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CONTINUOUS CASTING APPARATUS
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FIG. 1.

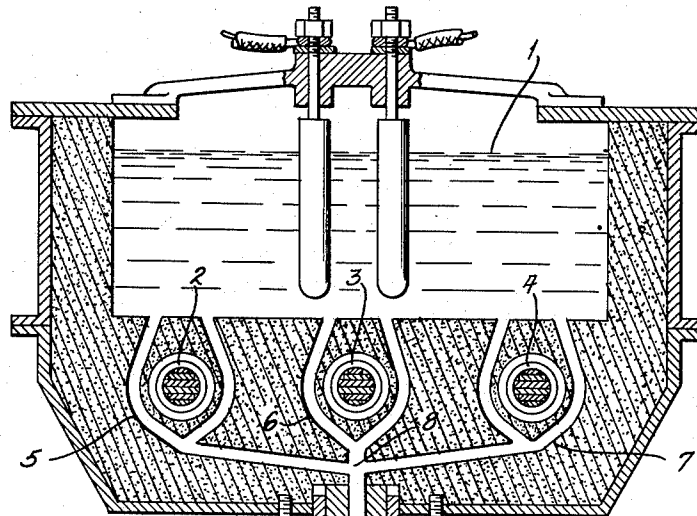
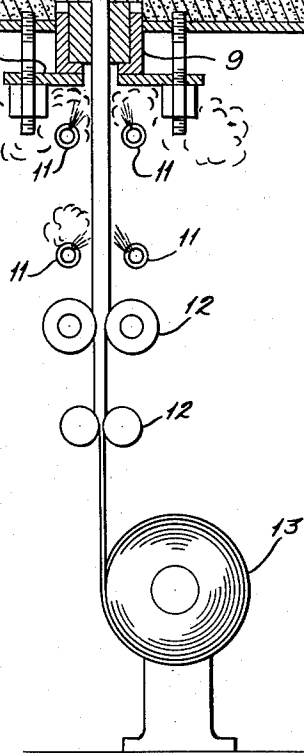
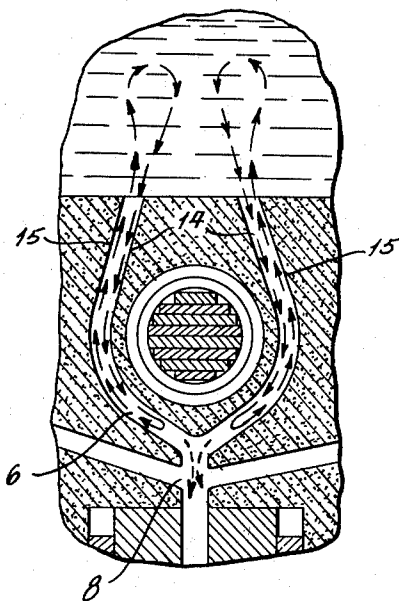


FIG. 2.



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CONTINUOUS CASTING APPARATUS

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2 Claims. (Cl. 22—57.2)

This invention relates generally to the continuous casting of metals and particularly to the continuous casting of alloys in thin, elongated strips.

While various efforts have heretofore been made to cast metals continuously in the form of elongated strips by passing a stream of molten metal through a chilled mold or die, difficulties have been encountered with the segregation of the alloy elements in such continuous casting. Such segregation of the alloying elements results in non-conformity of the casting and, where the casting is to be further worked, as by rolling into sheets or strips, the non-conformity per unit of cross section is accentuated and may render the resultant product unsuitable for use.

The object of the present invention, generally stated, is to provide an apparatus for continuously casting alloys where the tendency of the constituents to segregate is minimized.

A further object of the invention is to provide a continuous casting apparatus wherein the resultant casting is of uniform composition and physical characteristics throughout all cross sections poured from a common mold.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a continuous casting furnace constructed in accordance with the present invention; and

Figure 2 is an enlarged cross-sectional view showing the circulation pattern within the molten metal immediately ahead of the continuous casting mold or die.

The present invention makes use of the "Ajax" type of electric induction furnace and contemplates the correlation therewith of a continuous casting mold or die so arranged that the molten metal is supplied thereto immediately after it has been subjected to the inductive effect of the furnace, which is to say that each increment of molten metal reaches the mold in both an agitated and molecular compressed condition.

The "Ajax" type of furnace above mentioned is characterized by the feature that a circulating path is provided about an alternating current conductor in such relation that the molten metal occupying said path constitutes the secondary of a transformer, while the conductor constitutes the primary. While the molten metal is in this position, secondary induced currents flow therein and, as is well understood by those skilled in the art, the magnetic fields set up by the primary current and the induced current oppose each other and hence tend to force the secondary circuit away from the primary circuit. Consequently, the molten metal constituting the fluid secondary is subjected to inter-molecular compression and to circulation within the path about the primary conductor.

The present invention, therefore, takes advantage of the inter-molecular compression and circulation of an "Ajax" type induction furnace by providing a continuous casting mold adjacent the circulation path in which the

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molten metal constitutes the transformer secondary. Accordingly, the molten metal is delivered, in accordance with the present invention, to a continuous casting mold in a condition of compression (in excess of the static head upon it) and while internal circulations are taking place within the fluid stream thereof. In order to obtain the maximum advantage, in continuous casting, of the compressed and agitated condition of the molten metal as it emerges from the magnetic field of the primary, it is contemplated that the mold be disposed as close as convenient to the circulating path about the primary conductor. As the distance of the mold from such circulating path increases, the advantageous casting condition of the metal decreases until, at distances of several feet, the advantageous casting condition may be substantially lost.

In Figure 1 of the accompanying drawings, a typical "Ajax" type furnace is diagrammatically shown. In the embodiment illustrated, the furnace comprises a reservoir 1 for receiving and holding the charge of molten metal. The walls of reservoir 1 are formed of suitable refractory material. For continuous casting the reservoir 1 is of a sufficient capacity that molten metal may be continuously discharged therefrom without creating undesirable turbulence therein or too rapid a drop in the level of the molten metal therein. In order to maintain a substantially uniform static head of molten metal within the reservoir, it is desirable, in a continuous casting operation, to continuously charge the reservoir with raw material at the same rate that molten metal issues therefrom.

The furnace shown in the drawing is a three-phase furnace having primary conductors 2, 3, and 4, each encircling iron transformer core legs 16, 17, and 18 respectively and encased in refractory material and provided thereabout with open paths 5, 6, and 7, respectively, through which the molten metal may circulate and, while circulating, constitute the fluid secondary in a transformer relationship with primary conductors 2, 3, and 4. The relation of primary conductors within the circulating paths just described is the conventional construction for a so-called "Ajax" type furnace as shown in U. S. Patent No. 1,201,671.

In accordance with the present invention, one or more of the circulating paths 5, 6, and 7 are arranged to communicate with a gate 8. In the embodiment shown in the drawings, the gate 8 is arranged at the bottom of the path 6, and the molten metal is fed therethrough and delivered therefrom in a vertical direction to a mold 9, but it will be understood that the feeding and delivery may be horizontal.

The mold 9 is suitably supported adjacent the wall of the furnace and provided with a jacket through which a cooling medium may be circulated, in a manner well known to the art of continuous mold casting.

While in the accompanying drawing but one mold 9 is shown, and said mold is fed only from the circulating path about one primary conductor, it is to be understood that the several circulating paths may be gated to feed the same mold concurrently, or each circulating path may be gated to a different mold.

With the mold thus arranged to receive the molten metal immediately as it emerges from the circulating path 6 in which it constitutes the secondary of a transformer, the stream of molten metal as fed to the mold is undergoing intra-stream circulation and is under inter-molecular pressure in excess of the static head resulting from the over-burden of molten metal. In other words, the molten metal as delivered to the mold is in the same molecular condition as that which existed while the metal was the secondary of the transformer. In this condition, the alloying constituents are thoroughly mixed and uniformly distributed with uniform grain orientation.

The mold 9 is provided with a casting orifice 10, which may be dimensioned in the section shown in Figure 1, to deliver a casting having the thickness on the order of about 2½ inches or less, depending upon the capacity of the furnace and the thickness of the strip desired. The dimension of the orifice 10 in the direction normal to the section shown in Figure 1 is a matter of choice limited only by the capacity of the furnace to continuously supply it.

As the stream of molten metal passes through the orifice 10, it is solidified and therebeyond the casting is impinged by a series of streams of coolant with or without other surface-treating agent delivered by nozzles 11.

As the casting issues from the mold 9, it may be passed immediately between a series of reducing rolls 12 in order to further reduce the thickness of the sheet of strip, as desired, and finally the strip may be collected upon a reel 13 or cut into straight lengths for storage by the conventional shearing apparatus.

In Figure 2 of the drawings, the solid arrows indicate the recognized direction of fluid circulation within the path 6 about the primary conductor 3, while the broken arrows indicate the flow of molten metal through gate 8. When the molten metal is flowing through gate 8 to mold 9, the intensity of circulation in the general direction of the solid arrows is less severe than in the case of the conventional "Ajax" type furnace, there being less of the flow in the upward direction by the amount which is discharged through gate 8 at any increment of time. The general type of circulation continues to take place as the metal is delivered to gate 8, however, and in addition thereto, the molecules of molten metal are continuously urged away from the inner wall 14 and toward the outer wall 15 of the path 6. At any increment of time, the molecule nearest inner wall 14 is being urged toward outer wall 15 and, under the well known influence of such magnetic fields, continuous circulation is thus occurring not only within the path 6, as indicated by the arrows, but within the body of metal disposed in that path. Moreover, the "pinch" effect encountered in path 6 places the molten metal under further compression prior to entry of the metal into the mold 9, thereby assisting in expulsion of undesired gases and the like.

The apparatus hereinbefore described may be utilized for the continuous casting of any metal, but is of particular advantage in the casting of alloys such as copper-zinc alloys, aluminum copper alloys, and various steel alloys wherein segregation constitutes a problem. In the case of copper-zinc alloys, the tendency of zinc to segregate is a notorious difficulty, but the process and apparatus of the present invention provide agitation in character and degree sufficient to maintain the zinc uniformly

distributed within the copper as it is delivered to the mold 9, so that the molten metal is in a highly desirable condition for casting immediately prior to the solidification thereof.

While the invention has been disclosed with particular relation to a continuous casting apparatus, it is not necessarily limited thereto. In the case of casting alloys where the tendency toward segregation is a serious problem, considerable advantage will inhere in the withdrawal of a batch of casting metal through gate 8, as distinguished from the usual method of removing molten metal from an "Ajax" type furnace which involves tilting the furnace and pouring from the top thereof.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. Apparatus for the continuous casting of metals comprising a chamber for the melting and reservation of molten metal, said chamber having a relatively thick, solid bottom wall, said bottom wall having a U-shaped channel of substantially uniform cross-section disposed below the chamber, the divergent ends of said channel being connected with the upper surface of said chamber bottom and arranged to drain metal from the chamber, a metal congealing tubular mold the entry side of which is directly gated to the bottom of said channel, and a primary low-frequency current carrying iron cored coil positioned within and insulated by said bottom wall and surrounded by, and adapted to be in electroinductive relationship with the metal occupying, said channel.

2. The apparatus of claim 1 having a plurality of said U-shaped channels in the bottom thereof and a plurality of said coils each surrounded by one of said channels, the bottoms of all said channels being directly gated together and to said mold.

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