

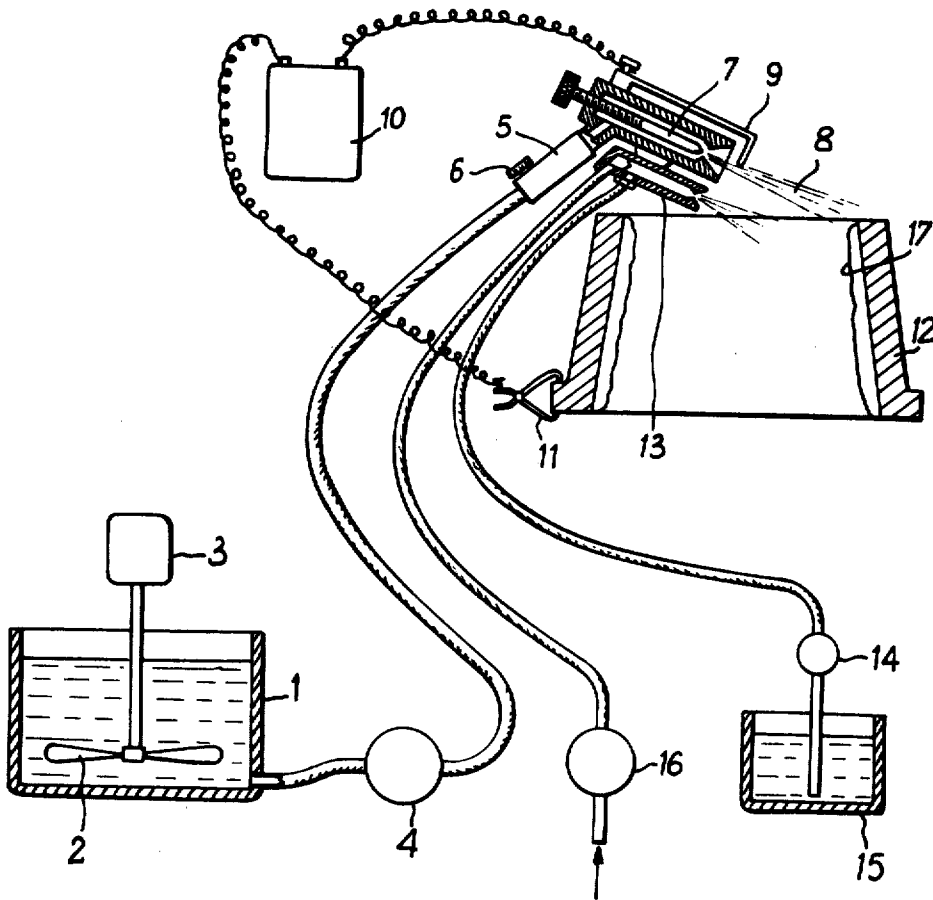
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METHOD OF APPLYING A THERMAL INSULATING COATING TO AN INGOT WALL

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1

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METHOD OF APPLYING A THERMAL INSULATING COATING TO AN INGOT WALL

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6 Claims

ABSTRACT OF THE DISCLOSURE

A method and composition for applying thermally insulating coatings to ingot molds, by spray coating a substantially nonaqueous suspension of refractory material such as silica, alumina, zirconia or magnesia, passing through a screen having a mesh opening of 0.149 mm., a low density heat-insulating material such as perlite, diatomaceous earth or wood flour, passing through a screen having a mesh opening of 0.297 mm., a binder for green strength which is a flocculable clay such as bentonite, and a binder for dry strength which is a synthetic resin or sodium silicate or gum arabic, in suspension in an alcohol having 1-3 carbon atoms, white spirit or toluene. The sprayed particles and the sprayed surface are given opposite electrical charges to attract the particles to the surface.

It is known that when casting metals, particularly when casting steels in ingot moulds, it is necessary to provide a certain quantity of metal known as a "feeding head," the solidification of which is retarded so as to make good the volumetric contraction of the main mass of metal that occurs during solidification. This delaying of the solidification of the feeding head is obtained, in numerous cases, by lining the walls of the part of the ingot mould or other mould surrounding the feeding head with insulating or exothermic coatings, or with coatings that are both insulating and exothermic. These coatings are most frequently provided by means of prefabricated moulded elements assembled in the ingot mould before casting. The advantage of this technique is to simplify to a maximum extent the work effected at the remoulding basin, but on the other hand it presents certain disadvantages, resulting primarily from the fragility of the prefabricated elements, which are liable to be damaged during transport and storage.

A method is likewise utilised of establishing the linings in situ, in which the insulating or exothermic mixture, comprising a sodium silicate agglomerating agent, is moulded between the wall of the ingot mould and a withdrawable shape, and is then hardened by an injection of CO₂. This method exhibits the disadvantage of not always being easy to put into operation on account of the poor accessibility of the ingot moulds, or else on account of their temperature.

A method is known on the other hand, of projecting paints by utilising a spray gun, bringing into operation merely the pressure of the liquid or of the thick suspension, which is projected without employing a gaseous vehicle. This spray-gun projecting, known as "airless," has the advantage that the speed of projection of the liquid is less, and decreases more rapidly, than in the case of a compressed-air spray gun. From this there results a greater

2

precision in the application, and an absence of splashes and mist in the immediate neighbourhood, these being disadvantages which are encountered with the conventional air spray guns.

Consequently the present invention relates to a method of applying thermally insulating coatings in ingot moulds and similar moulds, characterised by the feature that there is projected, by means of a nozzle, against the wall surface to be coated, a non-aqueous or very slightly aqueous liquid suspension of finely granulated refractory products, organic materials or materials of but slight density and fine granulation, products of agglomeration in a green state and products of agglomeration in a dry state, under a pressure of at least 20 kilogrammes per square centimetre, so as to obtain a coating, which is then dried.

According to another feature of the present invention, the liquid of the suspension is an electrically insulating liquid, and the particles, or the wall to be coated, or both, are electrically charged in such a way as to ensure an electrical attraction between the particles and the wall.

The liquids utilised for transporting the solid materials should contain very little water, or none at all, the coating produced in the ingot mould or other mould not being stoved, strictly speaking, and it must not contain more than 1.50% of water at the time of casting. These liquids are preferably alcohols, such as ethyl, methyl or propyl alcohol, white spirit or toluene. It is preferable to use an isopropyl alcohol on account of its price, and the freedom from noxious vapours.

The finely granulated refractory materials are highly refractory materials such as silica, alumina, zirconia, and magnesium oxide.

The granulometry of these materials should be such that they pass almost completely through a screen having a mesh opening of 0.149 mm. They may be put into operation in their natural form after crushing and screening. In the case of silica it is preferable to use light natural silicas, known as fossil silicas, the versed density of which is between 0.80 and 1. The mineral charges may undergo a preliminary preparation by the method known as foaming or frothing. In this case a slip is prepared, comprising a refractory charge and an emulsion of colophony glue. This slip is purified, to eliminate from its impurities which make it less refractory, and in particularly oxides of iron are eliminated by supplementary washing with acid, and decantation. The slip is presented in the form of a foam, which is either projected into a high-temperature flame, or poured into moulds, to be then cooked at a high temperature, and crushed. The percentage of refractory materials brought into operation is from 85 to 96% of the total weight of the various components, not including the agglomerants and the carrier liquid.

The aim of the organic or low-density materials is to increase the porosity of the coatings, and to improve its thermal insulation at high temperatures. They may consist of perlite, diatomaceous earths, or wood flour. Their granulometry should be such that they pass almost completely through a screen having a mesh aperture of 0.297 mm., and preferably through a screen with a mesh aperture of 0.210 mm. In order to reduce as far as possible the absorption of the carrier liquid, the very porous materials are subjected to an impermeabilising treatment by projecting them into a bath consisting of a saturated dilution of a wax, particularly paraffin wax, in a solvent, particularly kerosene. The percentage of these organic or low-density materials is from 4 to 15% of the total weight of the various components, not including the agglomerants and the carrier liquid.

The products of green agglomeration are designed to ensure the adhesion of the coating to the support, and the adhesion of the particles to one another before dry-

ing. It is mainly clays that can be flocculated, such as bentonite.

The products of dry agglomeration are synthetic resins, such as phenol resins, liquid or pulverulent, vinyl resins, and furan resins, sodium silicate, or gum arabic. When these resins necessitate bringing into play a catalyst, such as phosphoric acid for the furan resins, the catalyst is projected independently, through the medium of a separate spray-gun head.

The percentage of agglomerants brought into play is variable, according to the products and the operating conditions. It is most frequently between 3 and 18% of the total weight of the dry materials.

The drying is adapted to the agglomerants used. When the liquid carrier employed is inflammable, the coating may be flame-treated. The drying is effected by mere natural evaporation when the coating is effected in a hot ingot mould. When the coating contains rather a high percentage of water, the drying is effected by an exothermic reaction occasioned in the coating before the pouring of the steel. There may be used, by way of example, a heating reaction based upon aluminium and caustic soda, at the rate of from 5 to 12% of atomised aluminium and from 0.20 to 0.50% of dilute caustic soda in relation to the total weight of the elements involved, the aluminium being introduced into the suspension and the caustic soda being projected by means of a spray gun with separate air.

According to one development of the invention, the coating may be rendered exothermic by adding to it from 10 to 40% by weight of an exothermic composition based on a readily oxidisable body such as aluminium, silico-calcium, silico-aluminium, and a silico-aluminium-iron alloy, and an oxidising agent, particularly manganese dioxide, oxide of iron, or potassium nitrate. The exothermic composition may for instance be constituted by 56 to 80% by weight of silico-calcium, or silico-aluminium-iron alloy (containing from 45 to 75% silicon) and 20 to 44% oxide of manganese or of iron, or by 36 to 54% of atomised aluminium, 6 to 30% of potassium nitrate, 24 to 36% of iron oxide, 1.5 to 4.5% of fluorspar, and 6 to 15% of cryolite.

In setting the process going, the suspension is placed in a storage reservoir resistant to abrasion, and is kept under constant agitation, by mechanical stirring for example. It is subjected to pressure by a pump so as to be projected by means of a spray gun, the active elements of which are made of very hard materials, such as tungsten carbide, under a pressure of about 20 to 30 kilogrammes per square centimetre or at least 20 kilogrammes per square centimetre. With such a method of projection, the speed of the solid particles at 200 to 250 mm. from the muzzle of the gun is about 90 metres per minute, whilst the solid particles projected with an air spray gun may still reach this velocity at three metres from the gun. In this way a greater precision is obtained in the application, and splashes, and the formation of a mist, are obviated.

The present invention likewise covers a liquid suspension for the production of thermally insulating coatings, comprising a charge consisting of from 85 to 96% by weight of refractory products such as silica, alumina, zirconia and magnesium oxide, passing through a screen having a mesh opening of 0.149 mm., from 4 to 15% by weight of an organic material or a material of low density such as perlite, diatomaceous earth or wood flour passing through a screen having a mesh aperture of 0.297 mm., green agglomerants such as flocculable clays, and dry agglomerants such as synthetic resins, sodium silicate or gum arabic, in suspension in an alcohol, white spirit or toluene.

The process may likewise be utilised in casting systems for forming an insulating deposit for the casting or pouring cups, and for analogous applications.

Examples will be described hereunder of the use of compositions according to the invention:

EXAMPLE 1

There were put in suspension in a sufficient quantity of isopropyl alcohol 92 parts by weight of alumina foamed in a colophony glue as described above, and sprayed so as to pass through a screen having an aperture of 0.149 mm., 6 parts by weight of wood flour, impermeabilised with paraffin wax as described above, and 2 parts by weight of diatomaceous earth. To the suspension were added 4 parts by weight of bentonite, mixed with isopropyl alcohol to form a sludge, and 3.5 parts by weight of a pulverulent phenol resin, which is marketed under the mark "Novolak."

The mixture was maintained in suspension by mechanical stirring, and fed, under a pressure of 22 kg./cm.², to a spray gun of the "Airless" type, comprising control valves and needles for adjusting the flow of tungsten carbide, so as to be applied in the form of a coating 8 mm. thick and 220 mm. high in the lift of an ingot mould for an ingot of 1200 kgs.

The coating was dried by flame treatment with isopropyl alcohol.

The coating obtained had an apparent density of 0.72, a porosity of 83%, and a thermal conductivity, in Kcal./m./h./° C., ranging from 0.80 to 0.65 between 220° and 1000° C.

EXAMPLE 2

The same composition was used as in Example 1, except that the alumina was replaced by magnesium oxide (MgO) which had undergone the same foaming treatment, and the isopropyl alcohol was replaced by white spirit. This composition was set to work in the same manner as in Example 1.

The coating obtained had an apparent density of 1.35, a porosity of 59%, and a thermal conductivity, in Kcal./m./h./° C., ranging from 0.60 to 0.90 between 300° and 700° C.

EXAMPLE 3

The same composition was utilised as in Example 1, except that the alumina was replaced by silica which had undergone the same foaming treatment, and the isopropyl alcohol was replaced by toluene. This composition was set to work in the same manner as in Example 1.

The coating obtained had an apparent density of 0.54, a porosity of 81%, and a thermal conductivity, in Kcal./m./h./° C., ranging from 0.12 to 0.20 between 240° and 680° C.

EXAMPLE 4

In a special case, in which a highly refractory product was being sought for, the same composition was used as in Example 1, but the silica was replaced by zirconia.

EXAMPLE 5

To the mixture described in Example 1 were added 25 parts by weight of an exothermic mixture consisting, to the extent of 65% by weight, of silico-calcium, and 35% by weight of manganese dioxide. This composition was set to work in the same manner as in Example 1. The coating obtained had the same exothermic character as the usual exothermic coatings.

EXAMPLE 6

To the mixture described in Example 1, but in which the isopropyl alcohol contained 30% of water, were added 30 parts by weight of an exothermic mixture consisting of 50% by weight of atomised aluminium, 10% by weight of potassium nitrate, 25% by weight of iron oxide, 3% by weight of fluorspar, and 12% by weight of cryolite.

The accompanying drawing diagrammatically illustrates apparatus for putting this example into practice. The mixture provided in a tank 1 is maintained in suspension by mechanical stirring by means of an agitator 2,

5

driven by an electric motor 3. It is pumped by a pump 4, which sends it, under a pressure of 25 kg./cm.², to a spray gun 5 of the "Airless" type. This spray gun comprises an adjusting valve 6 and a needle 7 for adjusting the flow, the active elements of which consist of tungsten carbide, so as to project the mixture in the form of a jet 8. In this jet is placed one electrode 9 of an electrostatic generator 10, the other pole of which is connected by a clip 11 to the body 12 of the metallic rise or of the ingot mould to be coated.

With this "Airless" spray gun 5 is combined a small separate-air spray gun 13, which is supplied, by a dosing pump 14, with a measured quantity, at the rate of about 0.50% by weight of the mixture projected by the spray gun 5, of dilute caustic soda obtained from a reservoir 15, and by a compressor 16, with atomising air.

The two jets, which mix were projected on to the internal surface of the rise 12 to form a layer 17. In this layer the caustic soda reacts with a part of the atomised aluminium to give a heating reaction, which drove out the isopropyl alcohol and the water.

The coating obtained showed an exothermic character, like that of Example 5.

The above examples, described by way of illustration, admit of numerous modifications without going outside the ambit of the present invention.

Having described my invention, I claim:

1. A method of applying thermally insulating coatings to a metallurgical mold wall, comprising airlessly spraying under a pressure of at least 20 kg./cm.² against the mold wall to be coated a suspension in an organic liquid selected from the group consisting of ethyl, methyl and propyl alcohols, white spirit and toluene, a mixture of finely granulated materials consisting essentially of 85 to 96% by weight of refractory materials and 4 to 15% by weight of perlite, diatomaceous earth, or wood flour, in combination with a binder that imparts green strength to the coating and a binder that imparts dry strength to the coating, and then drying the coating.

2. A method as claimed in claim 1, and electrostatically charging said suspension by placing one electrode of an electrostatic generator in a stream of material projected by said spray gun and connecting the other electrode of said generator to said mold wall.

6

3. A method as claimed in claim 1, in which said drying is effected by igniting said organic liquid in the coating with flame.

4. A method as claimed in claim 1, in which said drying is effected by an exothermic reaction between aluminum and caustic soda, and projecting the aluminum and caustic soda toward the said mold wall independently by means of separate spray gun heads.

5. A method as claimed in claim 1, and rendering said coating exothermic by including in said suspension 10 to 40% by weight of an exothermic composition consisting essentially of a readily oxidizable substance and an oxidizing agent for said oxidizable substance.

6. A method as claimed in claim 5, said oxidizable substance being selected from the group consisting of aluminum, silico calcium and silico aluminum, said oxidizing agent being selected from the group consisting of manganese dioxide and iron oxide.

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