Sept. 20, 1966 N. L. MIRALDI 3,273,211

PROCESS OF MOLDING EXOTHERMIC COMPOSITIONS

Filed Nov. 29, 1963 2 Sheets-Sheet 1

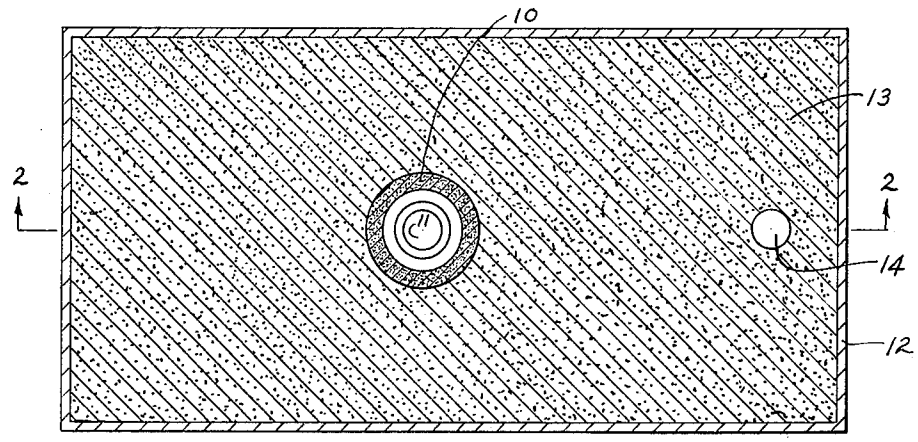


FIG. 1

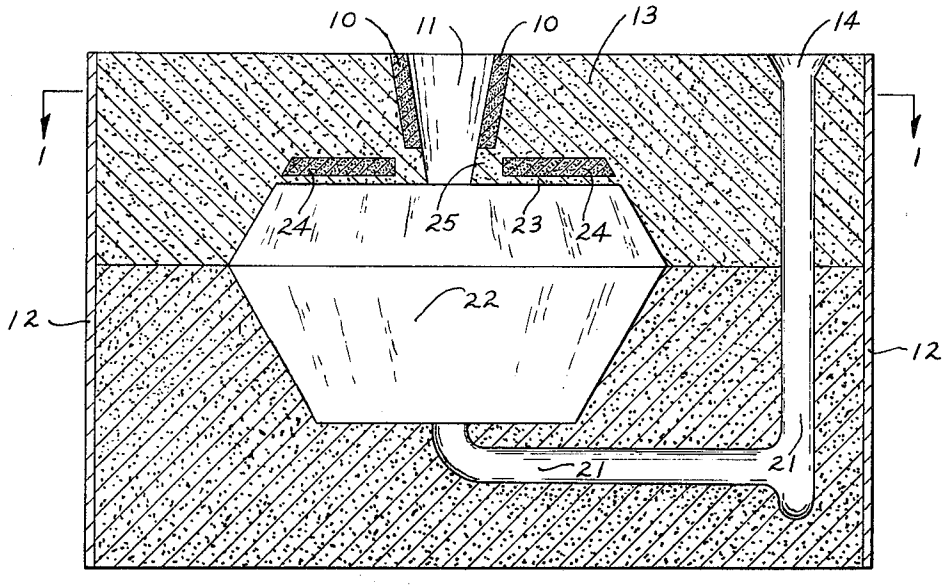


FIG. 2

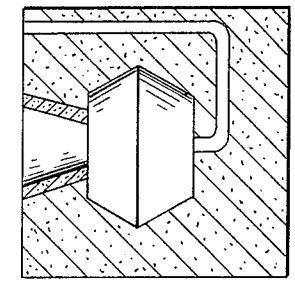
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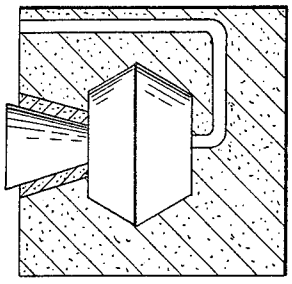
PROCESS OF MOLDING EXOTHERMIC COMPOSITIONS

Filed Nov. 29, 1963 2 Sheets-Sheet 2



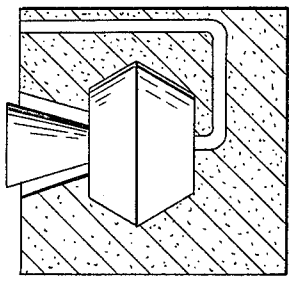
CORE BOX WITH FINISHED COPE

FIG. 6



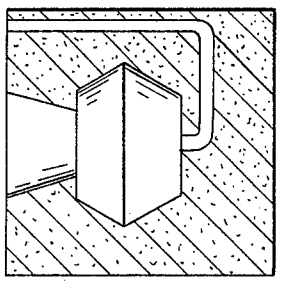
SAND RAMMED INTO ANNULAR SPACE AROUND PLUG TO FINISH COPE

FIG. 5



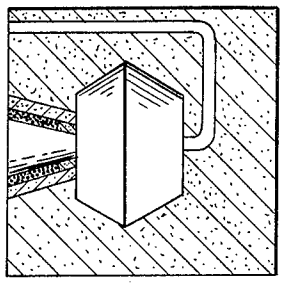
OVERSIZED PLUG INSERTED INTO UNFINISHED COPE

FIG. 4



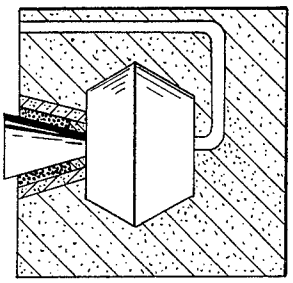
CORE BOX WITH UNFINISHED COPE

FIG. 3



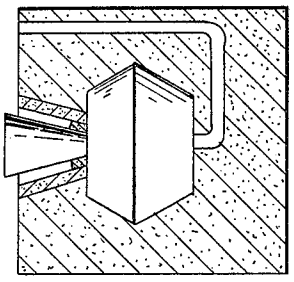
FINISHED MOLD WITH EXOTHERMIC RISER SLEEVE

FIG. 10



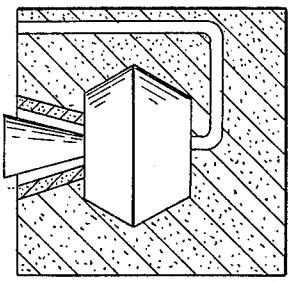
EXOTHERMIC COMPOSITION PACKED INTO THE REMAINDER OF THE ANNULAR SPACE TO FORM RISER SLEEVE

FIG. 9



SAND RAMMED INTO THE LOWER PART OF THE ANNULAR SPACE AROUND PLUG TO FORM INSULATING SHOULDER

FIG. 8



SMALLER PLUG INSERTED INTO FINISHED COPE TO TO FORM RISER SLEEVE

FIG. 7

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3,273,211

PROCESS OF MOLDING EXOTHERMIC COMPOSITIONS

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Filed Nov. 29, 1963, Ser. No. 326,992
5 Claims. (Cl. 22—193)

This invention relates to a method of fabricating exothermic riser sleeves and exothermic pads for foundry use. More particularly, this invention relates to the in situ formation of exothermic riser sleeves and exothermic pads during the foundry molding operation.

Risers have been used in the foundry art for many years. They serve the necessary function of providing a feeder head or reservoir of molten metal to feed the ingot with metal as it cools and shrinks. Without such a feeder head of molten metal, sound castings without tears and shrinks could not be made.

A riser, which is lined with a heat generating compound, is known as an exothermically lined riser or exothermic riser. The exothermic composition ignites spontaneously when the molten metal heats the composition to a high temperature.

Numerous exothermic compositions have previously been described. Exothermic compositions are heat producing materials which maintain molten metal in a fluid state longer than would normally be the case. The compositions are composed of an oxidizable metal such as aluminum and an oxidizer such as iron oxide or manganese oxide in an amount substantially less than that amount required to react completely with the aluminum. Such compositions usually also contain a fluoride compound to facilitate the start of the reaction, and to maintain the reaction to completion.

Exothermic compositions used in the foundry art may be separated into two broad categories: exothermic toppings and moldable exothermics. The present invention relates to the latter, that is moldable exothermics.

Basically, moldable exothermic materials are mixtures of an oxidizable metal and an oxidizer. These mixtures normally contain aluminum or other metallic powders as the oxidizable metal, oxidizers such as sodium nitrate and iron oxide, alkali metal fluorides, granular refractories and bonding agents. The binders used are such that the mix can be tempered with water, and thus molded into the desired form and dried into a hard refractory shape.

In the prior art, moldable exothermic compositions were molded in a core box which was specially prepared for forming the desired shape. After molding the exothermic material, the composition would be removed from the core box and baked in an oven to cure to a hardened state. Another method which has been used since the advent of hot box binders is that of blowing the exothermic composition into a heated pattern where it is cured to a hardened state. The prior art exothermic compositions could not, however be cured for extended periods of time at high temperatures due to the danger of igniting.

The preformed exothermic risers of the prior art would then be inserted into a prepared foundry sand mold prior to pouring the metal.

Moldable exothermic compositions were also used to prepare exothermic pads. The pads were molded into bars and plates which were then cured to a hardened state. The hardened pads would be inserted in the desired position in a mold prior to the pouring of the metal.

There are several disadvantages in having preshaped exothermic compositions. One disadvantage is that numerous risers of various sizes are required in the normal foundry operations, the size used being dependent on the size of the casting. For every riser of a different size, a

different mold is required. The cost of the molds is such that small foundries cannot afford to have their own riser sleeve molds. Another disadvantage is that preformed risers are fragile and easily broken after which they are of no value. Further disadvantages of preformed exothermic compositions are their increased cost and their requirement of storage area.

It is therefore an object of this invention to provide a method of forming exothermic risers in situ during the molding operation. It is another object of this invention to provide an exothermic composition that will withstand prolonged curing at high temperatures without igniting. It is a further object of this invention to eliminate the necessity of having numerous different size exothermic risers available for each different type of casting. It is another object of this invention to eliminate the need for expensive molding equipment to preform the riser sleeves. It is yet another object of this invention to eliminate the need for preformed exothermic riser sleeves and exothermic pads and thus eliminate the necessity of storage and decrease the loss encountered by breakage.

The objects of this invention are accomplished by the process which comprises fabricating green exothermic compositions directly into place in a mold during the molding operation and subsequently using them in the casting operation without further treatment, such as (1) torch drying prior to using or (2) baking the mold and in situ molded exothermic composition in the normal core baking process.

This procedure overcomes the inherent disadvantages of preformed exothermic compositions; in addition, it provides the numerous advantages of saving costs, eliminating of storage requirements, elimination of special molding equipment, and elimination of breakage. The simplicity of in situ formation of exothermic compositions provided by the processes of this invention, greatly expedites foundry operations.

The invention is described more fully with reference to the accompanying drawings, in which,

FIGURE 1 is a horizontal sectional view of a mold in a core box and,

FIGURE 2 is a longitudinal sectional view of a mold in a core box.

FIGURES 3 through 10 illustrate the process of this invention.

The embodiment illustrated in FIGURE 1, shows a horizontal sectional view at **1—1** FIGURE 2. The core box **12** is shown packed with molding sand **13**, indicating also the position of an exothermic riser sleeve **10**, and riser head **11**, located within the riser sleeve **10**. The bottom of the pouring spout **14** is also shown.

FIGURE 2 is a longitudinal sectional view at **2—2** of FIGURE 1. This view shows a cavity, in a core box **12**, ready for pouring. The riser head **11** is shown surrounded by the exothermic riser sleeve **10**, placed in its relative position in the molding sand **13**. The walls of the exothermic riser sleeve **10** are slightly tapered. The drawing is somewhat exaggerated to point out this distinction. An insulating shoulder **25**, protects the cavity **22**, from coming into contact with the exothermic riser sleeve **10**. The pouring spout **14**, into which molten metal is poured and the gating system **21**, which carries and distributes molten metal to the cavity **22**, compose the required parts of a closed core box **12**. Sufficient molten metal is poured so that the cavity **22** becomes a casting and the riser head **11** is completely filled with molten metal. In the normal casting operation, it is preferred that an insulating barrier **23**, separate the exothermic padding **24**, from the casting itself. The insulator aids in eliminating roughness on the face of the cavity **22** caused by the exothermic reaction.

Exothermic padding **24** is shown on the upper portion

of the cavity **22**, to facilitate the flow of molten metal from the riser head **11**, to the far corners of the cavity **22**.

Exothermic compositions are broadly defined as an oxidizable metal and an oxidizer. Numerous combinations have been described in the art and as examples thereof U.S. Patent No. 2,591,105 discloses an exothermic composition comprising 30 to 50% aluminum, 0 to 10% sodium nitrate, 5 to 20% manganese dioxide or iron oxide or mixtures of both, 1 to 5% alkali fluoride or alkali aluminum fluoride such as potassium aluminum fluoride, 0 to 2% bentonite, 2 to 7% core gum as a binder and the remainder being granulated grog. British Patent No. 798,710 describes an exothermic composition for foundry use comprising 20 to 30% by weight of aluminum particles or powder, 5.5% to 10% of sodium nitrate, 3 to 15% of manganese dioxide or 3 to 20% of ferric oxide or mixture of the two oxides, totaling 3% or more, with a maximum range of 15 to 20%, 5.5% to 10% of fluoride, 0.5% to 10% of sodium chloride together with 4% to 12% of clay and the remainder amounting to approximately 15% of granular refractory such as grog or silica sand.

Considerable variation may be made, however, both with respect to the quantities of such ingredients and in the ingredients themselves. Carbon can be included with the aluminum and considerable variation in the fluoride content may also be had. It is also possible to include a secondary oxygen containing substance such as a carbonate, a sulfate or phosphate.

Some manufacturers of exothermic compositions have been able to avoid the use of a fluoride entirely by appropriately proportioning the ingredients. Thus it is seen that numerous variations of exothermic compositions can be had by retaining the two basic ingredients, an oxidizable metal, and an oxidizing agent.

Analogous to exothermic riser sleeves are exothermic heater pads made of moldable exothermics. Exothermic materials used as heater pads are often somewhat different from those used in riser applications. They are compounded so as to give different rates of ignition and burning. Greater resistance to metal penetration during burning is important since the exothermic materials are often located deep in the mold. Most important, dimensional stability is required. They are also compounded or treated so as to minimize the risk of picking up harmful impurities.

Exothermic padding is used to provide heavier sections with a feed through thinner sections and also to increase the feeding distance of a riser to the extremities of the casting. The compositions used for exothermic padding obtain their dimensional stability by increasing the amount of refractory material and clays. The compositions basically contain the same type of oxidizable metals and oxidizing agents.

It was discovered that the processes of this invention are preferably carried out using an exothermic composition which is different from those previously used. The preferred composition will not ignite during baking, even under prolonged baking at high core baking temperatures. Yet, this composition performs extremely well during the metal pouring operation.

The preferred composition contains the following ingredients in the noted portions by weight based on the weight of the final composition, the total composition equalling 100%:

	Percent
Aluminum powder	3.0 to 7.0
Aluminum grindings	15.0 to 24.0
Oxidizing agent	18.0 to 44.0
Refractory material	15.0 to 44.0
Flax shive flour	0.5 to 2.0
Calcium fluoride	4.0 to 11.0
Phenolic binder	4.0 to 6.0
Dextrin	1.0 to 3.0
Clay	2.0 to 4.0

The use of calcium fluoride and the elimination of all nitrates produces an exothermic composition which will only ignite at metal pouring temperatures and not at high core baking temperatures. This eliminates the danger of premature ignition of the composition as well as making it practical to bake exothermic compositions at high temperatures.

In the preferred composition the refractory material is sand or grit, preferably a silica sand such as Wedron 70–30. The phenolic binder used is a phenol formaldehyde resin which is condensed under acid conditions. These resins are also known as Novolac resins. The oxidizing agent is preferably red iron oxide or manganese dioxide.

The exothermic compositions of the prior art are also useful in the in situ molding process of this invention but are less preferred since care must be used to avoid long high temperature baking lest the composition ignite during the baking operation. When the mold is used in the green state, no problem is encountered with the prior art compositions.

These exothermic compositions contain heat producing reactants, a granular refractory material, clay, water and a binder. The binder material is normally bentonite clay, cereal, dextrin, core oil or a thermosetting resin. Such binders are the same as those used in molding sand and core sand. The uncured exothermic composition which can be molded to a desired shape is known as a green exothermic composition.

There are three methods in which the in situ formed exothermic compositions are further prepared for casting after they have been molded into position. The molding is used as is without further treatment, or it is torch dried to form a thin crust over the surface or it is baked by conventional methods at temperatures up to about 600° F. The method used is dependent upon the binder used in the exothermic composition. When bentonite clay, cereal or other high green strength binders are used, the first two methods are usually quite satisfactory. That is, the mold can be used in the green state or it can be torch dried prior to use. However, when a core oil or a thermosetting resin is used as the binding means, it is often desirable to bake the mold and exothermic composition prior to use. This, however, is not a requirement but is preferred in order to obtain the maximum effectiveness of such binders.

As noted in FIGURE 2 of the drawings, the green exothermic compositions are embedded in molding sand. Molding sand is a high green strength composition which contains a refractory material such as sand and a binder which holds the sand together. The preferred molding sands contain clay or cereal and may contain other additives such as sea coal and parting agents.

In addition to normal molding sand, a core sand is often used. A core sand is composed largely of a refractory material such as sand and often contains green strength additives such as cereal and bentonite clay in addition to a polymerizable organic or inorganic binder which is cured to a hardened state. Such polymerizable binders include the normal core oils, which are organic compositions composed of a drying oil and petroleum polymers, synthetic thermosetting resins, such as the furan resins, phenol-formaldehyde resins, urea-formaldehyde resins, and the like, in addition to inorganic binders such as alkali silicates. The alkali silicates are cured by gassing with an acid gas. The organic binders are cured by baking or by the action of a polymerizing agent. Core sand is often desired in place of the less expensive molding sand when it is necessary to produce a very hard mold.

In practicing the process of this invention, the cope, which is the top portion of the mold, is prepared using molding sand or core sand as is the normal precedure. In packing the cope with molding sand an oversized plug, supported on the pattern, is used to form the outside di-

mensions of an oversize sleeve. This plug is removed after the cope is finished. The size of the plug is dependent on the size of the mold and amount of metal being poured.

The exothermic riser sleeve is then prepared by inserting a smaller plug in the center of the cavity formed by the first plug. This plug, which is also supported on the pattern, forms the inside dimensions of the riser sleeve. The molding sand is first rammed between the walls to form an insulating shoulder or barrier next to the pattern which utimately will form the casting. With the shoulder in place, a prepared exothermic molding composition is then rammed into the remaining void between the smaller plug and the riser sleeve. The plug is withdrawn leaving the exothermic riser sleeve in place. The finished mold is then ready for use as is or it can be baked by conventional means, torch dried or any other means used in the foundries for preparing molds for pouring.

If the mold and in situ formed exothermic composition are baked, normal core baking temperatures are employed, ranging from about 350° F. to 600° F. When the prior art exothermic compositions are employed, the lower baking temperatures are used.

This method is illustrated in the drawings, FIGURES 3–10.

Torch drying is accomplished by heating the mold with a flame. Exothermic padding is likewise placed into the desired location in the mold. The padding is normally not used where it will come in direct contact with the casting itself. Where it is desirable to have such padding, an insulating barrier of molding sand is placed between the casting and the exothermic composition. The padding is readily placed during the molding operation by ramming the desired amount of green exothermic composition into the desired position.

The plugs used to aid in placing the exothermic composition in the riser sleeve preferably are slightly tapered, cylindrical structures which are made of any rigid material such as wood, cardboard, plastic or hardboard. The slight taper aids in easily removing the plugs after ramming the mold. Disposable plugs can also be used for this purpose. A disposable plug, also known as an expendable liner, is a hollow structure of the same cylindrical shape which is composed of plastic, hard paper or other organic substance which will not interfere with the function of the lining. During the casting operation, the expandable liners are consumed by the heat of the molten metal and subsequently provide a vent for escaping gases.

The size of the riser is dependent upon the volume of metal used in the casting. The largest castings require the larger riser sizes. The thickness of the exothermic composition is dependent upon the riser diameter. Table 1 shows the average exothermic riser thickness required for a given riser diameter.

TABLE I

Riser diameter, in.:	Exothermic thickness, in.
Up to 2½	½
2½ to 6	¾
6 to 9	1
9 to 12	1¼
12 to 16	1½
16 to 24	2
24 to 30	2½

The invention will be better understood with reference to the following examples which are illustrations of certain preferred embodiments of the present invention. Unless otherwise indicated, all parts and percentages used herein are by weight.

Example I

A green exothermic composition containing 6.5 parts of aluminum powder, 16.3 parts of aluminum grindings, 21.3 parts of red iron oxide, 4.9 parts of calcium fluoride, 2.5 parts of bentonite clay, 1 part of flax shive flour, 40.6 parts of Wedron 70–30 sand, 4.9 parts of phenolic resin and 2.0 parts of dextrin was mixed with 12 parts of water to obtain a moldable composition. This composition had a compressive strength of about 7 to 9 pounds per square inch.

A foundry mold was then prepared by packing molding sand consisting of 1 part cereal, 2 parts bentonite and 100 parts of Nugent Lake sand into a cope containing a pattern. A slightly tapered cylindrical plug, having a maximum diameter of 6 inches, was inserted into the cope during the molding operation. After packing the molding sand securely into the cope and striking off the excess, the plug was removed leaving a cavity about 10 inches deep. A second slightly tapered plug, having a diameter 1½ inches less than the first plug, was then inserted and centrally positioned in the cavity left by the larger plug. Additional molding sand was packed into the cavity to form an insulating shoulder of approximately 1½ inches in depth. The exothermic molding composition was then rammed into the remaining void. The plug was removed leaving an in situ formed exothermic riser sleeve.

After having assembled the core box, gray iron was poured into this mold without further treatment of the mold. The exothermic riser performed its normal function extremely well.

Example II

Using the exothermic composition of Example I, a mold containing an exothermic riser and exothermic padding in the upper portion of the mold was prepared. The mold was prepared using core sand composed of 100 parts of Nugent Lake sand, 1 part of a core oil composed of 50 parts linseed oil, 30 parts petroleum polymer and 20 parts of mineral spirits, 1 part of cereal (corn flour) and 2.35 parts of water. The prepared core sand was rammed into a core box containing a pattern. An exothermic composition having the same composition as that of Example I was used to form an exothermic pad in the mold.

The pad was positioned in the upper portion of the mold to facilitate the flow of metal to the extremities of the casting. The pad was formed after placing about an inch of core sand next to the pattern and then filling in exothermic composition to a depth of about ¾ of an inch. After packing the exothermic composition into place the remainder of the mold was completed using core sand.

In forming the cope of the mold, the same slightly tapered, cylindrical plugs were used to form the outside and inside diameter of the exothermic riser sleeve as those used in Example I. The process was accomplished in the same manner using the same exothermic composition as that of Example I. The pattern was withdrawn from the core box and the mold weighing about 45 pounds was baked in an oven for 6 hours at 450° F. The baked mold was later assembled and used in the casting of gray iron. The exothermic composition in the padding and riser sleeve performed their normal functions extremely well.

Having described the processes of this invention, it is readily seen that these processes are extremely useful in the foundry art. This process may also be used wherever it is desired to maintain metal in a molten state for an extended period of time.

The specific embodiments in which an exclusive property or privilege is claimed are defined as follows:

1. A process for the production of foundry molds which comprises fabricating, directly into place in a mold during the molding operation, green exothermic compositions comprising 3.0 to 7.0% aluminum powder, 15.0 to 24.0% aluminum grindings, 18 to 44% oxidizing agent, 15.0 to 44.0% refractory material, 0.5 to 2.0% flax shive flour, 4.0 to 11.0% calcium fluoride, 4.0 to 6.0% phenolic binder, 1.0 to 3.0% dextrin and 2.0 to 4.0% clay; and subsequently using the mold in the green state.

2. The process of claim 1 wherein the fabricated green exothermic composition is torch dried prior to its use.

3. The process of claim 1 wherein the mold and the in situ molded exothermic composition are baked at a temperature of 350° to 600° F. prior to use.

4. A process for the production of foundry molds equipped with exothermic riser sleeves which are formed in situ, said process comprising

(1) inserting a slightly-tapered, cylindrical plug into the top portion of the mold to form an annular space between the plug and the mold, said plug being supported on the pattern;

(2) filling and ramming the annular space with molding sand;

(3) withdrawing the plug and inserting a smaller, slightly-tapered, cylindrical plug into the cavity from which the larger plug was withdrawn to form an annular space between the plug and the wall of the cavity, said plug being supported on the pattern;

(4) forming an insulating shoulder by ramming the lower portion of the annular space with molding sand;

(5) filling and ramming the remainder of the annular space with green exothermic composition; and

(6) withdrawing the plug to complete the mold.

5. The process of claim 4 wherein the green exothermic composition comprises 3.0 to 7.0% aluminum powder, 15.0 to 24.0% aluminum grindings, 18 to 44% oxidizing agent, 15.0 to 44.0% refractory material, 0.5 to 2.0% flax shive flour, 4.0 to 11.0% calcium fluoride, 4.0 to 6.0% phenolic binder, 1.0 to 3.0% dextrin and 2.0 to 4.0% clay.

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