

PATENT SPECIFICATION

(11) 1427872

1427872

- (21) Application No. 25280/74 (22) Filed 4 June 1974
 (31) Convention Application No. 62582/73 (32) Filed 5 June 1973 in
 (33) Japan (JA)
 (44) Complete Specification published 10 March 1976
 (51) INT CL² C21C 5/46
 (52) Index at acceptance
 F4B 7E2
 C1J 10 12 14 17 29 4 9 X



(54) STOPPER PLUG FOR CONVERTER TAPHOLE

(71) We, AIKOH CO. LTD., a Japanese Company, of No. 1—39 Ikenohata 2-Chome, Taito-Ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a stopper plug for insertion into a taphole of a converter, particularly, but not exclusively, an LD converter.

When a slag in a steel-making furnace flows out into a ladle together with the molten steel during tapping, part of the slag is suspended in the molten steel and does not surface. Also sulphur and phosphorus in the slag revert into the molten steel. Accordingly, the present practice is to perform the tapping operation in such a manner that the slag in the furnace does not flow out together with the molten steel.

Tapping of a converter, especially an LD converter, is carried out by gradually tilting the converter in order to release the molten steel from a taphole located in an upper part of the wall, the taphole having being plugged previously with a wooden stopper plug which is forced out of the hole as a result of increasing pressure of the molten steel as the converter is tilted. It is important that the taphole is opened by the pressure of the molten steel which increases with tilting of the converter proceeds, and is not opened by the low pressure of the molten steel at an early stage when the molten steel begins to cover the plug. This prevents the slag floating of the molten steel from flowing out of the taphole together with the molten steel. The tilting is stopped after almost all of the molten steel has flowed out and before the slag begins to flow out.

The stopper plug for the taphole is conventionally made by shaping a piece of wood so that the shape of the plug conforms to that of the taphole. However, it is very difficult to shape a piece of wood into a shape exactly corresponding to the taphole.

When the converter has been used many

times, the brick at the taphole is corroded by the molten steel and the hole is deformed, so that the stopper plug does not have a shape corresponding exactly to the taphole and the mere insertion of the stopper plug in the taphole does not ensure complete plugging of the taphole. Accordingly, the taphole must be plugged by inserting a sealing material, such as mortar, around the stopper plug.

As described above, the stopping of the taphole is very complicated. Also, since the stopper plug is firmly fixed by the mortar, frequently the plug is not forced out by the pressure of the molten steel caused by the tilting of the converter.

It is an object of the present invention to obviate or mitigate the above disadvantage.

According to the present invention, there is provided a stopper plug for a converter taphole, the plug comprising a moulding of a refractory material, a fibrous substance and a binder.

The mere insertion of this stopper plug can ensure a complete plugging of the taphole of the converter without using a sealing material such as mortar. In addition, the stopper plug can be produced very simply in a shape exactly corresponding to the shape of the taphole.

The refractory material used in this invention can be a non-porous refractory material, such as silica, quartz, magnesia, olivine, sand, mullite, aluminium oxide, (such as alumina "Alundum" (trademark), and corundum), chamotte, aluminium ash, dolomite, magnesite, limestone, fly ash or bauxite; or a porous refractory material, such as diatomaceous earth, lapilli, expanded vermiculite, expanded shale, expanded obsidian, expanded perlite, or expanded pitch-stone. The refractory material is a principal component of the stopper plug and serves to enhance the refractory properties of the plug.

Examples of suitable fibrous substances are inorganic fibrous substances such as asbestos, rock wool, slag wool, glass wool or steel wool, or organic fibrous substances such as an organic fibrous pulp, a cellulosic fibrous substance made by unbinding paper, cotton flax

or synthetic fibres. The fibrous substance reinforces the stopper plug of the moulding to prevent the stopper plug from breaking on impact during handling, for example, during its transfer or setting into the converter; and imparts elasticity, porosity and shrinking properties to the plug.

Examples of suitable binders are resin binders such as phenol-formaldehyde resins, urea-formaldehyde resins, furan resins, or epoxy resins, organic binders such as dextrin or starch, or inorganic binders such as water glass, cement or clay.

When it is desired to expedite the opening of the taphole, it is preferred to incorporate a combustible substance into the plug-forming composition. Examples of suitable combustible substances are wood powder, saw dust, coke powder, and coal powder.

One preferred composition for the stopper plug in accordance with the present invention is as follows:—

	% by weight
Refractory Material	40 to 70
Organic Fibrous Substance	15 to 35
Inorganic Fibrous Substance	5 to 20
Combustible Substance	5 to 20
Binder	1 to 7

The stopper plug is a porous moulding which is elastic and is capable of shrinking and deformation. To plug a taphole, a stopper plug having a diameter somewhat larger than the diameter of the taphole is preferred. Even when the taphole is somewhat deformed as a result of corrosion by molten steel, the mere tight insertion of this plug into the taphole can lead to complete plugging and sealing of the taphole without the necessity for a sealing material such as mortar.

The stopper plug so inserted is not forced out by the low pressure of the molten steel in the early stage when the converter is tilted and the molten steel begins to cover the stopper plug. Instead, the stopper plug is forced out of the taphole by the pressure of the molten steel which increases as the tilting progresses. Accordingly, the slag floating on the molten steel does not flow out together with the molten steel.

To facilitate the opening of the taphole, a stopper plug containing a combustible substance as described above or an organic fibrous substance as the fibrous substance, or a resin or organic binder as the binder is preferred. On the other hand, to retard the opening of the taphole, a stopper plug which contains a large amount of the refractory material, or an inorganic fibrous substance as the fibrous substance, or an inorganic binder as the binder is preferred.

One preferred example of a method for producing the stopper plug in accordance with the present invention is described below.

In order to disperse the fibrous substance uniformly, water or another liquid is added to the plug-forming components, and they are mixed to form a slurry or paste. The slurry or paste is charged into a mould for dehydrating and moulding, e.g. a metallic mould which is provided with a wire net, and dehydrated in a vacuum or using a press to form a green dehydrated moulding. The dehydrated moulding is then dried and solidified to form the moulding used as a plug.

As another example, the slurry or paste stage is eliminated. In this case, a mixture of the components of the stopper plug is charged into a mould to form a green moulding, and the green moulding is dried and solidified to form the moulding for use as a plug. To disperse the fibrous substance uniformly, preferably a surface active agent is added at the time of mixing the plug-forming components.

In the accompanying drawings:—

Fig. 1 is a schematic longitudinal sectional view of a converter in which the taphole in an upper part of the converter wall is plugged with the stopper plug according to the present invention, and

Fig. 2 is an enlarged view of portion A of Figure 1.

Referring to Figure 1, a taphole 3, which is located in an upper part of the wall of a converter 1, is plugged with a stopper plug 2. The converter 1 is lined with lining brick 4 and stamping material 5, and contains molten steel 6 and slag 7.

In Figure 2, the taphole 3 is made in the lining brick 4 and the stamping material 5. The taphole 3 is plugged using a tool such as an iron pipe or bar by the stopper plug 2 which is of the type described in the Example hereinbelow.

After the completion of steel-making, the converter 1 is tilted toward the taphole side. The stopper plug 2 comes out because of the pressure of the molten steel 6 which increases as the tilting progresses, and the taphole is opened. The opening of the taphole is accomplished when the molten steel 6 has covered the plug so completely that there is no possibility of the slag 7 flowing out together with the molten steel 6.

In the following Example, unless otherwise indicated, all parts and percents are by weight.

EXAMPLE

Water was added to a mixture of 51% by weight of siliceous sand, 22% by weight of pulp, 11% by weight of slag wool, 11% by weight of wood powder and 5% by weight of starch to form a slurry. The slurry was charged into a dehydration mould, and dehydrated in a vacuum to produce a dehydrated moulding. The dehydrated moulding was dried and solidified at a temperature of about 100°C to manufacture a stopper plug. This plug was of a truncated cone shape with

a length of 500 mm, a diameter at one end surface of 160 mm and a diameter at the other end surface of 130 mm.

- 5 Tests were performed ten times in a 100-ton LD converter. In each test, the stopper plug was inserted into the taphole of the converter using an iron bar to plug and seal the taphole. Steel was manufactured in the converter in which the taphole was so plugged.
- 10 After the steel-making, the converter was tilted toward the taphole side. The stopper plug came out of the hole because of the pressure of the molten steel, and tapping was effected. In each test, hardly any flow-out
- 15 of the slag at the time of tapping occurred.

WHAT WE CLAIM IS:—

1. A stopper plug for a converter taphole, the plug comprising a moulding of a refractory material, a fibrous substance and a binder.
- 20 2. A stopper plug as claimed in claim 1, wherein said refractory material is at least one of silica, quartz, magnesia, olivine, sand, mullite, aluminium oxide, chamotte, aluminium ash, dolomite, magnesite, limestone, fly ash,
- 25 bauxite, diatomaceous earth lapilli, expanded vermiculite, expanded shale, expanded obsidian, expanded perlite, and expanded pitchstone.
- 30 3. A stopper plug as claimed in claim 1 or 2, wherein said fibrous substance is at least one of an inorganic fibrous substance and an organic fibrous substance.
- 35 4. A stopper plug as claimed in claim 3, wherein said inorganic fibrous substance is

selected from asbestos, rock wool, slag wool, glass wool and steel wool.

5. A stopper plug as claimed in claim 3 or 4 wherein said organic fibrous substance is selected from organic fibrous pulp, a cellulosic fibrous substance made by unbinding paper, cotton, flax, and synthetic fibres.

6. A stopper plug as claimed in any preceding claim, wherein said moulding includes a combustible substance.

7. A stopper plug as claimed in claim 3, 4 or 5, comprising 40 to 70% by weight of said refractory material, 15 to 35% by weight of said organic fibrous substance, 5 to 20% by weight of said inorganic fibrous substance, 5 to 20% by weight of a combustible substance, and 1 to 7% by weight of said binder.

8. A stopper plug as claimed in claim 6 or 7, wherein said combustible substance is at least one of wood powder, sawdust, coke powder or coal powder.

9. A stopper plug as claimed in any preceding claim, wherein said binder is at least one of a phenol-formaldehyde resin, a urea-formaldehyde resin, a furan resin, an epoxy resin, dextrin, starch, water glass, cement or clay.

10. A stopper plug for a converter taphole, substantially as hereinbefore described with reference to the accompanying drawings.

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- 25 bauxite, diatomaceous earth lapilli, expanded vermiculite, expanded shale, expanded obsidian, expanded perlite, and expanded pitchstone.
- 30 3. A stopper plug as claimed in claim 1 or 2, wherein said fibrous substance is at least one of an inorganic fibrous substance and an organic fibrous substance.
- 35 4. A stopper plug as claimed in claim 3, wherein said inorganic fibrous substance is

selected from asbestos, rock wool, slag wool, glass wool and steel wool.

5. A stopper plug as claimed in claim 3 or 4 wherein said organic fibrous substance is selected from organic fibrous pulp, a cellulosic fibrous substance made by unbinding paper, cotton, flax, and synthetic fibres.

6. A stopper plug as claimed in any preceding claim, wherein said moulding includes a combustible substance.

7. A stopper plug as claimed in claim 3, 4 or 5, comprising 40 to 70% by weight of said refractory material, 15 to 35% by weight of said organic fibrous substance, 5 to 20% by weight of said inorganic fibrous substance, 5 to 20% by weight of a combustible substance, and 1 to 7% by weight of said binder.

8. A stopper plug as claimed in claim 6 or 7, wherein said combustible substance is at least one of wood powder, sawdust, coke powder or coal powder.

9. A stopper plug as claimed in any preceding claim, wherein said binder is at least one of a phenol-formaldehyde resin, a urea-formaldehyde resin, a furan resin, an epoxy resin, dextrin, starch, water glass, cement or clay.

10. A stopper plug for a converter taphole, substantially as hereinbefore described with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

