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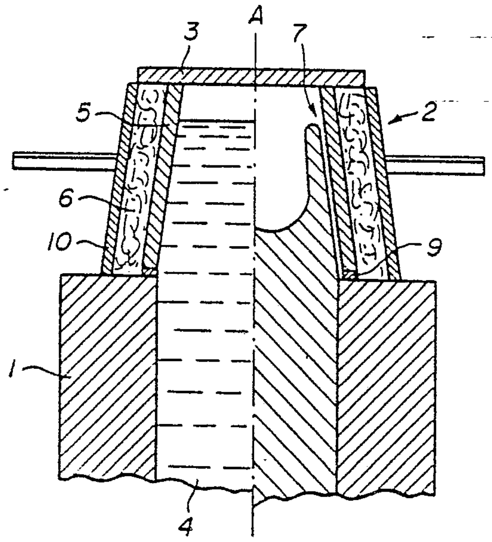
(54) Title: IMPROVEMENTS IN OR RELATING TO CASTING METAL INGOTS

(57) Abstract

A method of casting metal comprising teeming molten metal into an ingot mould with a hot-top, the hot-top having a metal inner wall which is thin compared to the thickness of the mould wall and is surrounded by a heat insulating barrier, the resulting thermal expansion of the hot-top forming a gap between the inner wall of the hot-top and the shell of solidified metal on the ingot without external manipulation.



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Improvements in or relating to casting metal ingots

The present invention concerns casting metals in an ingot mould with the use of a so-called hot-top positioned on the mould to reduce pipe-formation in the solidified ingot.

Such a method is described in U.S. patent specification No. 3766965. In this U.S. patent specification molten metal is poured into an ingot mould having a hot-top. After a shell or layer of solidified metal has been formed the hot-top is moved mechanically so as to provide a gap between the inner wall of the hot-top and the shell. This gap acts as insulation to prevent the upper portion of the ingot from cooling too rapidly.

Accordingly in one aspect the present invention consists in a method of casting metal ingots comprising teeming the molten metal in an ingot mould with a hot-top,
the hot-top having a metal inner wall which is thin compared to the thickness of the mould wall and which is surrounded by a heat insulating barrier, the resulting thermal expansion of the hot-top forming a gap between the inner wall of the hot-top and the shell of solidified metal on the ingot without external manipulation.

In a second aspect the invention consists in a hot-top for use with an ingot mould in the casting of metal ingots, the hot-top comprising a hollow body having a base adapted to be positioned at the upper end of an ingot mould and comprising an inner wall of heat conductive metal surrounded by a heat insulating barrier.

In a third aspect the invention consists in the combination of a hot-top as set forth hereinbefore with an ingot mould, wherein the thickness of the inner wall of the hot-top is chosen in relation to the capacity of the ingot mould in such a manner as to prevent melting or fusion of the inner wall during casting molten material in the mould, and wherein the inner wall is thin compared to the thickness of the mould wall.

In a fourth aspect the invention consists in an ingot mould comprising a hot-top, the hot-top having an inner wall which is thin compared to the thickness of the mould wall and is made of heat conductive material having a higher melting point than the material of the mould wall, said inner wall being surrounded by a heat insulating barrier and being positioned inside the upper part of the ingot mould, the said heat insulating barrier being formed between said inner wall and the wall of the said upper part of the ingot mould.

In order that the present invention may be more readily understood, various embodiments thereof will be described by way of example and with reference to the accompanying drawings wherein :

Figure 1 is a cross section through an ingot mould and an associated hot-top according to a first embodiment of the invention,

figure 2 is a cross section through an ingot mould with a hot-top according to another embodiment of the invention,

figure 3 is a cross section through an ingot mould with incorporated hot-top according to still another embodiment of the invention.

Figure 1 shows an ingot mould 1, a hot-top 2 and a cover plate 3 and is divided into two by a line A so that two stages of the casting process can be shown. The left hand side of the figure shows the mould just after molten metal 4 has been poured into the mould. The molten metal will normally be steel or iron, though non-ferrous metals may also be cast in a similar manner.

The hot-top 2 has a metal inner wall 5 having a thickness which is small compared to that of the mould walls. The inner wall 5 is surrounded by a heat barrier 6 made from a (heat resistant) ceramic fibre material. It is essential that the thickness of the inner wall 5 be chosen in relation to the capacity of the mould 1 such that the wall will not melt or become fused with the poured molten metal. The inner wall 5 should have a melting point which is not more than 300°C below the casting temperature of the molten metal. The inner wall 5 may be 10 to 30 mm thick. A suitable metal is cast iron but of course the material of the inner wall will depend on the metal being cast. As shown in figure 1 the hot-top tapers from its base to its open top which is closed by the top cover 3. This taper is not, however, essential.

An additional heat barrier 9 is provided around the lower edge of the inner wall 5 to prevent heat transfer between the inner wall and the ingot mould. This additional heat barrier may not always be needed.

The hot-top is surrounded by a metal head case 10 provided with lifting lugs by means of which the hot-top and head case can be mounted on or removed from the ingot mould.

The metal may be poured either uphill or downhill. In the latter case the cover plate 3, which may be as described in U.K. patent specification No. 1,496,348, is placed on the hot-top after pouring.

As previously mentioned the left-hand side of figure 1 shows the molten metal immediately after teeming. Shortly after the poured metal contacts the inner wall 5 a thin outer layer or shell of solidified metal is formed on the poured metal due to heat being conducted away from the molten metal by the mould 1 and the inner wall 5 of the hot-top.

The heat absorbed by the inner wall 5 causes the hot-top to expand. However, because of its lower mass with respect to the mould 1 the hot-top 2 will expand substantially more rapidly than the mould 1. Thus the hot-top is moved off the ingot without external manipulation to form a gap 7. Because of the above mentioned difference in masses the gap 7 between the hot-top 2 and the ingot will be formed more rapidly and will be larger than the gap between the ingot and the mould.

The metal is then allowed to cool until it is solid. This is the situation shown in the right hand side of figure 1. The hot-top 2 and the cover 3 remain in position throughout the entire cooling process. The gap 7, together with the insulation provided by the heat barrier 6, ensure that the upper portion of the ingot does not cool too rapidly with respect to the remainder of the ingot. Furthermore, there is no need to introduce exothermic material into the gap 7 during cooling of the cast metal because of the thermal insulation provided by the gap 7 and heat barrier 6.

It will be appreciated that the hot-top described is reusable and also avoids the necessity of special provision being made to move the hot-top mechanically during the casting operation.

Several modifications of the hot-top described above are possible. Thus in the case where the metall inner wall of the hot-top is made from a number of sections, it may be advantageous to position means for causing extra thermal expansion of the hot-top when it is heated during teeming. Thus the sections of the hot-top may be separated by strips of a material having a high degree of thermal expansion such as copper, or a bimetallic substance. Furthermore, the inner surface of the hot-top may be coated with a heat reflective or a parting agent.

Figure 2 shows a hot-top positioned inside the upper part of an ingot mould 21. An inner wall part 51 rests on a shoulder of the mould wall and is surrounded by a heat insulating barrier 61 corresponding to heat barrier 6 described above. The outer wall of the hot-top is constituted by the wall of the ingot mould itself, which leads to a simplified structure of the combination. A heat barrier 91 can be inserted between the lower edge of wall 41 and the shoulder of the ingot mould. The wall part 51 of the hot-top is made of a material such as steel having a higher melting point than the material of the input mould itself which is generally cast-iron.

Figure 3 shows an embodiment similar to that of figure 2 wherein an inner wall part 52 has a base part 53 which is incorporated in the wall of the ingot mould 22. In this case the inner wall of the hot-top is maintained at its lower edge in a given position with respect to the ingot mould, but its upper edge can expand to achieve the desired effect. A heat barrier 62 is again inserted between the ingot mould wall and the inner wall part 52.

The embodiment of figure 3 provides an ingot mould in which the hot-top wall is incorporated at the time of making the ingot mould itself and does therefore not require an additional manufacturing step.

It has been discovered that with the ingot mould and casting method described above the amount of piping on the final ingot is low and the contamination of the ingot is often negligible so that it can be rolled immediately on being stripped from the mould.

CLAIMS

1. A method of casting metal comprising teeming molten metal into an ingot mould with a hot-top, the hot-top having a metal inner wall which is thin compared to the thickness of the mould wall and is surrounded by a heat insulating barrier, the resulting thermal expansion of the hot-top forming a gap between the inner wall of the hot-top and the shell of solidified metal on the ingot without external manipulation.

2. A method as claimed in claim 1, including inhibiting the transfer of heat between the inner wall and the ingot mould by an additional heat barrier.

3. A method as claimed in claim 1 or claim 2, wherein the or each heat barrier is made from ceramic fibre.

4. A method as claimed in any one of the preceding claims, wherein the inner wall is a metal having a melting point not more than 300°C less than the melting point of the metal being cast.

5. A method as claimed in any one of the preceding claims including positioning a cover plate on the hot-top.

6. A method as claimed in claim 5, wherein the cover plate comprises ceramic fibre material.

7. A hot-top for use with an ingot mould in the casting of metal ingots, the hot-top comrpising a hollow body having a base adapted to be positioned at the upper end of an ingot mould, the body having an upper opening and being formed from an inner wall of heat conductive material

surrounded by a heat barrier of ceramic material.

8. A hot-top as claimed in claim 7, wherein the ceramic material is fibrous.

9. A hot-top as claimed in either claim 7 or claim 8, wherein the inner wall of the hot-top is coated with a parting of heat reflective material.

10. A hot-top as claimed in any one of claims 7 to 9, wherein the inner wall is maded from a number of metal plates interconnected by means for causing increased thermal expansion of the hot-top.

11. A hot-top as claimed in any one of claims 7 to 10, wherein the hot-top tapers from its base to its upper opening.

12. A hot-top as claimed in claim 10, wherein the means for causing increased thermal expansion comprise copper or bimetallic material interposed between the plates.

13. A hot-top as claimed in any one of claims 7 to 12, wherein the lower edge of the inner wall is provided with an additional heat barrier to prevent heat transfer between the inner wall and the ingot mould.

14. A hot-top as claimed in any one of claims 7 to 13, and surrounded by a head case provided with lifting lugs.

15. A hot-top as claimed in any one of claims 7 to 14, wherein the inner wall is from 10 to 30 mm thick.

16. The combination of a hot-top as claimed in ony one of claims 7 to 15 with an ingot mould, wherein the thickness of the inner wall of the hot-top is chosen in relation to the capacity of the ingot mould in such a manner as to prevent melting or fusion of the inner wall during casting molten material in the mould, and wherein the inner wall is thin compared to the thickness of the mould wall.

17. A combination as claimed in claim 16, and including a cover plate for closing the open end of the hot-top, the cover plate including ceramic fibre material.

18. An ingot mould comprising a hot-top, the hot-top having an inner wall which is thin compared to the thickness of the mould wall and is made of heat conductive material having a higher melting point than the material of the mould wall, said inner wall being surrounded by a heat insulating barrier and being positioned inside the upper part of the ingot mould.

19. An ingot mould as claimed in claim 18, wherein the lower edge of the inner wall is provided with an additional heat barrier to prevent heat transfer between the inner wall and the ingot mould.

20. An ingot mould as claimed in claim 18, comprising means for holding the lower edge of the said inner wall in a given position with respect to the ingot mould.

21. An ingot mould as claimed in claim 18, wherein said inner wall is provided with a base part incorporated in the wall of the ingot mould.

AMENDED CLAIMS
(received by the International Bureau on 12 July 1979 (12.07.79))

1. A method of casting metal comprising teeming molten metal into an ingot mould provided with a hot-top having a metal inner wall surrounded by a heat insulating barrier, wherein the nature of the constitutive metal and the thickness of the inner wall of the hot-top are chosen, in relation, respectively, to the nature of the metal to be cast and to the capacity of the mould, in such a manner as to prevent melting of the inner wall during casting the metal ; the thickness of the inner wall of the hot-top further being chosen to be, on one hand, sufficient to permit a sufficient amount of heat to be conducted away from the molten metal, to allow an outer shell of solidified metal to be formed at the top of the ingot, while the rest of the poured metal remains in a molten state, and, on the other hand, less than that of the mould wall, so that the thermal expansion of the inner wall of the hot-top, owing to heating caused by the contact with the poured metal, is greater than that of the mould wall, the heat insulating barrier surrounding the inner wall of the hot-top being made of a compressible insulating material, so that, upon teeming molten metal into the ingot mould, an outer shell of solidified metal is formed at least at the part of the ingot located within the hot-top, before the ingot has completely solidified, and the thermal expansion of the inner wall of the hot-top causes said wall to be moved off the ingot without external manipulation of the hot-top, a gap being thus formed between said inner wall and the ingot, said gap ensuring, together with the insulation provided by said heat barrier, that the upper portion of the ingot does not cool too rapidly with respect to the remainder of the ingot, pipe-formation in the ingot being, consequently, prevented or at least greatly limited.

2. A method as claimed in claim 1, including inhibiting the transfer of heat between the inner wall and the ingot mould by an additional heat barrier.

3. A method as claimed in claim 1 or claim 2, wherein the or each heat barrier is made from ceramic fibre.

4. A method as claimed in any one of the preceding claims, wherein the inner wall is a metal having a melting point not more than 300°C less than the melting point of the metal being cast.

5. A method as claimed in any one of the preceding claims including positioning a cover plate on the hot-top.

6. A method as claimed in claim 5, wherein the cover plate comprises ceramic fibre material.

7. A hot-top for use with an ingot mould in the casting of metal ingots, the hot-top comprising a hollow body having a base adapted to be positioned at the upper end of an ingot mould, said body having an upper opening and being formed from a metal inner wall surrounded by a heat insulating barrier, wherein the nature of the constitutive metal and the thickness of the inner wall of the hot-top are chosen, in relation, respectively, to the nature of the metal to be cast and to the capacity of the mould with which the hot-top is to be used, in such a manner as to prevent melting of said inner wall during casting the metal ; the thickness of the inner wall of the hot-further being chosen to be, on one hand, sufficient to permit a sufficient amount of heat to be conducted away from the molten metal to allow an outer shell of solidified metal to be formed

at the top of the ingot, while the rest of the poured metal remains in a molten state, and, on the other hand, less than tha of the wall of said mould, so that the thermal expansion of the inner wall of the hot-top, owing to heating caused by the contac with the poured metal, is greater than that of the wall of said mould, the heat insulating barrier surrounding the inner wall of the hot-top being made of a compressible insulating material.

8. A hot-top as claimed in claim 7, wherein the ceramic material is fibrous.

9. A hot-top as claimed in either claim 7 or claim 8, wherein the inner wall of the hot-top is coated with a parting of heat reflective material.

10. A hot-top as claimed in any one of claims 7 to 9, wherein the inner wall is made from a number of metal plates interconnected by means for causing increased thermal expansion of the hot-top.

11. A hot-top as claimed in any one of claims 7 to 10, wherein the hot-top tapers from its base to its upper opening.

12. A hot-top as claimed in claim 10, wherein the means for causing increased thermal expansion comprise copper or bimetallic material interposed between the plates.

13. A hot-top as claimed in any one of claims 7 to 12, wherein the lower edge of the inner wall is provided with an additional heat barrier to prevent heat transfer between the inner wall and the ingot mould.

14. A hot-top as claimed in any one of claims 7 to 13, and surrounded by a head case provided with lifting lugs.

15. A hot-top as claimed in any one of claims 7 to 14, wherein the inner wall is from 10 to 30 mm thick.

16. The combination of a hot-top as claimed in any one of clai 7 to 15, with an ingot mould.

17. A combination as claimed in claim 16, and including a cover plate for closing the open end of the hot-top, the cover plate including ceramic fibre material.

18. An ingot mould comprising a hot-top having a metal inner surrounded by a heat insulating barrier and positioned inside t upper part of the ingot mould, wherein the constitutive metal o the inner wall of the hot-top has a higher melting point than the material of the mould wall, and wherein the nature of the constitutive metal and the thickness of the inner wall of the hot-top are chosen in relation, respectively, to the nature of the metal to be cast and to the capacity of the mould, in such a manner as to prevent melting of said inner wall during casting the metal ; the thickness of the inner wall of the hot-top further being chosen to be, on one hand, sufficient to permit a sufficient amount of heat to be conducted away from the molten metal to allow an outer shell of solidified metal t be formed at the top of the ingot, while the rest of the poure metal remains in a molten state, and, on the other hand, less than that of the mould wall, so that the thermal expansion of the inner wall of the hot-top, owing to heating caused by the contact with the poured metal, is greater than that of the mould wall, the heat insulating barrier surrounding the inner wall of the hot-top being made of a compressible insulating material.

19. An ingot mould as claimed in claim 18, wherein the lower edge of the inner wall is provided with an additional heat barrier to prevent heat transfer between the inner wall and the ingot mould.

20. An ingot mould as claimed in claim 18, comprising means for holding the lower edge of the said inner wall in a given position with respect to the ingot mould.

21. An ingot mould as claimed in claim 18, wherein said inner wall is provided with a base part incorporated in the wall of the ingot mould.

STATEMENT UNDER ARTICLE 19

According to Article 19 (1) of the Patent Cooperation Treaty, we are enclosing herewith a copy of amended claims 1, 7, 16 and 18 of the above identified International Patent Application.

The other claims of this International Application (i.e. claims 2 to 6) should be left unchanged.

We are also enclosing one copy of amended pages 6 to 11 of the application, including the amended claims 1,7,16 and 18 and a renumbered page of the abstract of the disclosure, in replacement of original pages 6 to 9.

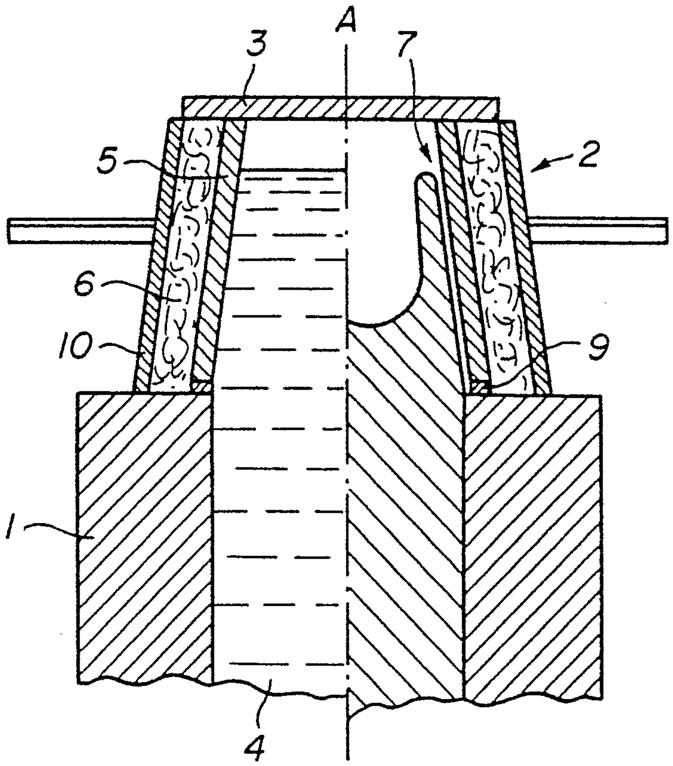

FIG. 1

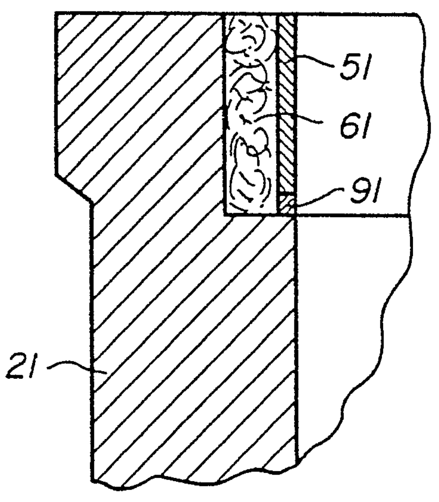

FIG. 2

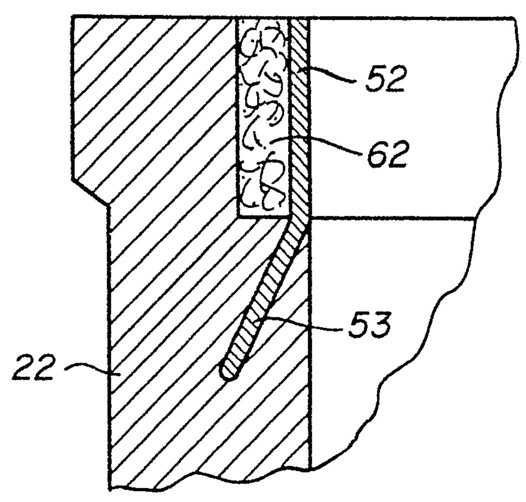

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 79/00003

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

B 22 D 7/10

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl^2	B 22 D 7/10; B 22 D 7/06

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	FR, A, 739258, published January 9, 1933, see page 2, lines 62-94; page 3, lines 17-19 and 70-85; figures 2,3, Fornander	1,4,5,7,11, 15,16,18,20, 21
X	US, A, 1738600, published December 10, 1929, see page 1, lines 22-29, 75-100; page 2, lines 1-5, 19-25; claim 2, Messler	1,3,4,5,7, 8,11,14,15, 16,18
	US, A, 1696986, published January 1, 1929, see page 1, lines 85-94, Trembour	16
X	FR, A, 2071442, published September 17,1971, see page 7, lines 5-14, Daussan	5,6

* Special categories of cited documents: [15]

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"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
2nd May 1979	16th May 1979
International Searching Authority [1]	**Signature of Authorized Officer** [20]
European Patent Office	G.L.M.KRUYDENBERG

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