This invention relates to molds for castings and to a method of making such molds.

While conventional molds with their cavities, formed with the aid of patterns and cores, permit the casting of structures of many different configurations, they do not lend themselves readily, if at all, to the casting of structures of many other desirable configurations, which would require excessive, if not practically impossible, coring or complicated parting lines, or both. Thus, in order to lay out structures intended for casting, the designers thereof not only must be familiar with molding in general, but are required to design these structures with first consideration for their ready molding and quite frequently at the sacrifice of design features which, while highly desirable and advantageous, would unduly complicate, or even prohibit, their molding.

It is the primary aim and object of the present invention to provide a mold which, for the casting of a structure of most any desired surface configuration, requires neither a core or cores nor any particular parting, thereby not only permitting expeditious and advantageous casting of many structures not cast heretofore because involving excessive coring or complicated parting of molds therefor, but also affording designers greater freedom in laying out structures to-be-cast with first, if not sole, consideration for their optimum utility and with little regard to their molding.

It is another important object of the present invention to provide a mold which is devoid of a conventional mold cavity and, instead, has an embedded form which in shape is an exact replica of the intended casting to the inclusion of any and all recesses, apertures and other surface configurations which heretofore required coring, and which is accessible through a conventional gate to a poured casting charge that causes fairly rapid combustion of the form without leaving appreciable, if any, residue and, hence, replaces the embedded form in the mold and solidifies therein into the intended casting of the exact shape of the replaced and vanished form, thereby achieving not only the-aforementioned coreless molding for castings of most any configuration, but also simple parting of the mold without any special regard to the shape of the form.

It is an object of the present invention to devise a method of preparing molds of the aforementioned coreless type with their embedded combustible forms far more expeditiously and with far less skill than molds with conventional cavities, thereby achieving a substantial reduction in the cost of many molding operations. Another important object of the present invention is to fabricate the aforementioned form parts for the instant coreless molds from suitable materials which not only are readily combustible without leaving any, or hardly any, residue and have more than adequate strength to withstand any and all stresses induced by ordinary hand or power ramming of molding sand thereagainst, but which may also be shaped easier and far more expeditiously than conventional pattern materials and given most any desired configurations by conventional hand or machine shaping and, whenever more convenient, may be made of any number of separate preformed parts that may readily be secured to each other with adequate firmness by simple cementing, doweling or wiring, for instance, thereby not only obtaining these form parts advantageously by expediencies which may be similar, but generally simpler to perform, than those practiced in conventional pattern making, but also greatly enhancing the simplicity of the aforementioned molding method not only by permitting the placement of most form parts, in their entirety and regardless of their shapes, in flasks without regard to parting lines, and eliminating the heretofore imperative and tedious tasks of removing impressed patterns from the molds and frequently finishing the exposed mold cavities including the placement and fitting of cores therein, but also permitting conventional ramming of molding sand, or an equivalent medium, against the form parts in the molds more expeditiously and with less care than heretofore without impairing the accurate casting reproduction capacity of the molds.

A further object of the present invention is to fabricate the aforementioned form parts for the instant coreless molds from suitable materials which not only have all the aforementioned properties, but which are also readily moldable into any specific shape, or extrudable as continuous stock of any desired core section, thereby further facilitating and expediting the fabrication of these form parts so much so as to adapt them for advantageous mass-production molding for many castings at no greater cost, and in many cases at considerably lower cost, than that of conventional cavity molding and coring for the same castings.

It is another object of the present invention to fabricate the aforementioned form parts of the instant coreless molds from relatively inexpensive expanded plastics, such as polystyrene or polyethylene, for instance, which may conveniently be shipped to and stocked in foundries in non-expanded form in containers or drums of small bulk, and which may be expanded under heat into lightweight blocks or other shapes of many times their original volume whenever needed for the fabrication of form parts therefrom, or may be expanded in molds for their direct formation into such form parts or separate elements thereof, thereby not only eliminating the need for stocking the various seasoned and relatively expensive woods customarily used in pattern and core making, but also making it entirely feasible and economical to prepare molds for the casting of exceptionally large non-repeat structures which heretofore involved prohibitive costs of the wooden patterns and the cores thereof, or which were formed in articulated fashion rather than cast due to the prohibitive molding cost thereof.

Other objects and advantages will appear from those skilled in the art from the following, considered in conjunction with the accompanying drawings.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a perspective view of a casting made in a mold embodying the present invention;

Fig. 2 is a perspective view of a form part used in a mold for producing the casting of Fig. 1 in accordance with the present invention;

Fig. 3 is a longitudinal section through the form part of Fig. 2 as taken on the line 3—3 thereof;

Fig. 4 is a cross section through the same form part as taken on the line 4—4 of Fig. 3;

Fig. 5 is a longitudinal section through a part of a mold being prepared in accordance with the present invention for the exemplary casting of Fig. 1;

Fig. 6 is a longitudinal section through the completed mold for the same exemplary casting; and
Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 10 designates an exemplary casting which is produced in a mold, and according to a method, embodying the present invention. The exemplary casting 10 has presently a bottom wall 12, an upwardly extending peripheral rim 14 with a slot 16 in one corner and a hole 18 in one end, and an upwardly extending boss 20 on the bottom wall 12. Extending upwardly from the bottom wall 12 and inwardly from the opposite sides of the rim 14 are lobes 22, while a strap like formation 24 is provided on the outside of one of the sides of the rim 14. Furthermore, the boss 20 is slotted at 26 over part of its axial extent, and the strap formation 24 is also slotted as at 28. The exemplary configuration of the casting 10 has been chosen because it serves well for readily expounding the various significant aspects of the new molding technique employed in the production of castings.

Most significantly, and in accordance with the present invention, the exemplary casting 10 is, first of all, produced in a mold which is devoid of the usual mold cavity and usual inserted core or cores and, instead, holds a form which in shape and size is exactly identical with the intended casting, save for shrinkage of the latter on solidification, and includes all recesses, notches, and other portions of the intended casting which heretofore required a separate core or cores. This featured form is adapted to be displaced in a mold by a poured casting charge in a manner described hereinafter. Thus, the form for the exemplary casting 10 is shown in perspective in Fig. 2 and designated by the reference numeral 30, it being noted that the form is in all respects identical with the casting 10 and its various parts are identified by the same reference numerals as their identical counterparts of the casting, except that the suffix "L" is added thereto.

The form 30 is adapted to be displaced in a mold by a poured casting charge, being converted substantially in its entirety into a gaseous state and permitted to escape from the mold through suitable vent provisions. Thus, the form 30 is to this end made of any suitable material which is readily combustible substantially without residue on subjection to a molten casting charge, and which is sufficiently rigid safely to withstand the stresses induced by the customary ramming of molding sand thereagainst. A tested material suitable for this purpose is a certain plastic in an expanded state, namely, polystyrene. Thus, polystyrene in an expanded state has been used for making entirely satisfactory forms for various castings, among them a form of the configuration shown in Fig. 2 for producing an entirely satisfactory aluminum casting of the configuration shown in Fig. 1. With respect to the use of this expanded plastic for making these forms, it has been found that it is well adapted for the intended purpose if it is expanded to a density of substantially not much more, and preferably less than 2 lbs. per cubic foot, for if this material has substantially greater density it will not readily burn away on subjection to a molten casting charge. On the other hand, there is a limit to the expansion of this material in order to be suitable for forms of this type, for if its density becomes too low it may lack adequate strength to withstand ordinary molding pressures and other stresses and give way thereunder, at least in part sufficiently to spoil a mold.

The polystyrene used experimentally may be purchased on the market either in a non-expanded state in convenient containers or drums, or in an expanded state in the form of blocks, sheets, and bars. Expanded polystyrene may also be extruded as continuous bar stock of most any profile or cross-sectional shape, the expansion and shaping of the stock customarily taking place on leaving the extrusion die. In either case, the usual granule-like non-expanded polystyrene particles are, on subjection to heat, expanded and formed into solid bodies of many times the volumes of the non-expanded particles from which they were formed by expansion. Non-expanded polystyrene may also be expanded into any desired singular shape and being heated and rammed into a mold. Finally, polystyrene in expanded form may readily be shaped by most conventional hand or machine operations.

With the aforementioned various expediencies available for forming expanded polystyrene into most any shape, it is comparatively easy to make a form of the material for the production of a casting of most any configuration. Thus, insofar as the exemplary form 30 (Fig. 2) is concerned, the same may, instead of being shaped from a solid block of expanded polystyrene in a laborious and expensive fashion, be advantageously formed of several simple parts which may be joined in any suitable manner, as by simple cementing, doweling or wiring, for instance. In the present example, the bottom wall 12 of the form 30 may be cut and shaped from a suitable block of expanded polystyrene, and the rim 14 may similarly be cut and shaped from a suitable block of the material, the slot 16 and hole 18 being provided therein by suitable hand or machine operations. Thus, the slot 16 may readily be cut with a suitable knife, while the hole 18 is advantageously drilled. After forming the parts 12 and 14, they may be secured to each other in their proper relationship by cementing, or together as at 22, the cement layer between these parts as well as the other parts of the form 30 being shown in Figs. 2 to 4 of exaggerated thickness for clearness of illustration. The boss 20 may next be cut from suitable expanded polystyrene bar stock, and slotted at 26 in any suitable manner or milling machine, whereupon this boss may in its proper location on the bottom wall 12 be cemented thereto as at 34. The lobes 22 may then be cut from a suitable block of expanded polystyrene and shaped by hand or by a machine operation or operations, whereupon they may in their proper location on the bottom wall 12 and rim 14 be cemented thereto as at 36. Finally, the strap formation 24 may be cut from a suitable block of expanded polystyrene and shaped, as well as slotted at 28, by hand or by machine operations, and then cemented to the bottom wall 12 and rim 14 as at 38.

While the described form 30 has been described as being made of expanded polystyrene, it is, of course, fully within the purview of the present invention to use any other material which is suitable for this purpose, as long as it is readily combustible substantially without residue on subjection to a molten casting charge, and may readily be shaped by hand or machine operations. Also, while in the above described exemplary formation of the form 30 (Figs. 2 to 4) the various parts thereof are cemented together, they may just as readily be wired together or in part doweled together. Of course, whenever parts of a combustible form are cemented together, the cement used for this purpose should burn without leaving any, or any residual, deposits, and several such cements are available on the market. Furthermore, if the casting 10 is to be produced in quantity, it may well be advantageous, from the viewpoint of expediency and cost, to make a mold, or several molds, in which to expand polystyrene directly into as nearly the overall configuration of the form 30 as molding will permit, and to have recourse to further molds or extruded profile stock to obtain the missing part or parts of the molded form for their ready attachment to the latter. It is thus obvious from the foregoing that various expediencies for making forms for various castings may be chosen from for optimum economy of any given casting operation or operations, keeping in mind that forms of the present type eliminate all conventional coring for castings of any surface configuration, as will appear more obvious hereinafter.
Reference is now had to Figs. 5 to 8 which not only show a mold 40 of the instant cavityless type but also illustrate the technique or method involved in preparing this mold. More particularly, the exemplary mold shown is formed for the production of the exemplary casting 10 (Fig. 1) and, hence, includes the form 30 (Fig. 2). In preparing the mold, 42 may in a varied fashion be placed on a molding board 44 (Fig. 5), and the form 30 is also placed on the same board within the confines of the flask, preferably with its bottomwall 12' lowermost. The flask 42 is then gradually filled with the molding sand S which is intermittently rammed, by hand or power operation, throughout the form 30 so that the latter cannot be removed from the mold body B without destroying the formed mold. For example, a conventional mold with a cavity of the instant cavityless type and with an embedded combustible form of the exact shape of an intended casting, to the inclusion of any and all recesses, apertures and other surface configurations thereof, readily lends itself to the casting of structures of many desirable configurations which heretofore required excessive, if not practically impossible, coring or parting lines, or both. While in abundance clear from the foregoing that a mold of the instant cavityless type requires no separate coring regardless of the configuration of an intended casting, it is also clear that parting lines may be ignored, and that there is no parting problem, for molding for any casting in accordance with the present molding method or technique. Thus, insofar as parting is concerned in connection with the instant mold for the exemplary casting 10 (Fig. 1), this can be arranged to suit, or may even be ignored for there is nothing to prevent bedding of the form 30 in its entirety and on all sides in the mold body B in the flask 42 and leading a gate and a riser as well as a multiplicity of vents to the wholly embedded form, and thus eliminating the need for the cope 54. Also, while it is true that in molding according to the present method a combustible form is required for the production of each casting, the overall cost of any particular molding operation done in accordance with the present method may, despite the cost of the combustible forms, be nevertheless far more economical than if done in accordance with the heretofore conventional techniques. Thus, the cost of the combustible forms may be far less than the cost of conventional coring alone in the case of many castings. Also, the preparation of a mold of the instant cavityless type is far more expedient and requires far less skill than the preparation of a mold with a conventional cavity, for reasons stated hereinafter, thereby achieving a further reduction in the cost of many molding operations. Also, expanded plastic, such as polystyrene, is much less expensive than the various woods from which conventional patterns are made, thus indicating the advantageous fabrication of a form from such combustible material for the casting of an extra large non-repeat structure which most likely would be formed in an articulated fashion rather than simply cast in a conventional manner due to prohibitive pattern cost and perhaps also other coring considerations. Further, the instant combustible forms need not necessarily be replicates of entire castings to be produced, but they may also be used as form inserts in conventional cavity molds as extensions of the mold cavities in places where recourse to conventional coring would otherwise be necessary. For example, a conventional mold with a cavity of the...
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7. A mold of the instant cavityless type lends itself, of course, to the casting of structures in all metals in which castings may be produced in conventional cavity molds. Thus, by way of example, a mold of the instant type lends itself to the casting of structures in gray iron, white iron, steel, bronze, brass and aluminum, among others. In fact, a mold of the instant cavityless type has proved advantageous in casting white iron, in that it received and satisfactorily cast a charge of the latter as it was taken directly from an electric furnace, whereas white iron has to be cooled for some time after leaving an electric furnace before it may be poured into a conventional cavity mold without ruining the same or producing a spoiled casting.

While in the foregoing description the mold bodies B and B' have been described as being formed of molding sand, they may, of course, be formed of any other suitable molding material, such as plaster of Paris, readily flowing cold-set sand mixtures and the sand mix used for CO₂ setting, for instance.

The invention may be carried out in other specific ways than those herein set forth, without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

What is claimed is:

1. A method of casting, comprising the steps of embedding in a mold body a form combustible substantially without residue on subjecttion to a molten casting charge and shaped for exact reproduction as a casting, providing in said mold body a passage for a molten casting charge to said embedded form, and pouring into said passage a molten casting charge for burning and replacing said embedded form in said mold body.

2. A method of casting, comprising the steps of embedding in a mold body a form having a recess and being combustible substantially without residue on subjecttion to a molten casting charge and shaped for exact reproduction as a casting, providing in said mold body a passage for a molten casting charge to said embedded form, and pouring into said passage a molten casting charge for burning and replacing said embedded form in said mold body.

3. A method of casting, comprising the steps of wholly embedding in a mold body a form combustible substantially without residue on subjecttion to a molten casting charge and shaped for exact reproduction as a casting, forming in said mold body a gate and a multiplicity of spaced vent passages leading to said embedded form and pouring into said gate a molten casting charge for burning and replacing said embedded form in said mold body.

4. A method of casting, comprising the steps of wholly embedding in a mold body a form combustible substantially without residue on subjecttion to a molten casting charge and shaped for exact reproduction as a casting, forming in said mold body a gate and a multiplicity of spaced vent passages leading to said embedded form of which at least part of said vent passages are extended into the interior of said form, and pouring into said gate a molten casting charge for burning and replacing said embedded form in said mold body.

5. A method of casting, comprising the steps of wholly embedding a form having a recess and being substantially without residue on subjecttion to a molten casting charge and shaped for exact reproduction as a casting including said recess therein, in a body of molding sand and ramming the latter against said form and into said recess therein to fill the latter and interlock therewith against removal of said form from said sand body, forming in said rammed sand body a gate and a multiplicity of spaced vent passages leading to said form, and pouring into said gate a molten casting charge for burning and replacing said embedded form in said sand body.

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