Jan. 28, 1969 J. E. BYRNES ET AL 3,424,130

ENTRY PORT MEMBER FOR DIP CRUCIBLE APPARATUS

Filed March 6, 1967

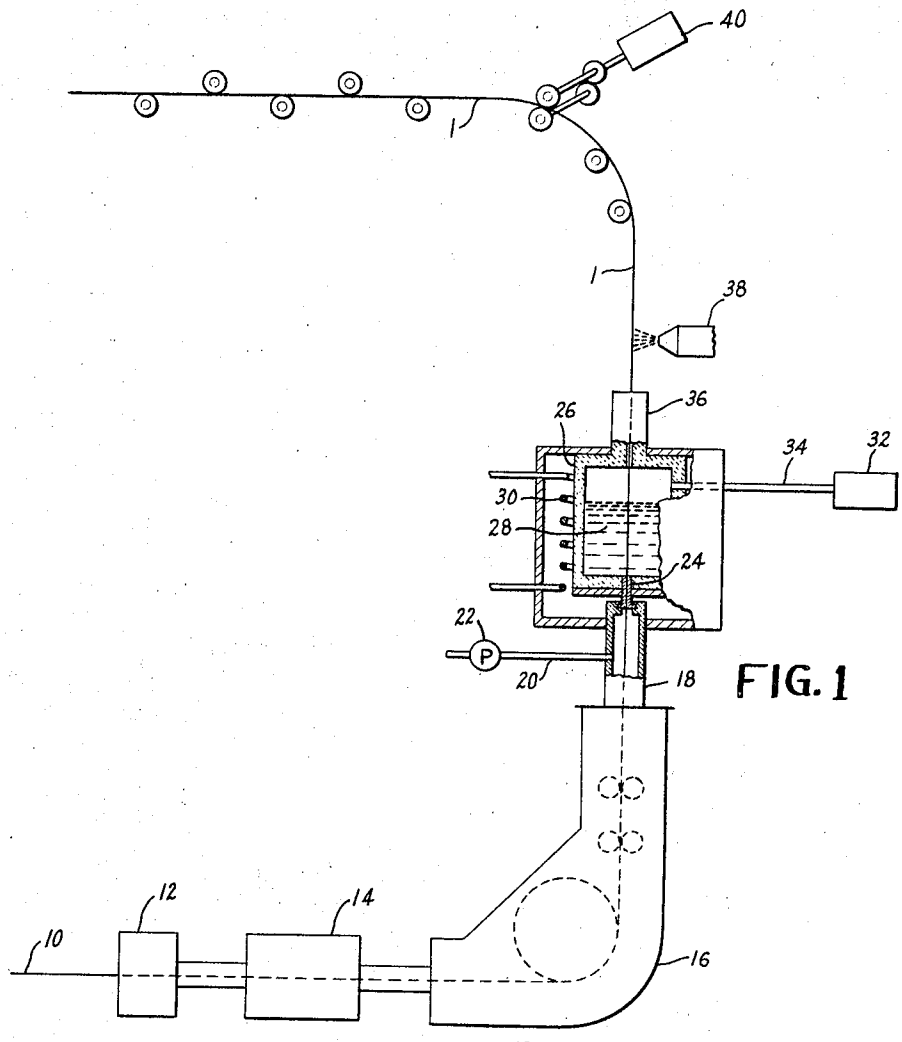


FIG. 1

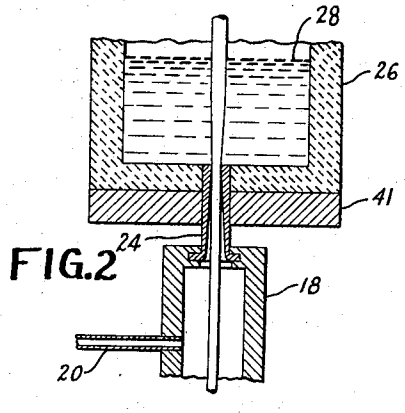


FIG. 2

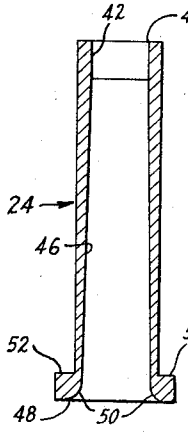


FIG. 3

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ENTRY PORT MEMBER FOR DIP CRUCIBLE APPARATUS

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Int. Cl. B05c 3/132; B22d 19/00

ABSTRACT OF THE DISCLOSURE

In accreting molten material onto a continuous, elongated core, the core is passed upwardly through a crucible containing a molten bath of the material. An entry port in the form of a cylindrical bushing is positioned in the bottom wall portion of the crucible through which the core is passed. The entry port is provided with relatively short land section having internal parallel surfaces extending from the upwardly disposed opening, and a second section having internal wall surfaces diverging from the land section terminating at the downwardly disposed opening thereby defining an opening of larger diameter than the upwardly disposed opening.

The dip forming process, such as used in casting metal, is now well known in the art. According to this process, an elongated body such as a metal rod is typically pretreated by passing it through a straightener, a surface cleaning apparatus and desirably through a drying means, and then through a vacuum entrance chamber positioned below or at the bottom of a crucible containing a bath of molten material. A continuous, elongated core or body is passed upwardly through the molten bath, which bath may have the same chemical composition as that of the core or a different composition. The molten material in the crucible accretes or deposits upon the outer surface of the core thereby increasing its cross-sectional area appreciably. After emerging from the crucible, the resulting cast member is cooled as by a water spray from one or more jet nozzles at least sufficiently so that the cast member can be rolled or worked. From there, the cast member may be passed through a suitable roll mechanism where it is drawn and reduced in cross-sectional area and then passed to a suitable receiving means such as a take-up reel.

In the dip forming process, the core is fed from the vacuum entrance chamber through an entry port in the bottom wall of the crucible and into a bath of molten material. This core entry port member is in the general form of a cylindrical bushing inserted in the bottom wall of the crucible. As practiced in the dip forming of copper for the production of copper rod, the crucible is constructed of graphite and the entry port member or bushing is made from a refractory metal such as molybdenum. An entry port useful in dip forming apparatus is disclosed in U.S. Patent Nos. 3,008,201, and 3,060,056, both assigned to the assignee of this application.

Typically in the dip forming process the core entry port member or bushing has been in the form of a relatively thin wall cylinder having straight and parallel internal and external cylindrical surfaces. It is desirable to maintain a minimum clearance between the core and the inside surface of the bushing. However, the core is usually undulating or wavy, and if the internal surfaces of the bushing are parallel, mechanical jamming occurs due to friction between the core and bushing. On the other hand, a significantly larger clearance can cause jamming due to major penetration of the molten metal into the clearance space.

The long, parallel surface on the interior of the bushing and the relatively tight fit between it and the core result

in high frictional forces between the core and the bushing. This causes mechanical jamming and definitely demands the action of a substantial pushing force on the core rod beneath the crucible and/or a substantial tensile force on the emerging hod rod, all creating undesirable effects. Such a tight fit over a continuous elongated core also results in larger heat losses from the crucible through the bushing to the core.

This invention has, therefore, as its primary object to provide an entry port member for a dip crucible apparatus which substantially eliminates mechanical jamming of the core upon entry to the crucible. This, together with other objects and advantages, may best be understood by referring to the following detailed description, and to the accompanying drawings, in which:

FIGURE 1 illustrates, partly in section, a dip forming apparatus including the crucible having incorporated therein the improvement of the present invention;

FIGURE 2 is a sectional view of a portion of the crucible shown in FIGURE 1 illustrating in greater detail the entry port member incorporated into the dip crucible apparatus; and

FIGURE 3 is a longitudinal sectional view of the entry port member of the present invention.

In the drawings, there is shown a preferred embodiment for practicing the invention, and although the invention is described hereinbelow with particular reference to forming copper rod, it should be understood that the invention is applicable for producing other stock such as sheet, tube or strip and of other materials or metals. Referring to FIGURE 1, a continuous core rod of copper **10** is introduced to a drawing apparatus **12** and shaving equipment **14** where the oxide coating or other surface contaminants are removed therefrom. If desired, other means may be utilized for cleaning the surface of the rod. The rod is passed through drive means **16** into tube **18** which may have connected thereto exhaust tube **20** and evacuating pump **22** to maintain a vacuum in the members **12**, **14**, **16** and **18**, thereby avoiding the formation of an oxide coating on the cleaned rod. An entry port member or bushing **24**, described hereinbelow in greater detail, is positioned in the bottom of crucible **26** which contains a molten bath of copper **28**, and the core rod is passed upwardly through the bushing into the crucible. The molten copper is supplied to the crucible from a suitable source such as an electric induction heated furnace (not shown), and the crucible is maintained at the desired temperature by suitable heating means such as an electric induction heater **30**. An inert atmosphere of dry nitrogen is introduced under pressure from source **32** into the crucible above the molten bath through a supply line **34**. As the rod passes through the molten bath of metal in the crucible, molten copper accretes progressively thereon thereby forming a rod of increased diameter with molten metal substantially bonded to the core rod. (See FIGURE 2.)

An elongated tube **36** extends upwardly from the crucible **26** and the resulting cast rod having copper accreted thereto is passed out of the crucible through the extension tube. The cast rod emerging from the crucible and extension tube is at a relatively high temperature and is cooled somewhat by cooling means **38**, such as a water spray nozzle, before the rod is passed through a regulated drive motor **40** desirably having incorporated therein a suitable shock isolation loop. From there, the cast rod is directed to a suitable drawing apparatus and storage area as desired.

Referring now to FIGURES 2 and 3, a cylindrical, open-ended bushing **24** is positioned in the bottom wall portion of crucible **26**. Desirably, a boot **41** is provided as spacing means between tube **18** and crucible **26**. The bushing is provided with a relatively short land or first

section **42** having internal parallel surfaces extending from the top opening **44** of the bushing. (See FIGURE 3.) The land or first section is provided with a diameter sufficient to provide clearance between the core rod and the inside surface of the bushing. A second section **46** extends from the land and is provided with diverging internal wall surfaces terminating at the bottom opening **48** of the bushing. In this manner, the bottom opening is of a substantially larger diameter than the top opening. It is desirable to provide the internal wall surfaces of the second section with arcuate termini **50** to facilitate feeding of the core rod into the bushing and crucible. Also, the bushing is provided with an outwardly directed annular flange **52** at or near the bottom for connection to exhaust tube **20** by means of clamps, bolts or other fastening elements. In this manner, a tight fit is provided between the bushing and the exhaust tube thereby assuring a good connection for maintaining a vacuum.

The land should not extend for more than one-fourth the total length of the bushing, and preferably should be about one-eighth to one-tenth of its total length. If the land is too long, the undulating core will jam in the bushing, as explained above. On the other hand, if the land is too short such that the internal surfaces of the bushing terminate at the upwardly disposed opening at too sharp a projection or point, molten metal penetrating the clearance will either freeze at the point and consequently tear the core rod or drip down through the bushing into the exhaust tube where it could eventually freeze and cause considerable difficulty. By reason of the present invention, a core rod having undulations will pass through the bushing. The diverging wall surfaces in the second section of the bushing substantially eliminates mechanical jamming of the core in the bushing. In addition, eliminating the long, parallel surfaces on the interior of the bushing reduces heat losses from the crucible through the bushing to the core.

A typical bushing found to be particularly useful in the dip forming process for forming copper rod, such as illustrated in FIGURE 3, may have an overall length of about 2.3 inches. The land section is about one-fourth inch in length and the internal diameter of the land is about 0.38 inch. The second section is provided with a diameter at the downwardly disposed opening of about 0.41 inch. The bushing may be made from molybdenum or other refractory metal, and the internal wall surfaces are provided with a high polish, the land desirably having the highest polish.

We claim:

1. In a dip forming crucible apparatus adaptable for containing a molten bath of metal and including a substantially cylindrical, open-ended bushing disposed in the bottom wall portion thereof, whereby a continuous metallic core member of extended length introduced to said crucible is passed upwardly through said bushing into said bath where said molten metal accretes to said core member, the improvement comprising: said bushing including a first section having internal parallel surfaces extending from the upwardly disposed opening of said bushing for a distance not more than one-fourth the length of said bushing, said first section having a diameter sufficient to provide clearance therethrough of said core member, and a second section having internal wall surfaces diverging from said first section and terminating at the downwardly disposed opening of said bushing to define an opening of larger diameter than said upwardly disposed opening, thereby substantially eliminating jamming of the core member in said bushing.

2. Apparatus according to claim **1** wherein said internal wall surfaces of second section have an arcuate termini.

3. Apparatus according to claim **1** wherein said first section extends for a distance of from one-eighth to one-tenth of the total length of said bushing.

4. In a dip forming crucible apparatus adaptable for containing a molten bath of metal and including a substantially cylindrical, open-ended bushing disposed in the bottom wall portion thereof, whereby a continuous metallic core member of extended length introduced to said crucible is passed upwardly through said bushing into said bath where said molten metal accretes to said core member, the improvement comprising: said bushing including a first section having internal parallel surfaces extending from the upwardly disposed opening of said bushing for a distance of from about one-eighth to one-tenth the length of said bushing, said first section having a diameter sufficient to provide clearance therethrough of said core member, and a second section having internal wall surfaces diverging from said first section and having arcuate termini at the downwardly disposed opening of said bushing to define an opening of larger diameter than said upwardly disposed opening, thereby substantially eliminating jamming of the core member in said bushing.

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