United States Patent

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[54] **FORMATION OF CONTINUOUS CASTING STARTER PLUGS**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **164/82,** 164/274
[51] **Int. Cl.** **B22d 11/08**
[50] **Field of Search** 164/82, 274, 282; 249/197

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ABSTRACT: In order to form a continuous casting starter plug a disintegratable refractory shape is placed into the last molten metal in the mold at the end of a casting cycle, allowed to disintegrate, the disintegration products are removed and the thus formed plug cut from the strand.

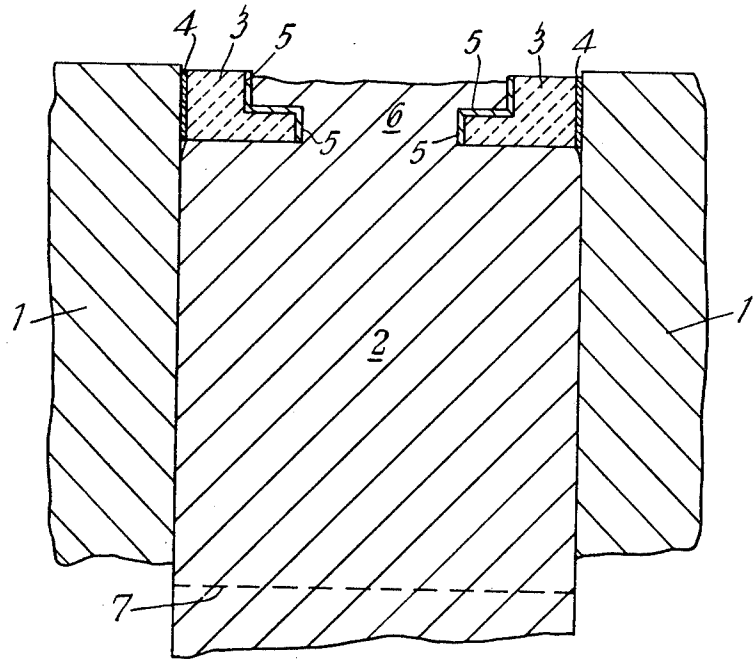


FIG.1.

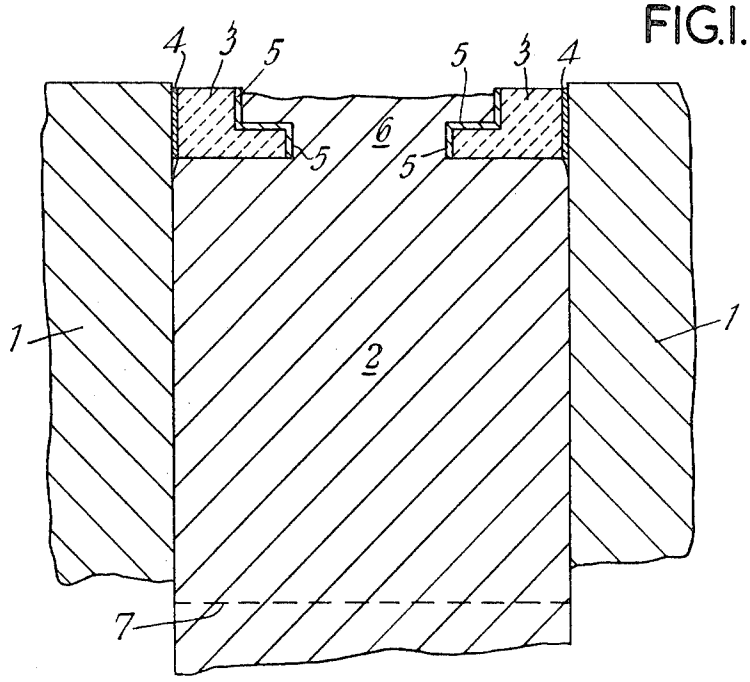
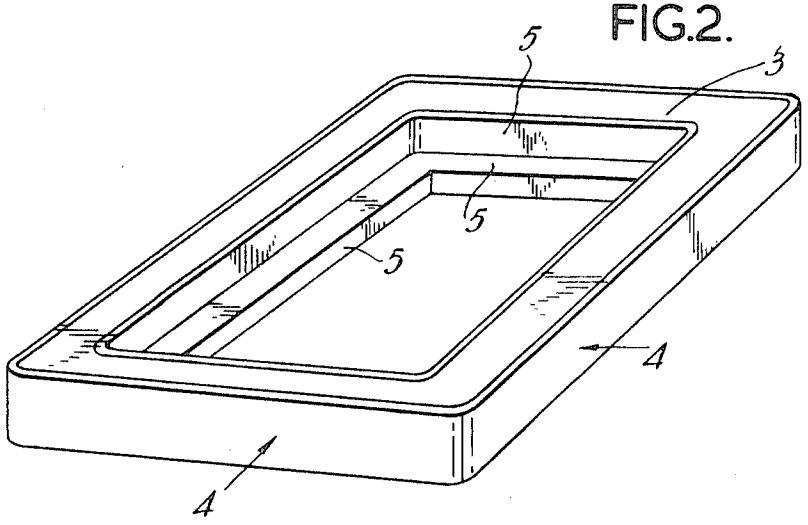


FIG.2.



FORMATION OF CONTINUOUS CASTING STARTER PLUGS

The present invention relates to the continuous casting of molten metal.

In the continuous casting of molten metal to form a strand of solidified metal, molten metal is poured from a ladle via a tundish into the top of a mould having walls, usually of copper, through which cooling liquid, usually water, is circulated. The solidified metal is withdrawn by a series of withdrawal rollers which grip the solidified metal issuing from the base of this mould as a continuous strand, which passes through a secondary cooling station where water is sprayed directly onto it. The strand is subsequently cut into slabs of desired lengths for further processing.

In order to start the continuous casting process a plug is inserted into the base of the mould, and molten metal then teemed into the mould. When the level of molten metal in the mould has reached that desired, the plug is withdrawn and continuous pulling of the cast strand commences. The plug must be of such configuration on its upper surface that the just solidified strand holds firmly to the plug and therefore is pulled from the mould as the plug is withdrawn.

Such a configuration is herein called, for brevity, a "key configuration."

The plug usually used is a metal casting which is removably attached to a flexible bar known as a "dummy bar." Before casting commences, the dummy bar must be raised through the withdrawal rollers and attached to the plug to ensure guidance of the cast strand through the rollers. The plug castings are expensive, especially when moulds of large cross-sectional area are used, and it is common practice to attempt to recover the casting from the piece of the solidified strand first cropped. Such recovery is itself an expensive process, the most practiced method being to try to cut away the strand from the casting with a flame cutter. This operation is a relatively simple one providing that the strand has not welded onto the casting. However, if welding has occurred, then cutting often results in damage to the casting itself too great to allow the casting to be reused. A further necessary feature of such a casting is that it should fit exactly into the casting mould and it may not do so if damaged by the flame-cutting operation.

It has been suggested that significant advantages might be derived from a process for the production of a continuous casting starter plug which comprises, at the close of a continuous casting operation, inserting into the molten metal at the top of a continuous casting mould a refractory shape, allowing the molten metal to solidify at the metal/refractory interface of said shape so that it acquires a key configuration as hereinbefore defined, removing said shape, withdrawing the solidified strand from the mould and cutting the last section of the strand from the solidified strand, said last section thereby constituting a starter plug or, more advantageously, a unitary starter plug/dummy bar.

In this way, a starter plug may be formed at the end of each continuous casting operation, for use in the next casting operation. The method has several other advantages: the starter plug is automatically of the correct mould size and configuration; use is made of metal otherwise due to be cropped and discarded as scrap; the method is extremely simple to effect, the majority of the steps being already necessary at the terminating of continuous casting.

Furthermore, the use of a unitary starter plug/dummy bar which remains from the previous cast can considerably ease resumption of casting, after a much shorter intervening shutdown; it was envisaged that this method would substantially increase the output of a casting machine. The connection between known dummy bars and starter plugs has been unreliable and prone to damage by the high pressure necessary to raise and support these elements in position.

However, in view of certain unexpected disadvantages, the above proposal could not be adopted, mainly because of the difficulties involved in removing the refractory from the cast key configuration; the use of tools to chip away the refractory shape from the solidified key configuration within the casting mould could not be practiced because of the danger of damaging the mould; removal at a position immediately adjacent to the mould, after withdrawal through the mould base, involves the risk of spillage of the refractory material on to the lower portions of the continuous casting plant and resultant abrasive damage thereto; complete withdrawal of the cast strand and refractory shape through the withdrawal rollers etc. for cleaning would partly defeat the object of the method since the section cropped as dummy bar and key configuration would then have to be treated in the conventional manner, i.e. it would need to be raised through the rollers to be repositioned in the mould.

It has now been found that the above disadvantages may be overcome by employing a refractory composition which, under the action of the heat of the molten metal, tends after a short while to disintegrate. In this way, the refractory shape may easily be removed from the cast strand, e.g. using a vacuum cleaner, whilst the cast key configuration is still within the mould.

According therefore to the present invention there is provided in a process of continuous casting the step of inserting at the close of a casting cycle into the molten metal at the top of the continuous casting mould a refractory shape, allowing the molten metal to solidify at the metal/refractory interface of said shape to acquire a key configuration (as hereinbefore defined), the said refractory shape being formed of a bonded refractory material which disintegrates in time under the heat of the solidifying molten metal, allowing said refractory shape to disintegrate, removing the disintegration products, withdrawing the solidified strand from the mould, and cutting the last section of the strand from the solidified strand, thereby to provide a plug for a next casting cycle.

A suitable refractory composition for the shape used may be produced as follows:

The following materials are used in the proportions given by weight to form two foamed mixtures.

	Parts by weight
Mixture 1:	
Foaming agent (Teepol=aqueous solution)	0.75
Liquid urea-formaldehyde resin	15.5
Water	1.4
Refractory (silica sand-60 mesh BSS)	73.45
Mixture II:	
Foaming agent (Teepol:aqueous solution)	0.25
Organic fibre (wood pulp)	2.25
Water	6.4
Catalyst (phosphoric acid)	0.025-1

The bench life of each mixture extends over days and may be regarded as indefinite. When it is desired to form slabs, the two mixtures are mixed together by any convenient means, and the resulting composition moulded to the required shape. The formed slab sets to a rubbery state in a predetermined time depending on the proportion of catalyst used. The metal-contacting surface of the slab is rendered nonporous by pressing against the slab a 60-mesh perforated metal sheet. Final hardening may either be effected by leaving at room temperature, e.g. for 6 to 10 minutes when a high concentration of catalyst is used, or by heating by any suitable means, e.g. ovens or dielectric heating, for a similar period of time when a low concentration of catalyst is used.

The type of refractory used in the manufacture of the bonded shape is unimportant, and it may be chosen from a wide variety of available materials such as sand, chamotte, grog, zircon flour, chromite flour, alumina or magnesia. The bonded refractory shape may include organic fibrous material which increases mechanical strength of the shape prior to use, but in use burns out and aids the slab in disintegration.

Such compositions are very effective insulating materials and they tend to maintain the cast metal in a molten condition for a prolonged period. In view of this, and their tendency to disintegrate when contacted by molten metal, there is a danger that premature disintegration, while the metal is maintained in a molten state, will lead to loss of the desired key configuration. Therefore it is desirable to provide the refractory shape with a means of chilling the metal with which it comes into contact so that the metal solidifies before the refractory shape disintegrates. The chilling effect may be induced in a number of ways; for example, ingredients having a high heat capacity may be incorporated in the insulating composition, powdered iron being one such suitable material; alternatively, the surface of the refractory to be contacted by molten metal may be provided with a bonded coating of powdered metal, such as powdered ferrosilicon or powdered iron applied with a suitable adhesive or binding agent (e.g. sodium silicate); more preferably however the metal-contacting portion of the refractory shape is covered with thin steel sheet. For this purpose a thickness of one-eighth inch steel sheet has been found to be satisfactory.

A preferred refractory shape is a ring of shape similar to the cross section of the mould, and of cross section parallel to the plane of the ring greater toward one side of the ring than the other; in use the side of larger cross section is placed downward. Thus a firm "dovetail" formation may be formed in the end of one strand. The ring should preferably extend to the sides of the mould, in order to avoid the formation of fins between the refractory ring and the mould wall, which may tend to become turned outward and thus damage the mould on insertion of the starting plug. In order to prevent mould scratching, the outside of the ring may be coated with a lubricating coating such as a graphite-containing coating.

Generally the refractory shape is placed in the top of the continuous casting mould at the termination of the normal teeming. Backfilling is then practiced to take up the pipe formed due to shrinkage of metal while it cools and in order to ensure formation of a satisfactory casting around the refractory shape. The withdrawal of the cast strand is usually interrupted for a few minutes during this process and this further necessitates a temporary closing down or reduction of activity of the secondary cooling plant. The disintegrated refractory material is preferably removed from the solidified metal in the mould using vacuum suction in order to minimize the risk of spillage of refractory material onto the lower portions of the continuous casting plant. The strand may then be withdrawn from the mould and the starter plug cut away as part of the normal cropping operation. However, it is preferable to allow the plug to remain within the mould for commencement of the following casting operation. In this case, the strand is cropped below the withdrawal and guide rollers, leaving a unitary starter plug/dummy bar in the correct position for the following cast, which may then proceed after a much shorter time interval, providing molten metal for casting is available, thereby leading to a greatly increased output from the casting machine. A secondary advantage is that this technique eliminates the problems caused by an unreliable connection between a conventional dummy bar and starter plug and the attendant damage to such items during use.

In the attached drawings:

FIG. 1 shows a cross section through a continuous casting mould just after the insertion of the refractory shape in the process of the present invention, and FIG. 2 is a perspective view of a refractory ring.

Referring to FIG. 1 there is shown a continuous casting mould 1 in which is cast a strand of metal 2. In the top of this strand is a refractory ring 3, which is coated at 4 with a graphite-containing lubricating composition and which fits the mould exactly. The ring is lined with one-eighth inch steel plate 5. Backfilling has just been terminated, filling up the pipe formed at 6, and giving a sound upper end to the cast strand. The ring is subsequently removed and the strand withdrawn, and the last portion cut off along dotted line 7. This last portion may then be fed back into the base of the mould and used as a starter plug as described above.

FIG. 2 shows the refractory ring used. The parts noted above are numbered as noted therein.

I claim as my invention:

1. In the process of continuous casting, the step of inserting at the close of a casting cycle into the molten metal at the top of the continuous casting mould a refractory shape, allowing the molten metal to solidify at the metal/refractory interface of said shape to acquire a key configuration, said refractory shape being formed of a bonded refractory material which disintegrates in time under the heat of the solidifying molten metal, allowing said refractory shape to disintegrate, removing the disintegration products, withdrawing the solidified strand from the mould, and cutting the last section of the strand from the solidified strand at a sufficient length so that it can subsequently act as a starter plug for the next casting cycle.

2. A process according to claim 1 wherein the refractory shape used is a ring of shape similar to the cross section of the mould, and of cross section parallel to the plane of the ring greater toward one side of the ring than the other.

3. A process according to claim 2 wherein the outside of the ring is coated with a lubricating coating.

4. A process according to claim 3 wherein said coating comprises graphite.

5. A process according to claim 1 wherein the refractory shape chills the molten metal so that the metal solidifies before the refractory shape disintegrates.

6. A process according to claim 5 wherein the molten metal is chilled by applying a bonded coating of powdered meal to the refractory shape.

7. A process according to claim 5 wherein the molten metal is chilled by covering the refractory shape with a steel sheet.