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(54) **Plug for use in a steel converter to minimize tapping off of slag.**

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INJECTION METALLURGY, vol. 214, May 1986, pages 228,232,234; S.C. McPHERSON: "Ladle metallurgy and clean steel production"
PATENT ABSTRACTS OF JAPAN, vol. 8, no. 138 (C-231)[1575], 27th June 1984, page 26 C 231; & JP-A-59 47 314 (SHIN NIPPON SEITETSU K.K.) 17-03-1984

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Description

The invention relates to a plug of refractory material for use in a steel converter to minimize tapping off of slag from the converter, and also to a method of tapping a steel converter using such a plug.

Counteracting the slag which comes out at the end of tapping the steel from the converter, known as the end slag, is a long-standing problem. Various methods are known for tackling this problem.

The simplest method is to observe the flow of steel and to stop tapping at the first appearance of slag.

Another method is to use a spherical ball which is introduced into the converter before tapping. The specific gravity of the ball is such that it floats on the steel but not on the slag. When the slag threatens to emerge, the ball closes the opening of the tap hole of the converter. A disadvantage of this method, however, is that this closing frequently occurs so early that much steel still remains behind in the converter. This is undesirable. For this reason, plugs are used which are not spherical, but for example take the shape of a cube. This kind of plug does not close the tap hole completely. The remaining steel may still run out of the converter, but at a lower velocity. At the point when slag threatens to emerge, tapping off is stopped. The article "Ladle metallurgy and clean steel production", S.C. McPherson, "Steel Times", vol. 214, 1986-5 (May), page 220 etc. illustrates such spherical and cubic plugs. EP-A-94241 describes a cubic plug for the same purpose.

When the cubic plug is positioned well, its use provides better control because of the reduced tapping velocity at the end of tapping. However, non-spherical plugs of this kind require very accurate positioning in the converter because they do not automatically find the tap hole at the end of tapping. This is because, in contrast to spherical plugs, their ability to roll is insufficient. As a result the closing of the tap hole is sometimes so poor that the flow of end slag is insufficiently counteracted. With non-spherical plugs, improvement in the probability of achieving a good closing off is sought by providing them with a long shank which is introduced into the tap hole of the converter. This holds the plug at the desired place so that the probability of accurate positioning is equivalent to that of the spherical plug. However, positioning the plug with a shank is considerably harder than positioning the spherical plug.

The object of the invention is to provide a plug which avoids the defects of the spherical plug and the cubic plugs described above, as well as those of the plugs with a shank. The plug of the invention given is claim 1 is of the shankless type and has a polyhedral shape with a plurality of generally flat faces. Each face joins at least one adjacent face at an obtuse angle. In some embodiments at least one end point of each intersecting line of two adjacent faces lies on an imaginary sphere enveloping the plug. This plug does not close the tap hole completely so that towards the end of tapping the flow of steel is reduced but not completely blocked. Moreover, this plug has sufficient ability to roll so that it does not need to be provided with a shank for positioning at the tap hole. As a result using the plug in accordance with the invention is as simple as using the known spherical plug, a method of tapping a steel converter using the plug of claim 1 being given in claim 7.

A preferred shape of the plug is one in which it has symmetrical upper and lower halves meeting at a common plane which has a larger area than any parallel sections of the upper and lower halves. The plug then fits releasably in the mould in which it is cast and can be removed from it without its shape being lost. In view of the large number of plugs needed in practice (per converter charge one plug is consumed), this represents an important cost advantage.

In practice a simple embodiment has been found to be a plug of which the common plane between the lower and upper halves has essentially a rectangular e.g. square shape. It is particularly desirable that the plug has a top plane and a base plane which are parallel to the said common plane of the lower and upper halves.

Embodiments of the invention will be described by way of non-limitative example with reference to the drawings, in which :

Fig. 1 shows a first embodiment of the plug in accordance with the invention ; and

Fig. 2 shows a further embodiment of the plug in accordance with the invention.

The plugs shown in Figs. 1 and 2 consist essentially of refractory material of appropriate density to float at the steel slag interface. This may be for example a suitable type of refractory concrete.

Fig. 1 shows an embodiment in which the plug has fourteen flat faces, of which six large faces 5 intersect each other at 90° and eight small triangular faces 6 form bevels at the corners. There are thus twenty four angles, each angle being the meeting point for three intersecting meeting lines of the faces. For example angle 1 is formed by the intersecting lines 2, 3 and 4. The plug may be lifted or tipped into a converter using an eye 7. Each of the faces 6 intersects each of the three adjacent larger faces 5 at an obtuse angle. The shape of the plug enables it to roll easily to lodge in the taphole of the steel converter.

Fig. 2 shows a further improved plug with edges bevelled off more. The shape of this plug reduces the risk of the angles crumbling away and improves its ability to roll.

In this case the plug is a body of polyhedral shape having a rectangular central plane of symmetry 10 and mutually symmetrical upper and lower halves 8, 9 on each side of this central plane. Each half 8, 9 has

four large planar faces 8a, 9a meeting the central plane of symmetry 10 and extending away from it at an angle less than 90°, specifically 75° and a planar end face 11, 12 meeting all the first planar faces 8a, 9a and lying parallel to the central plane of symmetry 10. At each meeting point of two of the first planar faces 8a, 9a and one of the second planar faces 11, 12 there is a small bevel face 13 at an obtuse angle to all three adjoining faces. There are rounded surfaces 14 at meeting zones of each adjacent pair of the first planar faces 8a, 9a.

Both the lower half 8 and the upper half 9 have a tapering shape. This has the advantage that the mould or die which is used for making the plug may be re-used. This reduces the production costs of the plug to a significant degree.

To give an example of dimensions, the plugs illustrated are each 205 mm high and have maximum widths of 205 mm.

Claims

1. A plug of refractory material for use in a steel converter to minimize tapping off of slag, the plug having a polyhedral shape and being shankless, characterized in that the plug surface consists of a plurality of generally flat faces (5, 6 ; 8a, 9a, 11, 12, 13) lying in respective planes with the planes of every adjacent pair of faces intersecting at angles not less than 90° and the plane of each face intersecting the plane of at least one adjacent face at an angle greater than 90°.

2. A plug according to claim 1 wherein the planes of every adjacent pair of said faces intersect at angles greater than 90°.

3. A plug according to claim 1 or claim 2 having mutually symmetrical upper and lower halves (8, 9) meeting at a common plane which has a larger area than any section of the upper and lower halves parallel to it.

4. A plug according to claim 3 wherein said common plane (10) of the upper and lower halves (8, 9) has substantially a rectangular shape.

5. A plug according to claim 3 or claim 4 having a top face (11) and a bottom face (12) both parallel to said common plane.

6. A plug according to any one of claims 3 to 5 wherein at least some of the meeting zones (14) of adjacent faces are rounded.

7. A method of tapping a steel converter comprising the steps of (i) placing a plug according to any one of claims 1 to 6 in the molten bath in the converter, the plug having a density such that it floats at the interface of steel and slag and (ii) tapping the steel from the furnace via a taphole in a manner such that the plug lodges in the taphole.

Patentansprüche

1. Ein Abstichstopfen aus Feuerfestmaterial für einen Stahlkonverter zum Minimieren des Mitabziehens von Schlacke, welcher Abstichstopfen eine polyedrische Gestalt besitzt und schaftlos ist, dadurch gekennzeichnet, daß die Stopfenoberfläche aus einer Vielzahl von allgemein ebenen Flächen (5, 6 ; 8a, 9a, 11, 12, 13) besteht, welche in entsprechenden Ebenen liegen, wobei sich die Ebenen Jedes benachbarten Flächenpaares unter einem Winkel von nicht unter 90° schneiden und die Ebene jeder Fläche die Ebene von zumindest einer benachbarten Fläche unter einem Winkel größer als 90° schneidet.

2. Ein Abstichstopfen gemäß Anspruch 1, wobei sich die Ebenen jedes benachbarten Flächenpaares unter einem Winkel größer als 90° schneiden.

3. Ein Abstichstopfen gemäß Anspruch 1 oder Anspruch 2 mit gegenseitig symmetrischer oberer und unterer Hälfte (8, 9), welche sich in einer gemeinsamen Ebene treffen, welche eine größere Fläche besitzt, als irgendein Schnitt der oberen und unteren Hälfte parallel zu ihr.

4. Ein Abstichstopfen gemäß Anspruch 3, wobei die der oberen und der unteren Hälfte (8, 9) gemeinsame Ebene (10) eine im wesentlichen rechteckige Form hat.

5. Ein Abstichstopfen gemäß Anspruch 3 oder Anspruch 4 mit einer oberen Fläche (11) und einer unteren Fläche (12), die beide parallel zu der gemeinsamen Ebene liegen.

6. Ein Abstichstopfen gemäß irgendeinem der Ansprüche 3 bis 5, wobei zumindest einige der zusammentreffenden Zonen (14) benachbarter Flächen gerundet sind.

7. Ein Verfahren zum Abstechen eines Stahlkonverters mit den Schritten (i) Anordnen eines Abstichstopfens gemäß irgendeinem der Ansprüche 1 bis 6 in das Schmelzbad im Konverter, wobei der Abstichstopfen eine solche Dichte hat, daß er an der Grenzfläche von Stahl und Schlacke schwimmt und (ii) Abstechen des Stahles vom Schmelzofen über ein Abstichloch in der Art, daß sich der Abstichstopfen im Abstichloch festsetzt.

Revendications

1. Bouchon en matériau réfractaire pour l'utilisation dans un convertisseur d'acier afin de minimiser l'écoulement du laitier, le bouchon ayant une forme polyhédrique et ne comportant pas de tige, caractérisé en ce que la surface du bouchon se compose d'une pluralité de surfaces globalement planes (5, 6 ; 8a, 9a, 11, 12, 13) se trouvant dans des plans respectifs, les plans de chaque paire de faces adjacente se coupant selon des angles qui ne sont pas inférieurs à 90°, et le plan de chaque face coupant le plan d'au

moins une face adjacente à un angle supérieur à 90°.

2. Bouchon selon la revendication 1, dans lequel les plans de chaque paire adjacente desdites faces se coupent à des angles supérieurs à 90°.

3. Bouchon selon la revendication 1 ou la revendication 2, ayant des moitiés supérieure et inférieure (8, 9) symétriques l'une par rapport à l'autre qui se rencontrent en un plan commun qui a une surface plus grande que toute section des moitiés supérieure et inférieure parallèle à celui-ci.

4. Bouchon selon la revendication 3, dans lequel ledit plan commun (10) des moitiés supérieure et inférieure (8, 9) a substantiellement une forme rectangulaire.

5. Bouchon selon la revendication 3 ou la revendication 4, ayant une face supérieure (11) et une face inférieure (12) qui sont toutes deux parallèles audit plan commun.

6. Bouchon selon l'une quelconque des revendications 3 à 5, dans lequel au moins certaines des zones de rencontre (14) des faces adjacentes sont arrondies.

7. Procédé pour vider un convertisseur d'acier, comportant les étapes suivantes :

(i) placement d'un bouchon selon l'une quelconque des revendications 1 à 6 dans le bain fondu dans le convertisseur, le bouchon ayant une densité telle qu'il flotte à l'interface entre l'acier et le laitier, et

(ii) évacuation de l'acier à partir du four par un trou de coulée d'une façon telle que le bouchon se loge dans le trou de coulée.

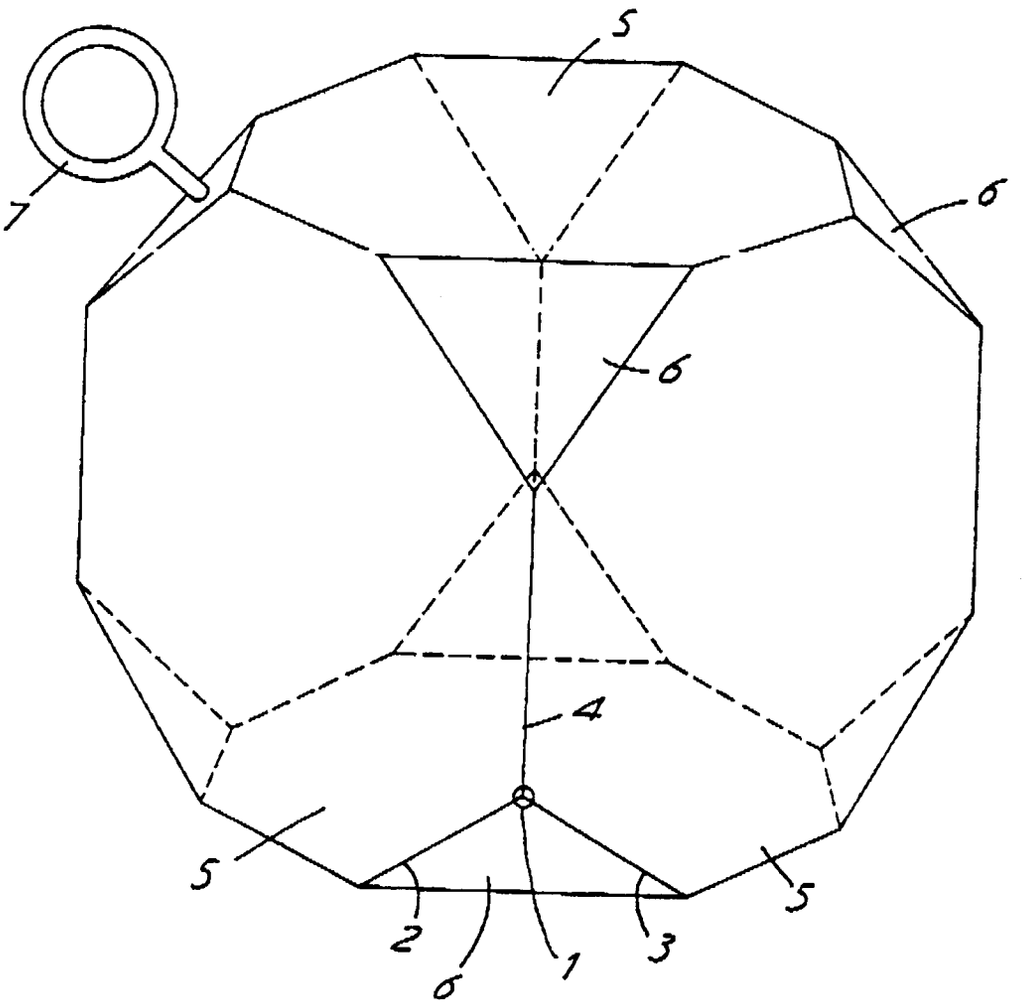

FIG.1

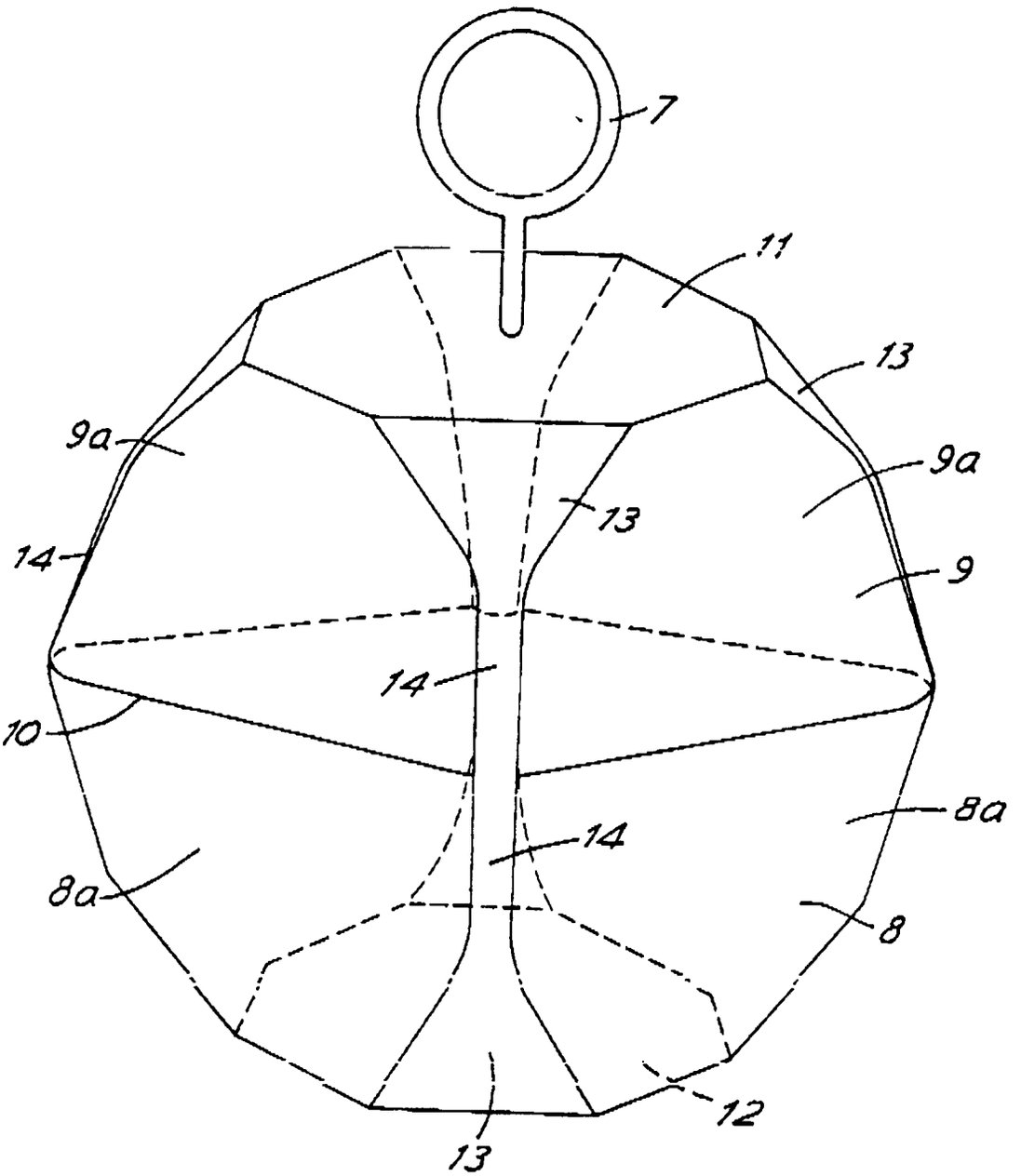

FIG.2