METHOD FOR CASTING TUBULAR MEMBERS

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METHOD FOR CASTING TUBULAR MEMBERS

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This invention relates to a method for casting tubular members having a passageway therethrough.

This invention is particularly suited for casting tubular members suitable for use as electrical insulating bushings for circuit breakers and other electrical apparatus. At present, circuit breaker bushings are manufactured by hot rolling apparatus or by an incinerator, paper on a mandrel. The mandrel is removed and the bushing is then machined to a proper size and shape. Finally, the bushing is given as many as six coats of varnish to reduce moisture absorption by the paper. At best, the varnish only reduces the rate of moisture permeability so that if the bushings are stored for long periods of time in humid atmospheres, their power factors become prohibitively high.

It would be desirable to mold bushings of the above described type from casting resins. However, many difficulties arise. If the bushing is molded as a solid member, a wasteful machining operation is required to bore a center hole for a conductor, such as copper or aluminum. Attempts have been made to cast the bushing around the conductor, but these have not been successful due to polymerization shrinkage and the difference in the coefficients of expansion of the resin and the metal conductor. This usually results in cracks in the cast bushing. Similar problems exist if the resin is cast around a split, sectional mold.

The object of this invention is to provide a method of casting in a mold having a central mandrel, polymerizable liquid compositions to produce tubular members having a passageway therethrough, by cooling the polymerizable liquid compound only at the surface of the passageway to a degree that it remains liquid during the casting operation, the remainder of the polymerizable liquid compound polymerizing to a solid tube, thereby producing a tubular member having no cracks therein and readily releasable from the mold.

Other objects will become more apparent from the following description thereof.

For a fuller understanding of the nature and objects of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a transverse sectional view of one form of molding apparatus of this invention;

Fig. 2 is a transverse sectional view of a circuit breaker bushing cast in the molding apparatus illustrated in Fig. 1; and

Fig. 3 is a transverse sectional view of a modification of the molding apparatus of this invention.

I have discovered a method for casting from polymerizable compositions, resinous tubular members having a longitudinal passageway therethrough. The members are cast from polymerizable liquid compositions such as the liquid polyesters, examples of which will be hereinafter given. The tubular members produced in accordance with this invention are sound, homogeneous and have no cracks therein. This is accomplished by keeping a thin layer of the casting composition at the passageway through the member, and in contact with the mandrel, liquid during the molding operation wherein the main body of the composition is heated to cause it to polymerize. As the casting composition polymerizes, it shrinks from the walls of the mold and against the liquid layer which acts as a cushion and is displaced, thereby effectively preventing cracking. When the cast resinous member is removed from the mold, the thin liquid layer forming the passageway therethrough is heated by the heat of polymerization present in the remainder of the cast tubular member and gels practically immediately and thus no "runout" occurs.

Referring to Fig. 1 of the drawing, there is illustrated an exemplary form of apparatus for carrying out the invention. A sheet metal mold 10 of any desired cross-section, having an upper opening and a closed bottom end is mounted in an upright position. The mold 10 may have one or more shoulders 11. The bottom end of the mold is closed by a disc member 12 having an opening 14 therethrough. A hollow cylindrical mandrel 16 having closed ends 18 and 20 is mounted through the opening 14 with a sufficiently tight fit so that liquid escape therethrough, and extends the length of the mold to the open end thereof. The mandrel 16 is to form a passageway through the tubular members to be cast in the mold 10. The cross-section of mandrel 16 may be circular, hexagonal or of any desired geometrical shape.

Mounted in the mandrel 16 is a pipe 22 for continuously circulating a coolant, such as tap water, through the interior of mandrel 16. The closed end 20 of mandrel 16 is provided with an overflow pipe 24 mounted therein for the discharge of the circulated coolant. During the entire molding operation, the mandrel 16 cools the adjacent polymerizable composition to a degree that a thin layer thereof surrounding the mandrel remains liquid.

The mold 10 is provided with a heating element 26 such as Nichrome wire wrapped around a layer of insulation comprising asbestos 27 cemented to the mold 10 with water glass. The Nichrome wire is connected to a suitable source of electrical current (not shown).

Instead of using the heating element such as the one described, the mold 10 may be constructed of ultra violet transmitting glass or like transparent material and the resinous composition cured by means of actinic light such as ultra violet rays, etc.

A tube is cast by pouring a liquid polyester resin 29, for instance, in the open end of the mold 10 which has been heated to a temperature of about 100° C. while tap water is circulated through the mandrel 16. As the main body 29 polymerizes to a solid, it shrinks away from the walls of the mold 16, but a thin layer around the mandrel 16 remains liquid. The solid resinous member is completely polymerized in 15 minutes and is inverted the mold 10, whereupon the member will slide out freely therefrom.

Illustrated in Fig. 2 of the drawing is a circuit breaker bushing 28 cast from a polyester resin in the mold 10. The bushing 28 is illustrated in Fig. 2 of the drawing is supported by bracket means 30 butted against struts 32. Insulating through the bushing 28 is a copper conductor 34. The passageway through the bushing was so molded that there is a tight fit between the bushing and the conductor. The conductor 34 is fixedly mounted in the bushing by threads at the ends of the conductor as at 36 and 38 and cooperating silicone rubber washers 40 and nuts 42.

Illustrated in Fig. 3 of the drawing is a modification of the apparatus in accordance with the invention, for producing thermostet tubular members of continuous length. A mold 44 is provided with a heating element 46 and a cooling mandrel 48 in the same manner as the construction illustrated in Fig. 1 of the drawing. The mold 44 has a barrier 50 provided with a plurality of
passageways 52 leading to a screw type plastic extruder 54. A screw conveyor 56 driven by gear 58 and pinion 60 continuously forces a polymerizable resin composition 62 through the passageways 52 into the mold 44 at a rate sufficient to allow the composition to polymerize and produce a solid continuous tubular member issuing from the open end of the mold 44. The cooling mandrel 48 passes through the axis of the screw conveyor 56, as shown in the drawing, and is cooled in the same manner as the mandrel 16 illustrated in Fig. 1 of the drawing.

The following examples illustrate the formulation of suitable casting compositions for use in the practice of this invention, which may be cured in molds at temperatures of from 60° C. to 150° C.

Example 1
A casting resin mixture was prepared from the following ingredients:

70 parts by weight of a mixture of 75% of castor-oil-maleate (0.02% quinhydrone as inhibitor) and 25% monostyrene by weight
30 parts by weight 365 mesh mica
0.7 part by weight aluminum acetyl acetonate
0.7 part by weight cobalt napthenate solution (6% cobalt)
0.7 part by weight 60% solution of methylketone peroxide.

The resulting mixture was a syrupy liquid. It was evacuated to remove air. The mixture was then poured into the mold illustrated in Fig. 1 of the drawing, which was heated to a temperature of 100° C. The mandrel 16 was cooled to about 20° C. by continuously passing tap water therethrough. After about 15 minutes, the mixture had gelled and polymerized to a solid which had shrunk away from the walls of mold 10. The resinous casting was then removed by inverting the mold whereupon it slid out. No cracking or sticking occurred.

Example II
A mixture of the following was prepared:

70 parts by weight of a composition comprising 30% of styrene and 70% of phthalic maleic anhydride propylene glycol polyester resin
30 parts by weight 365 mesh mica
0.14 part by weight each of cobalt napthenate and a 60% solution of methyl-ketone peroxide.

This mixture was vacuum treated to remove air and was cast in the mold illustrated in Fig. 1 of the drawing which was heated to 80° C. A solid hotcast mold was removed after 10 minutes treating time. A harder casting than the one of Example I was obtained from the above resin.

Completely-reactive compositions suitable for use in this invention may include any fluid polymerizable composition that, upon being heated to a predetermined temperature, polymerizes into a relatively-hard resinous body. The fluid resinous composition may comprise a single polymerizable component such, for example, as diallyl phthalate, diallyl succinate, diallyl maleate, diallyl adipate, allyl alcohol, methacryl acrylate, diallyl ether, alky acrylate, allyl crotonate or a partially condensed organosiloxane having a ratio of R to Si of from 1:1 to 1:1.8. It will be noted that many suitable compositions comprise at least one unsaturated group >C=CC< capable of vinyl-type reactive polymerization. The best results have been secured with monomers containing two or more of these unsaturated groups capable of polymerization upon being subjected to heat. It will be understood that mixtures of any two or more of the polymerizable monomers may be employed. Numerous other multi-component completely-reactive compositions are known to the art. Such compositions include, in many cases, an unsaturated resin component—particularly an unsatu-
having a passageway therethrough, the steps comprising introducing a polymerizable resinous composition in liquid form into a mold of desired configuration, curing the composition by heating to a temperature of from 60° C. to 150° C. for a period of time sufficient to polymerize the composition to a solid while cooling a thin layer of the composition at the surface of the passageway to a temperature sufficient to keep the composition liquid in said thin layer, and removing the solidified resin forming the tube from the mold.

2. The method of claim 1 in which the curing of the resinous composition is accomplished by actinic rays.

3. A process for preparing a tubular member having a passageway extending longitudinally therethrough which comprises (A) introducing a liquid polymerizable resinous composition into a mold having (1) a molding cavity of a configuration of the tube to be cast, and (2) a centrally disposed mandrel extending beyond the ends of the cavity for forming a passageway through the tube, (B) curing the resinous composition by heating to a temperature of from 60° C. to 150° C. for a period of time sufficient to polymerize substantially all the resinous composition to a solid while (C) simultaneously passing coolant through the mandrel to maintain the temperature of a thin layer of the resinous composition surrounding the mandrel low enough whereby that layer remains liquid, and (D) removing the resulting solidified tubular member from the mold.

4. The method of claim 3, in which the curing of the resinous composition is accomplished by actinic rays.

References Cited in the file of this patent

UNITED STATES PATENTS

2,265,226 Clewell et al. ................................. Dec. 9, 1941
2,359,013 Tucker ................................. Sept. 26, 1944
2,420,488 Marhoefer et al. ........................ May 13, 1947
2,518,504 Stott ................................. Aug. 15, 1950
2,534,722 Waters ................................. May 29, 1951
2,719,330 Stott ................................. Oct. 4, 1955

FOREIGN PATENTS

474,242 Great Britain ................................. Oct. 27, 1937
685,043 Great Britain ................................. Dec. 31, 1952