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Gotheridge et al.

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[54] **METHOD OF PRODUCING METAL CASTINGS BY USING INSULATING PADS IN THE MOLD**

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[52] **U.S. Cl.** **164/53,** 164/125

[51] **Int. Cl.** **B22d 27/04**

[58] **Field of Search** 249/62; 164/24, 53

[56] **References Cited**

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[57] **ABSTRACT**

By incorporating in sand moulds, at or near places where there is risk of insufficient metal feed during casting, pads of bonded fibrous refractory material, metal feed may be substantially improved and the need for padding the casting avoided.

6 Claims, No Drawings

METHOD OF PRODUCING METAL CASTINGS BY USING INSULATING PADS IN THE MOLD

This invention relates to the production of metal castings, particularly steel castings in sand or like moulds.

It is a well known phenomenon that difficulties arise in castings, especially in the vicinity of the narrow portions of the casting, due to inadequate feed of the molten metal at these sites. Difficulties arise where variable geometry of the casting dictates that a thin section must feed a thicker section. Difficulties also arise particularly in the casting of steel objects with awkward shaped and contours, especially those with necks, flanges and fins. Owing to the uneven cooling, due to the greater loss from the thin sections at fins or neck sections, the molten metal tends to solidify in these sections more readily than in the main body of the casting because of their lower modulus ("modulus" being the volume of the casting or relevant section of the casting divided by its surface area), and hence prevents molten metal feeding through these sections to parts of the mould remote from the metal feed.

This results in misshapen defective castings with shrinkage porosity which may have to be scrapped. Furthermore owing to the fact that these fin and flange sections tend to cool far more rapidly than the main body of the casting they will have contracted and solidified well before the body of the casting. Thus when the body of the casting cools and contracts, thermal stresses are set up and it tends to contract away from the already solidified thin sections, and lead to deformities known as hot-tears.

For instance when a large flange casting is made the metal normally has a tendency to solidify and contract at the flange. The flange is effectively anchored to the sand mould, and hence the metal will tear, because the flange is subjected not only to the hanging (dead) weight of the casting itself, but also to the thermal expansion of the moulding sand and the contraction of the solidified metal as it cools.

The traditional method of overcoming these difficulties, has been to increase the size of the mould cavity at those places where these difficulties arise, so that the casting, when it is withdrawn from the mould, is oversize in the flange, neck, fin or the narrow sections. It is then necessary to machine away the unwanted metal to obtain a casting of the requisite size. The extra metal is known as padding and its removal, referred to as fettling, is uneconomic in itself and during the casting process involves needlessly melting large quantities of metal.

These metal feed problems have been to some extent overcome by the use of exothermic compositions, which when applied to the interior of the mould, ignite on contact with the molten metal, and supply sufficient heat to prevent premature cooling of the thin sections and hence ensure an even molten metal feed by directional solidification to the remote parts of the mould. Compositions particularly suitable for this purpose are aluminothermic compositions which preferably consist of finely divided aluminum, oxidizing agent for the aluminum such as an alkali metal or alkaline earth metal nitrate or perchlorate, or iron oxide or manganese dioxide, and a refractory filler such as sand alumina, grog, chamotte or other refractory silicates known per se the quantity of oxidizing agent preferably being stoichiometrically insufficient to oxidize all the aluminum present.

However this system, while if correctly applied(which is a difficult process) assists in curing metal feed problems, it will only partially, if at all alleviate hot tearing problems. This is because most of the heat generated by exothermic compositions in the mould passes outwards toward the colder mould and mould walls. Hence only a small proportion of the heat is utilized for the purpose intended, which is to keep the thin section of the mould free-running so that liquid metal can flow through to those parts remote from the feeder. The exothermic material is inflexible and expands in a similar manner to the mould material. The use of exothermic compositions may also lead to contamination of the metal by the aluminum or other oxidizable material present, e.g. silicon, gas contamination by liberation of volatile materials and center line shrinkage due to overpadding.

it is an object of the present invention to provide a novel method of decreasing or eliminating the difficulties referred to above.

According to the present invention, there is provided a process for the production of a shaped metal casting by pouring molten metal into a sand casting mould, characterized in that there are provided at one or more locations in the mould where the cross-section of the mould cavity has a small dimension, lining pads located in he inner surface of the sand mould either against or slightly remote from the metal contacting face and providing with the remainder of the sand mould a cavity of the desired shape and dimensions, the said pads being formed of a composition comprising refractory fibrous material, and a binder. The said pads may be resilient or compressible.

According further to the present invention, there is provided a process for the production of a sand or like mould for casting molten metal which comprises applying to those portions of a pattern at which there is risk of insufficient feed in the casting of the shape of the pattern, a pad comprising a fibrous refractory material and a binder therefor, and subsequently applying around said pattern a moulding sand composition, hardening the sand mould and pad, and stripping the resulting mould and inserted pad from the pattern.

The pad may be a dry mixture or may be a mouldable mat which can be rammed into position around the pattern and hardened, for example by stoving, along with the mould itself.

The sand moulding mixture used may be any of these commonly used in the foundry industry, and in particular may be of the "fluid sand" type.

In this way a sand mould may be produced which, at points where padding, or the use of an exothermic nomposition as noted above, would be required, has inserts of highly refractory heat insulating material to facilitate the feed of the molten metal being cast.

The surface of the pad remote from the sand backing thereto may be provided with a protective layer of a refractory material or with a layer of exothermic composition.

The pad may consist solely of bonded refractory firres e.g. calcium silicate, aluminum silicate of aluminosilicate fibers slag wool, rock wool or mineral wool, and binder, e.g. sodium silicate, resin binders, colloidal silica sol, or aluminum acetate, or it may consist of these together with a proportion of a refractory filler, e.g. silica, alumina, crushed coke, grog, talc, diatomaceous earth, expanded vermiculite, expanded perlite or silicon carbide. The preferred refractory fillers are silica, alumina and crushed coke.

Generally, in order to achieve the desired flexibility and/or compressibility in the pad, e.g. proportion of fibrous refractory material should be at least 30 percent by weight of the pad composition, e.g., 30 –75 percent by weight thereof.

The density of these pads may be varied at will be adjusting the amounts of fiber filler and binder used. Usually the density of the pads is between 0.2–0.50 gcm^{-3}.

These insulating pads are effective in several ways; in the first place they reduce the heat loss from the thin sections, and hence assure an even feed and directional solidication and secondly, when the pads used are resilient, they are capable of absorbing thermal stresses set up on cooling and hence will prevent hot tearing by allowing some mould wall movement. Thirdly these insulating compositions are inert and in contact with the cast metal liberate little or no gases. Fourthly the insulator affects the thermal gradients within the casting in a different manner compared with exothermic materials and eliminates center line shrinkage. Finally insulating pads do not contaminate the metal by introducing elements such as silicon or aluminium.

Where small steel castings are being made, or where the metal to be cast has a low melting point,(e.g. copper) the insulating pad may be so placed in the mould that the molten metal abuts directly onto the inside layer of the pad. Thus for example in the production of a small steel casting, the pads may be placed at suitable points on the outside of the pattern, rammed up with sand, the pattern removed, and the pad

coated with a refractory dressing such as one of finely divided zircon. Steel is then cast into the resulting mould. The resultant casting will be sound, and of good quality, without any hot-tearing.

However, when this technique is applied to larger castings, the pads tend to show dimensional instability, and may be to some extent attacked by slag/ oxides present in the steel. They may become dilated and penetrated due to the combined action of temperature and ferrostatic pressure. For this reason it is preferred in the larger castings to interpose a layer of the refractory material such as sand and to adjust the thickness of this material so that the temperature of the cooler face of the refractory material i.e. the face furthest from the molten metal and abutting the insulating pad) is at a level that is below the melting or softening, or maximum working point, of the insulating pad. Simple calculations can be made to determine the optimum depth of the refractory facing material for any given casting, and the effective feeding ability and modulus of the combination.

Where the pad is designed to make direct contact with the cast metal it is preferred that it should be based on alumino silicate fibers However these fibers tend to be expensive and by the provision of a surface layer of refractory material such as bonded sand, between the pad and the cast metal, it is possible to obtain equally good results with less refractory fibers such as calcium silicate fibers.

Where the metal is cast iron either aluminosilicate fibers alone or calcium silicate fibers combined with a refractory filler may be used directly against the cast metal. With copper base and light alloys calcium silicate fibers may be used alone against the cast metal.

It has been found desirable in many cases to combine the use of exothermic compositions with the use of an insulating pad according to this invention. This results not only in the elimination of hot tears but also, due to the greater utilization of heat, a smaller amount of exothermic composition is required to ensure casting soundness. Thus the heat losses to the mould sand are reduced by over 50 percent and consequently, due to the smaller amounts of exothermic compositions required, the possibility of center line shrinkage and metal contamination is reduced.

Further more due to the inherent compressibility of the insulating pad, the thermal stresses set up on cooling can be taken up by the movement of the mould wall.

The insulating pads of this invention are sufficiently permeable, so that most mould gases can escape without blowing into the metal.

The following Examples will serve to illustrate the invention:

EXAMPLE I

In the production of a 3 cwt steel flange casting a bonded fibrous insulating pad which was 25 mm thick and made up of the following composition

72 percent alumino-silicate fiber
20 percent colloidal silicon sol (30% solids)
8 percent starch

was shaped and fitted into the heavy sectional C shaped mould. The mould metal contacting surface of the pad was coated with a zircon wash to a depth of 1.5 mm, and the molten metal teemed in.

The casting was allowed to cool, and found to be of good quality with excellent surface finish characteristics and radiographically sound.

EXAMPLE II

In the production of a large turbine casting an exothermic composition was applied to a template. This was then backed by a layer of refractory sand.

A bonded fibrous insulating pad which was of the following composition

72 percent alumino-silicate fiber
20 percent colloidal silica (30% solids)
8 percent starch

having a density of 0.22 g cm^3 was placed over the refractory sand layer and was then rammed up with a further layer of refractory sand.

The template was withdrawn, and the molten metal teemed. On cooling,the final neck portions were of high quality, and the casting exhibited no hot-tearing.

EXAMPLE III

A bonded fibrous insulating pad 9 × 9×¾ inch thick was produced having the following compositions:-

40 percent calcium silicate fiber
50 percent coke dust
10 percent phenol-formaldehyde resin

The pad was then placed on a silicate bonded, CO_2 hardened silica sand slab 9 × 9 × ¼inch thick and the two were placed on a heated metal plate maintained at a temperature of 1,420° C., the sand slab being in contact with the plate. The power requirement to maintain the temperature constant was plotted against time and form the graphs the thermal conductivity and the chill (in practical terms a measure of the heat which would be required to heat the moulding material in the region of the casting to the temperature of the molten cast metal) were measured. A similar experiment was carred out using a sand slab 9 × 9 × 1inch thick. The fibrous pad/sand comination gave a reduction in thermal conductivity of 62 percent and a reduction in chill of 20 percent compared with the sand slab alone.

A fibrous pad of the above composition was also used in the production of a steel test casting in the form of a plate 15" long × 5" wide by 1" thick. A layer of bonded silica sand ¼ inch thick was rammed on top of the pattern and a fibrous pad 13 × 5× ¾inch thick was applied as a backing, one end of the pad being adjacent to the riser. The mould was then completed by ramming bonded silica sand on top of the pad. After removal of the pattern molten medium carbon steel at 1,580° C. was poured into the mould.

The resultant casting was examined visually and radiographically and found to be free from shrinkage porosity. In a similar casting produced without the use of a fibrous insulating pad shrinkage porosity was evident.

We claim:

1. In the production of a shaped metal casting by pouring molten metal into a sand casting mould, the step of providing at at least one location in the mould where the cross-section of the mould cavity has a small dimension, lining pads located in the sand mould and providing with the remainder of the sand mould a cavity of the desired shape and dimensions, said pads being formed of a heat-insulating composition consisting substantially of refractory fibrous material present in an amount of at least 30 percent by weight and a binder and said pads having a density between from about 0.2 to about 0.5 gms. /cm.^{3}, said pads being flexible and compressible to absorb thermal stresses.

2. A process according to claim 1 wherein the pad consists substantially of fibrous refractory material, particulate refractory material and a binder.

3. A process according to claim 2 wherein the particulate refractory material is a member selected from the group consisting of silica, alumina and crushed coke.

4. A process according to claim 1 wherein the fibrous refractory material is aluminosilicate fiber.

5. A process according to claim 1 wherein the pad has a coating of refractory dressing on the side facing the mould cavity.

6. A process according to claim 1 wherein said lining pads are interposed in the sand mould to provide a layer of sand to contact the molten metal, the thickness of the pads being adjusted so that the temperature of the face of the pad away from the molten metal is below the melting point of the pad.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,662,809 Dated May 16, 1972

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet, after "[72] Inventors:" insert ---

[73] Assignee: Foseco International Limited, Birmingham, England ---

Signed and sealed this 6th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents