Fig. 3 embodies the salient features and advantages of the above-described furnace. In this form of furnace, the furnace pot 37 is likewise formed of block refractory material 39, but the electrodes are introduced through the side wall of the furnace at the bottom of the pot, as will be described, the furnace structure being modified accordingly.

A layer of rammed refractory material 40 surrounds the block refractory 39. Outside of the rammed refractory 40, metallic plates 41, formed of aluminum or other highly heat-conductive material, are placed around the sides and the bottom of the furnace. The plates 41 need not be tightly joined along their intersections since the purpose of these plates is merely to prevent liquid salt bath from leaking through cracks in the furnace wall, which tend to form after a period of operation of the furnace, and heating the outside shell of the furnace. Upon any molten salt contacting one of the metallic plates 41, the plates will immediately conduct sufficient heat away from molten salts so as to freeze the salt at that point and prevent its further flow within the furnace walls.

A layer of insulating material 42 surrounds the metallic plates 41 and is contained within the outer receptacle or shell 44, formed of heavy gauge steel plate. Electrodes 45, 45, see Fig. 4, may be formed of chrome iron or nickel iron to resist the corrosive effect of the salt bath. Each electrode 45 is formed of a long conductor or shank 46 having an open-topped recess or container 47, similar to container 26 previously described, welded or otherwise fixed to an end thereof. The opposite or outer end of the shank 46 has a somewhat smaller container 49 similarly secured to the shank. The electrodes 45, 45 are separated by a ceramic slab 48 similar to slab 27 of Figs. 1 and 2.

A series of cooling pipes 50 are placed transversely of the furnace both above and below the electrodes 45, 45, thus chilling the furnace wall at this point and preventing any molten salt from flowing to the outside of the furnace alongside the electrodes.

The large container 47 of each electrode 45 is filled with lead or other suitable material as above described, and the smaller container 49 of each electrode may be filled with molten lead and the terminal end of a bus bar 51 placed therein, the lead being allowed to solidify so as to provide a good electrical connection to a transformer. During operation of the furnace, heat conducted outwardly along the shank 46 of the electrode will not be sufficient, under any circumstance, to ap-

proach the melting point of lead so as to re-fuse the lead within the container 49.

This first modified form of furnace has substantially the same operating characteristics and advantages of the furnace above described. In addition, the electrode shanks of this furnace are further removed from the molten salt bath and tend to operate at slightly lower temperatures. This furnace is of particular advantage for deeper pots.

Referring now to the second modified form of my invention shown in Figs. 5 and 6, the furnace structure is generally similar to that shown in Fig. 3, similar parts being given the same reference numerals. However, in this instance the metallic plates 41 have been omitted and the cooling pipes 50 have been replaced by thin sheets 52 of aluminum or other good heat-conducting metal which is wound individually about the shank of each electrode 54. Any molten salt flowing outwardly alongside the shank of either electrode 54 will immediately be chilled and solidified upon contact with the sheets 52 due to their heat-conductive properties, serving to seal any space between the shank of the electrodes and the refractory material of which the furnace is formed. The heat at this portion of the furnace is normally insufficient to re-fuse solidified salt bath.

Electrodes 54, 54 of this furnace are generally similar to the electrodes 45, 45 of the furnace previously described, this furnace likewise employing pools of liquid metal as the principal bath-contacting portion of the electrodes.

A starting fork 55 is shown in position within this furnace, this fork consisting of a generally bifurcated strip or bar of chrome iron or other suitable corrosion-resistant electrical resistance material. A handle portion 56 projects upwardly for convenient handling of the starting fork.

The length and cross section of the bifurcated portion of the starting fork 55 is such as to form an electrical resistance heating unit of the proper electrical resistance so as to be capable of fusing salt bath between the electrodes 54, 54. In closing down the furnace, the starting fork 55 is inserted into the salt bath after the power is shut off and before the furnace is cooled sufficiently for the bath to solidify. For this purpose, pockets 57, 57 may be provided within the containers of the electrodes 54, 54 for reception of the starting fork.

Upon restarting the furnace after being permitted to cool, the solidified salt does not conduct any material amount of current and cannot be heated in its solid state by passage of current between the electrodes thereof through the bath. However, the current is conducted between the electrodes through the starting fork 55, heating this fork which in turn fuses the salt bath. As soon as the salt bath has been fused in a path between the electrodes, the current between the electrodes will flow through both the salt bath and the starting fork 55, continuing to heat the salt bath. After the salt bath has been sufficiently fused to permit withdrawal of the starting fork 55, it is withdrawn altogether from the furnace and not reinserted therein until the furnace is again closed down.

Referring now to the third modified form of our invention shown in Figs. 7 to 9, inclusive, the furnace wall structure shown therein is substantially similar to that shown in Figs. 5 and 6. The furnace electrodes 59, 59 of this furnace are generally similar to that shown in Fig. 4. However, in this instance, a hole or pocket 60 is provided

at one end of the recess or container 61 of each electrode for reception of an auxiliary electrode 62.

The auxiliary electrode 62 may be formed of conventional salt bath furnace electrode material, such as chrome iron or nickel iron alloy, and projects upwardly somewhat from the container 61 of each electrode. The auxiliary electrodes 62, 62 shorten the path of the current flowing through the salt bath of this furnace so as to permit use of this furnace with somewhat lower operating voltages than would otherwise be required, this form of furnace being operable with a standard fixed voltage transformer such as that used to operate an electrode salt bath furnace of the conventional type in which the electrodes are relatively closely spaced.

One further feature of this form of the invention is a cooling jacket 64 surrounding the shank of each of the electrodes 59, 59. This jacket, which is best shown in Fig. 15, is formed of a forging or casting of aluminum or other good heat-conductive metal which is formed in two mating halves 65 and 66 which may be bolted or otherwise secured separately about each electrode shank. The cooling jacket 64 is imbedded in the furnace wall and functions similarly to the sheets 52 wound about the electrode shank of the furnace shown in Fig. 5.

The wall structure of the fourth modified form of our invention, shown in Figs. 10 and 11, only a portion of which is shown, is similar to the structure shown in Figs. 5 and 7. However, in this furnace three electrodes 69 of the type shown in Figs. 3 and 4 are arranged in side-by-side relation across the bottom of the furnace pot, the electrodes being spaced by a pair of refractory insulating slabs 77, as shown in Fig. 11, these slabs being similar to the refractory slab 27 already described. The three electrodes of this furnace may be connected in any customary way, with a single-, two-, or three-phase alternating current supply.

In order to operate this furnace at a somewhat lower voltage than would ordinarily be required due to the spacing of the electrodes, secondary electrodes may be employed, these consisting of bars 71, 71 extending across the electrodes 69 and being spaced somewhat above the electrodes and within the salt bath. The secondary electrodes are formed of corrosion-resistant metal, such as nickel iron or chrome iron, and are supported on insulating ceramic blocks 72 positioned on the top edge of the refractory slab 77. In this furnace, the heating current of electricity passes through the salt bath principally between the electrodes 69 and the secondary electrodes 71, although some current also passes through the salt bath directly between the electrodes 69.

In the fifth modified form of the invention shown in Figs. 12 to 14, inclusive, the furnace structure is similar to that shown in Figs. 5, 7 and 10. However, instead of the solid shank electrodes used in those furnaces, the electrodes 74, 74 of this furnace are each formed of a hollow shell or wall of corrosion-resistant metal, such as chrome iron or nickel iron. Each electrode 74 is filled with lead or lead alloy, in operation the lead contained within the recess or container 75 placed within the furnace pot being molten and the lead in the outer part 76 of the electrode shank remaining solid. The outer end of the electrode 74 is extended upwardly to form a well 77 for receiving a bus bar 78 connected

with a transformer. The well 77 serves to balance the fluid pressure resulting from the lead and salt bath within the furnace pot in the event that, due to overheating for any reason, the lead within the electrode 74 should become entirely fused.

This modified form of furnace also utilizes the cooling jackets 64 previously described, one jacket being positioned about the shank of each electrode.

The features herein disclosed in any of the several modified forms of the invention are in general capable of use in any of the other modified forms of the invention and it is contemplated that they may be used interchangeably.

We claim:

1. An electrode type electric salt bath furnace, comprising a refractory furnace pot adapted to contain salts molten at the operating temperature of the furnace, a pair of spaced open-topped metallic containers at the bottom of the pot separated by a narrow refractory separator, the containers and separator occupying substantially the entire area of the bottom of the pot, and a conductor extending substantially entirely downwardly through the wall of the furnace pot from the top edge thereof and into each container, the containers being adapted to hold a metal liquid at the operating temperature of the furnace.

2. An electrode type electric salt bath furnace, comprising a refractory ceramic furnace pot adapted to contain salts molten at the operating temperature of the furnace, a pair of spaced open-topped metallic containers at the bottom within the pot and adapted to hold a metal liquid at the operating of the furnace, a relatively narrow, electrically nonconductive refractory separator between the containers, and solid conductors leading substantially entirely through the wall from the containers to the outside of the pot; the containers and the separator covering substantially the entire bottom of the pot and the containers covering the greater part of the pot bottom.

3. An electrode type electric salt bath furnace, comprising an open-topped refractory ceramic furnace pot adapted to contain salts molten at the operating temperature of the furnace, a metallic wall surrounding the ceramic furnace pot, a pair of spaced open-topped metallic containers at the bottom within the pot and adapted to hold a metal liquid at the operating temperature of the furnace, a narrow, electrically nonconductive refractory separator between the containers, and solid conductors leading from the containers substantially entirely through the wall of the furnace pot to the upper edge thereof; the containers and the separator covering substantially the entire bottom of the pot and the containers covering the greater part of the pot bottom.

4. An electrode type electric salt bath furnace, comprising a refractory ceramic furnace pot adapted to contain salts molten at the operating temperature of the furnace, a pair of spaced open-topped metallic containers at the bottom within the pot and adapted to hold a metal liquid at the operating temperature of the furnace, a narrow, electrically nonconductive, refractory separator between the containers, the containers and the separator covering substantially the entire bottom of the pot and the containers covering the greater part of the pot bottom and a side

wall of the pot extending over a portion of the containers, and a solid conductor leading upwardly from each container substantially entirely through the pot wall to the top of the pot.

5. An electrode type electric salt bath furnace, comprising a refractory ceramic furnace pot adapted to contain salts molten at the operating temperature of the furnace, a pair of spaced open-topped metallic containers at the bottom within the pot and adapted to hold a metal liquid at the operating temperature of the furnace and forming electrodes, a narrow electrically nonconductive refractory separator between the containers, and solid conductors leading substantially entirely through the wall from the containers to the outside of the pot; the containers and the separator covering substantially the entire bottom of the pot and the containers covering the greater part of the pot bottom: in combination with a removable resistance fork connecting the electrodes.

6. An electrode type electric salt bath furnace as claimed in claim 2 in which the conductors pass laterally through the side of the pot and a sleeve of good heat conducting properties surrounds each conductor within the furnace wall, the sleeve being adapted to freeze any molten salt bath flowing from the pot outwardly beside the conductor.

7. An electrode type electric salt bath furnace as claimed in claim 2 in which an aluminum plate encloses the refractory ceramic pot wall, the plate serving to conduct heat away rapidly from molten salt coming against the plate so as to freeze such salt.

8. An electrode type electric salt bath furnace as claimed in claim 2 in which solid metal electrodes project upwardly from the containers into the salt bath above the level of the separator.

9. An electrode type electric salt bath furnace as claimed in claim 2 in which solid metal electrodes located entirely within the salt bath extend above the metal containers and refractory separator.

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Certificate of Correction

Patent No. 2,512,206

June 20, 1950

ARTEMAS F. HOLDEN ET AL.

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 9, line 36, after the word "operating" insert *temperature*; same line strike out "relatively";

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of September, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.