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METAL DISTRIBUTION FOR CONTINUOUS CASTING

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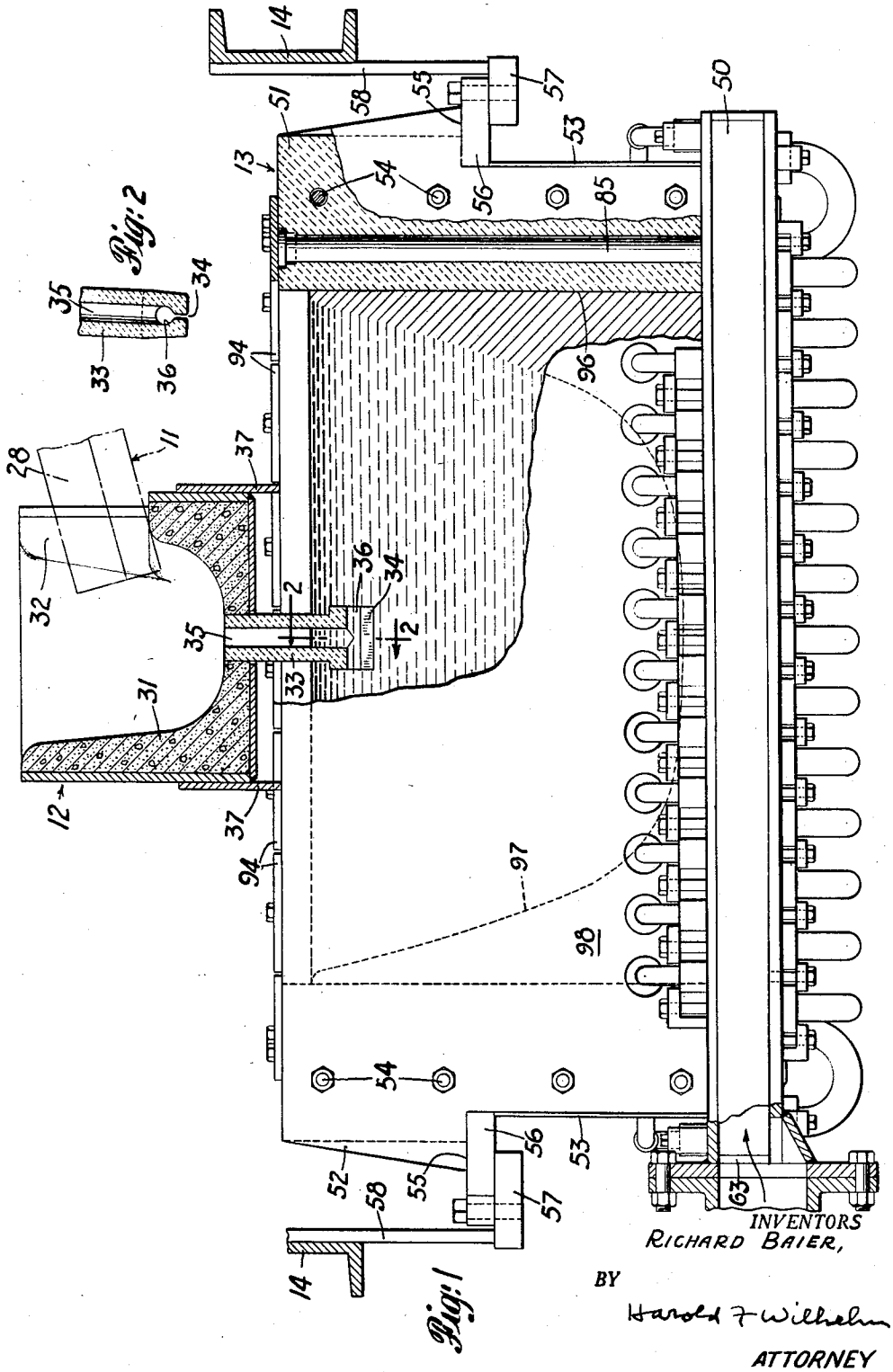


Fig. 2

Fig. 1

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METAL DISTRIBUTION FOR CONTINUOUS CASTING

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2 Claims. (Cl. 22—79)

The invention relates to continuously casting metal, and more particularly to distributing methods and devices for properly feeding and distributing molten metal to molds having an elongate cross section.

This application is a division of parent application Serial No. 606,518, filed August 27, 1956, entitled Block Graphite Mold for Continuous Casting.

According to the parent application, one preferred form of mold comprises a graphite block having a mold pocket oblong in horizontal cross section. The mold has an open top to receive the molten metal and an open bottom from which the congealed cake emerges. The present invention, in its preferred form, comprises a bowl having a refractory lining for receiving the molten metal. Connected to the bottom of the bowl is an inverted, refractory, T-shaped distributor having a vertical passage feeding a horizontal passage. The horizontal passage has open ends; it has an open bottom which may be in the form of a narrow slit or a series of bottom holes. The distributor is for the purpose of distributing the molten metal in the mold in such way as to obtain a more homogeneous casting as explained more at length hereinafter.

Other objects and features of the invention will be more apparent from the following description when considered with the following drawings in which:

Fig. 1 is a side elevation of a mold with the funnel distributor in place, parts of the mold being shown in section; and

Fig. 2 is a section on the line 2—2 of Fig. 1 taken through the T-shaped pouring nozzle.

In the accompanying drawings and in the description forming part of this specification, certain specific disclosure of the invention is made for purposes of explanation, but it will be understood that the details may be modified in various respects without departure from the broad aspect of the invention.

Referring now to the drawings, the funnel distributor is denoted in general by 12 and is shown resting on mold 13 which in turn is suspended from frame 14. Frame 14 may be vertically reciprocated as by the means indicated in the parent application. The molten metal, which may be copper, may be supplied from a holding furnace (not shown) to pouring ladle 11, which in turn delivers it to funnel distributor 12 which in turn supplies the mold as indicated. Only trough or spout 28 of ladle 11 is shown, for simplicity of illustration.

The mold 13 comprises a composite graphite block 51 of generally oblong horizontal cross section having a mold pocket 96 of similar cross section. The mold pocket, for example, may have a minor horizontal axis of about 4½ inches and a major horizontal axis of about 25 inches to produce a cake of corresponding size. The mold pocket 96 has an open top to receive the molten metal and an open bottom from which the congealed cake casting 98 emerges.

Surrounding the mold pocket 96, the graphite block 51 has a series of vertical drilled passages having copper

tubes 85 fitted therein for efficient heat transfer. Manifold device 50 supplies the tubes 85 with water, the manifold device having an inlet 63 to which cooling water is supplied.

The graphite block 51 is supported in a metal frame or box, the bottom of which comprises the manifold device 50 and the sides of which comprise two vertical parallel side plates 52, one on each side, and end plates 53 at either end. The frame is clamped together by horizontal bolts 54. The side plates 52 have steps 55 resting on transverse bars 56 which in turn rest on transverse bars 57 attached to hangers 58 suspended from frame 14. Top plates 94 protect the top of the mold from molten metal which may be accidentally spilled.

Since the details of mold construction form no part of the present invention, no further description will be given.

The funnel distributor 12 comprises a bowl or container 31 having a refractory lining with an entrance notch 32 for receiving the trough 28 of ladle 11. Funnel 12 has an inverted refractory T-shaped distributor 33 with a vertical passage 35 feeding a horizontal passage 36. See also Fig. 2. Horizontal passage 36 has, at its bottom, a narrow slit 34. Instead of slit 34, a series of bottom holes may be provided. The horizontal bar of the T and passage 36 may be short compared to the length of the major horizontal axis (width) of the mold, as indicated in the drawing. Funnel 12 is supported by bridging plates 37 resting on the side walls of mold 13.

The manner of handling the hot metal will depend on the nature of the metal. In the case of tough pitch copper, for example, the metal stream may fall through air in passing from the holding furnace to pouring ladle 11 and in passing from pouring ladle 11 to funnel 12. This is generally suitable also for highly deoxidized coppers. However, with all coppers, and particularly with oxygen-free and low residual phosphorous deoxidized coppers, it may be advisable to use a reducing gas at these points to prevent oxygen absorption.

The most important function of the funnel distributor 12 is to distribute the molten metal in the mold 13 in such way as to avoid hot spots, cold shuts, local sweats and other minor surface faults. In casting tough pitch copper it is particularly important to obtain a uniform stirring action at the molten surface level in the mold, to avoid the formation of heavy oxide scum which causes both surface defects and local interior islands of high-oxygen copper in the cast product.

The above action is accomplished by submerging the clay-graphite distributing tube 33 just below the surface of the molten metal in the mold, as indicated particularly in Fig. 1. The multi-directional outlet flow through the ends of the horizontal passage 36 and through the bottom slit 34 provides the necessary distribution; the open ends provide stirring at the ends of the mold, while the narrow bottom slit restricts downward velocity component at the center so that all of the hot metal is not directed with high velocity at one point. A compact stream with high velocity could result in a very localized central hot spot, which would increase the depth of the freezing zone of the metal in the mold, i.e. of crater 97.

On the other hand, if the entire metal supply is delivered horizontally, the excessive horizontal velocity of the metal streams will cause undesirable cold shuts and laps on the freezing surface. Thus there is a critical relationship between the area of the two end horizontal holes and the bottom slot (or vertical drill holes) depending on the rate of casting and the cross sectional area of the cast product.

It is one of the objects of this invention to provide a design, and a method of construction, of said delivery device which will maintain this critical relationship in

practice, despite the well known errosive effect of flowing molten metals, particularly tough pitch copper. I have found that clay-graphite is particularly advantageous for casting coppers.

The invention may be used in casting any metal or alloy, such as steel, silver, nickel, aluminum, magnesium and particularly copper. It is especially useful for casting oxygen-bearing copper such as tough pitch copper in any desired size; and for casting coppers free of oxygen such as oxygen-free or phosphorous deoxidized copper.

The term "oxygen-bearing copper," as used herein, is intended to include tough pitch copper as well as copper containing a lesser amount of oxygen; it is intended to include any copper in which oxygen is in available form for attacking the graphite if the reaction temperature of the graphite is exceeded.

On the other hand, the term "copper free of oxygen," as used herein, is intended to cover those coppers known as phosphorous deoxidized copper containing both high phosphorous and low residual phosphorous, any other deoxidized copper such as copper deoxidized by lithium, boron, calcium, etc., and also those coppers referred to as "oxygen free"; in other words, any copper in which there is no oxygen available for attacking the graphite at its reaction temperature.

For casting coppers free of oxygen, it is preferred to maintain a protective layer (not shown) of discrete particles of carbonaceous material, such as flake graphite, lamp black, pulverized anthracite, etc., floating on the surface of the molten metal in the mold. This cover acts both as a protective blanket to prevent oxygen absorption and as a moving mold wash to prevent adherence of phosphate slag or other extraneous material to the mold wall. Consequently, reciprocation has a special purpose when casting coppers of this type. When casting coppers requiring the above-mentioned protective layer of carbonaceous material, it is preferable to submerge the distributing tube **33** far enough below the surface of the molten metal in the mold to avoid sufficient stirring action at the surface to entrap the carbonaceous particles in the molten and solidifying metal. Oxygen bearing coppers act decidedly differently. Here, reactive carbon produces defects, and the use of a bare mold wall is preferable to the nuisance of trying to apply an inert mold dressing and maintaining a uniform coating at all times.

When casting copper containing no phosphorous or other slag forming residual deoxidizers, it is possible to operate with a neutral or reducing gas, such as nitrogen or carbon monoxide, instead of the finely divided solid carbonaceous material for the purpose of limiting or preventing oxygen absorption by the free surface of the metal in the mold.

Because of the stirring, distribution, and velocity-controlling action above described, the funnel distributor makes possible casting at higher rates. Thus, not only higher tonnages are obtained but more homogeneous interiors and better surfaces on the cast product are also obtained.

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. A distributor device for feeding molten metal to a mold having a mold pocket which is elongate in cross section, said device comprising a container holding the molten metal, a delivery tube communicating with the bottom of said container, said delivery tube being of inverted T-section comprising a vertical conduit and a transverse conduit, the ends of said transverse conduit being open, said transverse conduit having a restricted open bottom portion, whereby both vertical and horizontal components of motion are imparted to the molten metal leaving said delivery tube, the dimensions of said open ends and the dimension of said open bottom portion controlling the amount of vertical and horizontal component.

2. The apparatus of claim 1 in which said delivery tube is made of clay graphite.

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