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[54] **METHOD AND APPARATUS FOR CONTINUOUSLY CASTING NON-FERROUS METALS IN A GRAPHITE-GLASSY SUBSTANCE MOLD**

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[52] **U.S. Cl.** ..... **164/82,** 164/73, 164/138, 164/273 R

[51] **Int. Cl.** **B22d 11/02**

[58] **Field of Search** ... 164/73, 138, 273 R, 82, 283; 117/5.1, 5.2, 5.3; 72/467; 249/134, 135

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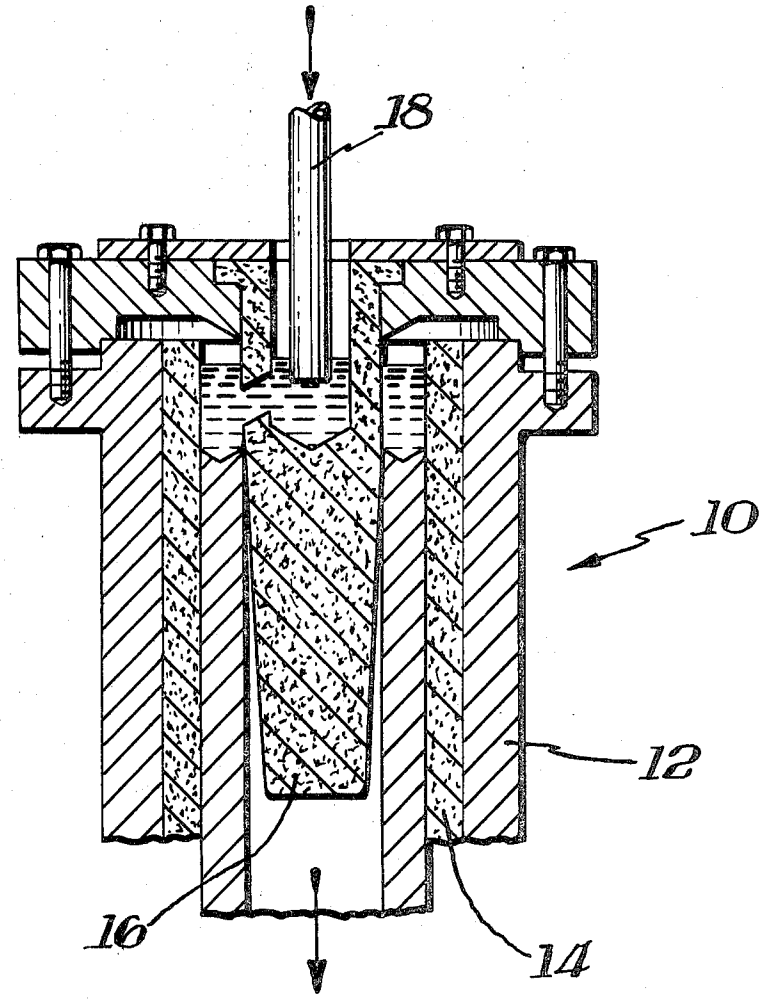
Primary Examiner—Robert D. Baldwin

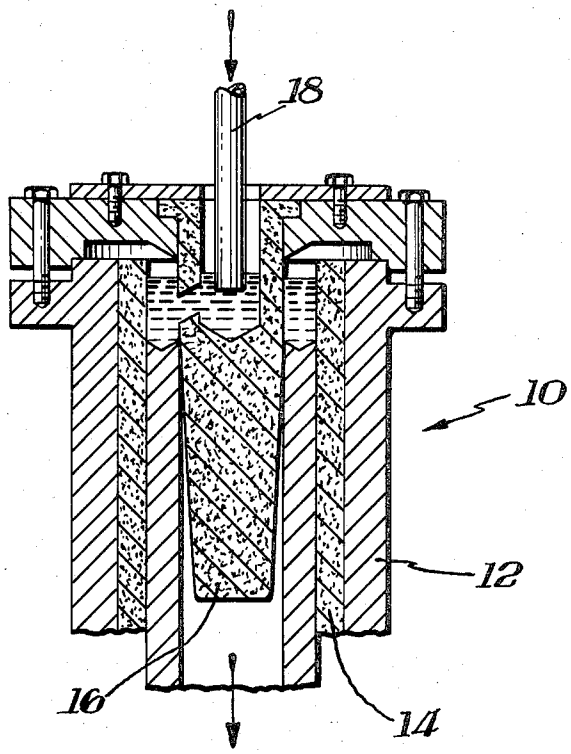
Attorney, Agent, or Firm—Connolly & Hutz

[57] **ABSTRACT**

Graphite dies or molds used for casting metals contain glasses or fluxes as a lubricant, which softens or melts below the solidification temperature of the metal melt.

10 Claims, 1 Drawing Figure




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METHOD AND APPARATUS FOR CONTINUOUSLY CASTING NON-FERROUS METALS IN A GRAPHITE-GLASSY SUBSTANCE MOLD

BACKGROUND OF INVENTION

In the casting of metals and especially in continuous casting the material from which molds or dies are made is of great importance to the success and economy of the casting process. In continuous casting both metallic and non-metallic molds may be used, depending on the melt, on the casting temperature and on the casting process. Of the metallic molds, those made of copper have proved very successful because of their good removal of heat. The molds are mostly used in the form of casting molds made of sheet copper which are cooled by water flowing through them.

At continuous casting of metals of higher melt temperatures, e.g., copper, copper alloys and steel, graphite plays an important role as a die material. The working life of such graphite dies depends on the durability of their surface in the area of the solidification zone of the metal melt. If, in continuous casting, the frictional forces between the molds and the cast become too great as a result of deteriorating surface quality of the mold, the semi-solidified or cooling cast breaks off. Each breakage results in a time-consuming interruption of the continuous casting process, especially if the mold is fixed in position, that is to say firmly connected to the melting furnace or to a tundish.

Synthetically produced graphite, so-called synthetic carbon or electro-graphite, is employed for the graphite dies which are nowadays extensively used. It is known that graphite possesses low friction and, in a sense, is "self-lubricating;" this is one of the properties which render graphite suitable for continuous casting dies. In many casting processes, however, the self-lubrication of graphite is not sufficient. If is not only desirable, but frequently necessary, to have additional lubrication inside the ingot mold when casting.

It has been proposed to supply lubricants to the mold wall on continuous casting and this proposal is used in practice. Accroding to one proposal the supply of lubricant should be effected from the melt surface, if the type of contruction of the furnace permits this. Since such lubrication is not reliably effective it has also been proposed to supply lubricants (for example, oils and other liquids or also viscous substances such as tallow, or solid substances such as carbon black) to the mold surface and the cast through apertures in the mold wall, further for example, it has been proposed to insert porous rings for the supply of lubricant to the cast in the mold. Another proposal is to supply the lubricant through the gap between the mold wall and the solidified and shrinking cast. However, at higher melt temperatures and when the ingot molds are firmly built into the melting furnace such lubricating processes fail.

SUMMARY OF INVENTION

The present invention is based on the observation that in continuous casting the lubricant must, in contrast to the hitherto proposed lubricating processes, be effective directly in the narrower zone on transition from the melt to the solidified cast and also that at higher temperature glass or flux in the molten state can form a good lubricant between the mold wall and the metal cast. This is understandable for chemical and physical reasons, and glass powder has already been used in the hot extruding of metals and steel to lubricate the dies and to facilitate shaping.

The present invention provides a graphite mold which contains a glass or flux as a lubricant and which softens or melts below the solidification temperature of the metal.

THE DRAWINGS

The single FIGURE illustrates a continuous casting mold which may incorporate the novel concepts.

DETAILED DESCRIPTION

Glass is not a compound of a definite chemical composition. Glasses are supercooled melts based on alkali-alkaline earth silicates. They do not have a fixed melting point and are viscous over a wide temperature range which can be varied by varying the composition, for example upwards if boric acid is also present in addition to silica, and towards lower softening temperatures if the calcium oxide is replaced by suitable different metal oxides. Thus lead glasses soften at temperatures below 600°C, as do glasses containing a high proportion of alkali. Conversely, glasses only soften at 800°C if they contain aluminum oxide or more boric acid.

As indicated hereinafter the concepts of this invention may be applied to both ferrous and non-ferrous metals. When light metals, e.g., aluminum or its alloys with casting temperatures of around 700°C are to be cast in the graphite molds of the present invention, therefore, it is necessary to choose glasses of the first kind which have a low proportion of silicon and softening temperatures below 600°C as lubricants. When casting copper or copper alloys having casting temperatures of around 1,000°C and above, both types of glass mentioned are suitable as lubricants, especially glasses having softening temperatures of about 500°C to 1,000°C. When casting steel, glasses which are rich in silica, having higher soltening temperatures of 800°C or more are used.

Suitable glasses are readily available to those skilled in the art. "Glass Engineering Handbook," second edition, 1958, published by McGraw-hill Book Company, Inc. lists typical glass compositions on page 4 and also lists softening temperatures on pages 17–18 thereof. By softening point is meant the temperature, well above the annealing range, at which it will deform under its own weight.

This temperature behavior of glasses, showing gradual softening and viscous behavior over a wide temperature range, which is advantageous of the molds of the present invention, is also a feature of some other chemically related or similar substances. These include enamel, which chemically also represents a glass, and furthermore chemical compounds which are described and used as fluxes, such, for example, as fluoride, boron compounds and other salts or oxides. In these fluxes the selection according to their melt temperature is again made in such a way that the melt temperature is below the solidification temperature of the particular metal melt. Mixtures of alkali fluorides, boron compounds and other salts or oxides melt in the range of the casting temperatures of light metals, pure alkali fluorides melt in the range of the casting temperatures of copper alloys, and calcium fluorides, fluorspar, melts below the casting temperatures of steel.

As used in the claims the term "glassy substance" is meant to include fluxes, such as indicated above, as well as glass.

Since it is difficult to supply glass or flux continuously for the lubrication of the mold wall during continuous casting, the invention provides that the glass or flux is preferably basically added to the mold graphite. The lubricant can be mixed into synthetic graphite, which is manufactured predominantly from coke powder and binders, in part with addition of natural graphite, during the preparation of the powder mix, that is to say before calcining and graphiting. This is advantageously done already with small proportions or more from 2 to 30 percent or more. After calcining and electrographiting the lubricant forms an additional constituent into the graphite die. The glass or flux can also be brought into the graphite after calcining or graphiting by filling of prepared cavities, or the glass or flux can also be filled into the pores as a liquid by soaking.

A typical synthetic graphite manufacturing process includes the steps of calcining petroleum coke in a large rotary or shaft kiln to drive out the volatile content; crushing for example to 0.005–0.5 inch in particle size; combining the crushed raw material with coal tar pitch; heating; forming to shape; adding a coke pitch binder in the formed piece at for example a temperature of 750°–900°C in the kiln; and graphitizing at 2,600°–3,000°C.

Glasses or fluxes of suitable composition, whose softening temperature lies below the particular solidification temperature of the metal melt to be cast, are in each case used for this purpose, so that lasting lubrication of the casting is ensured for a sufficient time.

For this purpose, the glass or flux can be mixed into the graphite as a powder in a fine or coarse-grained form. It can furthermore advantageously be added in the form of rods, filaments or also as spun glass or fabrics, or else by filling of the pores by soaking.

The form of the glass or flux employed can influence the deposit formation of the glass in the mold and be of importance for lasting lubrication of the casting if it is intended to cast continuously for long periods of time. Thus the form of rods or filaments is particularly advantageous for deposit formation.

The lubricant may, of course, comprise a mixture of one or more glasses or fluxes or a mixture of a glass with a flux.

The single FIGURE illustrates a continuous casting installation of the type generally disclosed in U.S. Pat. 3,342,252. The casting installation **10** includes a mold **12** having a glass containing graphite lining **14** with a mandrel **16** similarly being made of glass containing graphite. Molten material is fed to the mold through inlet conduit **18**. It is to be understood that the illustrated installation is merely exemplary and that any suitable die or mold construction may be used.

I claim:

1. In a graphite mold for the continuous casting of non-ferrous metals the improvement being in that the mold is a solid non-powdery body formed of a graphite material, a glassy substance in the amount of 2–30 percent being incorporated within the graphite material as an integral part of the mold to act as a lubricant, and the glassy substance having a softening temperature below 1,000°C.

2. In the mold of claim **1** wherein the softening temperature is about 500°C to about 1,000°C.

3. In the mold of claim **1** wherein the softening temperature is below 600°C.

4. In the process of continuously casting non-ferrous metals with the use of a mold having a surface which contacts the metal being cast, the improvement being utilizing a graphite material for the mold, incorporating a glassy substance in the amount of 2-30% within the graphite material as an integral part of the mold to act as a lubricant, the glassy substance having a softening temperature below the solidification temperature of the metal being cast, and forming the mold as a solid non-powdery body.

5. In the process of claim **4** wherein the metal being cast is copper or a copper alloy, and the glassy substance has a softening temperature of about 500°C to about 1,000°C.

6. In the process of claim **4** wherein the metal being cast is a light metal, and the glassy substance has a softening temperature below 600°C.

7. In the process of claim **4** wherein the glassy substance is added to the graphite material before calcining.

8. In the process of claim **4** wherein the glassy substance is added to the graphite material after calcining.

9. In the process of claim **4** wherein the glassy substance is added to the graphite material by soaking.

10. In the process of claim **4** wherein the glassy substance has a softening temperature below 1,000°C.

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