J. HÄRDÉN.

ELECTRIC FURNACE.

APPLICATION FILED MAY 7, 1909.

977,303. Patented Nov. 29, 1910.

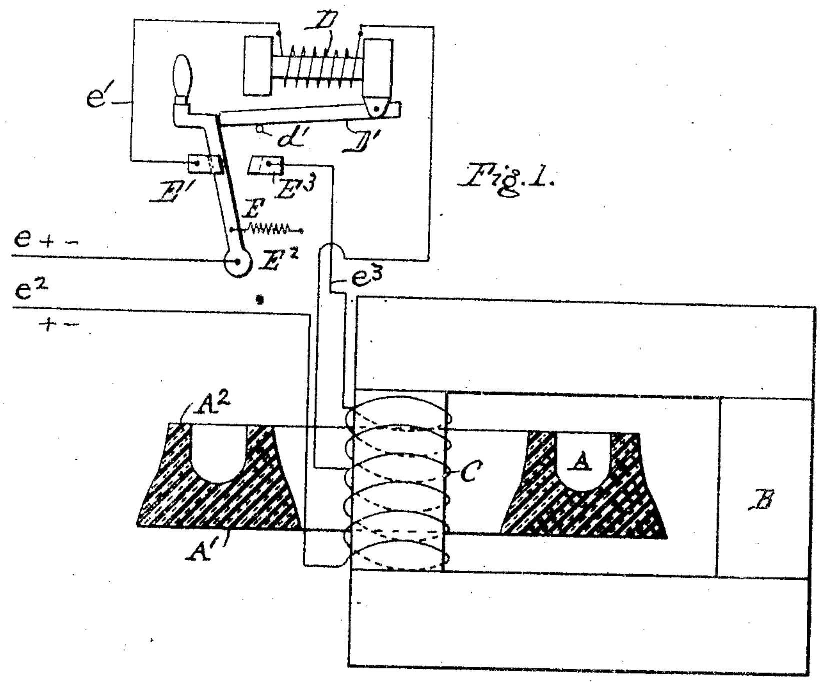


Fig. 1.

Fig. 2.

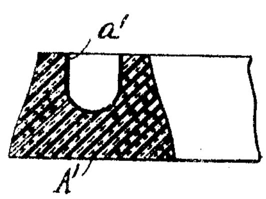
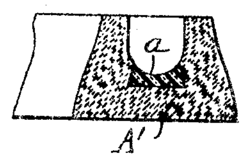


Fig. 3.



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ELECTRIC FURNACE.

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To all whom it may concern:

Be it known that I, JOHANNES HÄRDÉN, a subject of the King of Sweden, and residing in the city of London, England, have invented a certain new and useful Improvement in Electric Furnaces, of which the following is a specification.

My invention relates to electric furnaces and particularly to furnaces of the induction type, the object of my invention being to provide an improved apparatus of this character in the particulars hereinafter pointed out.

In induction furnaces of the common type the crucible or lining of the chamber in which the charge is contained, is of refractory non-conducting material and it is consequently necessary in order to start the melt of the charge, to first introduce cast or welded rings of the material to be treated. The induced current flowing through these rings raises their temperature by reason of the resistance encountered therein, until they and the adjacent portions of the charge are melted and the flow of the current through the charge thus established.

In addition to the expense attendant upon the preliminary casting or welding of the rings, this process is very unsatisfactory since it is difficult to secure rings of the same analysis as that of the rest of the charge. Furthermore it is practically impossible to obtain a ring of absolutely uniform resistance. Hence it is very apt to melt at one or two spots of high resistance and thus break the secondary circuit before a successful melt can be effected. Consequently it is necessary to keep a supply of molten metal at hand ready to be poured into the furnace to complete the ring should this be broken as described. This additional drawback is enhanced by the fact that it renders the induction furnace unsuitable for use in the production of certain alloys, the proportions of which must be exactly maintained.

A further and even more serious disadvantage results when dealing with metals or alloys of high conductivity such for instance as copper or bronze. In this case the current density may, owing to the low resistance of the charge, become so excessive that the so-called "pinch effect" takes place, viz. the elementary paths of current through the metal, owing to the high current density, attract each other with such force that the whole charge is contracted into a narrow stream of metal which is immediately vaporized by the current, thus breaking the ring. After the break has occurred the separated portions of metal will again flow together, causing a rush of current, and the same play begins again. This characteristic makes it almost impossible to treat copper, for instance, in a commercial way in induction furnaces. The present invention provides a furnace in which these disadvantages are eliminated.

In the accompanying drawings, Figure 1 is a cross section of a furnace in which my invention is incorporated; Fig. 2 is a vertical section of a crucible of modified form; Fig. 3 is a similar view of another modification.

My improved furnace has a lining or crucible composed of an intimate mixture of a suitable conductor such as graphite, with a refractory material such as fire clay which will stand the heat of the melt without material injury, the admixture being in such proportions as to secure a certain amount of electric conductivity without a material lowering of the refractory property of the clay. When a crucible of this type is placed around the primary coil and magnet core of an induction furnace, and the coil energized, a secondary current will be induced in the wall of the crucible, the resistance of which will heat the crucible, and eventually the charge, sufficiently to establish a melt. Inasmuch as the current will be distributed in accordance with the section of the crucible wall, I propose to make the latter of greater thickness in the body of the crucible than at the lip and thus secure its gradual heating from the bottom up as the electric energy is transmuted into heat. In combination with a crucible of this type, the resistance of which is high, I propose to use a divided primary coil in order to increase the inductive effect of the magnet core during the heating up of the crucible. Thus during the period of heating up, the full voltage of the furnace is sent through a portion, say only a third, of the primary coil, with the result that the magnet is greatly overexcited and its inductive effect greatly increased in order to heat up the crucible in the shortest time possible. As soon as the charge in the crucible has been melted sufficiently to form a complete ring (which is manifested by a rise of the primary current) the whole coil is switched in and the melt is completed with the current passing through the entire primary coil. This switching in of the remainder of the coil may be effected either by hand or by means of an automatic switch of the "overload" type which is actuated through the sudden rise of the primary current.

In some cases it may be desirable to so proportion the graphite and clay (or their equivalents) that the resistance of the crucible is much higher than that of the charge, with the result that after the melt has begun practically the entire induced current flows through the charge. In other cases, for instance when dealing with a charge of brass or aluminum, it may be desirable to make the proportion such that even after the charge is melted and the current is passing through the same, an appreciable percentage of the current is still passing through the crucible and generating heat. This result might also be attained by suitably regulating the cross section of the crucible with relation to the cross section of the metallic bath.

For the treatment of certain metals, a crucible of graphite and clay would be unsuitable as this would inevitably lead to the introduction of both carbon and silicon as impurities into the charge. When desirable therefore, I propose to provide the crucible with a neutral facing (Fig. 2) which may vary with the charge treated. Thus for a charge of aluminum, the graphite crucible might be suitably faced with magnesite. In some cases when a neutral facing is necessary, it is however sufficient to employ a crucible which has already been in use, since the graphite in the surface adjacent the charge will, for the most part, be taken up by the first few charges, leaving only a thin facing of the refractory clay as a substantially neutral facing.

A furnace of the character described has the obvious advantage that a melt may be started with the charge in any shape of metal, granular, irregular or otherwise, without the aid of a ring or a molten charge. Further the danger of "pinching" is eliminated, because as soon as the charge shows a tendency to contract, the contracted portion of the metal is bridged over by the conductive walls of the crucible which, being solid, cannot contract, thus checking this phenomenon very successfully. Furthermore a lining of this character, being in practice a compressed crucible made in one piece, through the use of a suitable binder, permits of shutting down the furnace and allowing the same to cool over night without danger to the crucible. This is impossible with linings of the character hitherto in use which are stamped in the furnace from powdery material which invariably cracks on cooling. Again, the present furnace may be completely emptied after each melt since there is no necessity for leaving a remainder of one charge in the crucible to facilitate the starting of the next charge. This is a distinct advantage when treating charges of different quality.

Obviously the crucible may be altered to meet the demands of the particular metal treated, and may be varied in detail of construction without departing from my invention and I do not limit myself to the precise structure shown. Thus in Fig. 3 for instance, I have shown merely a ring of graphite and clay molded in the wall of a refractory crucible of the common type, instead of forming the entire crucible in this manner.

I claim as my invention:

1. In an induction furnace for melting metals, a crucible in the walls of which the induced current flows until a melt is established, said walls comprising an intimate mixture of a refractory material and a suitable conductor.

2. In an induction furnace for melting metals, a crucible in the walls of which the induced current flows until a melt is established, said walls comprising an intimate mixture of a refractory material and a suitable conductor in such proportions that upon a contraction of the melted charge at any point the current flows at that point through the walls of the crucible, thereby avoiding the "pinch effect" mentioned, substantially as described.

3. In an induction furnace for melting metals, a crucible having walls comprising an intimate mixture of refractory material and a suitable conductor in suitable proportions, said walls being of greater cross section in the body portion than at the lip, whereby a gradual heating of the charge from the bottom up is secured upon the passage of the induced current through said walls, substantially as described.

4. In an induction furnace for melting metals, a crucible having conducting walls through which the induced current passes during the establishment of a melt, said walls being of greater current carrying capacity in the body portion than at the lip, for the purpose described.

5. In an induction furnace, a melting chamber or crucible of relatively high conductivity, said crucible being of greater cross section in its body than at its lip, in combination with a divided primary winding adapted to be partially energized to induce a strong current through said crucible at the starting of the furnace to secure a preliminary melt and means for switching in a further length of said primary winding after a melt has been established.

6. In an induction furnace for melting

metals, a melting chamber having in its structure a mixture of refractory and conducting materials forming a secondary circuit; with a primary winding for inducing a current in the structure of said melting chamber and in the material contained therein.

7. In an induction furnace for melting metals, a melting chamber having in its structure a relatively high resistance mixture of refractory and conducting materials forming a secondary circuit, with a primary winding for inducing a current in the structure of said melting chamber and in the material contained therein.

8. In an induction furnace for melting metals, a melting chamber composed of an intimate mixture of an electrical conductor and a refractory material constituting a secondary circuit, with a primary winding for inducing a current in the structure of said chamber and in the charge contained therein.

9. In an induction furnace for melting metals, a melting chamber having in its structure a mass of conducting material forming a secondary circuit and provided with a neutral facing for keeping a charge free from contamination from the material of the chamber; with a primary winding for inducing current in the structure of said melting chamber and in the material contained therein.

10. In an induction furnace for melting metals, a melting chamber having in its structure a mixture of refractory and conducting materials forming a secondary circuit; with means for first over-exciting of the magnet of the furnace and thereafter automatically reducing the inductive effect of said magnet when the furnace has been heated to a predetermined point.

11. In an induction furnace for melting metal, a melting chamber having in its structure a mixture of refractory and conducting materials forming a secondary circuit, in combination with a divided primary winding adapted to be partially energized to produce a higher voltage in the induced circuit at the starting of the furnace to secure the melt of the charge and means for switching in a further length of said primary winding after a melt has been established, for the purpose described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

JOHANNES HÄRDÉN.

Witnesses:
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