

PATENT SPECIFICATION

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(54) METHOD FOR MOULDING STRING-MOUNTED PLASTICS MEMBERS

(71) I, IRVING LEVINE, a citizen of the United States of America, residing at 23555 Park Belmonte, Calabassas Park, California, United States of America, do hereby declare the invention for which I pray that a patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement:—

10 This invention relates to a method for simultaneously fabricating a plurality of plastics members on a string-like supporting-element such as wire, nylon thread or the like.

15 There are several kinds of processes which are disclosed by the prior art for mounting thermoplastics materials on a string-like supporting element. The processes are generally described as compression moulding, injection moulding or casting. Conventional compression moulding and injection moulding processes are generally carried out by subjecting the thermoplastics material and the string-like supporting element to pressure above 1500 pounds per square inch and at temperatures in excess of 360°F. Depending upon the selection of plastics material and the shape of the mould, moulding pressures could be of the order of 10,000 pounds per square inch. The use of high moulding pressures is encountered in transfer moulding which is a form of injection moulding.

35 Casting is a typical method utilised in the electronics industry for encapsulating or otherwise embedding circuits or other media within a protective covering. The casting method is expensive and is not applicable to the mass production application to which the present invention is applied. One of the problems inherent in casting is the typical required step of curing the plastics material at elevated temperatures for periods up to or greater than 12 hours, the exact cure time being dependent

upon the temperature, mould shape and the selection of material.

The present invention is directed toward a process whereby thermoplastics members are mounted upon a string-like supporting element. One of the processes disclosed in the prior art for encapsulating a string-like supporting element with thermoplastics material utilises a two-piece mould which provides access channels for the string-like supporting element which in this case is typically a wire or other like structure. The thermoplastics material is enclosed within the mould and the mould raised to the gel temperature. The thermoplastics material is caused to flow around the string-like supporting element.

The present invention is directed toward a mass production operation wherein a plurality of string-like supporting elements are passed through the mould, thermoplastics members being securely fixed to the string-like supporting elements in sequential steps. None of the processes described in the prior art exhibit the necessary flexibility to permit execution of the stated operation. In those systems disclosed in the prior art a heated thermoplastics runner is injected into a channeled mould, each half of the mould containing complementary cavities to define the plastics member to be mounted. Prior to injection of the thermoplastics material, the string-like supporting element is aligned across the cavity, the string-like supporting element itself being used to prevent flow from one cavity to the other. Subrunners of the thermoplastics material provide for injection into all cavities in a manner which facilitates removal of the moulded material subsequent to cooling.

It is an object of the present invention to provide an improved method for forming thermoplastics members upon a string-like supporting element.

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It is another object of the invention to provide an improved method for forming thermoplastics members on a plurality of parallel string-like supporting elements.

- 5 It is still another object of the invention to provide an improved method for permanently mounting thermoplastics beads upon a string-like supporting element.

- 10 It is yet another object of the invention to provide an improved method for forming thermoplastics beads on a string-like supporting element in a simplified and economical manner.

- 15 According to the invention there is provided a method for the simultaneous fabrication of thermoplastics members directly upon a string-like supporting element using half mould plates each having complementary thermoplastics - member - forming cavities, string - like - supporting - element - receiving channels, runner channels and subrunner channels, comprising the steps of:—

- 25 (a) creating a body of flowable thermoplastics material by heating the material in the range of 360° to 400°F;
- (b) disposing a plurality of pairs of string-like supporting elements adjacent said thermoplastics - member - forming cavities intermediate the half mould plates;
- 30 (c) isolating each of said thermoplastics-member-forming cavities from each adjacent cavity by force-fitting therein the string-like supporting elements while closing the mould plates together;
- 35 (d) injecting the flowable thermoplastics material into the cavities and about the string-like supporting elements adjacent each cavity at a pressure in the range of 400 to 900 pounds per square inch; and
- 40 (e) allowing the thermoplastics material to remain in the mould for 10 to 20 seconds to effect cooling solidification of the formed members.

- 50 The method as just set forth may be carried out by apparatus of the kind described and claimed in the Specification of Patent Application No. 1974/74, (Serial No. 1 456 311).

- 55 The invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

- 60 Figure 1 is a side elevation view of a plurality of thermoplastics members fabricated in accordance with the invention,

Figure 2 is a side elevation view of one half mould plate and illustrates the input of a string-like supporting element prior to moulding the thermoplastics material,

- 65 Figure 3 is a rear elevation view of a

second half mould plate and illustrates the input for molten thermoplastics material,

Figure 4 is a cross-sectional view of the half-mould plate shown in Figure 3 taken on line 4-4 of Figure 3,

Figure 5 is a perspective view of the mounted half mould plate shown in Figure 2 including cooling ducts,

Figure 6 is a perspective view of the mould and illustrates the output of mounted thermoplastics members,

Figure 7 is a partial, cross-sectional view of the mould including means for disconnecting a thermoplastics runner subsequent to the moulding process as shown in Figure 3 taken on line 7-7 of Figure 3, and

Figure 8 is an enlarged cross-sectional view of mounted thermoplastics members including the gates from thermoplastics subrunners.

Figure 1 illustrates one form of product which can be produced by the method according to the invention. The product shown in Figure 1 constitutes a pair of string-like supporting elements 16 on which are mounted thermoplastics members shown as beads 10, 11, 12, 13, 14, and 15. The product illustrated in Figure 1 is the direct output of the method, when using apparatus as shown in the drawings, by the remaining presence of thermoplastics runner 17 and subrunners 18a, 18b, 18c, and 18d. Although only a small number of beads 10 to 15 are shown in Figure 1, the product produced by the method is substantially an endless chain which can be separated into lengths as desired.

As will be described hereinbelow, each bead 10 to 15 is formed by filling a cavity within a mould through the use of the runner 17 and subrunners 18a to 18d. While the thermoplastics material comprising the runner 17 and subrunners 18a to 18d is in a molten or flowable condition gates provide for a substantially cylindrical channel from the runner and subrunner channels to the cavities used for forming beads 10 to 15. As shown in Figure 1, the gates 19a to 19f provide for transmission of molten or flowable thermoplastics material from the runner 17 and subrunners to the cavities used for forming the beads 10 to 15 respectively.

The apparatus used to carry out the method when manufacturing the product shown in Figure 1 will now be described with reference to Figures 2, 3, 4, and 6.

As can be seen in Figure 6, the apparatus utilises a mould consisting of three plates 25, 26, 27 of which moulding is effected in cavities formed between the plates 25 and 26. Plate 26 which is shown in detail in Figure 2, includes an insert 28 which is set into and with the plate constitutes one half mould plate of the mould used for fabricating the beads shown in Figure 1.

Referring now to Figure 2 and Figure 5 the insert 28 includes a plurality of sets of half cavities used for fabricating the products 10 to 15 shown in Figure 1, the half cavities of each set being spaced apart in line and the sets disposed in parallel pairs. Insert 28 includes a pair of parallel runner channels 29a and 29b which are adapted to receive molten thermoplastics material which form the runners 17 when the plate 26 engages the plate 25. The plate 25 includes an insert 36 which is set into the plate 25 and which is complementary to the insert 28. Communicating with each runner channel 29a and 29b are a plurality of branches forming subrunner channels 30, the subrunner channels 30 being adapted to form the subrunners 18a to 18d of thermoplastics material when the plate 26 engages plate 25 during the moulding process.

The apparatus permits a number of thermoplastics members mounted on string-like supporting elements to be fabricated in parallel. As shown in Figure 2 and Figure 5, string-like supporting elements 31a to 31d are disposed through apertures 32 in the plate 26, the string-like supporting elements 31a to 31d being in parallel spaced relation with each other, grouped in pairs defined by reference numerals 31a and 31b, and 31c and 31d respectively. As will be explained hereinbelow, cooling lines 33, Figure 5 are disposed in the plate 26 adjacent each set of thermoplastics receiving cavities to provide for cooling of the molten or flowable thermoplastics material when the thermoplastics members are being fabricated about the string-like supporting elements. This will be explained in detail hereinbelow.

The structure of the complementary plate 25 can be best seen by reference to Figures 3, 4 and 7. Figure 3 illustrates a rear, elevation view of plate 25, Figure 4 illustrating a cross-sectional view of the thermoplastics receiving channels disposed in plate 25. Plate 25 upon the surface opposite from the plate 26 contains an insert which is a mirror image of the insert 28, and therefore all discussion with respect to the insert 28 applies equally well to that contained within the plate 25. The injection of molten or flowable thermoplastics material is accomplished through an aperture 35 disposed in the rear surface of plate 25. Each aperture 35 includes an orifice through the plate 25 and an insert 36, Figure 4, which is an insert complementary to the insert 28 described above. In addition, the aperture 35 communicates with transverse channels 37 and 38 which transversely extend across the insert 36. Channels 39a to 39c and 40a to 40c which are perpendicular to channels 37 and 38 extend through the depth of insert 36. Channels

39a, 39b and 39c communicate with the runner channel 29a of the insert 28, and channels 40a, 40b and 40c communicate with the runner channel 29b of the insert 28. As will be explained hereinbelow, when the mould forming plates 25 and 26 are in abutment, the complementary channels of the inserts 28 and 36 are formed for the transmission of molten or flowable thermoplastics material from the aperture 35 through the formation of runners 17, subrunners 18a to 18d and beads 10 to 15.

An understanding of the moulding of the thermoplastics members upon a string-like supporting element can be best gained by reference to Figure 8 wherein an enlarged, cross-sectional view thereof is shown. Subrunner 40 is a solidified mass of thermoplastics material which is filled in accordance with the process. As stated hereinabove, in order to fill the cavities adapted to receive the thermoplastics material which is to form beads 41 and 42, gates 43 and 44 are disposed intermediate subrunner 40 and beads 41 and 42 respectively. In order to provide a product which has a suitable appearance, beads 41 and 42 must be severed from gates 43 and 44 at the points of intersection 45 and 46 respectively. Therefore, the gate size of gates 43 and 44 must be a compromise between a diameter which is large enough to ensure that the cavities for the beads 41 and 42 will be completely filled prior to cooling and a diameter which is small enough not to leave any residue attached to beads 41 and 42 which will detract from the appearance thereof. The gate size will vary with the injection pressure as well as with the size of the bead. A suitable gate diameter is in the range of 0.015 to 0.022 inches. It has also been found that the pigment used to colour the thermoplastics material can influence injection pressure. Where an oil base or a synthetic oil base pigment is used, a higher injection pressure is necessary. An injection pressure of 400 to 900 pounds per square inch is used to ensure that the molten or flowable thermoplastics material is totally received by the inserts 28 and 36 (Figure 2 and Figure 4) prior to initiating the curing cycle.

Referring again to Figure 8, the beads 41 and 42 must be mounted upon the string-like supporting element 47 in a manner which will ensure substantial permanency as well as facilitate processing. As discussed hereinabove, the string-like supporting element 47 serves the purpose of isolating each cavity used to form the beads 41 and 42. As an example, the portion 48 of element 47 intermediate beads 41 and 42 was disposed intermediate the cavities being adapted to receive the thermoplastics material used to form the beads 41

and 42. Portion 48 of the element 47 isolates the cavities receiving the thermoplastics material. As can be seen in Figure 8, there is substantially no residue of the thermoplastics material in or about the portion 48 of element 47 external to the boundary of bead 41 or of bead 42. The material used to fabricate the string-like supporting element 47 must be sufficient to withstand the forces imposed upon the mould, the forces being typically in the range of 200 tons. It has been found that nylon is suitable to form the element 47 since it will withstand the forces on the three-plate mould as well as the temperatures used to cause the thermoplastics material to flow, i.e., 360 to 400°F.

As mentioned hereinabove, one of the objects of the invention is to provide a method for fabricating thermoplastics members on string-like supporting elements in parallel. Figure 5 and Figure 6, illustrate the manner in which the apparatus meets this object. As is shown in Figure 5, string-like supporting elements 31a, 31b, 31c, and 31d are directed through plate 26 via apertures 32, the string-like supporting elements being disposed in parallel pairs across the respective input channels of insert 28. When the plates 25, 26 and 27 are brought into contact, and after the thermoplastics material is injected as described in connection with Figure 3 and Figure 4, two sets 49 and 65, Figure 6, of a pair of string-like supporting elements with mounted thermoplastics members will be produced. This is amply shown in Figure 6. Where the gate size is suitable as shown in Figure 1, beads 10 to 15 mounted upon the string-like supporting element 16, Figure 1, can be stripped away from the solidified subrunners 18a to 18d leaving the separated string-like supporting elements with their mounted thermoplastics beads.

As was described in connection with Figure 3 and Figure 4, molten or flowable thermoplastics material is input at aperture 35 of plate 25, the molten thermoplastics material flowing into channels 37 and 38 and eventually reaching the complementary cavities disposed in the inserts 28 and 36. One of the problems inherent in any injection process is removal of the unused thermoplastics material. It has been described how the string-like supporting elements with the beads mounted thereon are separated from the runners and subrunners. In order to fully remove all unused solidified thermoplastics material in a manner which will meet the object of simplicity and economy, the solidified thermoplastics material in channels 37 and 38 and intermediate aperture 35 must also be removed. Referring now to Figure 7, a side elevation, cross-sectional view of the plates 25 and

26 in the engaged position is shown. Molten or flowable thermoplastics material injected at aperture 35 is caused to flow through a tapered channel 50, the flow thereof being distributed at channels 37 and 38, Figure 4, and the termination thereof being at the interface of the inserts 28 and 36. Subsequent to the curing cycle, material will be solidified in the channels 37, 38 and 50. The manner in which the solidified runners can be removed subsequent to the curing cycle will now be described. Channel 50 is integral with aligned channels 39b and 40b, Figure 3. In order to effectively remove the solidified runner, bores 51 and 52, Figure 7, are disposed through the inserts 28 and 36 of the plates 26 and 25. Bores 51 and 52 are in parallel relationship with each other as well as with the channel 50. Pins 53 and 54 are adapted to be slidably received within bores 51 and 52 respectively and are coupled to the plate 26. Pins 53 and 54 extend to the boundary of aligned channels 39b and 40b. The ends 55 and 56 of pins 53 and 54 respectively have axial protrusions 57 and 58 respectively thereon, of smaller diameter than the pin, the protrusions being enlarged at their ends to form knobs 59 and 60 respectively. When plates 25, 26 are separated, pins 53, 54 will be withdrawn from bores 51, 52 permitting the solidified runners to be removed.

When thermoplastics material is solidified within channels 37, 38 and 50, the thermoplastics material will be formed about knobs 59 and 60 and their axial bases 57 and 58 respectively. When plates 25 and 26 are separated, the thermoplastics material in channels 37, 38 and 50 will be severed from the remaining solidified thermoplastic material since knobs 59 and 60 will tend to sever or otherwise fracture the material at a joint adjacent axial bases 57, 58. Although Figure 7 illustrates only a single vertical structure for severing the thermoplastics runner from the remaining moulded material, it is clear that a number of pins and like structures are utilised throughout the plates where they are deemed necessary.

As stated, an object of the present invention is to permit the formation of a plurality of strands of thermoplastics beads on string-like supporting elements in a simultaneous operation. The basic material used to fabricate the product can be substantially any conventional thermoplastics material flowable at 360 to 400°F, such as polyvinyl chloride, but the preferred form of the invention utilises polystyrene. The thermoplastics material is heated to a temperature of 360 to 400°F to place the material in a molten or flowable condition suitable for injection into the mould. Injection pressure is in the range of 400 to 900 pounds per

square inch, the injection pressure being dependent on the size of the beads, the number of beads and the type of pigmentation used to provide colour to the beads. The mould is subjected to forces in the range of 200 tons. After the applicable force is imposed upon the plates forming the mould, the thermoplastics material is injected into plate 25 at aperture 35 and forced into the cavities in the bead inserts 28 and 36. Once the thermoplastics material has been injected into the mould, the solidification time is initiated. Since the thermoplastics material must be solidified prior to opening the moulds, an interval of approximately 10 to 20 seconds is allowed. The solidification of the thermoplastics material is effected by using cooling fluid at a temperature approximately 40°F, the cooling fluid being caused to flow to the plate 26 via cooling lines 33 (Figure 5). Subsequent to the expiration of the solidification time, the sets of joined beads 49 and 50 (Figure 6), are extracted from the separated plates 25 and 26 (Figure 6), additional string-like supporting elements 31a to 31d (Figure 5) being extended across plate 26 and insert 28 and into the applicable string-like-supporting-element-receiving slots. Plates 25 and 26 are again closed, subjected to the stated force and thermoplastics again injected as described hereinabove. Since the thermoplastics material can be remelted, the solidified runner and subrunner discussed in connection with Figure 7 can be recycled after they have been removed from the fabricated product, the solidified runners and subrunners being reground and used to augment the supply of thermoplastics material.

The invention comprises a method for simultaneously producing a plurality of string-like supporting elements each having thermoplastics beads mounted thereon in a more efficient and economical manner than provided in the prior art. The beads are mounted upon a nylon string-like supporting element in a manner which allows at least four such elements with beads mounted thereon to be fabricated simultaneously. The nylon elements are used to separate bead cavities in the moulds and thereby

simplify the apparatus. Since the basic thermoplastics material can be recycled, the separation of the beads by proper design of the gates allows separation of the beads from the solidified runners and subrunners thereby permitting recycling of the waste materials.

WHAT I CLAIM IS:—

1. A method for the simultaneous fabrication of thermoplastics members directly upon a string-like supporting element using half mould plates each having complementary thermoplastics-member-forming cavities, string-like-supporting-element-receiving channels, runner channels, and subrunner channels, comprising the steps of:—

- (a) creating a body of flowable thermoplastics material by heating the material in the range of 360° to 400°F;
- (b) disposing a plurality of pairs of string-like supporting elements adjacent said thermoplastics-member-forming cavities intermediate the half mould plates;
- (c) isolating each of said thermoplastics-member-forming cavities from each adjacent cavity by force-fitting therein the string-like supporting elements while closing the mould plates together;
- (d) injecting the flowable thermoplastics material into the cavities and about the string-like supporting elements adjacent each cavity at a pressure in the range of 400 to 900 pounds per square inch; and
- (e) allowing the thermoplastics material to remain in the mould for 10 to 20 seconds to effect cooling and solidification of the formed members.

2. A string of thermoplastics members on a string-like supporting element made by the method according to Claim 1.

3. A string of thermoplastics members according to Claim 2 wherein the members have the form of beads.

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square inch, the injection pressure being dependent on the size of the beads, the number of beads and the type of pigmentation used to provide colour to the beads. The mould is subjected to forces in the range of 200 tons. After the applicable force is imposed upon the plates forming the mould, the thermoplastics material is injected into plate 25 at aperture 35 and forced into the cavities in the bead inserts 28 and 36. Once the thermoplastics material has been injected into the mould, the solidification time is initiated. Since the thermoplastics material must be solidified prior to opening the moulds, an interval of approximately 10 to 20 seconds is allowed. The solidification of the thermoplastics material is effected by using cooling fluid at a temperature approximately 40°F, the cooling fluid being caused to flow to the plate 26 via cooling lines 33 (Figure 5). Subsequent to the expiration of the solidification time, the sets of joined beads 49 and 50 (Figure 6), are extracted from the separated plates 25 and 26 (Figure 6), additional string-like supporting elements 31a to 31d (Figure 5) being extended across plate 26 and insert 28 and into the applicable string-like-supporting-element-receiving slots. Plates 25 and 26 are again closed, subjected to the stated force and thermoplastics again injected as described hereinabove. Since the thermoplastics material can be remelted, the solidified runner and subrunner discussed in connection with Figure 7 can be recycled after they have been removed from the fabricated product, the solidified runners and subrunners being reground and used to augment the supply of thermoplastics material.

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 - (c) isolating each of said thermoplastics-member-forming cavities from each adjacent cavity by force-fitting therein the string-like supporting elements while closing the mould plates together;
 - (d) injecting the flowable thermoplastics material into the cavities and about the string-like supporting elements adjacent each cavity at a pressure in the range of 400 to 900 pounds per square inch; and
 - (e) allowing the thermoplastics material to remain in the mould for 10 to 20 seconds to effect cooling and solidification of the formed members.
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