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METHOD OF REINFORCING GREEN SAND CORES AND MOLDS WITH FOAM POLYMER COATED METAL ELEMENTS

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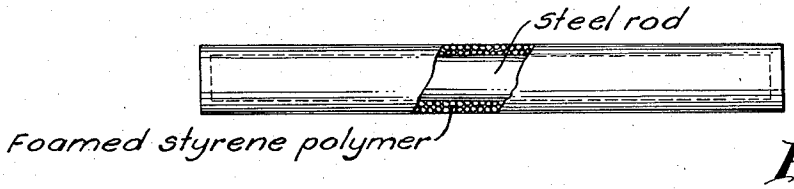


Fig. 1

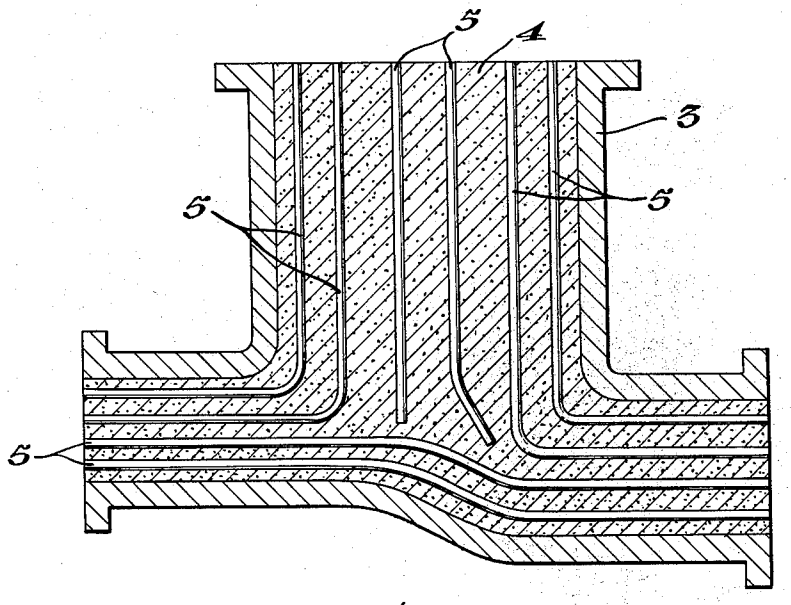


Fig. 2

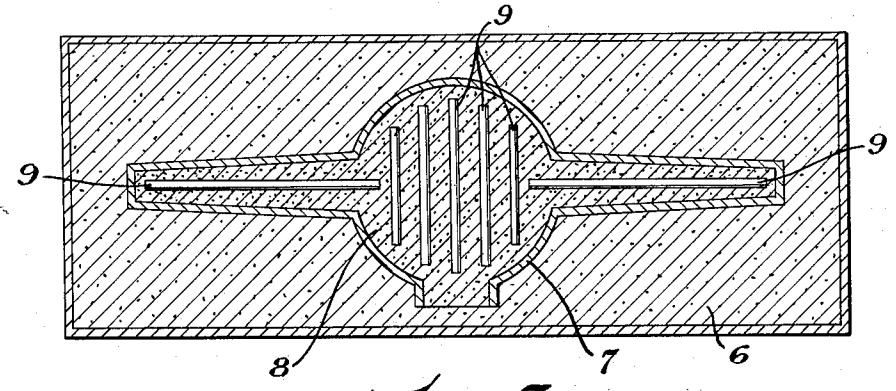


Fig. 3

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METHOD OF REINFORCING GREEN SAND CORES AND MOLDS WITH FOAM POLYMER COATED METAL ELEMENTS

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This invention relates to the manufacture of cast metal articles and more particularly relates to improvements in the making of reinforced sand molds and cores for the casting of metals. It pertains especially to improvements in embedding reinforcing metal rods, bars, strips, bonds, webs and the like in sand molds and cores prior to curing the same.

It is common practice to embed reinforcing metal rods, bars, webs and the like in green sand molds and cores to strengthen the same to inhibit or prevent breaking or cracking of the same during handling in the green state prior to curing or hardening of the shaped molds or cores. In general, reinforcing of green sand cores is necessary when cores of relatively large size are prepared in order to facilitate handling and to avoid cracking or breaking of the green sand cores prior to their being cured or hardened to a condition suitable for use in the casting of metals.

However, because of differences in the coefficients of expansion of the cured sand cores and metals, e.g. iron or steel, the embedded reinforcing metal rods, bars, or webs expand more rapidly or to a greater degree than the sand core, by heating upon pouring of the molten metal to be cast, with the result that the mold or core is cracked or broken and imperfect castings are obtained.

It has now been discovered that these difficulties can be prevented or substantially inhibited by embedding in the green sand core, reinforcing metal rods, bars, strips, bands or webs having on the surfaces thereof an adherent layer or coating of a foamed organic polymer of a thickness sufficient to provide a cushion for expansion of the reinforcing metal without producing appreciable stress or strain in the cured sand mold or core, upon being heated by the pouring of the molten metal to be cast into the mold.

It has further been found that the foam coated reinforcing metal rods, bars, strips, bands, webs, or the like are equally as effective for strengthening the green sand molds or cores to facilitate handling and prevent cracking or breaking in the green state as are uncoated metal reinforcing rods, bars, webs and the like, and are particularly effective for preventing breaking or cracking of the cured sand molds and cores in use for the casting of metals.

The coating can be a foam of any organic polymer such as a foamed polyurethane, foamed phenol-formaldehyde resins, foamed epoxy resins, foamed vinyl resins, foamed olefin polymer, or foamed alkenyl aromatic polymers, e.g. styrene polymers. Foamed alkenyl aromatic polymers, are preferred. By an alkenyl aromatic polymer is meant the normally solid homopolymers and copolymers containing in chemically combined, i.e. polymerized and interpolymerized, form at least 50 percent by weight of at least one alkenyl aromatic compound having the general formula

$$Ar-\overset{R}{\overset{|}{C}}=CH_2$$

wherein Ar represents a member of the group consisting of aromatic hydrocarbon and aromatic nuclear halogenated hydrocarbon radicals of the benzene series and R is a member of the group consisting of hydrogen and the

methyl radical. Examples of suitable alkenyl aromatic polymers are the homopolymers and copolymers of one or more alkenyl aromatic compounds such as styrene, vinyltoluene, vinylxylene, ethylvinylbenzene, isopropyl styrene, tert.-butylstyrene, ar-dichlorostyrene, methoxystyrene, fluorostyrene and the like, copolymers of one or more of such alkenyl aromatic compounds and a minor proportion of another copolymerizable ethylenically unsaturated monomer such as methyl methacrylate or acrylonitrile; and graft copolymers e.g. copolymers of from 1 to 15 percent by weight of natural or a synthetic rubber and a monoalkenyl aromatic compound such as styrene, vinyltoluene, vinylxylene and the like, and mechanical blends of alkenyl aromatic resins and from 1 to 15 percent by weight of natural or a synthetic rubber.

Methods for making foamable granules from such polymers are well known. For example, foamable granules can readily be prepared by polymerizing the monomer, e.g. styrene, in admixture with a volatile organic fluid such as pentane, hexane, petroleum ether, dichlorodifluoromethane, dichlorotetrafluoroethane, and the like, under pressure until a solid polymer is obtained, cooling the product under pressure, releasing the pressure and thereafter crushing, grinding or cutting the solid material to a granular form. In an alternative procedure, the monomer can be polymerized in admixture with the volatile foaming agent while dispersed as droplets in an inert liquid medium such as water or brine, under pressure, whereby the foamable granules are obtained. In another procedure, the foamable granules can be prepared by suspending granules of the polymer in an inert liquid medium such as water or brine and heating the granules of the polymer in admixture with the volatile organic foaming agent at temperatures between about 30° and 125° C. under pressure, whereby the resin granules are impregnated with the foaming agent, then cooling the mixture, releasing the pressure, separating and drying the impregnated polymer. The polymer can contain from about 0.03 to about 0.4 gram molecular proportion of the volatile organic foaming agent per 100 grams of the polymer, or stated differently foamable polymer compositions containing from about 3 to 8 percent by weight of pentane or an equivalent foaming proportion of a volatile organic fluid compound are satisfactory.

The foam coated metal rods, bars, strips, bands or webs to be employed as reinforcement in the green sand cores or molds can be prepared in any usual way. For example, metal bars, rods or webs, e.g. a screen or checkerboard panel, can be sprayed with a liquid mixture of a foamable polyurethane resin which is allowed to foam up on the metal to form a layer or coating of the foam of a desired thickness. In the case of using foamable beads or granules of the polymer such as foamable alkenyl aromatic polymer beads, the metal bar, rod, or web is first coated with a suitable adhesive such as a liquid curable phenol-formaldehyde resin or an epoxy resin to form a tacky coating on the metal, then contacting the adhesive coated metal with a body of the foamable beads or granules suitably of sizes of from about 0.5 to 5, preferably from about 1 to 3, millimeters in diameter to adhere the beads to the metal in a substantially uniform layer, and thereafter heating the adhered layer of beads in any usual way such as by steam, hot air, in an oven, infra-red lamps, or in a porous mold, to foam the beads and cure the adhesive, whereby the metal rod, bar or web is uniformly or is substantially uniformly coated with a layer of the foamed polymer. Such layer of the foamed polymer can be of a thickness of from about 1 to 20, preferably from about 2 to 20, millimeters or more thick. For best results the coating of the foamed polymer should be of substantially uniform thickness and should cover all or substantially all parts of the metal, particularly the ends

of the rods or bars so as to provide a cushion of the foamed polymer for lengthwise, or other, expansion of the rods or bars without transfer of such stress directly against the surrounding sand core or mold.

The foamed polymer coated reinforcing rods or bars and the manner in which they are embedded in a green sand core or mold in practice of the invention is described more particularly with reference to the accompanying drawing wherein:

FIG. 1 is a diagrammatic sketch partly in section showing an enlarged view of steel reinforcing rod coated with a layer of a foamed styrene polymer adhesively bonded to the rod by a heat-curable phenol-formaldehyde resin.

FIG. 2 is a diagrammatic sketch showing in cross section an arrangement of foamed polymer coated steel reinforcing rods embedded in the sand core for the casting of a metal valve body, e.g. from molten stainless steel or ordinary carbon steel.

In the drawing the numeral 3 indicates a metal valve body in cross section showing a sand core indicated generally by the numeral 4 having a plurality of foamed polymer coated steel reinforcing rods 5 embedded in the sand core 4, and

FIG. 3 is a diagrammatic sketch showing in cross section a sand mold 6 for the casting of a truck metal rear axle and differential housing 7 employing a sand core 8 having embedded therein foam polymer coated metal reinforcing rods 9.

In practice, among expansion areas where defects usually occur because of stress or strain resulting from unequal expansion of the reinforcing metal rods and the sand core when the reinforcing metal is not coated with a foamed polymer are those points or areas where bends occur in the reinforcing metal and where linear expansion of the reinforcing rods causes excessive stress or strain, e.g. at the ends of the casting shown in FIG. 3. However, when foam polymer coated metal rods are employed as reinforcing material in accordance with the invention in making the green sand core which is subsequently cured or hardened then used in the casting of metal, the effect of any stress or strain resulting from unequal expansion of the metal reinforcing rods, which are required to strengthen the green sand core but are not necessary in the cured core, is avoided because the foam provides a cushion for absorbing the difference in expansion of the materials upon heating and prevents such stress or strain from being transferred to the sand core.

The number, size and shape of the reinforcing metal bars, rods or webs to be embedded in the green sand core or mold is dependent upon the size, shape and configuration of the core or mold and will be apparent to those skilled in the art, it being necessary only in practice of the invention that the reinforcing metal elements be coated with a layer of organic polymer foam of a thickness sufficient to prevent or substantially inhibit the effect of unequal expansion of the cured sand core or mold and the metal reinforcing elements embedded therein and to cushion such expansion so as not to produce a resultant stress or strain between sand core or mold and the reinforcing metal.

The following examples illustrate ways in which the principle of the invention has been applied, but are not to be construed as limiting its scope.

Example 1

Carbon steel rods 0.5 inch in diameter and about 7 feet long commonly employed as reinforcing elements in the making of sand cores for a cast stainless steel valve body similar to that shown in FIG. 2 of the drawing were coated by brushing with a liquid curable phenol-formaldehyde resin and while sticky were rolled in a bed of foamable polystyrene granules of sizes between about 0.8 and 1.5 millimeters in diameter and containing about 6.5 percent by weight of pentane as the foaming agent, thereby forming a layer of the polystyrene beads adhered to the rods. The bead coated rods were heated with steam and were foamed to form a substantially continuous layer of the foam varying from about 9.5 to 12.5 millimeters thick surrounding the steel rod. The foam coated rods were embedded as reinforcing elements in a green sand core for a cast stainless steel valve body weighing about 2000 pounds and similar to that shown in FIG. 2 of the drawing. The foam coating on the reinforcing rods was tough, durable and was not broken by packing of the green sand in the core box. The green sand core containing the foam polymer coated steel reinforcing elements was cured and was subsequently employed as the core for casting a stainless steel valve body similar to that shown in FIG. 2 of the drawing and having the approximate internal dimensions of 30 inches, 20 inches and 9 inches respectively, for the valve body outlets, and a wall thickness which ranged from 6 inches to 5 inches to 3.5 inches, respectively, for said outlets. The foam polymer coated steel reinforcing elements were satisfactory for strengthening the green sand core, and the cured sand core was substantially better than a sand core made with uncoated steel reinforcing elements, for the casting of the stainless steel metal valve body.

Example 2

Carbon steel rods 0.25 inch in diameter and of lengths from 6 to 8 to 24 inches long were dipped into a liquid phenolic resin, were removed and allowed to drain for a period of from 30 to 60 seconds, then were dipped or plunged into a body of foamable polystyrene beads of sizes between about 0.8 and 1.5 millimeters diameter, containing about 6.5 percent by weight of petroleum ether (B.P. 30–45° C.) as blowing agent, thereby adhering a layer of the foamable beads to the resin coated steel rods. The bead coated rods were heated in an oven at a temperature of 120° C. for a period of from 2 to 5 minutes, thereby causing the beads to foam. The rods were removed from the oven, and while still in a foamed and plastic condition, the layer of foam was pressed with gloved hands and shaped to a substantially uniform layer covering the entire length and ends of the rods to a depth of the foamed layer of from about 6.5 to 9.5 millimeters.

The foam coated rods were employed as reinforcing elements in the making of a sand core for the casting of a metal rear axle and differential housing for a motor vehicle by embedding the foam coated rods in the green sand core in an arrangement similar to that shown in FIG. 3 of the drawing. The green sand core was cured and was employed for the casting of a steel rear axle and differential housing for a commercial motor vehicle similar to that shown in FIG. 3. The resulting casting was a perfect replica of the mold cavity.

In contrast, when a similar sand core was prepared employing the 0.25 diameter steel rods, without the polystyrene foam coating, as reinforcing elements and the cured core was used to cast a steel rear axle and differential housing it was found that linear expansion of the reinforcing rods caused breaking of the sand core at each of its ends. The resulting casting was unusable.

We claim:

1. In a method for making sand cores for the casting and molding of molten metals wherein the green sand core contains reinforcing metal elements embedded therein to strengthen the core prior to curing the same, the improvement which comprises coating the reinforcing metal with an adherent layer of from about 1 to 20 millimeters thick of a foamed organic polymer and embedding the foam coated reinforcing metal in the green sand core and thereafter curing said core.

2. A method according to claim 1, wherein the organic polymer is a foamed thermoplastic alkenyl aromatic polymer.

3. A method according to claim 2, wherein the foamed alkenyl aromatic polymer is polystyrene.

4. A method for making sand cores for the casting and

molding of molten metals which method comprises forming and shaping a green sand core while embedding within said core reinforcing metal elements coated with an adherent layer of from about 1 to 20 millimeters thick of a foamed organic polymer and thereafter curing said green sand core.

5. A method for making sand cores for the casting and molding of molten metals, which method comprises forming and shaping a green sand core while embedding within said core reinforcing metal rods coated with an adherent layer of from about 1 to 20 millimeters thick of a foamed thermoplastic alkenyl aromatic polymer, and thereafter curing said green sand core.

6. A method according to claim 5, wherein said foamed alkenyl aromatic polymer is polystyrene.

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