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[54] INDUCTION APPARATUS FOR CONTINUOUS AND SEMICONTINUOUS CASTING

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[58] **Field of Search** 164/51, 82, 89, 251, 281, 283

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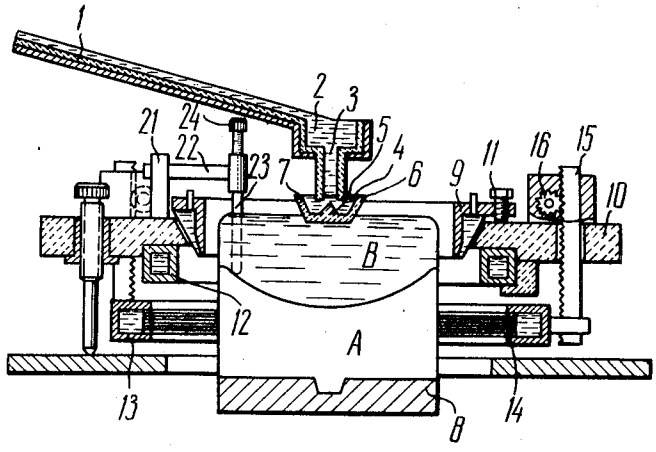
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[57] **ABSTRACT**

Apparatus for continuous and semicontinuous casting of metals by feeding molten metal into an annular electromagnetic inductor creating a field for forming an ingot cooled by a liquid supplied by a ring device made in the form of a perforated tube and mounted under the inductor so as to be capable of movement in a vertical direction.

2 Claims, 2 Drawing Figures



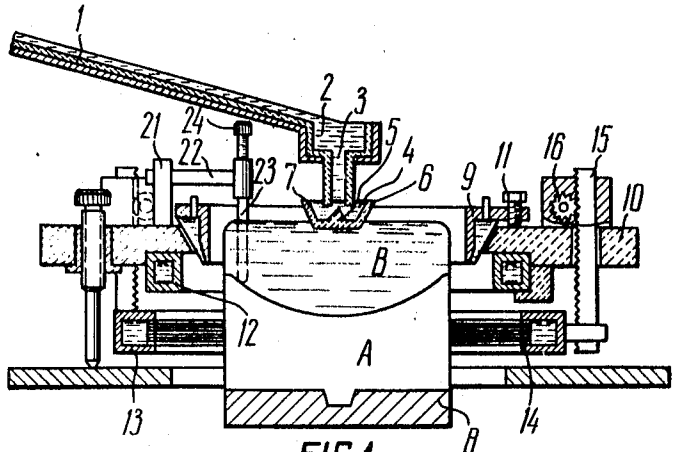


FIG. 1

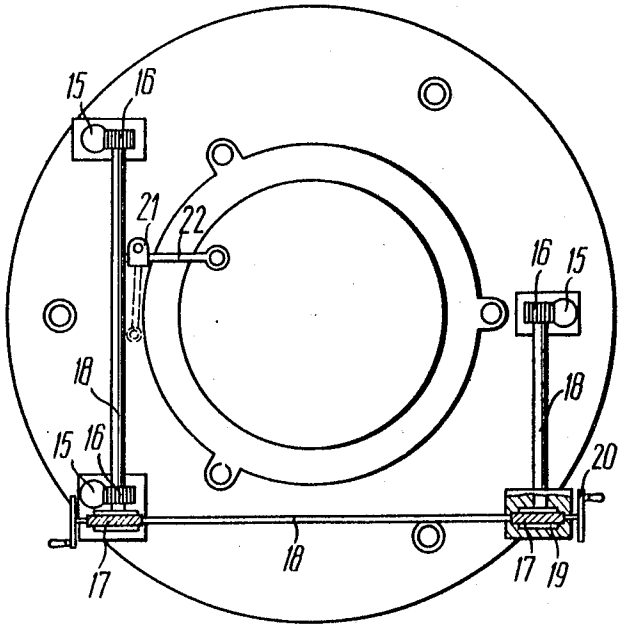


FIG. 2

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INDUCTION APPARATUS FOR CONTINUOUS AND SEMICONTINUOUS CASTING

The present invention relates to apparatus for continuous and semicontinuous casting of metals.

Known in the art are apparatus of the type comprising an annular electromagnetic inductor, into which is supplied molten metal, an electromagnetic screen for distributing the electromagnetic field of the inductor in an axial direction and a ring device for supplying a cooling liquid onto the surface of the ingot being formed.

The device for supplying a cooling liquid consists of a ring collector with an annular nozzle formed by the collector wall and the lower cone-shaped portion of the electromagnetic screen.

The nozzle feeds the cooling liquid into the gap between the inductor and the ingot and directs it to the ingot surface at an acute angle.

The annular inductor creates an alternating electromagnetic field around the molten metal fed into the ingot-forming zone, which field produces within the molten metal forces directed into this metal and preventing it from flowing, thus shaping it. In this case the molten metal acquires a required shape in cross section and required overall dimensions. The lateral surface of the column of molten metal shaped by the electromagnetic field is supplied with a cooling liquid, due to which it cools down and completely solidifies during the movement, thus forming an ingot.

It has been found that the distance between the cooling zone (the place of contact of the cooling liquid with the surface of the ingot) and the boundary between the solid and liquid phases depends basically upon the casting speed.

The casting speed depends on the alloy composition and, even though the ingots to be cast have the same size, the casting speeds vary within a wide range.

At the same time, the boundary between the liquid and solid phases of the ingot is usually located at the level of the middle portion of the inductor. This means that in the process of casting ingots of the same size but of different alloys of one metal, for example aluminum, it is necessary to change the position of the cooling zone.

At low casting speeds of alloys the distance between the cooling zone and the boundary between the liquid and solid phases is sufficiently large (for example, this distance for aluminum alloys is equal to 90–100 mm.), while the angle of inclination of the cooling liquid flow is small (not higher than 8°–10), therefore, even at small deviations of the ingots from a vertical axis which are practically unavoidable during the casting, there is developed a considerable distortion of the cooling zone.

This leads to the fact that in the places where the cooling zone rises above the middle portion of the inductor, the surface of the peripheral portions of the liquid phase can solidify and the supplied molten metal, while rolling along the solidified surface, forms shapeless overflows on the ingots.

In the places where the cooling zone is disposed below the middle portion of the inductor, the metal is not completely solidified within the zone of action of the inductor and flows along the ingot surface, thus considerably deteriorating the ingot quality.

The use of an electromagnetic screen as a guide for the cooling liquid makes it difficult to simultaneously provide for optimum distribution of the electromagnetic field and for the required position of the cooling zone, because each of the said independent characteristics depends on a single parameter (the angle of cone of the electromagnetic screen).

The known apparatus does not allow the position of the cooling zone to be controlled, as this position depends on the construction of the lower cone portion of the electromagnetic screen directing the cooling liquid onto the surface of the ingot.

The basic object of the present invention is to provide an apparatus for continuous and semicontinuous casting of metals, in which the construction of the components and the

disposition of the device for feeding a cooling liquid onto the ingot surface make it possible to improve the quality of the ingots, particularly those cast at low speeds, and provide for the possibility of casting the ingots from any alloys needing various casting speeds without any change in the construction of the apparatus, the optimum conditions of cooling the ingot and the optimum distribution of the electromagnetic field of the inductor being maintained simultaneously.

This and other objects are attained by providing an apparatus for continuous and semicontinuous casting of metals by means of feeding a uniform supply of molten metal into an annular electromagnetic inductor, in which the electromagnetic field forms an ingot cooled with the help of a ring device for feeding a cooling liquid onto the surface of the ingot, in which, according to the invention, the ring device for feeding a cooling liquid is made in the form of a tube with perforations facing the ingot and is located under the inductor close thereto with the possibility of movement along the ingot axis.

For determining the value of displacement of the ring-shaped device feeding a cooling medium along the ingot axis, the apparatus is preferably provided with a device for determining the boundary between the liquid and solid phases of the ingot being formed, the latter device being operatively connected to the drive for displacing said ring device relative to the inductor.

The essence of the invention consists in the following.

Owing to the fact that the ring device for supplying a cooling liquid is made in the form of a tube with perforations facing the ingot, the cooling liquid is fed perpendicular to the ingot surface, therefore, even at deviations of the ingot from a vertical axis, the cooling zone is maintained in a substantially horizontal position, thus providing for a high quality of the ingot.

The disposition of the ring device for supply of a cooling liquid under the inductor close thereto and adapted for movement along the ingot axis makes it possible to cast ingots from various alloys without any change in the construction of the apparatus, solely by displacing the position of the cooling zone which depends mostly on the casting speed.

Furthermore, in the proposed apparatus the electromagnetic screen and the device for supplying a cooling medium perform different functions, therefore, there are provided the best conditions for the optimum distribution of the electromagnetic field of the inductor and for cooling the ingot so that the quality of the ingot is improved.

The invention is better understood from the following description of its preferred embodiment, reference being made to the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view of the apparatus for continuous and semicontinuous casting of aluminum;

FIG. 2 is a top view of the same apparatus.

As shown in the drawings, the apparatus comprises a feed tray 1 (FIG. 1) terminating at its lower or outer end in a tank 2 with a hole 3, a device for even distribution of molten aluminum consisting of a cup 4 with a cone 5 in the center thereof and with openings 6 evenly distributed about its sidewalls 7, a pan 8, a water-cooled electromagnetic screen 9 mounted on a plate 10 by means of screws 11, an annular electromagnetic inductor 12 secured on the plate 10, a tube 13 having a rectangular, round or other suitable section with perforations 14 in its inner wall, i.e., on the side facing the ingot.

The tube 13 is suspended from the plate 10 and is adapted to be moved in a vertical direction by means of racks 15 secured to the tube 13 and engaging gear wheels 16.

The apparatus has three such mechanisms for vertically moving the tube 13 which are angularly positioned at an angle of 120° with respect to each other and connected through a common drive consisting of worms 17 (FIG. 2), shafts 18, worm wheels 19 and a manual control wheel 20.

Mounted on the plate 10 on the upper portion thereof is a device for determining the boundary between the liquid and solid phases of the ingot being shaped. This device consists of a stand 21 capable of pivoting or revolving in the horizontal

plane of the bracket **22**, i.e., about a vertical axis, and terminating at its outer end in a feeler **23**. The upper portion of the feeler **23** serves as an indicator **24** for determining the value of deviation of the boundary between the liquid and solid portion of the ingot from the level of the middle portion of the inductor.

The above-described apparatus operates as follows.

Prior to the process of continuous casting, the pan **8** (FIG. **1**) is introduced into the inductor **12** while the ring-shaped tube **13** is installed close to the inductor in a position in which the boundary between the liquid and solid phases of the aluminum is at the general level of the middle portion of the inductor.

The molten aluminum is fed along the tray **1**, through the hole **3** of the tank **2**, and is applied onto the pan **8** inserted into the inductor **12** from below. The water used as a cooling medium and fed from the ring-shaped tube **13** through the perforations **14**, flows onto the pan **8** and cools the molten metal thereon, which metal starts to solidify.

The solidified portion of the ingot is shown in the drawing as A while the molten portion thereof is indicated as B.

The electromagnetic field excited by the inductor **12** creates forces within the melt due to which the molten portion B of the ingot is prevented from flowing and is shaped so that its section acquires that of the inductor.

As the height of the column of metal shaped, partially solidified and bearing on the pan **8**, increases, the pan **8** comes down. As this takes place, the cup **4** is installed on the upper surface of the molten metal (of the portion B). The molten metal applied on the cone **5** of the cup **4** flows along the cup bottom and through the openings **6** is evenly supplied into the inductor **12**.

The molten metal fed into the inductor is solidified, forming a column of solid metal which comes down together with the pan. The solidification occurs when water is applied directly onto the lateral surface of the ingot.

The cooling liquid is applied on the ingot surface in the form of separate sprays, basically at an angle of 90°. In order to provide uniform cooling of the metal, the perforations **14** in the tube **13** are disposed in a few rows and are staggered at such distance from each other that separate streams of the cooling medium do not join.

In order to check whether the boundary of the liquid and solid phases is at the level of the middle portion of the inductor, the feeler **23** is lowered into the molten aluminum near the lateral surface of the shaped ingot until it touches the solidified portion A of the ingot.

In the case of deviation of the boundary of the liquid and solid phases from the required position, the magnitude of this deviation is determined by the rule or indicator **24** on which the required position is marked by a cut line.

Depending on the measured deviation, the tube **13** is displaced along the ingot axis by rotating the control wheel **20** of the tube drive.

In this case the worms **17** rotate the worm wheels **19** (FIG. **2**) and shafts **18**, which, in turn, rotate the gear wheels **16** engaging the racks **15**, thus displacing the tube **13** in a vertical direction along the ingot axis.

The proposed apparatus makes it possible to cast high-quality ingots having a diameter of up to 1,000 mm. from aluminum alloys.

I claim:

1. An apparatus for continuous and semicontinuous casting of metals into ingots comprising in combination: a device for uniform feed of molten metal, an annular electromagnetic inductor located under said device for uniform feed of molten metal for creating an electromagnetic field which holds the molten metal in the shape of an ingot before solidification, a ring device for supplying a cooling liquid onto the surface of the ingot for its solidification, said ring device comprising a tube having perforations on the side facing the ingot and being located under said inductor in close proximity thereto, and means for moving said ring device along the ingot axis.

2. An apparatus as claimed in claim **1**, further comprising a device for determining the boundary between the liquid and solid phases of the ingot being formed and giving an indication of the vertical location of such boundary, said ring device being vertically adjustable in accordance with the indication of said device.

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