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ELECTRODE ASSEMBLY FOR ELECTRIC SLAG MELTING

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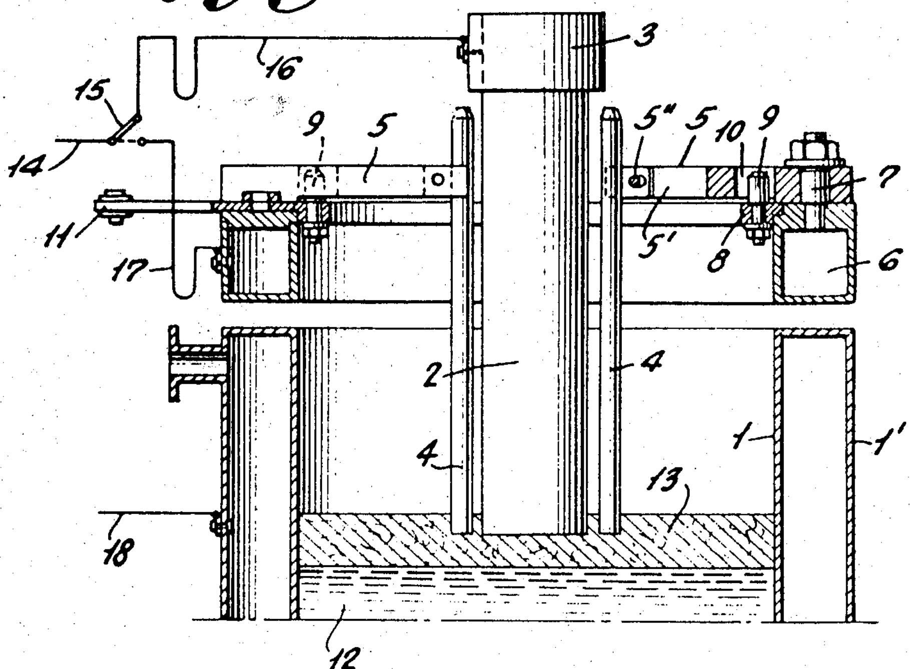
Fig. 1.



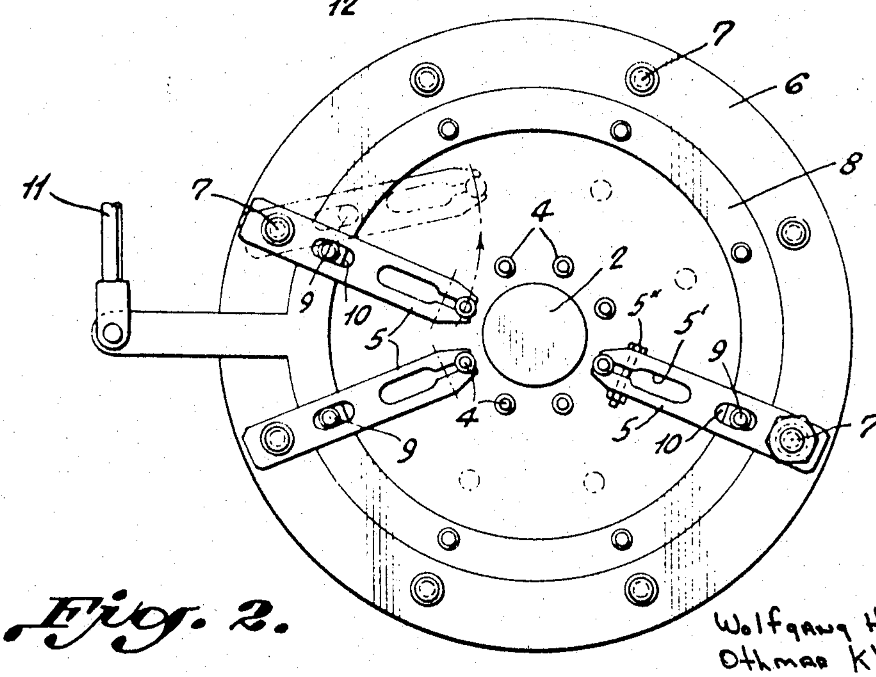


Fig. 2.

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ELECTRODE ASSEMBLY FOR ELECTRIC SLAG MELTING

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ABSTRACT OF THE DISCLOSURE

A main electrode holder is adapted to detachably carry a main electrode on an axis. An auxiliary electrode holder comprises a plurality of mountings angularly spaced around the axis. A plurality of rods of electrode material define an auxiliary electrode and are carried by the mountings parallel to the axis and are in spaced relationship to one another as well as the main electrode. The auxiliary electrode only carries current when the main electrode is shut down, e.g. is being replaced.

This invention relates to an auxiliary electrode for maintaining the temperature of molten metal, particularly molten steel, which has been formed by the electric melting of a self-consuming main electrode, said auxiliary electrode surrounding the consumable main electrode and carrying current while the main electrode is being replaced.

In order to provide improved and more efficient electric remelting processes, it is desired to make steel ingots from at least one main electrode, which is successively melted down. When the main electrode has been consumed down in the remelting process to a short stub by the heat which is generated by an electric arc flowing out of the main electrode, the main electrode holder is lifted to pull the electrode stub out of the ingot mold and a new main electrode is inserted. The main electrode holder is then lowered to introduce the new main electrode into the ingot mold where the new main electrode is consumed. During the above described operation of replacing the main electrode, the molten metal in the ingot mold must not cool down and solidify. For this reason, it is usual to employ so-called auxiliary electrodes which carry electric current during this interval.

Known electrodes of this type are helically wound or tubular, and are mounted in a fixed position. They consist of a material which has a higher melting point than the main electrode, e.g., of graphite, tungsten or molybdenum. When main electrodes and/or ingot molds having various diameters are employed, as is often the case, these known auxiliary electrodes must be kept in stock in different diameters so that an auxiliary electrode having a proper diameter is available for each of the main electrodes and/or ingot molds which may be employed. A further disadvantage of these known auxiliary electrodes resides in that they are expensive due to their form because the manufacture of such tubular or helical auxiliary electrodes is difficult and time-consuming and often involves considerable loss of material.

It is an object of the invention to avoid these disadvantages and to provide an auxiliary electrode of the kind which can be adjusted to any of several main electrodes and/or ingot molds having different diameters.

This object is accomplished according to the invention by the provision of an improved auxiliary electrode for maintaining the temperature of the molten metal, particularly molten steel, which has been formed by electric melting of a self-consuming main electrode, which auxiliary electrode surrounds the consumable main electrode and only carries current while the main electrode is being replaced. This auxiliary electrode comprises a plurality of rods, which are preferably detachably mounted in a holder and extend parallel to the main electrode and define air gaps between adjacent ones of said rods.

Even if the auxiliary electrode is made from the same material as the main electrode, the electrical energy losses will not be increased when alternating current is used for melting the main electrode. This use of alternating current has various advantages. On the other hand, if a tubular or helical auxiliary electrode is used under the same conditions, the electrical energy losses will be substantially increased because high losses due to magnetization are incurred in the upper portion of the auxiliary electrode, where the temperatures are substantially below the Curie point, i.e., in the temperature range in which the auxiliary electrode exhibits a strong ferromagnetism. The magnetic flux lines permeating the auxiliary electrode according to the invention concentrically surround the main electrode and must also permeate the air gaps between the rods. These air gaps considerably add to the reluctance so that only very weak alternating magnetic fields are established in the auxiliary electrode according to the invention and do not give rise to substantial losses due to magnetization. This explains the above-mentioned avoidance of electrical energy losses.

The auxiliary electrode according to the invention is suitably movable, particularly in a vertical direction. With this arrangement, the auxiliary electrode can be adjusted during operation to a position in which it dips into the slag layer which floats on the molten metal and which serves for purifying and shielding the molten steel, whereas the lower end of the auxiliary electrode is spaced a desired distance from the molten metal.

In a preferred embodiment of the auxiliary electrode according to the invention, the rods thereof are identical, preferably circular, in cross section and are evenly spaced on a circle, which is concentric to the main electrode.

Further details of the auxiliary electrode according to the invention will become apparent from the subsequent description of an embodiment, which is diagrammatically illustrated in the drawing.

FIG. 1 is a longitudinal sectional view showing an ingot mold which contains a main electrode and the auxiliary electrode according to the invention; and

FIG. 2 is a top plan view showing the elements of FIG. 1.

A precast cylindrical main electrode **2** of steel is coaxial to a cylindrical ingot mold **1** and is surrounded by an auxiliary electrode, which consists of a plurality of rods **4**. The main electrode **2** and the rods **4** consist of the same material. The rods **4** are detachably secured to the horizontally extending swivelable levers **5**. The same are pivoted on vertical pins **7**, which are carried by a carrying ring **6**. The swivelable levers **5** are adjustable to vary the radial distance from the rods **4** to the axis of the ingot mold. A rotatable ring **8** is provided for this adjustment and has pins **9**, which extend into slots **10** of the swivelable levers **5**. The ring **8** is rotatable with the aid of a rod **11**, which is adjustable by a suitable transmission, not shown. To facilitate the removal of the rods **4** which constitute the auxiliary electrode and the mounting of such rods on the swivelable levers **5**, the latter are provided at their ends adjacent to the rods **4** with slits **5′** and with set screws **5″**, which extend at right angles to said slits. With the aid of these set screws, the rods **4** can easily be secured to the swivelable levers **5**. The holder **3** for the main electrode **2** and the carrying ring **6**, which is disposed above the ingot mold **1**, are carried by lifting carriages, which are not shown and which are vertically slidably mounted on a column and operable by pulling ropes. With this arrangement, the main and auxiliary electrodes can be adjusted during operation to dip into the slag layer **13**, which floats on the molten metal **12** and serves for purifying and shielding the molten steel, whereas the ends of the electrodes have the desired spacing from the molten metal **12**.

From one terminal of a source of current (not shown) which is employed and consists generally of the secondary winding of a transformer, an electric lead **14** extends to the change-over switch **15**, from which electric leads **16** and **17** extend to the holder **3** for the main electrode **2** and the carrying ring **6** for the auxiliary electrode. The other terminal of the source of current is connected by an electric lead **18** to the ingot mold **1**. When the main electrode **2** dips into the slag layer **12**, the change-over switch **15** is in a position to energize the main electrode **2** through the electric lead **16** so that the main electrode **2** is being consumed. When the residual stub of the main electrode **2** must be pulled out of the ingot mold **1** for replacing the main electrode, the change-over switch **15** is preferably automatically moved into the opposite position, which is indicated in dotted lines, so that current flows through the electric lead **17** to the rods **4** of the auxiliary electrode. As a result, the auxiliary electrode maintains the temperature of the molten metal **12** and the rods **4** are consumed. This fusion will take place under particularly suitable conditions if the total cross-sectional area of rods **4** is approximately the same as the cross-sectional area of the main electrode **2**.

For the sake of completeness it may be mentioned that the ingot mold **1** is cooled with water, which flows through the space defined by the ingot mold and a jacket **1'**.

The auxiliary electrode according to the invention has the important advantage that it can be adjusted to match various diameters of the main electrodes and/or ingot molds which are employed without need for keeping auxiliary electrodes differing in diameter in stock, as is the case with the known auxiliary electrodes which are tubular or helical. It will be sufficient to keep rods in stock which are identical in cross section (diameter). Another advantage of the auxiliary electrode according to the invention resides in that the rods of said electrode can be manufactured at much lower costs than the known, auxiliary electrodes which are tubular or helical, particularly if the rods consist of the same material as the main electrode, as is taught by the invention.

We claim:

1. In an electrode assembly for electric slag melting comprising a liquid-cooled mold; at least one electrode holder and a consumable main electrode, said electrode being detachably mounted in said holder; an auxiliary

electrode; and a power source the improvement comprising said auxiliary electrode which consists of a plurality of consumable rods arranged in spaced relationship to one another and surrounding said respective main electrode, the axes of said rods being parallel to said main electrode axis; mounting means for moving said rods relative to said main electrode; and switch means between said power source and said electrodes wherein after said main electrode is consumed and is raised for replacement, the current is shunted by said switch means to said auxiliary electrode to prevent deleterious cooling of the contents of said mold.

2. An electrode assembly as claimed in claim **1** wherein said rods are made of the same consumable material as said main electrode.

3. An electrode assembly as claimed in either claim **1** or **2** wherein the collective cross section of the rods is substantially equal to the cross-sectional area of their main electrode.

4. An electrode assembly as claimed in claim **1** wherein said power source supplies A.C. current; and said rod mounting means are adjustable in a plane normal to said axes such that the radial distance between said rods and said main electrode can be adjusted.

5. An electrode assembly as claimed in either claim **1**, **2** or **4** wherein said rod mounting means consists of a carrying ring, a rotatable ring and swivelable levers for each rod, said levers being pivotably mounted on said carrying ring and actuated by said rotatable ring so that all said rods are arcuately swung relative said main electrode in a plane normal to same to adjust the rod spacing therefrom.

6. An electrode assembly as claimed in claim **5** wherein said swivelable levers are each provided with slits and set screws for adjustably mounting said rods, said levers each further having a slot intermediate said slit and said pivot mounting, said slot coacting with a pin mounted on said rotatable ring to swing said lever.

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