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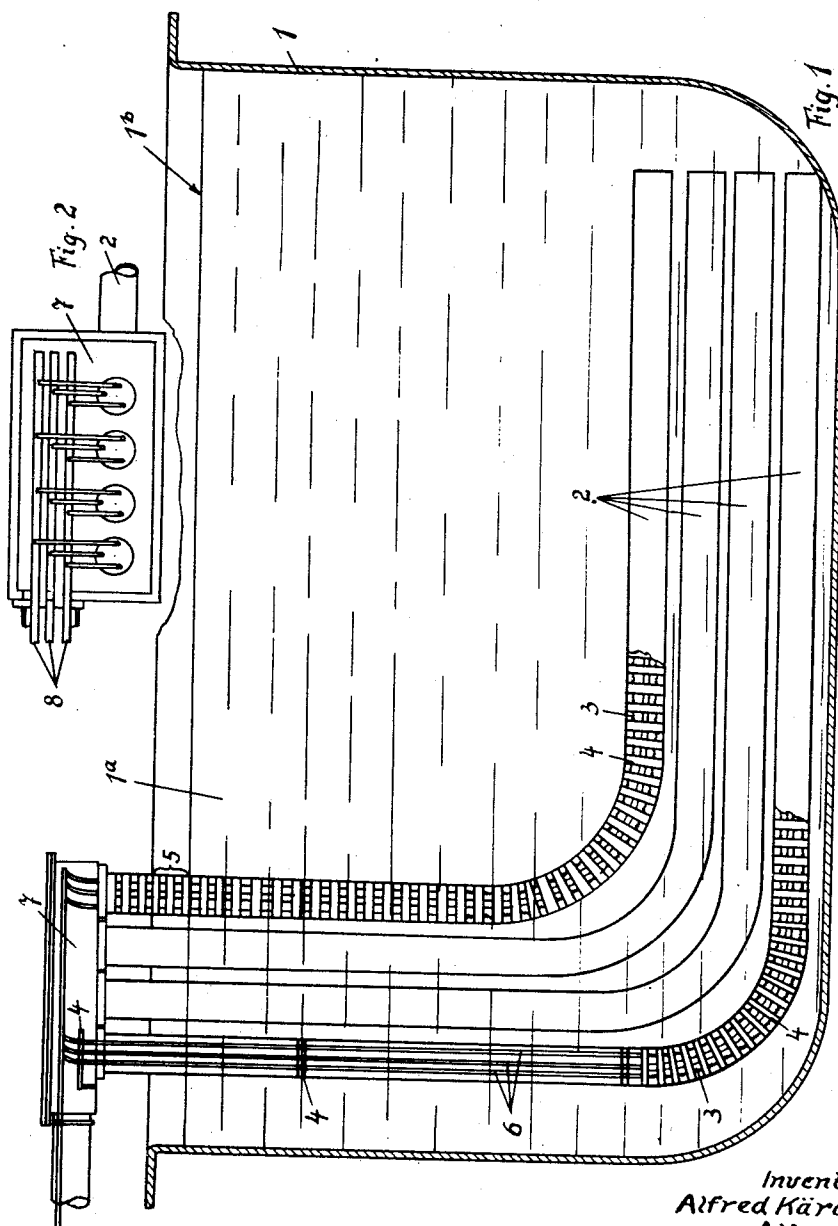
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2,097,981

IMMERSION HEATER FOR SALT BATHS

Filed Sept. 3, 1935

3 Sheets-Sheet 1



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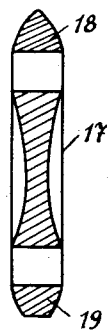
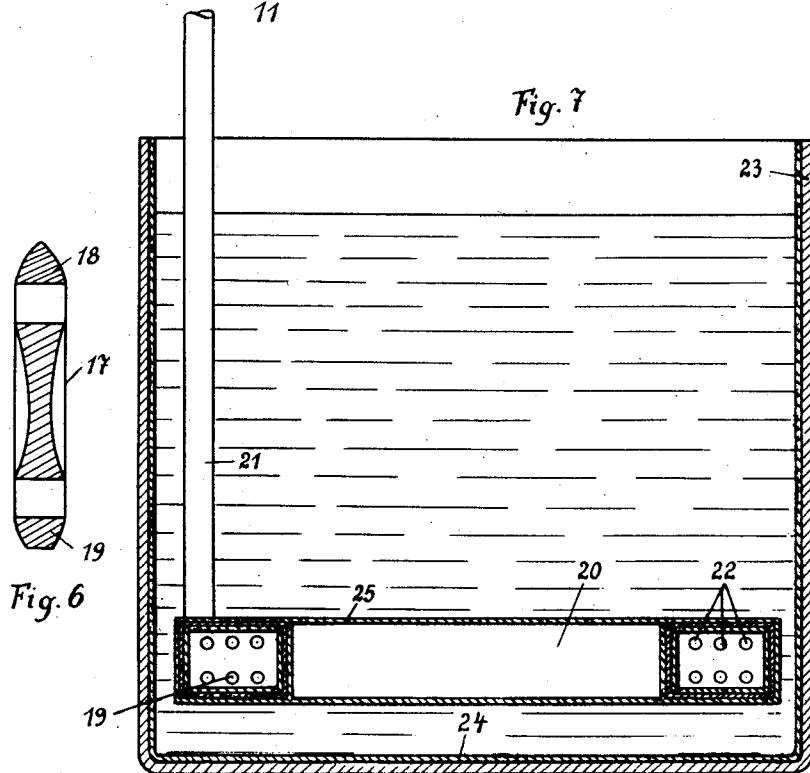
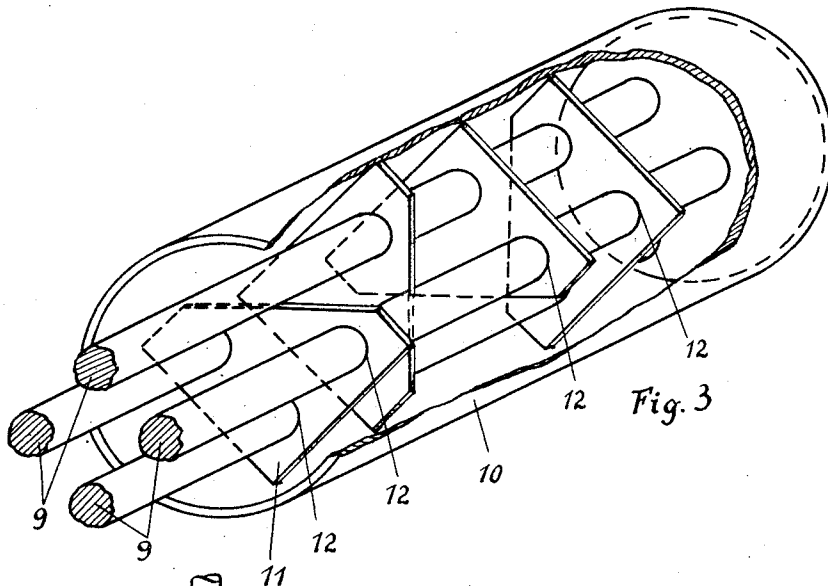
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IMMERSION HEATER FOR SALT BATHS

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3 Sheets-Sheet 2



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IMMERSION HEATER FOR SALT BATHS

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3 Sheets-Sheet 3

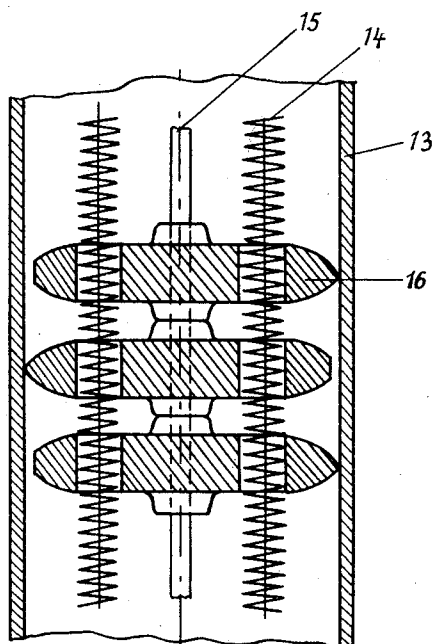


Fig. 4

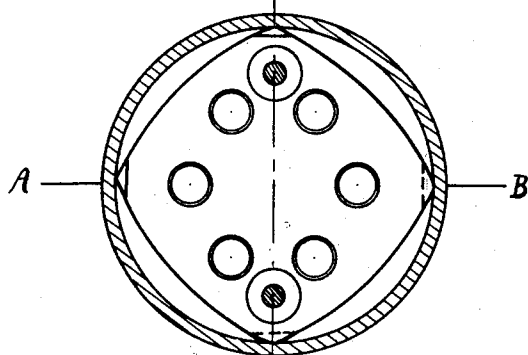


Fig. 5

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UNITED STATES PATENT OFFICE

2,097,981

IMMERSION HEATER FOR SALT BATHS

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15 Claims. (Cl. 219-41)

REISSUED

The invention relates to electrically heated im-
 mersed heating elements for the heating of baths
 which like salt melts tend to intrude into heating
 bodies and have the faculty to destroy the heating
 plants.

It is a known fact to heat liquids, more espe-
 cially water by means of electrically heated
 immersed heating elements consisting of an im-
 mersed pipe and eventually with suitable addi-
 tional immersible pieces such as spiral pipes of
 suitable material, for instance of metal in which
 the heating elements e. g. the resistance windings
 are lodged. These heating elements have how-
 ever not proved satisfactory for the heating of
 salt melts and the like, though in various direc-
 tions they have great advantages. The fault of
 the suitability of such heating elements for bath
 liquids similar to salt melts is, as has been found
 out, essentially due to the fact that the arrange-
 ment of the heating mantle e. g. the pipe with
 numerous windings and the like that are meant
 to enlarge the surface, requires a number of
 welds and that these welds form exactly the favor-
 able points of attack for the obnoxious ingredi-
 ents of such baths. No such difficulties have been
 experienced by the use of water baths or in the
 heating of liquids that do not attack the mantle
 pipes. With such heating bodies therefore an
 exchange of the actual heating elements is not
 necessary. For the treatment of salt melts, how-
 ever, an easy possibility to exchange the heating
 elements is of special importance, inasmuch as
 differences of temperature of some duration be-
 come very detrimental and first of all may bring
 about a stiffness of the smelt.

By the heating element according to the inven-
 tion the aforesaid disadvantages are obviated and
 thus the use of electrically heated immersed heat-
 ing elements for the treatment of salt melts is
 made possible.

It has been found that by avoiding forms of
 construction e. g. branchings of the pipes, mouth
 pieces and the like and thus doing away with
 welds, the life of the immersed heating elements
 is considerably prolonged and what is even more,
 the exchangeability of the heating gear is possible
 without any interruption of the working.

The heating element according to the inven-
 tion consists of a pipe closed at its immersed
 end, that lies only with one simple curvature in
 the bath, in the interior of which a heating gear
 body of resistance spirals is located easily to be
 pushed in or else just as easily removed, which are
 kept in suitable position by thimbles of ceramic

material and facilitate the putting in or the re-
 moval of the heating gear.

By this arrangement is attained that on the
 whole heating element only one single welded
 joint viz. at the closure of the pipe end is neces-
 sary. This welded joint can however also be
 spared, if pipes are used that are closed by forging.
 Salt melts or other bath liquids that easily lead to
 corrosions do not thereby find any points of easy
 attack. If the exchange of the heating gear
 should become necessary, it can easily be taken out
 of the bath region, as the only profitably but slight
 curving offers no resistance. The exchange of
 the heating gear can therefore be effected without
 interruption of the working of the bath especially
 if the heating element consists of several heating
 bodies according to the invention which warrant
 in case of short circuit or the like the maintenance
 of temperature of the bath.

As has furthermore been shown short circuits
 are in most cases by the peculiarity of salt melts
 to intrude into the pipes after a long period of
 working only created in the plane of touch be-
 tween bath and the air outside. It has been found
 that important concentrations of salt take place
 just at such points of the heating gear that are
 located in the level of the salt surface or in its im-
 mediate neighbourhood preferably above, while at
 the other points of the heating gear such concen-
 trations are not yet to be found.

It has therefore been proved to be of advantage
 not to fit the heating gear that consists of several
 resistance spirals that are kept in position by
 thimbles of ceramic material, with distance mem-
 bers within the region of the strong salt concen-
 trations just mentioned, since by these distance
 members the saturated salt steam is enabled to
 condensate and thus to form, as it were, bridges
 that provoke a short circuit.

As another suitable form of execution has been
 found one in which the heating gear from the
 closed end in the interior of the bath is continued
 only up to just below the surface of the bath, but
 close below the surface of the bath straight
 metal rods are connected with the heating gear by
 current connecting terminals. By such an ar-
 rangement salts or other bath liquids that could
 intrude into the interior of the heating gear are
 deprived of the possibility of any such influence
 and furthermore, even if such substances could
 intrude, a concentration on such parts is pre-
 cluded by which the current conductors among
 themselves or against the earth could get short
 circuit. A deposit at the hot parts of the heat-

ing gear while in operation is only slightly noticeable and involves practically no disturbances.

Another possibility to prevent to a large degree a deposit of salts or the like and at the same time to facilitate the exchangeability of the heating gear is effected by fitting the heat conductor supports i. e. the thimbles with one or several broken edges in such a way that at least one edge remains. Thereby will be attained that these supports offer but a slight resistance to the insertion of the whole heating gear into the pipes, that they possess comparatively but little mass and thus show but little accumulated warmth and finally offer no too high resistance to the immediate radiation of warmth from the heating conductor on the pipe walls.

By leaving at least one unbroken edge of the three or more edged e. g. plate like thimbles it is possible to hold the heating gear by the various thimbles in the wanted position within the mantle body. The number of touching points and thus also the shifting resistance of the heating conductor supports on the inside wall of the pipe is thereby reduced to a minimum while the position of the heating conductor remains warranted. Furthermore the mass of the distance bodies is at the same time reduced and the space for the immediate radiation of warmth, as mentioned, is enlarged.

As specially advantageous has been proved to break one of the edges e. g. of a quadrangular distance plate to such an extent that the heating conductor lies completely free at that point. It is profitable to arrange the sequence of the supports, one after the other, of the heating gear in such a way against one another that the unbroken edges lie in a screw like line. It has been shown that thereby the insertion of the bendable heating gear more especially in tightly bent pipes is considerably facilitated.

To increase the free space for the immediate radiation from the heat conductor to the pipe wall it is furthermore of advantage to form the heat conductor support in such a way that its cross cut along the axis of the pipe to be heated at the ends touching the inner wall of the pipe runs out as it were in a point.

Furthermore the choice of material for the mantle body especially the part of the heating body to be immersed into the bath is, as has very often been proved, of particular importance. In working it has been shown that a permeating of salts through the heated walls of immersed heating bodies cannot sufficiently be avoided even by using special iron alloys. This resulted in the fact that immersed heating bodies for salt baths and the like have practically not been used any more.

It has however been proved that by covering of material which like nickel can be attacked but little by the melts, also in such baths an excellent security against the permeation of salts is effected. Tests have shown that a nickel covering of preferably a thickness of more than .08 mm. prevents permeation. More especially by galvanization to such thick layers of nickel perfectly cheap heating bodies of this kind may be manufactured. It is well known that for so called immersed heaters as they are for instance used in households for heating water and similar liquids, nickeled mantles are used. In this case the covering of such heaters with layers of nickel means however only to prevent rusting or rather to produce a pleasant appearance. The use of inside heating bodies as heating bodies on a large

scale of smelting baths forms however in various directions different tasks. The question of prevention of rust is here of minor importance.

It was immaterial to use therefore instead of the hitherto used protecting pipes of iron for these forms of use, pipes of nickel or pipes with nickel covering. It is known first of all that for instance saltpeter containing baths at certain temperatures lead to exothermic reactions with iron, that can become the reason for a sudden melting of the iron and even for explosions. It could hardly be foreseen, how these apparitions that hitherto have not been cleared up, would be changed by using nickel. It is therefore surprising that covering layers of nickel or other material belonging to the type of tinder free alloys do not lead to overheating, explosions and the permeation of salt and the like. It has been shown that by coverings of such kind of material also existing welded joints are so securely cleared that they are practically immune to any destruction by the salt. As has been shown such protecting layers are fitted with advantage not to the heating bodies only but also in the reservoirs i. e. preferably on the surfaces of the reservoirs that face the heating body.

The proposed use of layers of material of the kind mentioned has yet the further advantage that the thermo-pressure existing between the protecting cover and the wall material may be used as is usual with thermo elements to immediately measure the temperature of the wall and of the bath. Such measuring at the walls has the advantage that overheating of the walls may easily be found and quicker regulated than it was possible by the usual manner of measuring the temperature of the salt bath, because here the rises of temperature at the walls came only by a round about way over the salt to the thermo element.

By increase of the thermo currents these appearances can easily be observed also with but little sensitive measuring instruments.

By the enclosed drawings some forms of execution of immersed heating bodies according to the invention are shown.

Fig. 1 shows a longitudinal cut of a salt bath with several immersed heating bodies of various forms.

Fig. 2 shows a down view of a heating body arrangement.

Fig. 3 shows the arrangement of several heat conductors with distance members, showing broken edges in a heating pipe.

Fig. 4 is an axial cut through a piece of pipe with several distance members.

Fig. 5 is a pipe cross cut as per Fig. 4.

Fig. 6 represents a special form of execution of a heat conductor support.

Fig. 7 shows a scheme of a bath with an immersed heating body in longitudinal cut in which several level parts of the heating body as well as of the reservoir are fitted with protecting layers.

According to Fig. 1 the bath reservoir 1 with the salt melt 1a which reaches up to the bath surface 1b through the heating body 2 is heated by four single pipes. These pipes consist each of a horizontal side which represents the actual heating division and a vertical side which serves as supply main. The sides are bent towards one another in such a radius that a bendable heating gear can be inserted from the open end of the pipe.

Two of these pipes are shown in the drawings

cut open. In the upper one of the cut open pipes lies the heating gear in the manner hitherto usual. This heating gear consists of the heating wire spirals 3 as such, which are held in the desired position to one another and to the pipe 2 by the thimble 4 of ceramic material.

As mentioned before, with such an arrangement in the neighbourhood of the bath surface, preferably at the point marked 5 a specially strong deposit of salt in the pipe shows itself. In the lower cut open pipe the heating gear is according to the invention not brought up right to the surface of the bath, but the heating wire spirals 3 are continued by metal rods 6, which permit simply by a single distance support (thimble) below the bath surface to secure the position of the current conductor in the pipe. These metal rods are furthermore far outside the bath held by a corresponding holder. By this arrangement it is impossible that at the endangered point salts are deposited at such parts which connect the current conductor.

The open ends of all pipes 2 are embodied in a closed casing 7 which contains also the collector rails 8 lying on tension, with which the heating wire spirals are connected.

In the detailed drawings according to Fig. 3 the single heating conductors e. g. wire spiral 9 are kept in the desired position in pipe 10 by the thimbles 11. The thimbles or supports of heat conductor 9 consist of quadrangular plates, the one end of which is to a large extent cut off. These plates contain openings 12 through which the heating wires are led. These openings are arranged in the supporting bodies in such a way that they form a ring around the centre of the quadrangle having equal distance from one another, by the shortening of the one edge of the quadrangle, there is however no room for an opening left for one of the wires. Thus the wire gets no lead at that point. The sinheat conductor supports 11 are however arrayed here on the four drawn wires in such a way that the supports following one another are in each case transposed by one hole portion. Thereby the unbroken edges in the longitudinal direction of the pipe lie on a screw line.

In Figs. 4 and 5 a part of a heating gear is shown. In the pipe 13 lie the wire spirals 14 as heat conductors, furthermore the supporting wire 15 on which the supports 16 are centrally arranged. These bodies contain, as shown in Fig. 5 approximately quadrangular cross cut, but with limiting lines curved outward. Two of the edges are broken off, while the other two neighbouring edges are kept. As will be seen from Fig. 4 the three thimbles arranged one above the other e. g. soap stones or preferably stones of even denser mass are arranged one against the other so that the corresponding unbroken edges of the stones in succession form a screw line; as shown in Fig. 4 are furthermore the edges of the heat carriers pointed adjacent to the pipe wall, so that the level piece of the pipe which is getting radiation immediately from the heat conductor is covered as little as possible. The longitudinal cut through a supporting body as per Fig. 6 shows a further minimizing in order to reduce the mass obstructing the radiation. The body 17 is, as will be seen, formed in its middle on both sides concave, the one edge 18 is unbroken, while the other 19 is broken. As shown in Fig. 4 for the strengthening of the opening for a supporting wire on both sides of this opening a flange may be provided.

In the example of execution as per Fig. 7 the heating body 19 is fitted with a junction pipe 20 in ring form. The pipe 21 acts as conductor main. In the heating part 20 the electric heating gears 22 are placed. The bath reservoir 23 can, if needs be, be surrounded by a heat wiring. Its outside walls may in this case be fitted with a protecting layer of material immune to corrosion 24. It is also provided on the inner surface towards the heat carrier with such a protecting layer 24 for instance of nickel.

The immersed heating body has such a protecting layer 25 in the actual heating part viz., inside as well as outside.

The protection on the inside of the pipe has double the effect, viz., in the first instance to prevent the permeation of salt through the wall and at the same time to protect the wall side facing the heat bodies from smoldering. Nickel coverings on the outside of the bath reservoir 20 have proved of advantage only, if heating from outside is resorted to.

I claim:

1. An electrical heating element for immersion heating of salt baths comprising a curved pipe 25 having a conductor supported by spaced insulators extending therein, said insulators being substantially flat, and thin in section, and being formed with a plurality of corners which provide substantially point-like bearings for said insulators against the inside walls of said pipe.

2. An electrical heating element as in claim 1, in which said insulators are substantially rectangularly shaped, but have at least one corner removed, whereby the number of point-like bearings for each insulator is reduced.

3. A heating device for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, and consisting of a heating conductor and substantially flat insulating elements contacting said conductor, said elements being spaced from each other and supporting said heating conductor in spaced relation to the inner wall of the pipe, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross sectional area of the interior of said pipe on a plane lying normal to said axis and the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact.

4. A heating element as in claim 3, successive insulating elements being angularly displaced about the axis of the pipe whereby the engaging portions of said insulating elements with said pipe are in staggered arrangement.

5. A heating element as in claim 3, said insulators being substantially polygonal in shape but having at least one corner thereof removed whereby the number of contact points of each insulating element is reduced.

6. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, at least one heating conductor passing through each of said insulating elements, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the

interior of said pipe on a plane lying normal to said axis and the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact.

- 5 7. A heating element for immersion heating of salt baths comprising a pipe having a single curve therein and being closed at one end, and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, at least one heating conductor passing through each of said insulating elements, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the interior of said pipe on a plane lying normal to said axis and the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact.

8. A heating element for immersion heating of salt baths comprising a curved pipe closed at one end, and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, at least one heating conductor passing through each of said insulating elements, said insulating elements mounted on said conductors extending from the end of the heating conductors to a point below the level of a bath in which said heating element is adapted to be immersed, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the interior of said pipe on a plane lying normal to said axis and the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact.

9. A heating element for immersion heating of salt baths comprising a pipe having a single curve therein and being closed at one end, and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, and the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the interior of said pipe on a plane lying normal to said axis, at least one heating conductor passing through each of said insulating elements, and at least one heating conductor passing through a space between an insulating element and the inner wall of the pipe.

10. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, said insulating elements being polygonal in shape with at least one corner removed, and at least one heating conductor passing through each of said insulating elements, successive insulating elements being angularly displaced about the axis of the pipe.

11. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the interior of said pipe on a plane lying normal to said axis, the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact, at least one heating conductor passing through each of said insulating elements, and a supporting wire passing through said insulating elements.

12. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, the maximum projected area of each of said insulating elements in the direction of the longitudinal axis of said pipe being less than the cross-sectional area of the interior of said pipe on a plane lying normal to said axis the bearing surfaces between said insulating elements and said wall being substantially fine areas of contact, at least one heating conductor passing through each of said insulating elements, said heating conductors being adapted to and arranged to terminate in a heating bath below the surface thereof and said pipe to extend above the surface of the bath, and supply leads connected in said pipe with the heating conductors.

13. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, said insulating elements being in substantially point-like contact with the inner wall of said pipe, and at least one heating conductor passing through each of said insulating elements, said insulating elements being pointed toward the contact points.

14. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, said insulating elements being polygonal in shape with at least one corner removed and being in substantially point-like contact with the inner wall of said pipe, and at least one heating conductor passing through each of said insulating elements, said insulating elements being provided with cavities and pointed toward the contact points, the successive insulating elements being disposed at equal angles about the axis of the pipe.

15. A heating element for immersion heating of salt baths comprising a curved pipe and a uniform flexible heating element movably arranged in said pipe, said heating element consisting of at least two heating conductors and substantially

5 flat insulating elements spaced from each other for maintaining the heating conductors spaced from each other and from said pipe, said insulating elements being in substantially point-like contact with the inner wall of said pipe, and at least one heating conductor passing through each of said insulating elements, the successive insulators being disposed at equal angles about the

axis of the pipe, the surface of the pipe being coated by a material resistant to the corrosive action of a melting bath, and said insulating elements being adapted and arranged to terminate in said bath below the surface thereof. 5

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