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[54] **ELECTROSLAG REMELTING APPARATUS FOR MAKING METAL INGOTS**

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

[58] **Field of Search** ..... 164/52, 252, 250, 48, 50; 75/10 C, 15

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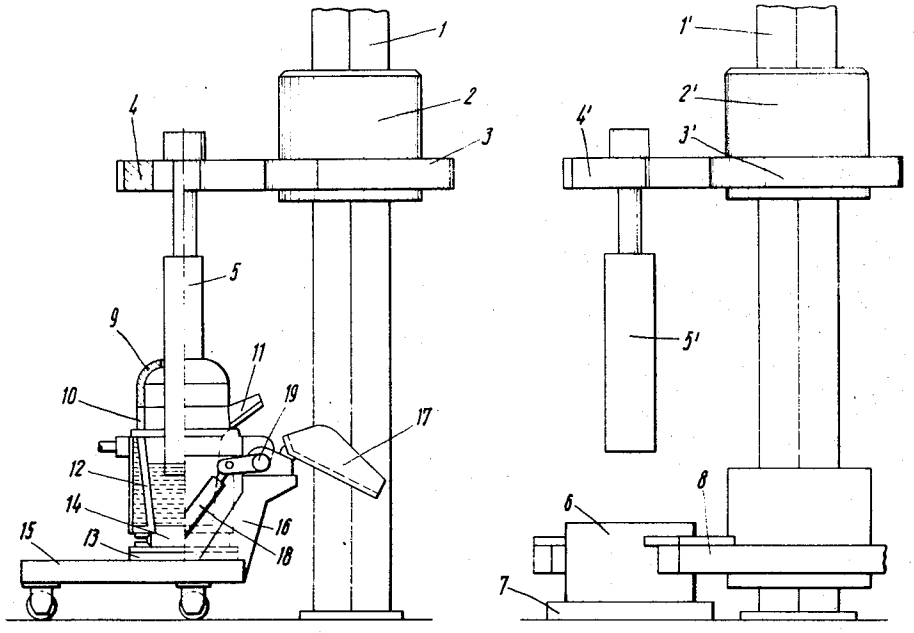
[57] **ABSTRACT**

At least two vertically slidable electrode holders are provided, in an electroslag remelting apparatus each of which has a predetermined working range. Means are provided for electrically connecting each of said electrode holders to a transformer. A cooled ingot mold of metal is disposed within the working range of said electrode holders and has a cooled mold bottom. A slag-melting vessel is adapted to be disposed within the working range of at least one of said electrode holders and has cooled metal walls. This vessel has a smaller cross-sectional area than the ingot mold. Means are provided for transferring liquid slag from the slag-melting vessel to the ingot mold.

5 Claims, 2 Drawing Figures



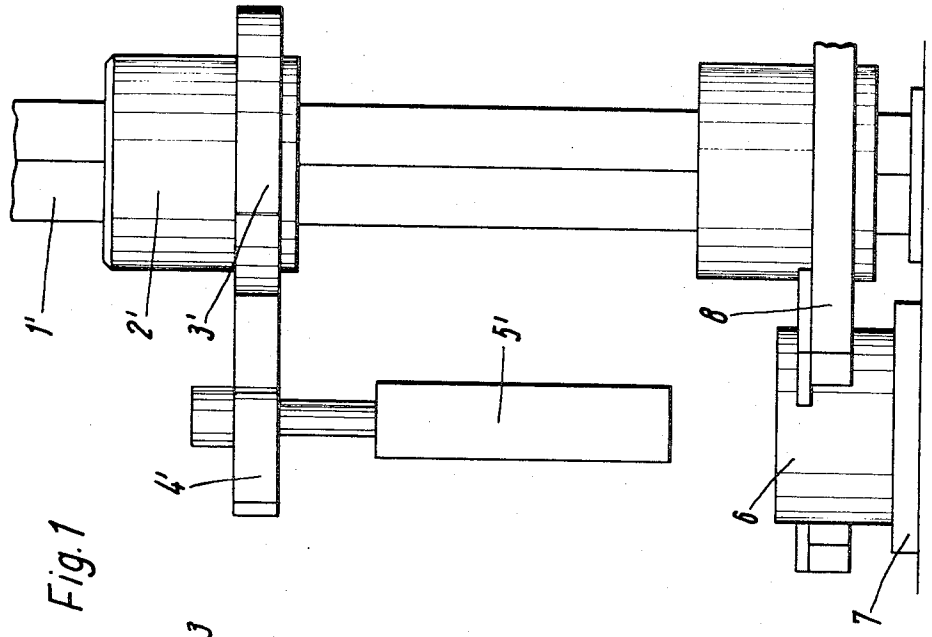
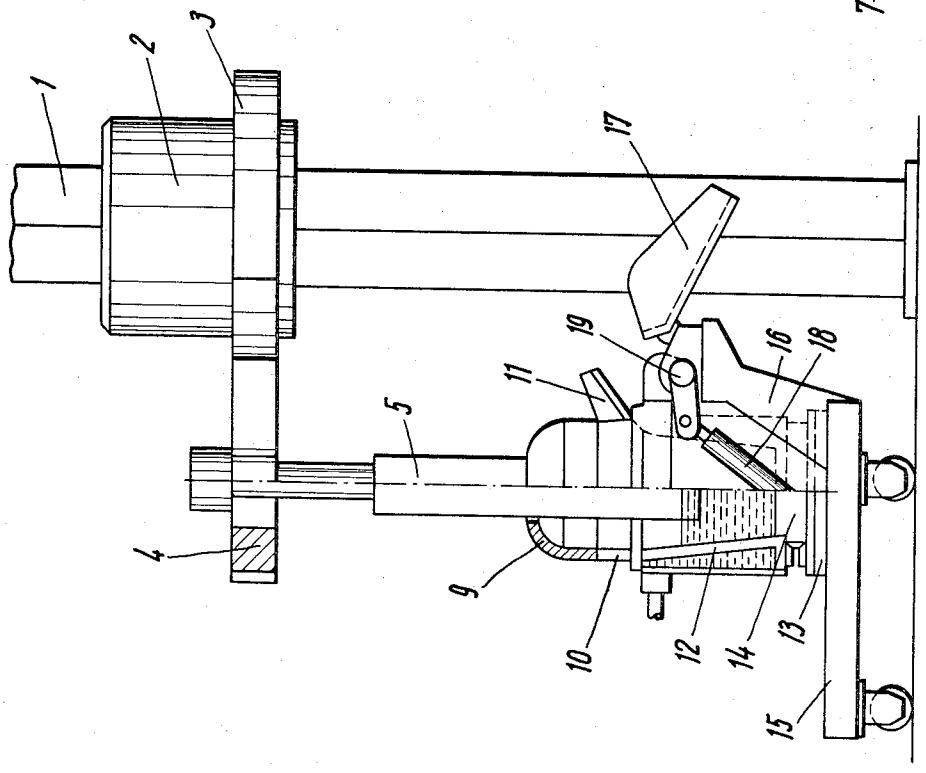


Fig. 1



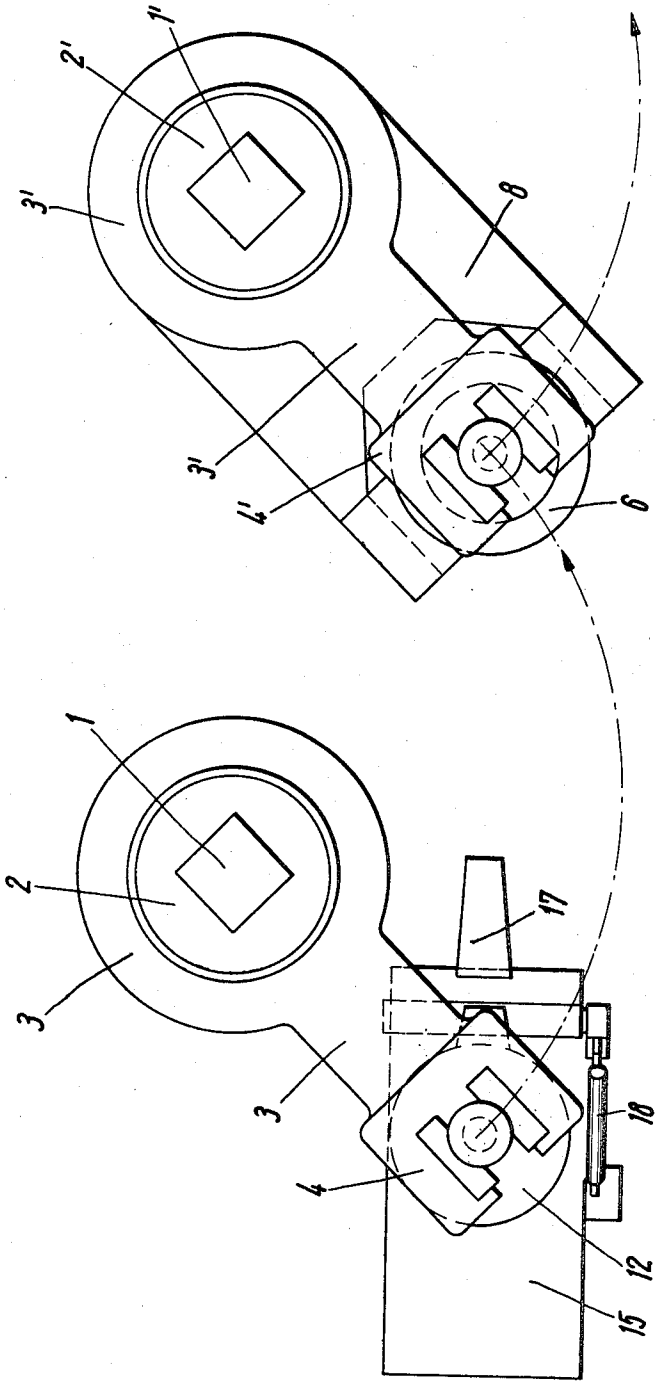


Fig. 2

ELECTROSLAG REMELTING APPARATUS FOR MAKING METAL INGOTS

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to an electroslag remelting apparatus for making metal ingots, preferably of steel, which apparatus comprises at least two vertically slidable electrode holders, which are connected, or adapted to be connected in alternation, to one and the same transformer, a cooled ingot mold of metal disposed adjacent to electrode folders, and a cooled ingot mold bottom.

Electroslag remelting apparatus generally comprises only one transformer, a fusible electrode, an electrode carrying arm, which is slidable along a column and provided with an electrode holder, a cooled ingot mold of metal, a cooled ingot mold bottom, and electric leads which connect the transformer to the fusible electrode and the ingot mold bottom. At the beginning of the remelting operation, an electric arc is formed between the remelting electrode and a plate which rests on the ingot mold bottom and consists of a material similar to that of the ingot to be formed, and granular, premelted slag is added to form a slag bath.

During the melting of the slag, the electrode begins to fuse too. Particularly in ingot molds which are relatively large in diameter, the melting of the electrode results in a high contamination of the lower end of the ingot with unmolten slag so that a large portion of the ingot is not suitable for further processing.

To avoid this disadvantage, it is known to melt the slag in a separate slag-melting furnace and to pour the molten slag into the ingot mold from above or, as in bottom teeming operations, from below through ducts in the bottom plate and then to begin the remelting operation. That process has the great disadvantage that a separate slag-melting furnace is required.

It has also been proposed first to melt the slag in the ingot mold by means of a non-consumable electrode in an electroslag remelting apparatus of the kind defined first hereinbefore, then to move the ingot mold on wheels under the fusible electrode and thereafter to begin the remelting operation. That process is carried out in an apparatus which comprises two columns, each of which is provided with an electrode-carrying arm and an electrode holder, a non-consumable electrode suspended from one carrying arm, and a remelting electrode suspended from the other carrying arm. The two electrodes are connected to the transformer of the installation. The ingot mold is mounted on a car for moving the ingot mold between the two electrodes. Alternatively, the process can be carried out by an apparatus which is provided with only one column and one electrode-carrying arm and in which both electrodes are suspended from one and the same carrying arm one beside the other. In that case too, the ingot mold for melting the slag is disposed first under the non-consumable electrode when it is desired to melt the slag and the ingot mold is subsequently pushed under the remelting electrode.

Whereas there is no need for a separate slag-melting furnace in that process, the process has the disadvantage that the melting of the slag takes a very long time and the slag cannot be melted completely if ingot molds

are used which are large in diameter as the non-consumable electrodes are relatively thin.

It is an object of the present invention to eliminate the disadvantages of the known processes and apparatus. In an electroslag remelting apparatus of the kind defined first hereinbefore, this is accomplished according to the invention by a slag-melting vessel, which is disposed in the working range lateral displacement of at least one electrode holder and which has cooled metal walls and a cross-sectional area which is smaller than the ingot mold, and means for transferring liquid slag from the slag-melting vessel into the ingot mold.

In order to enable the making of different amounts of slags under favorable conditions with a single slag-melting vessel, it is a further feature of the invention that one of the cooled metal walls is inclined rather than vertical in such a manner that the cross-sectional area of the slag-melting vessel is larger on top than on the bottom.

To reduce the radiant losses during the melting of the slag, the slag-melting vessel is preferably provided with a cover of refractory bricks, which cover has an aperture for the electrode.

The bottom or hearth of the slag-melting vessel may consist in known manner of a tamped carbon composition, and the lower end of each metal wall may lie entirely or in part on the outer edge of the layer of the tamped carbon composition.

The means for transferring liquid slag from the slag-melting vessel into the ingot mold includes preferably a car which carries the slag-melting vessel and is adapted to move the slag-melting vessel close to the ingot mold, and a tilting device for tilting the slag-melting vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention is shown on the accompanying drawing, in which

FIG. 1 is an elevation and;

FIG. 2 is a top plan view showing an electroslag remelting apparatus according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The electroslag remelting apparatus comprises two vertical columns 1, 1'. A guide member 2, 2' is vertically slidably mounted on each of these columns. An arm 3 or 3' is mounted on each of said guide members for a horizontal rotational movement. An electrode holder 4, 4' provided with gripping jaws for the electrodes 5, 5' is mounted at the outer ends of the arms 3, 3'. In this arrangement, the two electrode holders 4, 4' are pivotally movable about the respective columns along an arc each of a circle. The cooled ingot mold 6 provided with the ingot mold bottom 7 is disposed under the intersection of these two arcs. Remelting electrodes can be remelted in alternation in the ingot mold by means of the two electrode holders. Because the ingot mold can be raised by means of a carrying arm 8 which is slidable on the column 1', an ingot which is much longer than the ingot mold may be made from a plurality of remelting electrodes. A slag-melting vessel having cooled metal walls, such as is used with slag-melting furnaces, is used in the working range of the electrode holder 4 and sufficiently spaced from the ingot mold 6. It consists of refractory lined cover 9, an

intermediate ring **10** which opens to a spout **11**, cooled metal walls **12** widening to the top, and the bottom formed by a cooled metal plate **13** with a layer of rammed carbon **14.** The lower end of the metal walls **12** rest in part on the outer edge of the layer of rammed or tamped carbon composition **14.**

The slag-melting vessel stands on a car which has a superstructure **16** carrying a spout **17** and the bearings **19** about which the slag-melting vessel **12** is tiltable by means of a hydraulic cylinder **18.**

The apparatus according to the invention has the following mode of operation.

When a remelting operation has been completed, the ingot produced thereby is removed and the ingot mold **6** and the bottom plate **7** are prepared for the next following remelting operation. At the same time, the slag is melted which is required for the next remelting operation. For this purpose, the slag-melting vessel and the electrode holder **4** are in the position shown. A non-consumable electrode **5,** e.g., of graphite, is suspended in the electrode holder **4.** An electric connection, not shown, is established from the output terminals of a single-phase transformer to the electrode holder **4** and the plate **13,** the electrode **5** is lowered to strike an electric arc between the electrode and bottom, and the slag constituents are added. Because the slag-melting vessel is relatively narrow and the entire power output of the transformer is available for melting the slag, the slag is melted within very short time. As soon as the slag has been melted and sufficiently heated above its melting point, the electrode **5** is raised, the electrical connection to the transformer is broken, and the slag-melting vessel on the car **15** is emptied into the ingot mold. The car is then retracted and the melting electrode **5'** is lowered until it contacts the bath of slag so that the remelting operation carried out with this electrode begins.

The non-consumable electrode **5** is then replaced by a remelting electrode which corresponds to the electrode **5'.** As soon as the remelting electrode **5'** has been consumed, the electrode holder **4'** is raised and swung out. The holder **4** provided with the new remelting electrode is swung in as soon as possible and is used to continue the remelting operation in the usual manner virtually without interruption.

It will be understood that the invention is not restricted to the embodiment shown by way of example and that the advantages afforded by the invention may be utilized in all electroslag-remelting apparatus which comprise at least two electrode holders which are connected or can be connected to the same transformer. These two holders may be mounted on a single carrying arm; in that case the slag-melting vessel is in its melting position under the electrode holder from which the non-consumable electrode can be suspended whereas the other holder provided with the remelting electrode is disposed over the ingot mold. If in that case the arm cannot be pivotally moved or moved on wheels in such a manner that both holders can be positioned over the ingot mold, the ingot mold must be movable on wheels in such a manner that it can be moved fast enough under the other holder.

For this reason, the invention can be used to special advantage in remelting apparatus which are provided with two separate columns to enable an alternate melting of electrodes, whether such columns are provided with pivoted arms or pivoted holders or whether the columns are suspended from cranelike apparatus so that they can be moved to any desired position within a certain range.

The invention may also be used with apparatus which comprise four columns or four holders to enable a simultaneous remelting of four electrodes. In this case too, the slag-melting vessel is disposed beside the ingot mold and the slag is melted by means of one or two of the four electrode holders by means of one or two non-fusible electrodes. When the slag has been transferred from the slag-melting vessel into the ingot mold, the remelting operation begins with the aid of only one or two remelting electrodes and is continued with four electrodes as soon as the non-fusible electrodes have been replaced by fusible electrodes. It will be understood by a person skilled in the art that all known circuits may be used which comprise a plurality of electrodes, which may be connected in parallel or in series, and that the bottom of the ingot mold and/or the bottom of the slag-melting vessel may or may not be connected.

The advantages afforded by the invention will be obtained in all cases. They reside in that liquid slag at a temperature above its melting point is available from the beginning of each remelting operation and a separate slag-melting furnace is not required for the production of slag. For this operation, a slag-melting vessel is sufficient because the transformer which is required for the remelting operation is available also for the melting of the slag.

What is claimed is:

1. An electroslag remelting apparatus for making ingots of metal, which apparatus comprises:

a transformer;

at least two vertically slidable electrode holders, each of which has a predetermined working range of lateral displacement;

means for electrically connecting each of said electrode holders to said transformer;

a cooled metal ingot mold disposed within the working range of each of said electrode holders, which mold includes a cooled mold bottom;

a slag-melting vessel laterally spaced from said mold and disposed within the working range of lateral displacement of at least one of said electrode holders; which vessel includes cooled metal walls and has a smaller cross-sectional area than said ingot mold; and

said melting vessel being in structural combination with means for transferring liquid slag from said slag-melting vessel into said ingot mold.

2. The electroslag remelting apparatus as claimed in claim **1,** in which said slag-melting vessel has a larger cross-sectional area at the top than at the bottom.

3. The electroslag remelting apparatus as claimed in claim **1,** wherein

said slag-melting vessel is provided with a removable cover consisting of refractory bricks and having an aperture, and

said electrode holder having a working range of lateral displacement in which said slag-melting vessel is disposed is adapted to hold an electrode adapted to extend through said aperture into said slag-melting vessel.

4. The electroslag remelting apparatus as claimed in claim **1,** in which

said slag-melting vessel includes a bottom which consists of a cooled metal plate

said metal plate is covered by a layer of a tamped carbon composition, and

said cooled metal walls of said slag-melting vessel rest on said layer near its outer edge.

5. The electroslag remelting apparatus as claimed in claim **1,** in which said means for transferring liquid slag from said slag-melting vessel into said ingot mold comprises a car on which said slag-melting vessel is tiltably mounted, and a device for tilting said slag-melting vessel.

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