United States Patent [19]

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[54] **HOLLOW, MULTI-LAYERED, CROSS-LINKED PLASTIC STRUCTURES AND PROCESS FOR PRODUCING SAME**

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[52] **U.S. Cl.** **264/255;** 260/873; 264/114; 264/310

[51] **Int. Cl.**[2] **B29C 5/04;** B29D 9/00; B29D 23/08

[58] **Field of Search** ..... 264/310, 311, 114, 255, 264/240, 270; 260/873, 94.9 GA

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[57] **ABSTRACT**

Hollow, multi-layered plastic structures are provided comprising a layer of thermoplastic polyester material and a layer of polyethylene, the polyethylene and polyester layers being cross-linked together at their interface. A process for producing such structures which comprises charging a mold with thermoplastic polyester material, rotating and heating the mold so as to fuse and form a layer of the polyester material on the inner surface of the mold, cooling the mold to a point below the melting point of the polyester but above the melting point of a subsequently added cross-linkable polyethylene material, stopping the rotation and charging the mold with the cross-linkable polyethylene material, resuming the rotation of the mold and heating it to a temperature sufficient to fuse and cross-link the polyethylene with the polyester layer, cooling the mold to a point below the melting point of the polyethylene and removing the finished structure from the mold.

6 Claims, No Drawings

PLAINTIFF'S EXHIBIT

CEL-1323

chamber where the biaxial rotation was maintained and a fan directed on the mold for 7 minutes to set the polyester layer within. The spindle was then indexed with the mold to a load-unload station where rotation was stopped and the Teflon plug removed from the filling opening in the mold end opening cover. Through this filler opening, 15 lbs. of cross-linkable polyethylene (FLAMOLIN MF-15711) in finely divided powder form of about 50 mesh was dumped into the mold and the filling plug replaced in the mold cover. Biaxial rotation was restarted and the spindle was then indexed with the mold to an oven station set at 450°F where it was kept for 25 minutes so that a layer of polyethylene was formed on and cross-linked to the polyester layer. The speeds and ratio of rotation thereof were the same as employed in the first heating station. At the end of the second oven cycle the mold was positioned in a cooling chamber where it was subjected to a fan for 8 minutes followed by a water spray for 10 minutes and then a fan again for 2 minutes; thus lowering the temperature to a point below the melting point of the polyethylene. Following this cooling, the mold was indexed to the unload station where the cover was unclamped from the mold and set aside. The mold was then tilted to a 30° angle whereupon the molded battery case dropped out of the mold with a slight pulling force on the case. After suitable cooling at room temperature, the molded case was cut to desired height. The polyester layer in the finished product had a thickness of approximately ¼ inch while the polyethylene layer was approximately 0.100 inch thick.

As used in this description of the invention the term "multi" is intended to encompass two layers of layered polymeric material.

The above described process may be used in the production of a wide variety of structures including tanks, containers, vessels, barrels, and the like. Particularly useful multi-layered structures produced according to this invention serve as cases for industrial size batteries. Such a case will have an outer surface with the characteristic structural strength and other properties of polyester but the added feature of resistivity to chemical attack in its inner surface.

I claim:

1. A process for producing a hollow, multi-layered cross-linked, plastic structure from a linear thermoplastic polyester and a cross-linkable polyethylene having a melting point lower than the melting point of the polyester, said process comprising the steps of: charging a mold with a sufficient amount of the thermoplastic polyester material to form a substantially uniform layer on the inner surface of said mold; heating said mold to a temperature above the melting point of the polyester; rotating said mold so as to fuse the polyester contained within the mold and to uniformly distribute the fused polyester on the inner surface of the mold; cooling said mold to a temperature below the melting point of the polyester but above that of the cross-linkable polyethylene thus crystallizing the polyester to a solid layer; stopping the rotation of the mold; charging said mold with a sufficient amount of the cross-linkable polyethylene to form a substantially uniform layer on said polyester layer; heating said mold to a temperature above the melting point of the polyethylene and sufficiently below the melting point of the polyester so as not to cause dimensional distortion of the polyester; rotating the polyethylene charged mold for a sufficient period of time to fuse said polyethylene, uniformly distribute the polyethylene on the inner surface of the polyester layer and effect cross-linking of said polyethylene so as to set the polyethylene layer and effect cross-linking of said polyethylene to said linear polyester; and stopping the rotation of said mold to remove the resulting hollow, cross-linked multi-layered polymeric structure.

2. A process as defined in claim **1** wherein said thermoplastic polyester is a glass-fiber filled polyester of terephthalic acid and a glycol of the series $HO(CH_2)n$ OH wherein *n* is a whole number within the range of 2 to 10.

3. A process as defined in claim **2** wherein said cross-linkable polyethylene includes a fire retardant agent.

4. A process as defined in claim **3** wherein said cross-linkable polyethylene includes a cross-linking agent selected from the group consisting of dicumyl peroxide, 2-5 dimethyl 2,5-di(t-butyl peroxy) hexane and 2,5-dimethyl-2,5-di(t-butyl peroxy) hexyne -3 and a halogenated fire retardant agent.

5. A process for producing a fire retardant, hollow, multi-layered, cross-linked, plastic structure comprising the following steps: charging a mold with a sufficient amount of a linear, thermoplastic polyester material having a melting point between about 400°F and about 500°F to form a substantially uniform layer on the inner surface of said mold biaxially rotating and heating said mold to a temperature between about 500°F and about 650°F for a period of time between about 20 and about 30 minutes so as to fuse the polyester contained within the mold and uniformly distribute said fused polyester on the inner surface of said mold; cooling said mold while maintaining its biaxial rotation to a temperature between about 280°F and about 350°F to set the polyester to a substantially set layer; stopping the rotation of the mold and charging said mold with a sufficient amount of cross-linkable polyethylene including a cross-linking agent and a fire retardant agent; biaxially rotating and heating the polyethylene charged mold to a temperature between about 425°F and about 450°F for a period of time between about 20 and about 25 minutes so as to uniformly distribute the polyethylene on the inner surface of the polyester layer and effect cross-linking of said polyethylene and said linear polyester at their interface; cooling said mold to a temperature below the melting point of said polyethylene so as to substantially set the polyethylene layer; and stopping the rotation of said mold to remove the resulting fire retardant, hollow, cross-linked, multi-layered polymeric structure.

6. A process as defined in claim **5** wherein said cooling of the mold containing said fused polyester is effected by exposing the mold to a fan and the cooling of the mold containing both the set polyester layer and the fused polyethylene layer is achieved in a three-step procedure including exposing the mold to a fan for about 8 minutes followed by a water spray for about 10 minutes and a fan again for about 2 minutes.

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