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**Paton et al.**

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[54] **PROCESS AND PLANT FOR ELECTROSLAG REMELTING OF CONSUMABLE ELECTRODES**

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[51] **Int. Cl.** .......................................... **B22d 27/02**

[58] **Field of Search** ..................... 164/52, 252; 13/9

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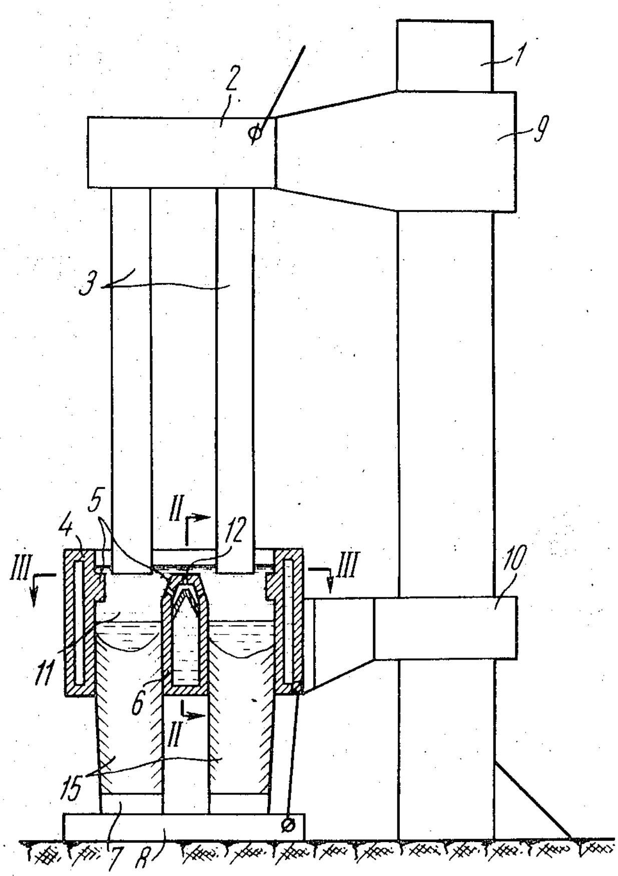
[57] **ABSTRACT**

A process for remelting electric-slag of consumable electrodes which has a higher density current in certain parts of the melting zone of the consumable electrodes.

A plant for practicing the above process incorporating a mould whose cavity is fitted with projections located in the melting zone of the consumable electrodes.

**11 Claims, 4 Drawing Figures**



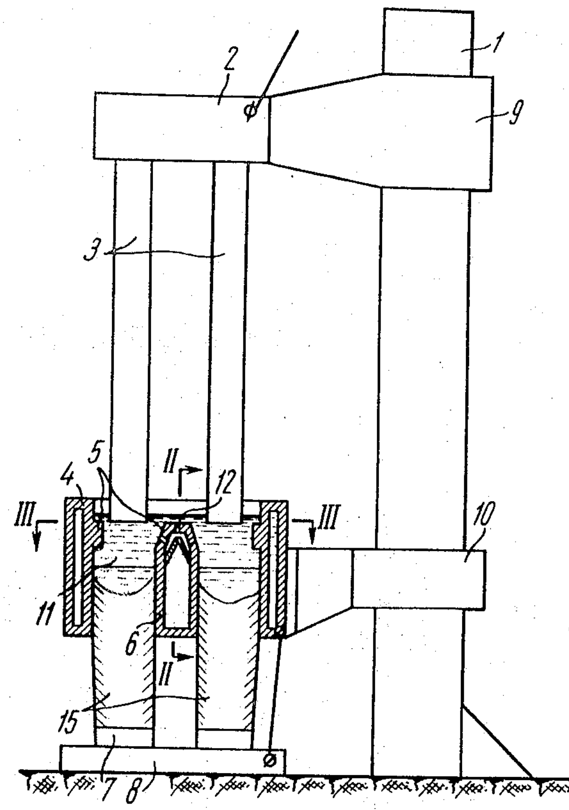


FIG. 1

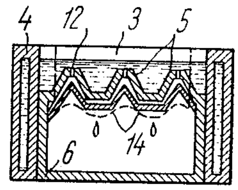


FIG. 2

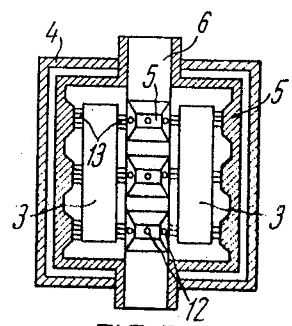


FIG. 3

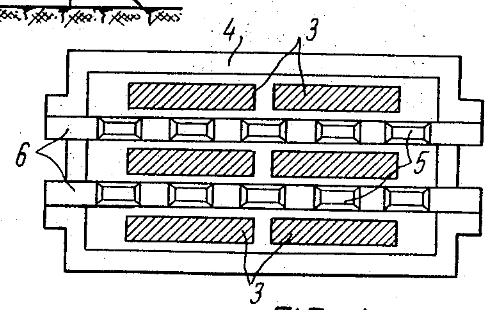


FIG. 4

## PROCESS AND PLANT FOR ELECTROSLAG REMELTING OF CONSUMABLE ELECTRODES

The present invention relates to electrometallurgy and more particularly to processes for the electro-slag remelting of consumable electrodes and to electro-slag remelting installations.

Processes for electro-slag remelting consumable electrodes in installations (furnaces) incorporating: a mast with an electrode holder carrying one or several consumable electrodes which are connected to a power source, a baseplate for a mould having a cavity for melting the consumable electrodes and for forming ingots, and driving gears whose function is to provide relative motion to the electrode holder with respect to the mould and baseplate are commonly known in the art.

The above said furnaces are well suited for producing ingots of both round and rectangular cross-sections (slabs). In the furnaces in question the surface of the consumable electrode being fused off takes the shape of a cone.

As a result the base of the liquid metal pool on the surface of the ingot being shaped is also cone-shaped. This is attributable to the fact that droplets of liquid metal heated to a high temperature fall into the central portion of the metal pool increasing its depth at the sacrifice of the ingot.

Thereby the upper portion of the ingot being shaped is funnel- or cone-shaped with the central part of the cone accumulating low-melting objectionable admixtures (sulphur, phosphorus, non-metallic inclusions) which affect the ingot quality adversely. The cone shape formation also exerts a deleterious effect during the crystallization of the ingot as the location of the crystals are not in parallel with the longitudinal axis of the ingot but almost at a right angle which is detrimental to the mechanical and plastic properties of the ingot.

Besides, when melting rectangular ingots-slabs a substantial irregularity in the distribution of the temperatures in the upper portion of the ingot being formed results in nonuniform crystallization in the ingot cross-sections causing deterioration of the surface quality, especially in the corners.

Various attempts have been made to reduce the taper of the metal bath base. Thus use was made of a consumable electrode composed of several electrodes having a small cross-section, and spaced apart from each other.

This however resulted in a sharp reduction in the efficiency in filling the mould by melting the electrode since the total sectional area of the composite electrode is considerably smaller compared with a solid electrode of similar size, therefore necessatating a furnace of increased height.

In addition the composite electrodes are much more complicated than the solid ones in terms of production which in turn raises the cost of the electro-slag remelting using consumable electrodes.

The principle object of the present invention is to provide an electro-slag remelting process which would ensure that the melting of the surface of a consumable electrode would form several cones which would tend to reduce the taper of a metal pool base.

Another object of this invention is to enhance the quality of the ingot by reducing the amounts of non-metallic inclusion and harmful admixtures.

Still another object of the invention is to improve surface quality of the ingot at the corners.

Still another important object of this invention is to provide a more compact and efficient plant.

These and other objects of the invention are achieved by developing a process for electro-slag remelting for consumable electrodes in which conforming to the invention a current of higher density is passed between individual parts of the internal surface of a mould and the opposite surface of the consumable electrode immersed in a slag bath which results in the fusing off the above latter surface in the form of at least two cones.

With the above method of remelting the consumable electrodes the shape of the surface being fused off can be changed in such a manner so as to decrease the taper of the base of a metal pool.

The problem is also solved by designing a plant for consuming electrodes by the electro-slag remelting process comprising: a mast with an electrode holder carrying the consumable electrodes, an associated electric power source, a baseplate for a cooled mould whose cavity has several zones for melting the electrodes and shaping the ingot, a driving gear for providing relative motion to the aforesaid electrode holder, a mould and a baseplate in which the plant conforming to this invention walls of the moult cavity in the melting zone where the electrodes are being consummed are fitted with projections.

The foregoing projections make it possible to establish zones of higher electric conductivity in the molten slag which would contribute to the more intense melting of the separate parts of the consumable electrode and would give the electrode surface being fused a multi-cone shape. This favors both the shape of the metal bath and the quality of the ingot being formed.

The mould cavity may also be provided with a vertical partition with projections in its upper face disposed in the zone where the consumable electrodes are being melted.

Such a partition enables several ingots to be produced in a single mould when fitted with the projections which cause multi-cone fusing upon consuming the electrodes.

The distance between the middle points of adjacent projections should be not less than the thickness of the consumable electrodes.

In such case the most favourable conditions are established for fusing off the consumable electrodes and for shaping that part which is submerged in the molten slag in the form of several cones.

It is desirable that the projection height will amount to at least one half of the width of the smallest wall dimension of the ingot-shaping cavity.

This will contribute to a more distinct separation of the molten slag into zones which exhibit higher and lower electric conductivity.

It would be expedient if each projection were made in the form of a truncated pyramid with its large base located on the upper face of the partition.

This would provide for the most favourable conditions for removing of solidified slag upon completion of the ingot melting process.

It is also desirable that the length of its base of each projection should be smaller than the thickness of the consumable electrodes.

Thus the facilities provide for fusing off that part of the consumable electrodes immersed in the molten slag which takes the form of several cones.

It is desirable that the distance between each projection and the surface of the consumable electrodes should be not less than 10 mm.

This will increase operation safety and provide facilities for the formation of a slag skin on the projections formed.

The spacing between an extreme projection in a row and a narrow wall of the mould shall preferably amount to 0.5–2.0 of the width of a minimum wall of the ingot-shaping cavity.

The above spacing tends to improve the formation of the surface of narrow sides of the ingots-slabs.

It would be expedient that the width of each projection would not exceed that of the partition.

This will facilitate the removal of solidified slag on completion of the ingot-melting process and increase safety of operation.

Good practice is to fit the projections with conduits running into the melting zone of the consumable electrodes and intended for feeding gas and gas-powder mixtures.

This will make it possible to produce separate gas streams in the molten slag which will promote obtaining higher electric conductivity of the molten slag in their zone of action which in turn will contribute to the formation of projections on the part of the consumable electrode being fused off.

For the purpose of giving those skilled in the art a better understanding of the invention given below is the following detailed description of exemplary embodiments of plants for practicing the proposed process to be considered with reference to the accompanying drawings in which:

FIG. 1 is a general cut-away view of an electro-slag remelting plant;

FIG. 2 is a section taken along line II–II of FIG. 1;

FIG. 3 is a section taken along line III–III of FIG. 1;

FIG. 4 depicts a top view of a mould for the simultaneous melting of three ingots.

An electro-slag remelting plant incorporates: a mast **1** (FIG. 1) carrying electrode holder **2** which is rigidly fixed to it consumable electrodes **3** connected to a power source (not shown in the drawing), a cooled mould **4** with projections **5** on the internal side of its walls and a cooled vertical partition **6**, dummy bars **7** rigidly fixed on a baseplate **8**, a drive **9** for shifting the electrode holder **2** with consumable electrodes **3** and drive **10** for moving the mould **4**.

An end plane of partition **6** located in the molten slag **11** is fitted with projections **5**. The latter are provided with conduits **12** for feeding gases and gas-powder mixtures into the melting zone.

A plant for practicing the proposed process operates as follows:

Before the electro-slag remelting process is initiated, dummy bars **7** are rigidly fixed on stationary baseplate **8** with mould **4** is mounted on said baseplate. The consumable electrodes **3** are then introduced into mould **4** whereupon consumable electrodes **3**, mould **4** and baseplate **8** are energized and molten slag **11** is poured in mould **4**. As molten slag **11** touches the lower face of consumable electrode **3** the latter starts fusing off. Due to projections **5** provided on the internal walls and mould **4** or on the face of partition **6** (FIG. 2) zones **13** are established in molten slag **11** between mould **4** and consumable electrodes **3** and between consumable electrodes **3** and partition **6** (FIG. 3) which feature high electric conductivity. This enables the melting of consumable electrodes **3** which is accompanied by the formation of two or more drop-sources **14** (FIG. 2) on their parts immersed in molten slag **11**.

Liquid metal obtained by melting consumable electrodes **3** is admitted into mould **4** where it forms ingots **15** (FIG. 1). As the ingots **15** are built-up, the mould **4** is moved vertically.

In the above embodiment for practicing the proposed process the ingots are melted with the ingots while the mould is being moved relative to each other by shifting the comparatively short mould vertically upwards with respect to the motionless ingots.

The aforesaid relative motion can be however performed by removing the built-up ingots from a fast mould.

In addition the formation of higher-electric-conductivity zones in the molten slag is feasible not only because of the projections on the internal mould wall or on the partition but also by blasting the part of the consumable electrodes immersed in the slag by gases or gas-powder mixtures fed via openings in the projections.

What is claimed is:

**1.** A process for electro-slag remelting of consumable electrodes which comprises: establishing a slag bath in a cavity of a cooled mould and melting the consumable electrode immersed in the said slag bath by passing a current of higher density between individual parts of an internal surface of the said mould and opposite parts of the surface of the said consumable electrode immersed in the said slag bath whereby the surface of the said consumable electrode is fused off in the form of at least two cones.

**2.** A device for the electro-slag remelting of consumable electrodes comprising: a mast; an electrode holder secured on the said mast; consumable electrodes fastened in the said electrode holder and associated electrically with a power source; a cooled mould with a cavity for melting the said consumable electrodes and shaping an ingot; a baseplate covering the cavity of the said mould; projections on cavity walls of the said mould located in the melting zone of the said consumable electrodes; driving gears for providing relative motion of the said electrode holder, mould and baseplate.

**3.** A device as claimed in claim **2** in which a cavity of the said mould is fitted with a vertical partition with the said projections on its upper face located in the melting zone of the consumable electrodes.

**4.** A device as claimed in claim **3** in which the spacing between the middle points of the said adjacent projections is not less than the thickness of the said consumable electrode.

**5.** A device as claimed in claim **3** in which the said projections are equal in height to not less than one half of the width of a minimum ingot-shaping wall of the cavity of the said mould.

**6.** A device as claimed in claim **3** in which each of the said projections has the form of a truncated pyramid with a larger base located on the face of the said partition.

**7.** A device as claimed in claim **5** in which the base of each of the said projections is equal in length to at least the thickness of the said consumable electrodes.

**8.** A device as claimed in claim **7** in which the distance between each of the said projections and the surface of the said consumable electrode is at least 10 mm.

**9.** A device as claimed in claim **8** in which the distance between the said extreme in a row projection and a narrow wall of the said mould amounts to 0.5–2.0 of the width of a minimum ingot-shaping wall of a cavity of the said mould.

**10.** A device as claimed in claim **9** in which each of the said projections does not exceed in thickness that of the said partition.

**11.** A device as claimed in claim **10** in which the said projections are fitted with conduits running into the melting zone of the said consumable electrodes and intended for feeding therein gases and gas-powder mixtures.

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