United States Patent Office

3,344,838

Patented Oct. 3, 1967

3,344,838

METHOD FOR PRODUCING AN EXOTHERMIC LINING FOR INGOT AND FOUNDRY MOLDS AND HOT TOPS

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No Drawing. Filed Dec. 28, 1964, Ser. No. 421,586
Claims priority, application France, Dec. 31, 1963, 958,963; May 29, 1964, 976,414
9 Claims. (Cl. 164—33)

The present invention has for its object exothermic structures and more particularly exothermic linings for the upper ends of ingot molds or hot tops with a view to delaying the solidification of the dead head and also exothermic inserts for foundry molds. Such structures may be constituted by a unitary element or else by an assembly of elements fitted in the upper section of the ingot mold, in the hot top or in the mold.

Generally speaking, linings are of two types, to wit: insulating linings constituted by insulating, generally refractory materials, which have for their object to delay the transfer of heat from the molten metal towards the mold, the ingot mold or the metallic hot top and the so-called exothermic linings, constituted by mixtures producing an exothermic reaction when the temperature produced by the molten metal raises that of the lining.

It has also been proposed to line the casting molds with structure incorporating a layer of an exothermic material covered by an insulating layer.

For executing such insulating and/or exothermic linings, numerous compositions have already been proposed, but without satisfying completely the technical requirements, as concerns in particular the heat capacity of the insulating layers and the temperature at which the exothermic layers react.

As concerns the insulating layers, the fact should be taken into account that those layers should show a heat conductivity as low as possible so as to reduce the speed of transfer of the heat out of the cast metal towards the mold or the metallic hot top, and furthermore they should have a low heat capacity. As a matter of fact, the lining when in contact with the molten metal, is raised to a predetermined temperature in accordance with a predetermined gradient and some amount of heat is carried off the molten metal. In order to increase the insulation, one is naturally led to increase the thickness of the insulating layer, but this leads of course to an increase in the heat capacity of the lining and, beyond a certain thickness, the heat capacity becomes exaggerated and a premature solidification of the outer surfaces of the dead head occurs, which leads to a thick edged U-shaped shrinkage hole.

This leads therefore to a limitation in the thickness of the insulating layer, but this limitation in thickness is detrimental from an economical standpoint by reason of the comparatively low cost price of the component materials which have been saved when compared with the corresponding increase in the cross-section of the dead head and the consequent loss of metal.

The exothermic layers used either alone or in association with insulating layers are chiefly constituted by means of a base of aluminum and of an oxidizing substance. The composition obtained with such components have a comparatively high volumetric cost price, which makes their use prohibitive from an economical standpoint when it is necessary to use substantial thicknesses.

In order to cut out these drawbacks, it has been attempted to produce a so-called "double-acting" lining including a superficial exothermic layer having as a base aluminum and lined at the rear by an insulating layer of a conventional type, but the problems referred to hereinabove are not solved thereby since the cost price of the exothermic layer and the heat capacity of the layers resorted to are too high.

Furthermore, structures incorporating an exothermic layer were obtained hitherto in accordance with various methods, chiefly through molding or blowing by means of a core-producing machine. Such methods resort to mixtures of dry powders or of pasty substances carrying comparatively reduced contents of water, the excess water being subsequently removed through evaporation during the kiln-drying procedure. Such structures were also constituted by elements in a pulverulent condition or aluminium shot and/or by-products containing aluminium, soluble oxidizing substances such as alkaline nitrates and chlorates, or insoluble oxidizing substances such as iron and manganese oxides or fluxes such a fluor spar and cryolithe and various fillings such as silica, fireclay and the like.

The exothermic products having the above composition show not only the above-mentioned drawbacks, but also further drawbacks ascribable chiefly to the presence in their composition of soluble oxidizing substances or salts. Among said further drawbacks, it is possible to mention:

The risk of self-ignition at room temperature by reason of the absorption of the water dissolving the salts, which starts a reaction producing a rise in temperature,

A partial degradation of the aluminium as a result of the attack of the metal element by the alkaline substances which are partly or entirely dissolved,

The drop in hardness of the kiln-dried structures, as a result of the reduction in the water contents before kiln-drying, which reduction in the water contents is produced by the heating accompanying the initiation of an exothermic reaction,

The reabsorption of moisture after-kiln-drying by the soluble salts contatined in the composition, which lowers the mechanical properties and in particular the superficial hardness,

In the case of shaping techniques which require a very moist paste out of which water is removed through filtration, pressing or draining, the solubility of the components becomes prohibitive, since said components are carried along by the water which has been removed and their contents remaining in the final molded element finally are insufficient.

The present invention has for its object to remove these drawbacks and to cut out or remove to a considerable extent the percentages of soluble salts by resorting to substances of a volumetric cost price which is less high than all prior substances used for this purpose for a same yield of heat, while forming an exothermic composition which is particularly suitable for the execution of mold linings including an exothermic layer and an insulating layer associated therewith, which compound linings ensure better results than any composition proposed hitherto. The invention also covers the replacement of aluminium by ele-

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ments which, for a same granulometric value, are less liable to be attacked by alkaline salts than aluminium.

The invention has more particularly for its object a novel exothermic composition for the execution of linings and structures of ingot molds or hot tops for steelworks or foundry molds, said novel composition being used as an element of a lining including an exothemic layer, alone or associated with one or more insulating layers, wherein the oxidizable component is constituted by silico-calcium or silico-aluminium, while the oxidizing component is constituted by a metal oxide such as manganese dioxide or iron oxide. The oxidizable and oxidizing elements are incorporated together with a binder and with mineral and/or organic fillers.

The mineral and organic fillers may be of any known type adapted to improve the refractory character, the insulating capacity, the mechanical resistance or the other properties of the lining and to reduce its specific weight. It is possible in particular to resort to crushed fireclay, to siliceous sand, to pulverulent silicate, to dolomite or to calcium carbonate so as to obtain the desired refractory character and further to kieselguhr or an infusorial earth, husks of rice and wood meal with a view to reducing the specific weight and to improving the insulating capacity of the composition, the wood meal also acting as a scouring reagent, while preferably refractory fibres such as asbestos fibres may serve for improving the mechanical resistance and resilience and finally to alumina under a comparatively pure form or in the form of aluminium ashes and pitch are used so as to improve the stripping. Said composition preferably includes:

Silico-calcium or silico aluminium	6 to 35% by weight.
Manganese dioxide or iron oxide	10 to 22% by weight.
Fireclay	0 to 30% by weight.
Siliceous sand or pulverulent silica	0 to 30% by weight.
Kieselguhr or light infusorial earth	0 to 9% by weight.
Wood meal	8 to 12% by weight.
Asbestos fibres	0 to 11% by weight.
and additionally	
Synthetic resin	7 to 11% by weight of the total above solid materials.

The above compositions are highly satisfactory as far as exothermic properties are concerned and they show the advantage of reacting slowly. It should however be remarked that there is often a slight impregnation during the casting of the metal. To remove this drawback, it is possible, without detrimentally reducing the chief advantage of the method, to introduce into the composition a small percentage of aluminium ashes at a rate of for instance up to 12% by weight of the composition.

In said exothermic compositions, the chemically reacting substances constituted by silico-calcium and silico-aluminium and the oxidizing substances should have a fine granulometric value above 100 AFS so as to further the reaction, whereas comparatively large granulometric values of a magnitude of 50 AFS are selected for the other constituents so as to ensure the maximum permeability furthering the release of the gases.

The exothermic compositions according to the invention may be used for forming a lining directly on the wall of the hot top or they may be used as pre-shaped elements.

Preferably and in accordance with the invention, the lining element is constituted by the association of at least one exothermic layer having the above composition and one insulating layer, the exothermic layer having an exothermic capacity compensating the heat capacity of the lining considered as a whole.

With such a lining, no transfer of heat is obtained during the exothermic reaction of the product between the metal and the exothermic layer and at the end of the reaction, the mass forming the lining shows always, whatever may be its thickness the theoretically optimum temperature gradient without any absorption of heat out of the dead head metal.

Experience has shown that such a lining allows obtaining substantially flat shrinkage holes showing no peripheral edging.

The lining may possibly include in special cases several refractory or insulating layers of different natures or of the same nature, associated in various manners with the exothermic layers so as to ensure technical results such as a delay in the ignition of the exothermic layer, an easier stripping, a proper scouring and the like.

With such a lining, the heat capacity of the components has no longer any action on the solidifying procedure of the metal forming the dead head and it is possible to merely limit as far as possible the losses through heat conductivity by reducing the specific weight and increasing the thickness of the lining. The lowering of the specific weight also reduces the heat capacity of the lining and therefore the exothermic capacity required for the exothermic layer. The increase in thickness leads to a reduction in the cross-section of the dead head and in the volume of the latter, said reduction being advantageous since it reduces the waste of metal, while it is not detrimental to the feeding of the ingot by reason of the perfect downward movement of the metal passing out of the dead head.

The insulating layer includes mineral and/or organic fillers such as those described hereinabove for the exothermic layer, said filler being associated with a binder.

The invention more particularly covers an insulating composition including:

Siliceous sand or pulverulent silica	15 to 40% by weight.
Fireclay	15 to 40% by weight.
Kieselguhr or light infusorial earth	4 to 12% by weight.
Wood meal	7 to 15% by weight.
Asbestos fibres	0 to 11% by weight.
and additionally	
Synthetic resin	7 to 11% by weight of the total above materials.

The pre-shaped elements of the lining may be obtained through any known or novel methods. The pasty substances may be diluted in water with percentages of water ranging between 25 and 700% by weight of the solid material with a view to obtaining any desired grade of fluidity value; said pastes may be treated centrifugally without any risk of loss of part of its components. It is possible to mention as methods:

Molding by hand or by means of a machine,
Blowing by means of coring machines,
Laying through filtering of a sludge under suction or compression,
Laying through draining or centrifugation,
Extruding.

The products thus obtained are generally kiln-dried at about 180° C. so as to remove a large proportion of the incorporated water, which leads to the possibility of increasing the porosity of the molded element when the fillers have a comparatively coarse granulometric value.

The use of a high percentage of water implies the use of substances which are not soluble in the mixtures, whether insulating or exothermic, and, in particular, beyond the use of nonsoluble oxidizing substances for the oxidizing layer, the agglomeration is obtained through the use of synthetic resins which are very sparingly soluble and preferably by means of a pulverulent phenolic resin.

The thicknesses of the exothermic portion of the lining are generally selected as ranging between 5 and 10 mm. but they may be as large as 25 mm. if required, chiefly when said exothermic section is used alone. The thickness of the exothermic section varies with the exothermic capacity of the selected composition and with the heat capacity of the lining for which compensation is desired. However, for reasons of execution on the one hand and of behavior of the lining structure during the casting on the other hand, one is generally led to using for multilayer linings, exothermic thicknesses above 5 mm. or still better above 7 mm.

The thickness of the insulating material forming the rear section of the lining may vary when the lining includes such a layer between 11 and 32 mm. according to the duration required for the complete solidification of the dead head.

According to the method for producing a lining including two or more layers, one of the compositions to be resorted to is first inserted as a first layer over which are formed the layers constituted by the second and possibly the further components.

Three applications of the invention will now be disclosed by way of example.

Example 1

For the formation of the dead head of a foundry mold, a lining has been used which is constituted by an exothermic section of the following composition:

	Percent by weight
Silico-calcium	34
Manganese dioxide	21.6
Pulverulent silica	26.8
Wood meal	9
Asbestos	2.35
Aluminium ashes	12.45
Formaldehyde-phenol binder	7.8

Example 2

The lining of the hot tops of an ingot mold for an ingot of chromium-manganese steel weighing 1200 kg. includes an exothermic layer of a thickness of 7 mm. and an insulating layer of a thickness of 23 mm.

The composition of the exothermic layer is as follows:

	Percent by weight
Silico-calcium (fineness index AFS=150)	27
Manganese dioxide (AFS=150)	18
Fireclay (particles ranging from 0.3 to 1 mm.)	26
Aluminium ashes	10
Wood meal	11
Asbestos fibres	8
Pulverulent phenolic resin	7

The solid materials have been diluted in 500% by weight of water and are given the desired shape inside a mold having walls made of perforated metal sheets.

This being done, there is laid on a third layer an insulating layer having the following composition:

	Percent by weight
Siliceous sand (granulometry AFS=65)	31
Fireclay (particles ranging from 0.3 to 1 mm.)	37
Kieselguhr or light infusorial earth	10
Wood meal	11
Asbestos	11
Pulverulent phenolic resin	9

The above composition was diluted with 400% of its weight of water and then cast.

Example 3

An ingot of steel weighing 2500 kg. for roller bearings was cast with a lining of the hot top constituted by an exothermic layer of a thickness of 8 mm. and an insulating layer of a thickness of 12 mm.

The composition of the exothermic layer was as follows:

	Percent by weight
Silico-calcium (fineness index AFS=150)	6
Iron oxide (AFS=200)	13
Siliceous sand (AFS=60)	25
Kieselguhr	9
Asbestos fibres	11
Wood meal	11
Pulverulent phenolic resin	9

And the insulating layer had the following composition:

	Percent by weight
Siliceous sand (AFS 60)	40
Fireclay	28
Kieselguhr	10
Wood meal	11
Asbestos fibres	11
Pulverulent phenolic resin	9

The compositions and applications thereof as given hereinabove by way of example may obviously be modified in any desired manner within the scope of the accompanying claims.

What I claim is:

1. A method for producing an exothermic lining for ingot and foundry molds and hot tops, comprising producing at least one mixture with water, of a powder selected from the class consisting of calcium silicide and aluminum silicide of a powder insoluble in water of an oxide of a metal selected from the class consisting of manganese and iron in an amount effective to oxidize said silicide, and of a filler and a binder insoluble in water, depositing said at least one mixture in at least one layer on a porous substrate by filtration, and drying the deposit and setting the binder at elevated temperature.

2. A method as claimed in claim **1** and removing the lining from the porous substrate and securing the lining to a metallic mold part.

3. A method as claimed in claim **1**, in which said lining is deposited in a plurality of separate but superposed layers of different compositions, at least the second layer being deposited by filtration on the first layer.

4. A method for producing an exothermic lining for ingot and foundry molds and hot tops, comprising producing at least one mixture with water of about 6 to 35% of a powder of a compound of silicon with a metal selected from the class consisting of calcium and aluminum, of about 10 to 22% of a powder insoluble in water of an oxide of a metal selected from the class consisting of manganese and iron, said powders having an AFS. granulometric value higher than 100, of at least a mineral filler and of about 8 to 12% of wood meal, with moreover 7 to 11% by weight of the total above materials of an organic binder, depositing said at least one mixture in at least one layer on a porous substrate by filtration, and drying the deposit and setting the binder at elevated temperature.

5. A method as claimed in claim **4**, in which the exothermic layer is combined with at least an insulating layer deposited by filtration of an insulating mixture.

6. A method as claimed in claim **4**, in which the dry components of said at least one mixture include up to 30% by weight of fireclay, up to 30% by weight of comminuted silica, up to 9% by weight of kieselguhr, and up to 11% by weight of asbestos fiber.

7. A method as claimed in claim **6**, in which the materials other than the oxide and the silicon compound have an AFS. granulometric value of about 50.

8. A method for producing a molded lining for ingot and foundry molds and hot tops comprising a layer constituted by an exothermic mixture of silicon combined with a metal selected from the group consisting of calcium and aluminum and of an oxide of a metal selected from the group consisting of manganese and iron and a further layer constituted by an insulating mixture, said method consisting in producing insulating and exothermic

mixtures with large water contents, filtering one of the mixtures over a predetermined thickness to form a deposit, and filtering the other mixture through the deposit thus formed to reduce its water contents and to form a further deposit with less water, in which the dry contents of the aqueous insulating mixture include about 15 to 40% by weight of comminuted silica, about 15 to 40% by weight of fireclay, about 4 to 12% of kieselguhr, about 7 to 15% of wood meal, up to 11% of asbestos fiber, and about 7 to 11% of synthetic resin.

9. A method as claimed in claim **1**, and producing an insulating mixture with a large water content, and filtering said insulating mixture through said at least one layer.

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