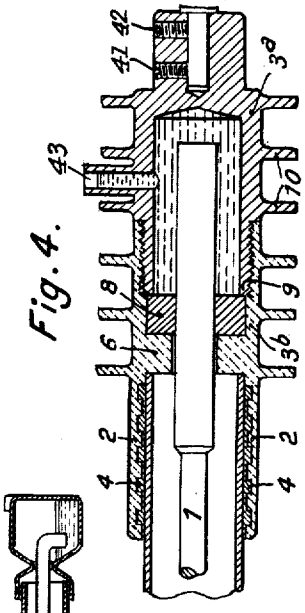
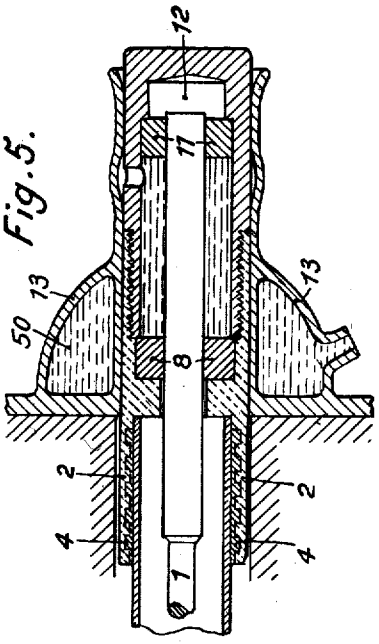
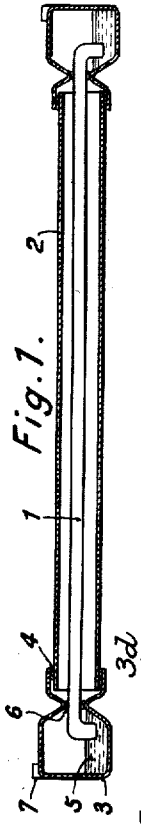
Aug. 26, 1941. Y. PEYCHES 2,253,981

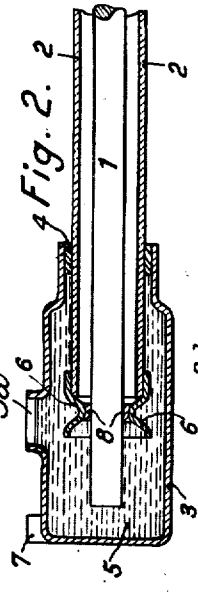
CURRENT SUPPLY DEVICE FOR RESISTORS OF ELECTRIC FURNACES

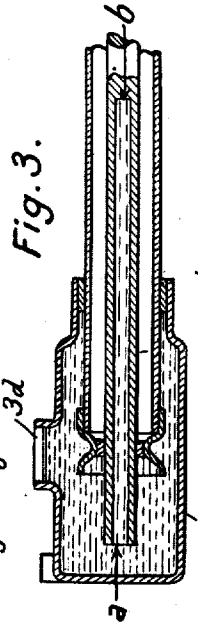
Filed July 13, 1939 3 Sheets-Sheet 1

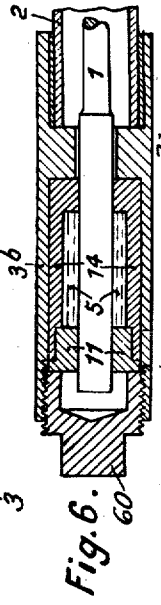


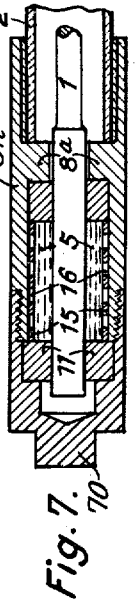












INVENTOR
YVAN PEYCHES
BY Richards & Geier
ATTORNEYS

Aug. 26, 1941. Y. PEYCHES 2,253,981

CURRENT SUPPLY DEVICE FOR RESISTORS OF ELECTRIC FURNACES

Filed July 13, 1939 3 Sheets-Sheet 2

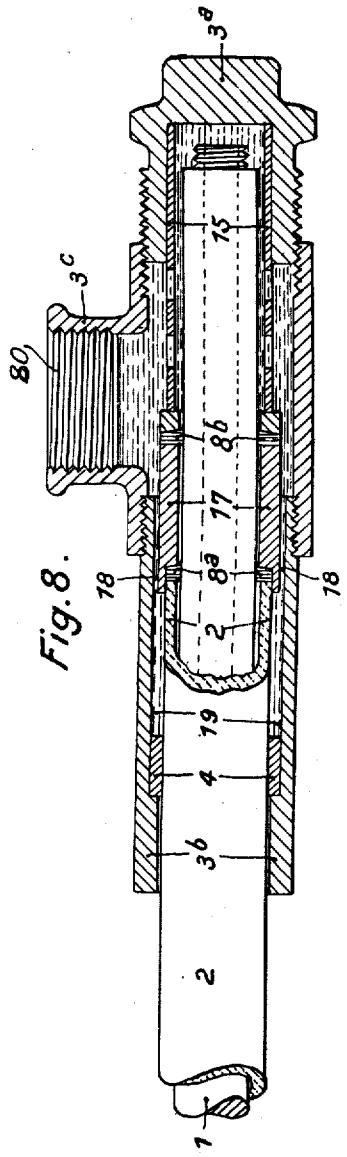


Fig. 8.

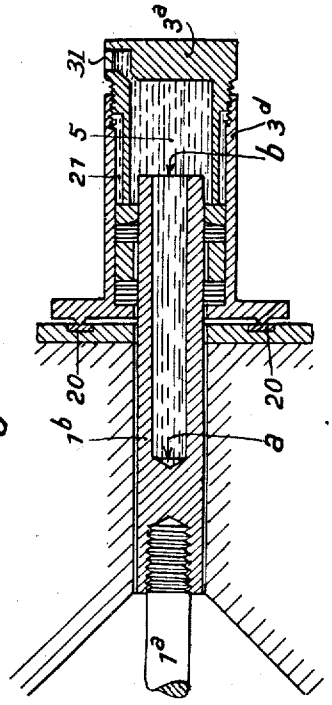


Fig. 10.

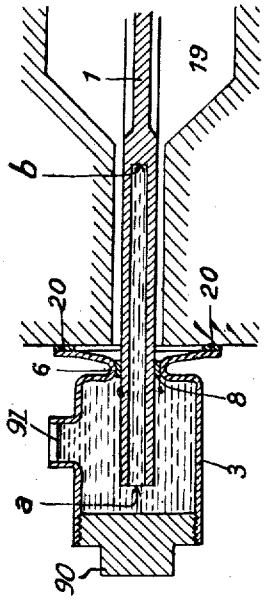


Fig. 9.

INVENTOR
YVAN PEYCHES
BY Richards & Geier
ATTORNEYS

Aug. 26, 1941. Y. PEYCHES 2,253,981

CURRENT SUPPLY DEVICE FOR RESISTORS OF ELECTRIC FURNACES

Filed July 13, 1939 3 Sheets-Sheet 3

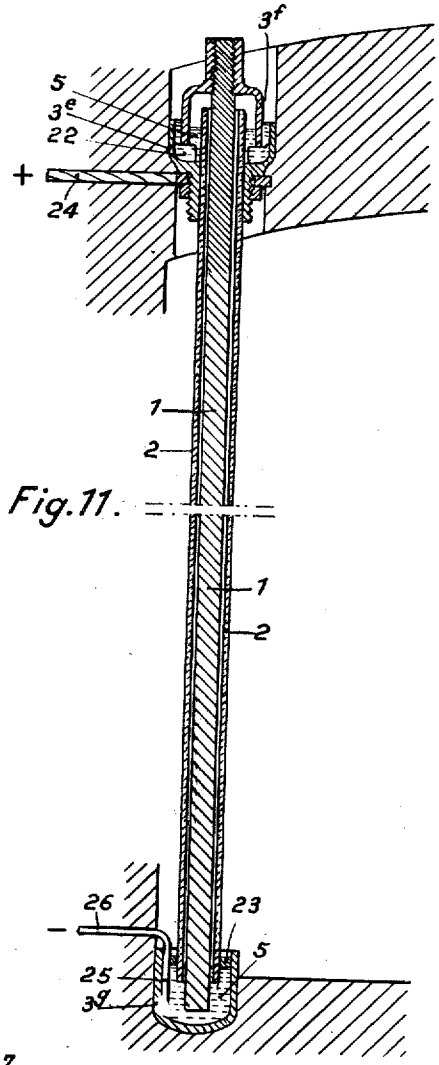


Fig. 11.

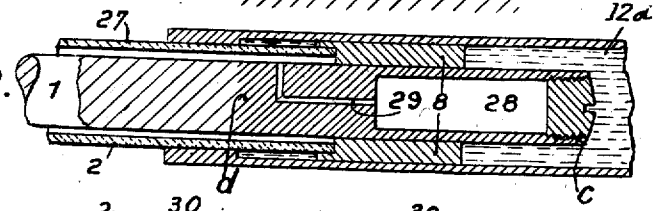


Fig. 12.

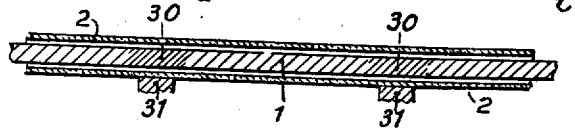


Fig. 13.

INVENTOR
YVAN PEYCHES
BY Richards & Geier
ATTORNEYS

Patented Aug. 26, 1941

2,253,981

UNITED STATES PATENT OFFICE

2,253,981

CURRENT SUPPLY DEVICE FOR RESISTORS OF ELECTRIC FURNACES

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

Application July 13, 1939, Serial No. 284,151
In France July 28, 1938

9 Claims. (Cl. 13—25)

The present invention relates to the problem of heating high temperature electric furnaces by means of heating resistances generally called resistors. It is known that the satisfactory operation and the life of these members,—for example bars of graphite or of amorphous carbon—depend to a great extent on the atmosphere in which they are intended to operate. It is well known, in particular, that some of such resistors—especially those which, on the other hand, possess the greatest aptitude for heating, such as the above mentioned resistors—frequently undergo at the temperatures in question, of the order of 1600° C., a detrimental chemical reaction with the atmosphere which is in contact with them.

In order to increase the life of the heating resistances, in particular of those which are formed by bars of carbon, graphite, or other oxidizable materials exposed to an oxidizing atmosphere at the same time as to high temperatures, it has already been proposed to provide special means for making the enclosure of the furnace as fluid-tight as possible, or even to enclose these elements in refractory sheaths made of a material which is impervious to gases at the temperature of use. In certain cases, said sheaths are in direct contact with the resistor, and in others they leave around same an annular space in which is confined an atmosphere that is not detrimental to the heating element.

It has also been proposed to make plastic coatings (glass coatings) on the resistors, but such coatings only act as a protector above their softening temperature and consequently allow a lack of protection to remain at the ends which are always colder.

The presence of said sheaths, or more broadly, the necessity of making the resistors operate inside a gas-tight chamber, gives rise to serious mounting difficulties, for the solution of which various more or less efficient artifices have already been proposed.

It is in fact necessary for the enclosure, the resistor and the current supply members as a whole, to be arranged in such a manner as to provide simultaneously: as perfect an electrical connection as possible between the resistor and said members, the free axial and transverse expansion of the resistor, the permanent fluid-tightness of the enclosure round the heating portion of same, and finally, the greatest possible reduction of energy losses—by Joule effect or by thermic conductivity—in the zone of the current supply members.

In the known assemblies, all these conditions are not fulfilled.

For example, in the case of a resistor provided with a sheath and having no direct contact with same, manufacturers have been led to crimp the current supply members on the sheath, with the interposition of a rigid fluid-tight joint, but it is necessary in this case for the resistor to be able to expand axially, independently of the sheath, owing to the fact that it is practically impossible to find a conducting material and an impervious refractory material which have the same coefficients of expansion.

This requirement has led to the construction of slipping contact members. However, it has been found that these contacts have the drawback of offering a rather high resistance to the passage of the current, which resistance furthermore changes in an unforeseeable manner owing to the rise of temperature and the relative movement of the contacts and of the resistor.

It has also been proposed, in order to permit of the free expansion of a resistor which is protected by a sheath, to cut out said resistor in helical shape, so as to make it resilient.

The object of the invention is to fulfill the various above mentioned conditions, either in the case of resistors which are directly protected by enclosures of the sheath type, such for example as a fluid-tight sillimanite tube, or in the case of resistors which are not provided with sheaths and as regards which the enclosure of the furnace itself acts as a fluid-tight protector.

The invention consists in constructing the current supply members for resistors of electric furnaces, in the shape of a conducting head which is generally made of metal, is fluid-tightly connected to the enclosure of the resistor, and contains a conducting liquid, for example a molten metal, which bathes the end of the resistor and permits of the free relative expansion of the resistor and of the other associated members, while ensuring the supply of current to the resistor under far better conditions than those obtained by the juxtaposition of rigid surfaces.

In addition to these main features which it fulfills in all cases, the liquid conductor contained in the current supply head may further, under certain conditions, in particular when the enclosure is formed by a refractory sheath, serve to complete the fluid-tightness between said sheath and the current supply head.

In order further to decrease the heating of the heads and, consequently, the losses by Joule effect dissipation in the ends of the resistor, a

cavity may be provided at said ends and into which penetrates the conducting liquid which is a better conductor than the resistor. A similar result can be obtained by graphitization of the ends of the resistor, in combination or not with the replacement of a part of the graphite by the conducting liquid.

The choice of the conducting substance forming the contact bath is guided by the following considerations:

The substance chosen must melt at low temperature and nevertheless have a low vapour tension at the temperature to which the head is raised in normal operation.

Said substance must also be capable of producing a good contact with the resistor and also with the metal forming the current supply head. On the other hand, whether in the liquid or in the vapour state, said substance must not appreciably attack these materials.

One embodiment of the invention consists in using molten tin as a conducting bath, since same fulfills these various technical conditions particularly well, while being satisfactory from the economical standpoint. Furthermore, the use of molten tin as a conducting liquid is particularly advantageous, since when it comes into contact with an oxidizing gas which is capable of passing through the joints, the tin oxidizes and stops up said joints.

The accompanying drawings show various current supply devices possessing the features of the invention.

In said drawings:

Figs. 1 to 3 are diagrammatical views showing various characteristic embodiments.

Figs. 4 to 8 are views showing longitudinal sections of various modifications of construction of current supply devices according to the invention.

Fig. 9 shows the application of the invention in the case in which the fluid-tight enclosure has to be formed by the furnace itself.

Fig. 10 is a longitudinal section of a current supply device, in the case in which the resistor is extended at each end by an intermediate part which conducts the current.

Fig. 11 shows an embodiment of the invention in the case in which the resistor is placed vertically.

Figs. 12 and 13 show peculiarities of construction which, for their part, are objects of the invention.

Figs. 1, 2 and 3 show the principle of the invention, in the case in which the resistor 1 is enclosed within a sheath 2.

In Fig. 1, according to the invention, each current supply head 3 is fluid-tightly connected, by the joint 4, to the sheath 2 and contains a quantity of conducting liquid 5, for example tin. The sheath 2 consists of a non-porous material, such as sillimanite, sintered alumina, porcelain and the like. The resistor, which is centred in the sheath by means of a constriction 6 of the current supply head, bathes with its ends in the conducting liquid which transmits to it the current that is supplied to the metal head by a terminal 7.

It can be seen that the variations of length of the resistor proportionally to the temperature can be effected freely owing to the interposition of the liquid bath 5 between the resistor and the current supply head.

The device shown in Fig. 2, which is derived from the previous one, is a particularly advantageous embodiment of the invention, wherein the liquid 5 fills the chamber 3 completely, so that the whole of the end of the resistor is covered by said liquid, the supply of the current to the resistor being effected under the best conditions. Furthermore, since said liquid has access to the cement joint 4, it contributes to ensure fluid-tightness under the conditions mentioned above. The liquid is introduced through the opening 3^d and the level of the liquid is higher than the joint 4 and the adjacent wall of the joint 3, so that a perfect hydraulic seal is attained.

In this embodiment, the constriction 6 which serves for centring the resistor, is part of a special member fixed on the sheath 2 and carries a joint 8 which is intended to prevent the liquid from penetrating into the annular space between the sheath and the resistor.

It is moreover unnecessary for said joint to be absolutely fluid-tight, since the small quantity of liquid that might succeed in passing into said annular space and in vaporizing therein would recondense inside the colder zones formed by the chambers 3.

In the exemplary embodiment of Fig. 3, in order to decrease the heating of the current supplies by joule effect dissipation, the resistor 1 has been hollowed out over a certain length *a—b*, in such a manner that the liquid employed, which in this case is a better conductor than the material of the resistor, substitutes itself for said resistor in the cavity thus provided. Furthermore, this substitution enables, for the same electric conductivity of the ends of the resistor, the cross-section of said resistor to be reduced at its ends and, consequently, the losses by thermic conductivity to be reduced. The end of the resistor is enclosed by the casing 3 having an opening 3*d* for the introduction of the liquid.

In the exemplary practical construction shown in Fig. 4, in order to enable the resistor to be dismounted and extracted, the current supply head is made in two parts 3^a—3^b which are assembled by screwing. The part 3^a is provided with a tube 43 for the introduction of liquid tin. Between the part 3^b and the sheath 2 is interposed the joint 4. A graphite bush 8, which is pressed against a shoulder 6 of the part 3^b by the end 9 of the part 3^a, serves for centring the resistor which is made for example of amorphous carbon. The portion 3^a of the current supply head carries a plug 40 and screws 41 and 42 engaging the plug 40.

A sufficient cooling of the current supply head is provided by the fins 10.

Fig. 5 shows a modification by means of which the drawbacks are eliminated which may be caused by an untimely solidification of the liquid at the rear of the resistor, either when the heating is stopped without taking any precaution, or in the case of too sudden a cooling of the current supply head.

For this purpose, the chamber which is adapted to contain the liquid in the conducting head is limited by the ring 8 and by a second ring 11 through which the resistor passes. At the rear of the ring 11 is provided a compartment 12, by means of which the axial expansion of the resistor can take place freely.

The cooling of the current supply head is obtained in this case by means of a water jacket

13 enclosing a chamber 50 which is filled with water.

Fig. 6 shows a practical embodiment of the previous device, in which the liquid is contained in a cartridge 14 which is hooped by the body 3b of the conducting head and is closed by the ring 11. A plug 60 is screwed into the body 3b.

In the example of Fig. 7, in order to avoid, as in the previous case, the transmission of the current from having to be effected by the contact between the rigid elements 3b and 14, the collar 8a and the ring 11 are kept spaced apart by means of a cylinder 15 provided with openings 16 through which the conducting liquid 5 is in direct contact with the current supply head. A plug 70 carrying the ring 11 is screwed upon the body 3h which is integral with the collar 2a.

Fig. 8 shows a preferred embodiment of the invention, in which the current supply head is formed by the assembly of a tube 3b, a central body 3c and a rear element 3a forming a plug. The central body 3c has a threaded opening 80 for the introduction of liquid tin.

The joint which is intended to prevent the conducting liquid from passing into the sheath 2 is formed by two rings 8a—8b separated by a sleeve 17, the whole arrangement being held in position and pressed against the refractory tube 2 by the cylinder 15 provided with openings. Clamping is effected by means of the plug 3a.

A passage 18 enables the liquid to penetrate into the annular chamber 19 so that said liquid can thus complete the fluid-tight action of the front joint 4.

Fig. 9 relates to the case in which the resistor 1 is not provided with a sheath and is mounted inside a furnace 19 which forms a fluid-tight chamber owing to the interposition of a joint 20 between the current supply head 3 and the lateral wall of said furnace. The resistor is centred by a constriction 6 provided with a joint 8, according to an arrangement similar to that of Fig. 2.

As in the case of Fig. 3, a channel *a—b* is provided in the end of the resistor. The casing 3 enclosing this end of the resistor is closed by a plug 90 and is provided with an opening 91 for liquid tin.

In the example of Fig. 10, which shows a practical embodiment of the arrangement of Fig. 9, each of the ends of the heating part 1a of the resistor is electrically connected to the liquid 5 by means of graphite bodies 1b. In the example under consideration, said bodies are provided with a channel *a—b*. Between the plug 3a and the body 3d is provided a water jacket 21 for cooling the end of the current supply head. The convection currents, that occur in the liquid which is hotter in the zone *a—b* than in the zone 5, contribute to the cooling of the part 1b which is in contact with the heating element 1a. The plug 3a is provided with a passage 31 for the liquid.

It is obvious that the principle of mounting current supplies which characterizes the invention applies to the case of a vertical resistor. Fig. 11 illustrates an application of this kind to a resistor provided with a sheath.

This resistor 2, for example an earthenware tube, is sealed at its upper part in a cup 3e which is made of a current conducting material and contains the conducting liquid 5. Said cup is embedded in the arch of the furnace.

At its upper end, the resistor 1 is screwed in a conducting bell 3f which rests on ribs 22 of the cup 3e.

The resistor 1 and the tube 2, which are simply held at their upper part, hang freely in the liquid which is contained in a refractory pot 3g sealed in the sole of the furnace. A diaphragm 23, for example made of fusible glass, protects the liquid from the action of the atmosphere of the furnace.

The current is supplied to the cup 22 by a cable 24, passes through the upper liquid 5, then through the resistor, then through the lower liquid 5 and leaves same through the dipping member 25 of a cable 26.

Since the lower part of the bell 3f is partially imersed in the liquid of the cup 22, the outer air cannot penetrate into the enclosure containing the resistor.

In all the above described current supply devices, the replacement of the resistor can be readily effected. It is particularly quick and easy to effect in the example of Fig. 11.

It must be observed that, when the furnace is cooled, a drop in pressure occurs in the space between the resistor and the protecting sheath. Said drop in pressure would be liable to favour a penetration of the conducting liquid into said space, through the joints 8 of the previous figures.

Fig. 12 shows a means which enables the extent of said drop in pressure to be decreased in the space 27 between the resistor 1 and the sheath 2. Towards the ends of the resistor, which are cooler than the heating portion, is provided a chamber 28 which communicates, through a channel 29, with the space 27. A chamber 12a surrounding the sheath 2 is also filled with liquid. The volume of said chamber 28 is such that, when the furnace cools, the pressure in the arrangement 27—28 remains sufficiently near the atmospheric pressure exerted on the conducting liquid, for there to be no tendency for any infiltration of same to occur through the joints 8. However, the decrease of conducting cross-section thus produced opposite said chamber 28 would be liable to cause an excessive heating in this region. A feature of the invention consists in this case in locally transforming the end *c—d* of the resistor into graphite, which resistor is itself made of amorphous carbon, graphite being a better conductor than amorphous carbon.

This graphitization, which improves the conductivity and therefore decreases the heating at the spots where the graphite is produced, is advantageously effected, as shown in Fig. 13, in the zones 30—30 of the resistor which are placed opposite the supports 31—31 on which the protecting sheath 2 may rest.

This partial graphitization of the resistors may also be advantageously applied to their ends. In a general manner, said graphitization may be applied whatever be the type of carbon resistors and of current supply members used.

I claim:

1. In electric furnaces, in combination, a resistor, an enclosure surrounding said resistor, and spaced therefrom, said resistor having a free uncovered end extending beyond said end closure, a conducting head surrounding said end and being spaced therefrom, means constituting a fluid-tight connection between said conducting head and said enclosure, and a conducting liquid situated in said head and bathing said end of the resistor.

2. In electric furnaces, in combination, a resistor, an enclosure surrounding said resistor and spaced therefrom, said resistor having a free, uncovered end extending beyond said enclosure, a metallic conducting head surrounding said end and being spaced therefrom, means constituting a fluid-tight connection between said conducting head and said enclosure, and molten metal situated in said head and bathing said end of the resistor.

3. In electric furnaces, in combination, a resistor, an enclosure surrounding said resistor and spaced therefrom, said resistor having a free, uncovered end extending beyond said enclosure, a conducting head surrounding said end and being spaced therefrom, means constituting a fluid-tight connection between said conducting head and said enclosure, a conducting liquid situated in said head and bathing said end of the resistor, and separate means closing that end of the enclosure which is situated close to said free end of the resistor, the last-mentioned means engaging said resistor to prevent a penetration of said liquid between said enclosure and said resistor.

4. In electric furnaces, in combination, a resistor, an enclosure surrounding said resistor and spaced therefrom, said resistor having a free, uncovered end extending beyond said enclosure, a conducting head surrounding said end and being spaced therefrom, a conducting liquid situated in said head and bathing said end of the resistor, and means open to said liquid and constituting a fluid-tight connection between said conducting head and said enclosure.

5. In electric furnaces, in combination, a resistor, an enclosure surrounding said resistor and spaced therefrom, said resistor having a free, uncovered end extending beyond said enclosure, a conducting head surrounding said end and being spaced therefrom, means constituting a fluid-tight connection between said conducting head and said enclosure, and a mass of molten tin situated in said head and bathing said end of the resistor.

6. In electric furnaces, in combination, a resistor, and enclosure surrounding said resistor and spaced therefrom, said resistor having a free, uncovered end extending beyond said enclosure, a conducting head surrounding said end and being spaced therefrom, means constituting a fluid-tight connection between said conducting head and said enclosure, and a conducting liquid situated in said head and bathing said end of the resistor, said free end of the resistor having a recess formed therein which is filled by said conducting liquid.

7. In electric furnaces, in combination with a resistor and an enclosure containing the resistor, a current supply device, which comprises a conducting head formed by the assembly of a tube, a central body and a rear element forming a plug, means for fluid-tightly connecting said conducting head to the enclosure, a conducting liquid within said head, said liquid bathing the corresponding end of the resistor, two rings forming joints and fitted on said end before the bathed part of the resistor, a sleeve separating said two rings, a cylindrical body provided with holes and adapted to push the rings and the sleeve against the end of the enclosure, said cylindrical body bearing, on the opposite side, against the inner end of said plug.

8. In electric furnaces, in combination with a resistor and an enclosure containing said resistor; a current supply device, which comprises a conducting head, means for fluid-tightly connecting said conducting head to the enclosure, an intermediate body extending said resistor and penetrating into said current supply head, a channel provided in said intermediate body and extending adjacent the junction zone between said body and the resistor, and a conducting liquid in said head and penetrating into said channel up to the end of same.

9. In electric furnaces, in combination with a vertical resistor and a sheath surrounding the same; a current supply device, which comprises, at the lower part, a pot into which dip the resistor and the sheath, a conducting liquid contained in said pot, a conducting cup crimped to the upper part of said sheath, a conducting liquid in said cup, a bell secured to the upper end of the resistor and fitting over same, the open base of said bell being immersed in the conducting liquid in said cup.

YVAN PEYCHES.