

March 3, 1970

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3,498,360

METHOD OF CASTING IN A MOLD WHICH IS COATED DURING CASTING

Original Filed July 30, 1963

3 Sheets-Sheet 1

FIG. 1

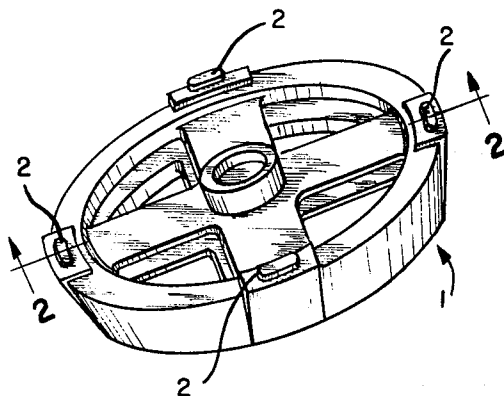


FIG. 2

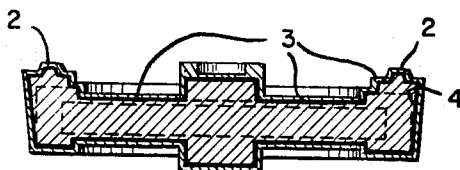


FIG. 3

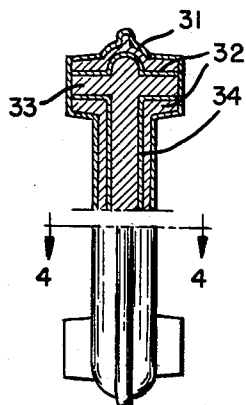
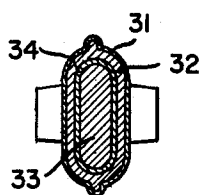


FIG. 4



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FIG. 5

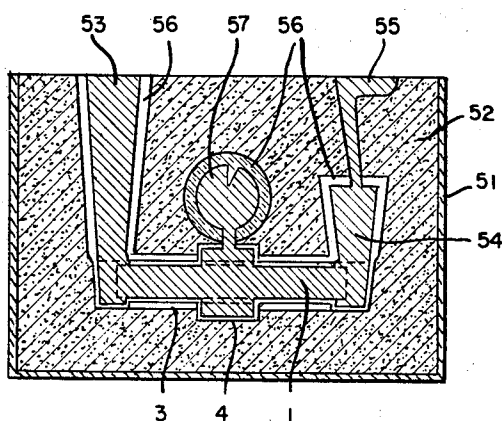


FIG. 6

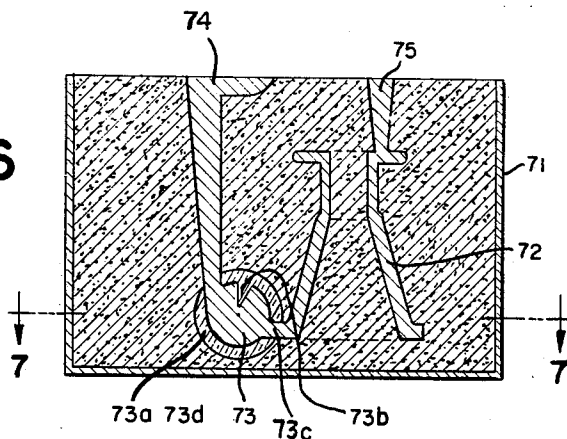
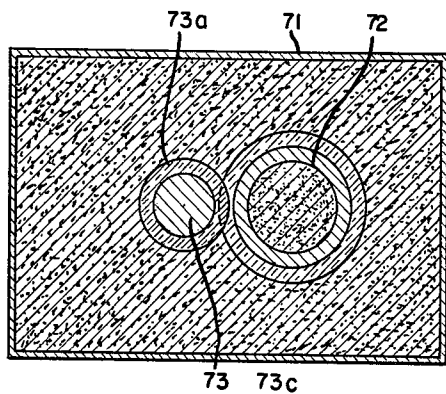


FIG. 7



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FIG. 8

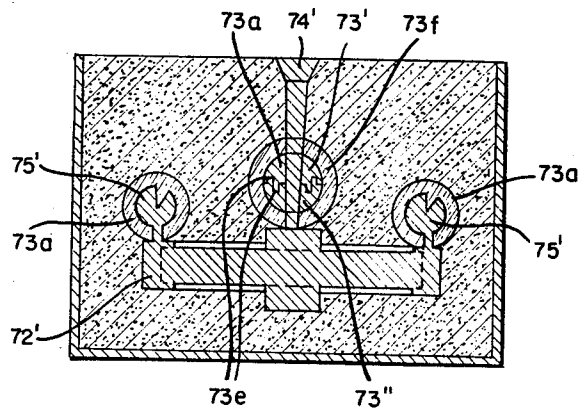


FIG. 9

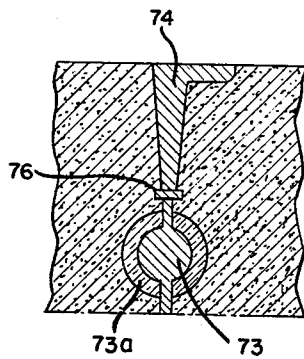
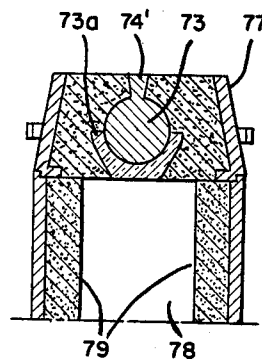


FIG. 10



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METHOD OF CASTING IN A MOLD WHICH IS COATED DURING CASTING

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Application July 30, 1963, Ser. No. 298,676, now Patent No. 3,314,116, dated Apr. 18, 1967, which is a continuation-in-part of application Ser. No. 270,085, Apr. 2, 1963. Divided and this application Nov. 1, 1966, Ser. No. 615,866

Int. Cl. B22c 9/04

U.S. Cl. 164—47

5 Claims

ABSTRACT OF THE DISCLOSURE

A method of casting, comprising the steps of forming a pattern which is gasifiable substantially without residue when subject to a molten casting charge, and which is shaped for exact reproduction as a casting, covering the surface of the pattern with a layer of gas permeable refractory material suspended in a liquid, drying said material, embedding the covered pattern in a mold body, providing in the mold body and the layer a passage for a molten casting charge, and pouring into the passage a molten casting charge to gasify and replace the embedded pattern in the mold body.

This application is a division of our co-pending application Ser. No. 298,676, filed July 30, 1963, now Patent No. 3,314,116 issued Apr. 18, 1967 which is a continuation-in-part of our application Ser. No. 270,085, filed Apr. 2, 1963 now abandoned.

The present invention relates to a casting arrangement and method, and more particularly, the present invention is concerned with improvements relating to gasifiable patterns.

According to conventional casting procedures a pattern having the shape of the casting to be made and consisting of wood-metal, wax, synthetic resin etc. is embedded in an appropriate molding material or molding sand respectively, in the mold. After packing the molding material to form a mold body, the pattern is removed and the melt is poured into the cavity which remains in the molding material. For this procedure lost patterns can be applied that means patterns which are destroyed after embedding, for example when employing a wax pattern which is melted out.

It is another object of the present invention to improve the usefulness of gasifiable casting patterns.

It is a further object of the present invention to provide gasifiable casting patterns which can be produced and used in a simple and economical manner.

It is a further object of the present invention to provide casting arrangements including improved feeder head patterns.

Other objects and advantages of the present invention will become apparent from a further reading of the description of the appended claims.

The present invention includes a method of casting, comprising the steps of embedding in a mold body a form which is gasifiable substantially without residue on subsection to a molten casting charge and which is shaped for exact reproduction as a casting and the surface of which is covered with a layer consisting of a solid material which remains solid and is gas permeable at the temperature of the molten casting charge, providing in the mold body and in the layer a passage for a molten casting

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charge to the embedded form, and pouring into the passage a molten casting charge for gasifying and replacing the embedded form in the mold body.

According to the present invention, the outer surface of the pattern is provided with a shell-like, substantially incombustible coat or layer which will not be affected by the temperature of the penetrating melt and which preferably will be highly permeable to gas or becoming permeable to gas during the pouring process. It is also within the scope of the present invention, to incorporate in the cellular plastic casting pattern solid or gaseous materials which will act on, or react with, the molten casting charge, for instance in the case of a molten metal casting charge, a material which will cause a metallurgical treatment of the casting metal.

The present invention thus overcomes the difficulties experienced up to now in connection with gasifiable casting patterns and will result in the production of cast bodies or castings of the desired surface structure, even when embedded in a loose molding material such as dry quartz sand which need not contain any binder. Even metal shot or similar materials may be used as the molding material. Furthermore, according to the present invention, not only an improvement of the surface of the casting is achieved but also of its inner structure which may be influenced by the incorporation of suitable materials in the gasifiable cellular plastic casting pattern.

The shell-like, substantially incombustible coat or layer on the outer face of the cellular plastic pattern will also advantageously act as a barrier preventing the escape of alloying and similar materials which may have been incorporated in the cellular gasifiable plastic casting pattern. In other words, when upon contact with the molten casting charge the expanded or foam cellular plastic pattern is burned out or decomposed and in any event gasified and the thus formed gases pass outwardly through the porous incombustible layer surrounding the cellular plastic pattern and separating the same from the molding material, the surrounding incombustible layer may be such as to prevent passage therethrough of alloying or other materials which had been distributed throughout the gasifiable plastic pattern. The porous layer thus may be traversed by the gases formed, for instance, by pyrolysis of the cellular plastic but will retain and prevent passage therethrough of the particles of the alloying or the like material in the mold, which particles of alloying or the like material will thus be incorporated in, or react with, the casting charge.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a gasifiable casting pattern according to the present invention;

FIG. 2 is a cross sectional view taken along lines II—II of FIG. 1;

FIG. 3 is an elevational view partially in cross section of a casting pattern for a radiator, according to the present invention;

FIG. 4 is a cross sectional view taken along lines IV—IV of FIG. 3;

FIG. 5 is an elevational cross sectional view of a casting mold incorporating the casting pattern of FIGS. 1 and 2;

FIGS. 6—10 will serve primarily to illustrate embodiments of the present invention which encompass a gasifiable feeder head.

The casting pattern 1 which is illustrated in FIGS. 1, 2 and 5 may serve as an example for producing a casting

in accordance with the present invention without requiring a core, while at the same time providing the casting with hardened surface portions in the area of the wheel body. Furthermore, as illustrated in FIG. 5, the casting will be produced in accordance with the present invention so as to be substantially free of cavities and pipings.

The upwardly extending portions 2, as shown in FIG. 1, serve for reliable serve for reliable attachment of the risers and feeding conduits shown in FIG. 5.

As illustrated in FIG. 2, the gasifiable foamed plastic pattern 1 carries a porous layer or coat 3 which covers the entire outer surface of plastic pattern 1. Incorporated and substantially evenly distributed throughout foam cellular plastic pattern 1 may be alloying materials or other materials which will act on the molten casting charge when the same is introduced into the mold so as to gasify and replace the plastic pattern. Interposed between the layer 3 of solid material, which remains solid at the temperature of the molten casting charge and which preferably will be gas permeable at such temperature, and the gasifiable member 1 may be a layer 4 of a material adapted to act on and to influence the surface portion of the casting during formation of the same, for instance to increase the hardness of the surface portion.

FIGS. 3 and 4 illustrate one of the relatively rare cases when by proceeding in accordance with the present invention it is nevertheless desirable to use a core.

As illustrated, the outermost layer 31 as shown in FIGS. 3 and 4, consists of a solid material which will remain solid at casting temperatures and layer 31 contacts the outer surface of the gasifiable cellular plastic pattern 32. The core consists of cellular plastic body 33 and a layer 34 interposed between cellular plastic core 33 and cellular plastic pattern 32. Layer 34 consists of a material of low heat conductivity so that upon introduction of the molten casting charge and replacement of gasifiable plastic pattern 32 by the casting charge, heat penetration toward the gasifiable cellular plastic core portions 33 will be considerably retarded, namely for a sufficient length of time so that gasification of plastic core bodies 33 will take place only after the portion of the casting charge adjacent to layer 34 has been solidified and has become shape-retaining and self-supporting. Such cores containing a gasifiable body are particularly suitable for castings which include relatively thin walls and which are formed with one or more inner cavities access to which is relatively difficult.

FIG. 5 illustrates the casting patterns of FIGS. 1 and 2 incorporated in a molding arrangement which includes a shell 51, mold body 52, open feeder funnel 53 and feeder 54 with riser 55. Feeding funnel 53, feeder 54 and riser 55 consist, initially similarly to pattern 1, of gasifiable cellular plastic material and feeding funnel 53 and feeder 54 are surrounded by a layer of heat insulating material 56. The foamed cellular gasifiable plastic pattern again may have incorporated therein suitable alloying or treating materials for acting on or reacting with the casting charge. Heat insulating layers 56 may consist of the porous gas permeable solid material which remains solid at casting temperatures as described further above. The spherical blind riser 57 which is also surrounded by heat insulating layer 56 is formed with a small cutout at its upper portion which will serve for maintaining the elevated temperature of the melt for somewhat longer period of time. The constriction underneath spherical riser 57 will facilitate breaking off the material which has solidified in riser 57.

It will be understood by those skilled in the art that many variations of these auxiliary devices are possible and are within the scope of the present invention. Feeder and riser arrangements which are surrounded by heating means, usually providing heat by an alumino-thermic or the like process, or by insulating materials have been known for a long time. However, up to now these ele-

ments had to consist of pressure resistant, hard, ceramic hollow bodies which had a relatively limited heating or insulating effect and were quite expensive, while, according to the present invention, these members will consist of a form of gasifiable cellular plastic material which is covered with a layer of suitable insulating material or the like.

Thus, in accordance with the present invention, by preforming feeders, risers and the like of gasifiable cellular plastic materials, which may be joined to the casting pattern of the same type of materials, it is possible to utilize layers of insulating materials which are highly insulating and relatively inexpensive although affording less pressure resistance, such as layers of mineral wool, and the like.

The materials which may be used for forming the solid gas permeable layer 3 and which also may be used for forming the heat insulating layer 56, are conventional materials which are, per se, known in the art. Heat resistant materials which are porous or which will become highly permeable to gas when exposed to the temperature of the molten casting charge are highly suitable for the first purpose. These materials include diatomaceous earth or kieselguhr, asbestos, synthetic mineral fibers such as mineral wool, fire clay, clay, pumice, bentonite, perlite, vermiculite and the like, to which quartz sand or a similar material may be added if desired. As binding agents for these mineral materials may be used thermosetting or preferably cold setting substances such as plaster of Paris, cement, starch or synthetic resins, the latter being preferred. In a most simple manner, the layer is formed by preparing a suspension of the mineral material and binding agent in water, to which suspension a suitable wetting agent and/or film forming agent may be added and which is then applied to the cellular plastic pattern, for instance, by hand, spray gun, immersion or other methods. The coating or layer will require only a short period of air drying, but it need not be subjected to a special drying process and may be allowed to stand in wet condition. The thickness of the coating preferably will not exceed 6 mm. and more preferably will be between 2 and 6 mm. The outside of the layer or coating may remain in rough and uneven condition. It is a further advantage of the above-described coating that it is possible to incorporate therein without difficulty materials which, when coming in contact with the casting charge, will affect the surface properties of the casting. Moreover, it is possible to form a layer of a material which will favorably affect the properties of the casting between the cellular pattern and the heat-resistant coating. Such layer, for instance, may be applied to the surface of the cellular plastic pattern prior to forming the heat resistant layer thereon.

In the production of castings which are required to have particularly hard, wear-resistant surface portions, such as rollers and cam shafts, such treating layer or coating may consist of graphite, tellurium or ferrosilicon, in other cases, particularly when producing light metal castings, a treating layer of silicon or sulfur frequently will be found advantageous for improvement of the surface quality of the casting.

The specific material of which the heat resistant gas permeable layer is to be formed will depend on the type of casting which is to be produced, such as whether an aluminum casting is to be produced at about 700° C. or a steel casting at about 1,500° C.

For instance, in case of a casting to be formed of a metal having a high melting point, the heat resistant porous layer may be formed of a mixture of about 85% by weight of unblown perlite, about 5% of water glass (aqueous solution containing 30% by weight of sodium silicate) as binder and about 10% by weight of ground graphite.

Water which may contain a wetting agent and a film-forming agent is added in an amount sufficient to form a

stiff paste which may be easily applied to the cellular casting pattern by hand and which dries quickly and adheres well to the surface of the cellular plastic pattern. When it is desired to apply the layer by dipping or spraying, then a greater quantity of water is added so as to achieve the desired consistency which is best suitable for the respective manner of applying the paste.

The perlite in the above-described mixture may be replaced by similar proportions of mineral wool, kieselguhr, ground pumice and the like.

The water glass binder may be replaced by a starch solution or a suitable solution or dispersion of synthetic resin.

The graphite may be suitably replaced by ferro-silicon or silicon.

The materials which may be incorporated in the heat resistant layer or which may be interposed between the heat resistant layer and the surface of the cellular plastic pattern, may either be mixed into the mass of which the heat resistant layer is formed, or may be applied as an intermediate coating, for instance dispersed in alcohol or water containing a wetting agent and/or film forming agent.

As has been described above, it is possible according to the present invention to introduce into the casting charge while the same is filling the space originally occupied by the cellular plastic pattern, at least one additional material which will serve to influence metallurgically the material of the cast workpiece. This is done by employing the cellular plastic material as the carrier for introducing such material.

The material which is intended to have a metallurgic effect on the melt or casting charge, or to alloy with the same, may be distributed as evenly as possible in the plastic material prior to blowing of the same, so that as a result of the expansion of the plastic material, an even distribution of the added materials will be accomplished in the cellular gasifiable plastic pattern.

The gasifiable expanded plastic material which contains the evenly distributed addition material may also be used to form the pouring system of the mold. Thus, for example, to influence the graphite formation is cast-iron alloys, materials such as ferrosilicon or nodular graphite-forming elements such as magnesium and corium may be added. Powdery substances may also be added to the expanded plastic for either preventing or promoting the solidification of cast-iron alloys in the form of white cast iron, for example magnesium and silicon (preventives) or sulfur and tellurium (promoters).

Furthermore, alloying constituents, such as vanadium, molybdenum and the like may be introduced into the melt in accordance with the present invention.

Such alloying materials, or other materials which serve to influence the quality of the casting formed of the molten casting charge, are usually added in such quantities that, with reference to the weight of the casting, the alloying metals are present in an amount of up to 1%, silicon in an amount of up to 0.8% and magnesium in an amount of up to 0.1%. In order to incorporate such proportions of added material in the casting, when employing the gasifiable expanded plastic pattern as carrier, the expanded plastic may contain up to 500% of its weight of alloying metal or silicon, or up to about 50% of its weight of magnesium, based on the weight of the expanded plastic.

In order to achieve a uniform distributed of such added alloying or other material in the expanded plastic, the additional material may be incorporated in the pre-expanded granulate or in the monomers of the plastic. In the latter case, the added material may be distributed homogeneously, prior to the polymerization, in one or more of the monomers prior to their admixture, or in the monomer mixture. The added material should be introduced in finely sub-divided form. This last procedure is particularly advantageous because it will result in a very

even distribution of the added material, for instance an alloying constituent, in the expanded plastic.

If, in customary manner, the expansion of the plastic polymer will be carried out with the help of a suitable expanding agent under the influence of the super-heated steam, then certain difficulties are encountered when the added material, for example magnesium in powder form, is attacked by water. If, on the other hand, the added material is introduced into the monomeric resin, then the material which is sensitive to steam will be distributed very homogeneously in plastic expanded with the use of steam and apparently remains protected against attack by water due to the plastic material surrounding each of the particles of magnesium or the like.

Referring now to the heat barrier or layer of low thermal conductivity, such as layer 34 of FIGS. 3 and 4, very good results are obtained in the case of aluminum castings with layers formed of one part by weight of a polyvinylpropionate resin dispersion containing about 30% by weight of resin and 50% by weight of water, two parts by weight of lithopone, two parts by weight of white cement and three parts by weight of water with the addition of a small amount of a wetting agent.

The thickness of the thus formed dry layer of low thermal conductivity preferably will be about 2-3 mm. and its weight about 300 grams per square meter. However, these quantitative data should not be considered as limiting the invention since innumerable variations may be made for specific purposes. For instance, a metal powder or metal flakes and the like may be incorporated in the layer, depending on the casting temperature. The heat insulating layer 56 which primarily covers the cellular plastic material which is located in place of the riser and feeder conduits, preferably will consist of a material of the type which is suitable for forming layers 3 or 31, and very good results are achieved with respect to forming such porous layer by using therefor mineral wool and a smoothening and binding agent such as bentonite. However, layers 56 preferably will be considerably thicker than layers such as layers 3 and 31.

The casting method of the present invention is not limited to any specific casting charge or material. It is possible to cast according to the present invention substantially all casting metals such as bronze, light metals, iron, steel, heavy metals, as well as glass and silicate melts (quartz), molten Al_2O_3 , SiC and the like. It is of course required that the melt will be sufficiently fluid within a temperature range which will be sufficiently above the decomposition or gasification temperature of the foam plastic pattern, and the last condition generally is met by a temperature of about 400° C. Furthermore, it is of course desirable that there should be as little reaction as possible between the molten charge and the porous heat resistant layer or the layer of low heat conductivity which covers the plastic pattern.

The plastic pattern according to the present invention, with the porous layer thereon, is also suitable for forming castings in a mold body consisting of loose sand without binder, for instance of free flowing quartz sand.

The incorporation of reactants such as alloying elements in the cellular plastic pattern has the great advantage that, for instance, starting with a casting charge of regular pig iron, a cast body of alloyed metal can be produced. The loss of the usually valuable reactants or alloying materials is insignificant and can be further reduced by using the porous heat resistant layer interposed between the cellular plastic pattern and the mold body. When it is desired to influence the hardness or other qualities of only the surface portion of the casting, then such reactants are preferably applied as a thin layer or incorporated in a thin layer on the surface of the cellular plastic pattern, as has been described further above.

It is also possible according to the present invention to have the closed cells of the cellular plastic pattern

filled with a gaseous substance which will affect the quality of the casting. Thus, the cells may be filled with a gas which does not support combustion, e.g. nitrogen, carbon dioxide, halogenated hydrocarbons such as $\text{CF}_2-\text{CCl}_2\text{CF}_2=\text{CClF}$ and similar materials which are known by the trade name "Freone." Thereby it will be achieved on the one hand that combustion of the cellular plastic is prevented and consequently the amount of gas which has to be removed upon gasification of the plastic is reduced and, on the other hand, it is possible in this manner to carry out the pouring of the casting charge in a protective gas atmosphere. It is also possible, according to the present invention to incorporate gaseous halogens such as chlorine in the expanded plastic, i.e. in the cells thereof which halogens, particularly chlorine, will react advantageously with certain light metal melts, such as a casting charge of aluminum. Particularly the type of heat resistant layers or coatings which become porous only when subjected to heat, will permit the storing of the cellular plastic patterns covered with such heat resistant layer for a considerable length of time, without loss of the gas incorporated in the plastic pattern.

In general, cores are not required in connection with patterns made of gasifiable expanded plastic material. If, however, in exceptional cases such cores are required due to poor accessibility of interior recesses of the plastic pattern, then the cores may be incorporated when foaming the expanded plastic patterns or they may be inserted thereafter. For this purpose it is possible to use not only cores made of conventional material, i.e. bonded sand and the like, but also cores which consist of gasifiable expanded plastic, provided that the gasifiable expanded plastic core is surrounded by a solid layer of low thermal conductivity, a so-called heat barrier layer, which will retard the transmission of heat from the melt to the expanded plastic core until after the melt layer adjacent the core, i.e. outwardly and adjacent of the solid layer of low heat conductivity, has solidified. Due to the high temperature of the casting charge, the core will then be gasified and a recess will remain in the casting, the latter being covered adjacent to such recess by the barrier layer which can be easily blown off or otherwise removed.

Such barrier layer may consist of gypsum, clay, magnesium, calcium oxide or similar materials with hydraulic or organic binders such as polyvinyl acetate resin, starch and the like, or including metal powders or metal flakes, and the heat barrier layer may be applied to the expanding plastic core in the same manner as the heat resistant porous coating is applied to the expanded plastic pattern. Usually, a thickness of the barrier layer of a few millimeters will be sufficient for retarding heat transmission therethrough to such an extent that the core will be gasified only after the portion of the charge adjacent to the barrier layer has solidified.

It is possible to make not only the casting pattern of gasifiable expanded plastic, but also the pattern for ingate, ventilation and connecting conduits and/or feeder heads (so-called blind risers), and to adhesively adhere the expanded plastic pattern to the expanded plastic material of such conduits or feeders, either during the foaming process or thereafter. The term "feeder" is to be understood to denote additional storage space for the melt in the mold, i.e. additional space which can be filled with molten charge. Such an additional space is frequently desirable in order to prevent hole or piping formation in metals which have a great tendency to shrink.

Hitherto parts of the molding system being particularly susceptible to shrink hole formation were provided with heating means or heat insulating means by introducing suitable materials into the mold cavity after having removed a conventional pattern. Thermite mixtures were used as heating means and hard burned ceramical materials which were brittle, rather expensive and of relatively limited effect served as insulating material. The

coating provided according to the invention represents a considerable progress in this respect, as it can be applied without difficulty near or at all critical points of the pattern in any desired thickness in order to secure the insulating effect required in every particular case. The thickness of the coating may amount to 20 mm. or more. If required, the insulating effect can be increased by conventional heating means. The insulating portions of the coating may consist substantially of the above mentioned mineral fiber materials, i.e. asbestos or synthetic mineral fibers. Coatings of this kind have by far better insulating effects than the hollow ceramic bodies conventionally used for this purpose. In spite of the relatively loose structure of such fibrous materials no difficulties arise when embedding the pattern, as all forces or stresses occurring thereby are absorbed by the expanded plastic pattern. The gasifiable patterns are not only suited for molding metals but also for molding other melts, as for example glass and silicate melts and the like provided that their casting temperature is sufficiently higher than the decomposition temperature of the expanded plastic material.

As an example only without, however, limiting the invention the solid content of the intermediate coatings (4) only comprise in percent of weight: 75-95 pulverized silica, 5-8 ground graphite, 1-5 water glass, up to 3 bentonite, and Al_2O_3 at the balance.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of molding arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in an ingot mold arrangement, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A method of casting, comprising the steps of embedding in a solid mold body a form which is gasifiable substantially without residue on subjection to a molten casting charge and which is shaped for exact reproduction as a casting, covering the surface of said form with a layer consisting of a solid substantially incombustible material which remains solid and is gas-permeable at the temperature of a molten casting charge; providing in said mold body and in said layer a passage for a molten casting charge to said embedded form; and pouring into said passage a molten casting charge for gasifying and replacing said embedded form in said mold body, said layer providing a gas permeable shell-like coating which is substantially unaffected by the molten casting charge.

2. A method of casting, comprising the steps of embedding in a mold body a form which is gasifiable substantially without residue on subjection to the elevated temperature of a molten casting charge and having distributed therethrough a substance adapted to act on said molten casting charge, said form being shaped for exact reproduction as a casting; covering the surface of said form with a layer consisting of a solid substantially incombustible material which remains solid and is gas-permeable at the temperature of said casting charge, providing in said mold body and in said layer a passage for a molten casting charge to said embedded form; and pouring into said passage a molten casting charge for gasifying and replacing said embedded form in said mold body, said

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layer providing a gas-permeable shell-like coating which is substantially unaffected by the molten casting charge.

3. A method of casting, comprising the steps of embedding in a mold body a form which is gasifiable substantially without residue on subjection to a molten casting charge and having distributed therethrough a substance adopted to act on said molten casting charge, said form being shaped for exact reproduction as a casting, covering the surface of said form with a layer consisting of a solid substantially incombustible material which remains solid and is gas permeable with temperature of a molten casting charge; providing in said mold body and in said layer a passage for a molten casting charge to said embedded form; and pouring into said passage a molten casting charge for gasifying and replacing said embedded form in said mold body, said layer providing a gas-permeable shell-like coating which is substantially unaffected by the molten casting charge.

4. A method of casting comprising the steps of forming a pattern which is gasifiable substantially without residue at the elevated temperature of a molten casting charge and which is shaped for exact reproduction as a casting, covering the surface of the pattern so formed with a layer consisting of a solid substantially incombustible material which remains solid and is gas-permeable at said elevated temperature, embedding the covered pattern in a mold body, providing in said mold body and in said layer a

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passage for a molten casting charge, and pouring into said passage a molten casting charge at a temperature above said elevated temperature to gasify and replace said embedded pattern in said mold body, said layer providing a gas-permeable shell-like coating which is substantially unaffected by the molten casting charge.

5. The method set forth in claim 4 wherein said layer consists of a solid refractory material suspended in a liquid and including the step of drying said liquid after the application thereof to said pattern.

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U.S. Cl. X.R.

164—34