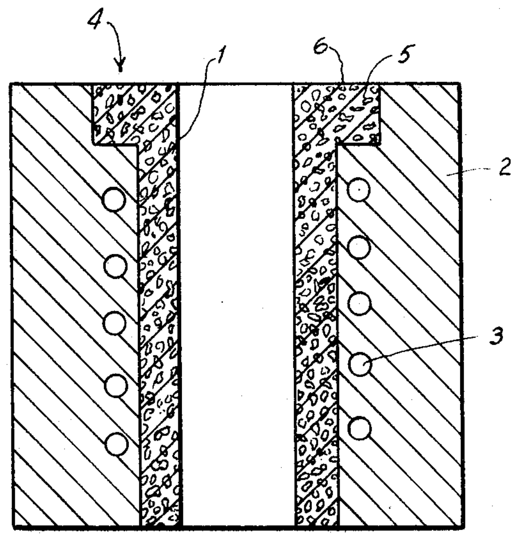
July 28, 1970 F. K. VOSS 3,521,849

CONTINUOUS METAL-CASTING MOLD

Filed Oct. 20, 1967



INVENTOR.
FRIEDRICH KARL VOSS

BY Sandoe, Hill, Schottler & Wikstrom

ATTORNEYS

United States Patent Office 3,521,849
Patented July 28, 1970

3,521,849

CONTINUOUS METAL-CASTING MOLD

Friedrich Karl Voss, Dusseldorf, Germany, assignor to Schloemann Aktiengesellschaft, Dusseldorf, Germany, a corporation of Germany

Filed Oct. 20, 1967, Ser. No. 676,956
Claims priority, application Germany, Oct. 22, 1966, 1,508,975
Int. Cl. B29c *1/02*
U.S. Cl. 249—135 8 Claims

ABSTRACT OF THE DISCLOSURE

A mold for the continuous casting of steel comprising a body of high strength metal of low thermal conductivity such as tungsten, molybdenum or titanium, for example, having a skeletal or porous structure providing voids containing a metal of high thermal conductivity such as silver or copper, for example.

The invention relates to a metal-casting mold, and particularly to a mold open at both ends for the continuous casting of steel.

As is known, an essential requirement to be satisfied by such molds is that they permit the relatively rapid abstraction of sufficient heat for the formation of at least a solidified continuous-casting skin of adequate strength. The mold must therefore consist of a material of sufficiently high thermal conductivity. This requirement is usually satisfied by making the mold of copper. Such molds, however, also have many drawbacks insofar as the quality of the continuous casting produced and the operation of the machine as a whole are concerned, said drawbacks being due essentially to the specific properties of the material. Since copper, for example, has low strength, the thermal and mechanical stresses produced during casting may result in permanent warping of the mold wall. This, in turn, may give rise to cracks in the continuous casting. Moreover, because of the relatively low strength of the metals used to make them, such molds are subject to much wear and tear, with attendant impairment of the dimensional accuracy of the continuous casting after extended use of a mold. Another important factor is the surface tension between the mold material and the liquid metal to be poured. When it results in marked sticking to the inner wall of the mold, the forces which the pinch rolls exert on the continuous casting and which are known to cause elongation over the region of plastic deformability of the continuous-casting skin may produce cracks and breakouts.

The mold may be fabricated from a metal of considerably higher strength and better able to withstand the aforesaid stresses. However, a specific property of such metals is that their thermal conductivity is substantially lower, for which reason the mold wall must be made relatively thin if the relation between thermal conductivity and wall thickness is to be held within tolerable limits from the standpoint of the cooling system, and this in turn results again in reduced loadability and a number of other difficulties with regard to design and mounting.

The invention has as its object to provide a metal-casting mold which is not afflicted with the aforesaid drawbacks and other disadvantages of prior-art designs. Specifically, the mold is designed to undergo substantially less deformation even when subjected to very heavy stresses of a thermal and mechanical nature; to have low frictional adhesion relative to the skin of the continuous casting; to be easy to mount; and to permit ready stripping of the continuous-casting skin. In accordance with the invention, this is accomplished essentially by giving the mold a body fabricated from a high-strength metal and having voids that are filled with another metal of high thermal conductivity. The metal-casting mold in accordance with the invention thus consists of a composite meaterial in which the specific properties of at least two metals or alloys ccooperate either to overcome the aforesaid difficulties completely or at least to minimize them considerably. This result is all the more remarkable as it has hitherto been held that a mold could have either strength and poor thermal conductivity or good thermal conductivity and low strength. In the metal-casting mold in accordance with the invention, however, the body has sufficiently high resistance to wear and deformation while the metal of high thermal conductivity introduced therein provides adequate abstraction of heat from the metal to be solidified. Sticking of the continuous casting to the inner wall of the mold is greatly minimized thereby and the requirement for self-lubrication during the passage of the continuous casting are likewise satisfied, although additional lubrication may still be provided.

The simplest way of introduciong the metal of high thermal conductivity is to impregnate the body, still solid at this temperature, with it in the liquid state. To assure satisfactory casting operation, it is further proposed in accordance with the invention that the metal introduced into the body have a substantially lower boiling point than the metal used to fabricate the body, and that it have a wide temperature spread between the melting and boiling points.

The properties required for the purpose may be imparted to the body of high-strength metal by giving it a skeletal structure. Or, more advantageously yet, it may be given a porous structure, its porosity then being from 18 to 23 percent of its volume. The pores will have to be of the so-called open type which on the one hand will absorb the metal of high thermal conductivity to be introduced therein and on the other hand will offer no resistance in the direction of the heat flow to the heat to be abstracted.

The body having voids is suitably fabricated from tungsten, molybdenum, titanium or a similar metal. This may be done by a sintering process, for example, in which the individual metal particles are fused together without, however, forming closed pores.

Metals which from the standpoint of high thermal conductivity are suited for introduction into the body having voids are particularly silver and copper. Since the melting points of the metals are far apart, the immersion of the body in a melt of the impregnant metal for introduction thereof presents no difficulties. Also suited for this purpose are aluminum, beryllium or silicon as well as pulverized bituminous coal mixed with silver and adapted to be graphitized by the passage of current through it ("lectrographitized").

Particularly low adhesion between the continuous casting and the mold wall can be secured by making the body of the mold of tungsten and/or molybdenum and introducing silver into it.

The proposal of the invention is not, of course, limited to the use of pure metals but is applicable also, and to good advantage, to alloys.

A mold constructed in accordance with the invention is shown in the drawing. The embodiment there illustrated involves a mold **1** that is open at both ends and is mounted upright in a mold mount **2**. The cooling tubes **3** through which a coolant is circulated are arranged in the mold mount **2** in such a way that the heat given off can rapidly be extracted through the wall of the mold **1**. The mold **1** is formed of a body **4** which in accordance with the invention is fabricated from a high-strength metal **5**. The metal of high thermal conductivity is introduced into the voids **6** present in said body. As may be seen from the drawing, the open-ended mold is largely supported on its porous high-strength metal body. Since the metals introduced into its voids **6** actually form a thermally conductive bridge between the inner and outer walls of the mold, adequate heat abstraction is assured at the same time.

I claim:

1. A metal-casting mold, such as an open ended mold for continuous casting, comprising a body of a metal having pores therein and other metal filling said pores, one of said metals having higher resistance to wear and deformation than the other and the other having higher thermal conductivity than the one, whereby the higher thermal conductivity metal provides a thermally conductive bridge through the higher resistance metal.

2. The mold of claim **1** in which the metal of the body has higher strength and lower thermal conductivity than said metal in the pores.

3. The mold of claim **1** in which the porosity of said body is from about 18 to about 23 percent of its volume.

4. The mold of claim **1** in which the metal in said pores is a metal having a substantially lower boiling point than the metal of the body.

5. The mold of claim **1** in which one of said metals is from the group consisting of tungsten, molybdenum, titanium and alloys thereof.

6. The mold of claim **1** in which one of said metals is from the group consisting of silver, copper, aluminum,

beryllium, silicon, alloys thereof, and silver mixed with graphite.

7. The mold of claim **1** in which the metal of the body is from the group consisting of tungsten, molybdenum, titanium and alloys thereof, and the metal in the pores is from the group consisting of silver, copper, aluminum, beryllium, silicon, alloys thereof, and a mixture of silver and pulverized bituminous coal that has been graphitized.

8. The mold of claim **1** in which the metal of the body is from the group consisting of tungsten, molybdenum and alloys thereof, and the metal in the pores is silver.

References Cited

UNITED STATES PATENTS

2,949,652	8/1960	Hobbs et al.	164—283
3,336,973	8/1967	Ratcliffe	164—283
3,349,836	10/1967	Rossi	164—273

FOREIGN PATENTS

1,381,748	11/1964	France.
204,184	11/1956	Australia.

J. SPENCER OVERHOLSER, Primary Examiner

R. S. ANNEAR, Assistant Examiner

U.S. Cl. X.R.

164—138, 273