METHOD OF ENCAPSULATING A MAGNET WITH POLYTETRAFLUOROETHYLENE

Filed March 4, 1958

Fig. 1.

Fig. 2.

Fig. 3.

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METHOD OF ENCAPSULATING A MAGNET WITH POLYTETRAFLUOROETHYLENE

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Filed Mar. 4, 1958, Ser. No. 719,148
5 Claims. (Cl. 18—59)

This invention relates to a method of encapsulating magnets.

One method of stirring liquid substances in containers, such as glass beakers, is to dispose a magnet in the beaker on the bottom thereof and to provide a moving magnetic field below the beaker which causes the magnet to move within the beaker and stir or agitate the liquid. Such a stirring method is finding increased popularity in laboratories. A serious problem arises, however, in that in order to preclude reactions between certain liquids and the magnetic material comprising the magnet, it is necessary to coat or encapsulate the magnet with an inert substance. This protective coating must be free of flaws as even the slightest passage therethrough may be sufficient to permit contamination of the liquid which may result in serious economic and time loss.

A material which has been found to be particularly well-suited for such protective coating, due to its inert characteristics, is Teflon (tetrafluoroethylene polymer). While Teflon has the desirable characteristics of inertness, it has a serious disadvantage in that it is difficult to mold uniformly around the magnet without flaws. To avoid this problem, one method of encapsulating the magnet has been to provide a pair of preformed cup-shaped Teflon elements which are placed over the opposite ends of the magnets and fused together as by slitting. This method has the disadvantages of distorting the Teflon elements so that a grinding finishing operation is necessary, and the fused joints are relatively weak. Another method of encapsulating the magnet is to provide a cup-shaped Teflon preform having a depth approximately equal to the length of the magnet and providing a plug to close the open end of the preform after the magnet is inserted therein. This arrangement has the same defect as in the previously described arrangement, as there is an inherent weakness in the connection between the plug and the cup-shaped member often resulting in the popping out of the plug therefrom.

To avoid this separation of the jacket elements, a method of molding the Teflon completely around the magnet has been devised wherein granulated Teflon is disposed around the magnet and heated to an elevated temperature whereupon the Teflon fuses into a solid jacket. A serious disadvantage of this method is that during the preforming of the granular Teflon around the magnet into the shape desired, some flow of the Teflon particles occurs in different portions thereof. This flow causes weak sections or flaws to result in the jacket which renders the product unsuitable for use.

The principal feature of this invention is the provision of a new and improved method of encapsulating an elongated element, such as a rod magnet, in a body of Teflon.

Another feature is the provision of such a method wherein granular Teflon is compacted about the magnet during the preforming operation, the arrangement of the granular Teflon and the molding means being such that during the compressive preforming operation, the density of the granular Teflon increases without substantial flow thereof.

Another feature of the invention is the provision of a new and improved method for effecting the novel arrangement of the granular Teflon relative to the magnet to permit such non-flowing compression thereof.

Other features and advantages of this invention will be apparent from the following description taken in connection with the accompanying drawings wherein:

Fig. 1 is an isometric view of a lower core pin and a mold cavity associated therewith for use in a preforming of the encapsulated magnet, the mold cavity being shown in a retracted position;

Fig. 2 is an isometric view of the lower core pin and mold cavity of Fig. 1 with the mold cavity in a performing position;

Fig. 3 is an isometric end view of the lower core pin and mold cavity as arranged in Fig. 2 and in operable association with a charge measuring and depositing means;

Fig. 4 is an isometric view of a magnet depositing means inserted into the mold cavity to deposit the magnet on the top of a first charge of Teflon therein, the retracted position of the mold depositing means being shown in dotted lines;

Fig. 5 is an isometric view similar to that of Fig. 3 but with the charge measuring and depositing means arranged subsequent to the depositing of a second charge of Teflon over the magnet in the mold cavity;

Fig. 6 is an isometric view of the assembled upper and lower core pins and mold cavity with the Teflon charges and magnet therein, a pressure applying member being shown fragmentarily;

Fig. 7 is a vertical section showing the arrangement of the upper and lower core pins upon completion of the compacting step;

Fig. 8 is an isometric view of the lower core pin and mold cavity in the retracted position, with the completed preform accessibly exposed;

Fig. 9 is a fragmentary isometric view of an oven means with the preformed encapsulated magnets being arranged in trays for sintering in the oven;

Fig. 10 is a longitudinal section of an encapsulated magnet; and

Fig. 11 is a transverse section thereof.

The novel method of encapsulating an elongated element, such as a rod magnet, as comprehended by our invention, may be seen by a consecutive reference to Figs. 1 through 9 of the drawings. Broadly, the method comprehends the provision of means defining a suitable elongated mold cavity, closing the lower end of the mold cavity, depositing a first quantity of granular Teflon in the mold cavity on the core pin in such a way as to provide an increased depth of the Teflon at the opposite ends of the cavity, placing the rod magnet in the deposited Teflon in a centered position, depositing a second, similarly arranged quantity of granular Teflon over the magnet and first quantity in the mold cavity, inserting an upper core pin to abut the upper surface of the Teflon and urging the core pins relatively together to compact the granular Teflon about the magnet in the cavity. The completed preform is then picked up and placed in a suitable oven where it is sintered to complete the encapsulation process.

More specifically, a lower core pin 10 is provided having a base portion 11 and an upsetting pin portion 12 terminating in an upper, concave end 13. A block 14 defines a mold cavity 15 which is transversely elongated and has a horizontal cross section closely comparable to the external horizontal cross section of the core pin 12. Block 14 is vertically movable on portion 12 of the lower core pin to permit end 13 to be exposed above
block 14 (in a retracted position of the block as seen in Fig. 1), or to be disposed adjacent to the bottom of the cavity (in the molding position of the block as seen in Fig. 2). The horizontal cross section of core pin portion 12 (and, thus, of cavity 15) includes a rectangular side portion defined by elongated parallel sides 16, and opposite semicircular ends 17. As seen in Fig. 3, block 14 is raised in the raised, molding position by suitable means, such as a spacer device 18, and the assembly is associated with a charge measuring and depositing means generally designated 19. Means 19 comprises a stand 20 provided with a horizontally extending, fixed plate 21 having its upper surface 21a flush with the upper surface 14a of the mold cavity block. A slide plate 22 overlies fixed plate 21 and is movable under a scraper bar 23 to a position overlying the mold cavity 15 in block 14. Slide plate 22 is provided with a plurality of dumbbell-shaped apertures 24, the walls of which extend perpendicular to the flat plane of plate 22. Extending from slide plate 22 is a handle 25 for use in moving the slide plate from a charge receiving position overlying fixed plate 21 (as shown in full lines in Fig. 3) to a depositing position wherein an aperture 24 overlies mold cavity 15 (as shown in dotted lines in Fig. 3). To provide proper charge, a granular Teflon is placed in apertures 24, while slide plate 22 is overlying fixed plate 21, so as to completely fill the apertures. Any excess granular Teflon extending above the upper surface of the slide plate is scraped off by scraper bar 23 as the plate is moved outwardly to the depositing position. Thus, an accurate amount of granular Teflon is measured within the apertures. As seen in Fig. 3, when the outer aperture 24a moves into an overlying position relative to cavity 15, a measured Teflon charge 27 falls thereinto from the cavity. Because of the dumbbell-shaped apertures, where each aperture is provided with an elongated, narrow mid-portion 24b and laterally enlarged end portions 24c, a substantially greater depth of charge 27 results at ends 17 of cavity 15 as compared to the depth thereof between sides 16 of the cavity. When charge 27 has been properly deposited, a cylindrical rod 28 and magnet 44 is placed within the cavity in a centered position on top of charge 27. The length of the cavity between sides 16 is preferably comparable to the length of magnet 28 so that the magnet is substantially fully received between sides 16, ends 17 of the cavity extending outwardly beyond the opposite ends 28e of the magnet.

As seen in Fig. 4, a magnet inserter 29 is utilized in placing the magnet on charge 27. Inserter 29 comprises a block 30 of non-magnetic material, such as brass, having a transverse cross section similar to the cross section of cavity 15. At its inner end, the block is provided with a slot 30a in which is received a keeper 31 formed of a magnetic material such as iron. The width of the groove is slightly less than the width (diameter) of the rod magnet 28. The keeper is movable alternately upwardly and downwardly in slot 30a by means of a rod 32 extending outwardly from the block and provided at its outer end with a knob 33 and adjustable stop nuts 34 for limiting the inward movement of the rod. At the innermost limit of travel of rod 32, keeper 32 is disposed just slightly within slot 30 so that the magnet 28 can contact the keeper and be retained thereagainst by the induced magnetic attraction.

To deposit magnet 28 on charge 27, the inserter 29 is inserted into cavity 15 with magnet 28 retained by keeper 31 in a center position at the lower end of the block. As the block has a close fit with the walls of the cavity, the magnet is automatically positioned. When the magnet is resting on top of the charge 27, knob 33 is moved upwardly while the block is retained in place in the cavity. This separates keeper 31 from the magnet as the magnet cannot follow the keeper upwardly into the groove due to the somewhat narrower width of the groove. With keeper 31 maintained in the upwardly spaced position, the entire inserter is removed from the cavity (see fragmentary in dotted lines in Fig. 4), leaving the magnet in a centered position on top of charge 27.

A second charge 35 of Teflon is now deposited on top of first charge 27 and magnet 28 resting on first charge 27. This is accomplished by moving slide plate 22 outwardly from stand 20 until a second aperture 24d is disposed above cavity 15 permitting the measured Teflon charge therein to drop into the cavity. As with charge 27 delivered from aperture 24a, an extra quantity of Teflon is deposited at the ends of the cavity to compensate for the fact that the magnet does not extend thereinto.

The Teflon is now compacted around the magnet by inserting an upper core pin 36 into cavity 15 to abut the upper surface of second charge 35. Suitable means 37 are provided to apply a substantial pressure against core pin 36 to urge the core pin downwardly into the cavity and compact the Teflon about the magnet. The particular means employed for providing the pressure forms no part of this invention and, thus, requires no further description here other than to indicate that means 37 shall be provided to deliver pressure over a period of one minute from 0 pound per square inch to 7,000 pounds per square inch and holding this maximum 7,000 pounds per square inch pressure for approximately one-half minute to effect the necessary compacting preforming of the Teflon.

At its innermost travel in the compacting operation, upper core pin 36 remains spaced slightly from lower core pin portion 12. The lower end 38 of upper core pin 36 is concave complementarily to upper end 13 of the lower core pin, the concave ends 13 and 38 having generally cylindrical mid-portions 13b and 38b, respectively, and generally segmentally spherical end portions 13a and 38a, respectively. Thus, the Teflon is formed by abutment with the ends 13 and 38 into a generally rounded preform 41. However, between core pin ends 13 and 38, the preform assumes the surface configuration of the cavity wall and thus, flat parallel surfaces 39 are formed which are diametrically opposed relative to the axis of the magnet. Further, because of the fact that the core pins are slightly smaller than the cavity to permit ready movement therebetween, surfaces 39 are disposed somewhat outwardly from the cylindrical configuration defined by the core pin ends, thus slightly slanting bosses 39a are formed which have their outermost ends on the flat surfaces 39. Because of the circular nature of ends 17 of cavity 15, the side surfaces 39 are joined at the ends of the preform by cylindrical surfaces 40.

Upon completion of the pressure application step, upper core pin 36 is removed and spacer means 18 is withdrawn to permit the mold cavity block 14 to move back to the retracted position where it rests on base 11 of the lower core pin. This disposes the completed preform 41 upwardly of upper surface 14a of the mold cavity block allowing the preform 41 to be picked up from its position on end 13 of the lower core, and placed on a suitable tray, such as tray 42, for insertion into an oven 43 wherein the preform is sintered to complete the encapsulation process. It should be noted that this sintering occurs without confinement of the preform (no molding means are retained around the preform during the sintering operation) while yet the compacted structure of the preform maintains the shape thereof very accurately. In the sintering of the preform, the temperature is raised over a period of one and one-half hours to approximately 720°F, which temperature is maintained for approximately one-half hour. The temperature is then raised to approximately 500°F, within one hour, and then to room temperature as desired. The resultant encapsulated magnet 44 is very closely similar in size to the preform 41. As no flaw inducing stresses are developed in the Teflon
during the preforming process, such as might be caused by a flow of the Teflon during the preforming process, the resulting encapsulated magnet 44 has been found to be substantially free of the defects caused from having a free rolling action on flat surfaces, such as counter tops, substantially facilitating their use. Further, because of the projecting boss structure 39a, an additional roll preventing structure is provided as well as a structure which imparts an improved stirring action due to the fact that the encapsulated magnet does not present a completely symmetrical rounded exterior.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. The method of preforming a Teflon encapsulated rod magnet comprising in combination, the steps of: depositing a first quantity of granular Teflon in a mold cavity so as to provide an increased height of the upper surface of the Teflon at opposite portions of the cavity; depositing a rod magnet on the deposited Teflon in a centered position to extend between said opposite portions in the cavity; depositing a second quantity of granular Teflon over said first quantity and magnet in the mold cavity, the depositing of the second quantity being controlled to deliver a greater amount of the Teflon to opposite portions of the cavity than to the portion therebetween; and urging means relatively together in the cavity to compact the Teflon about said magnet without substantial flow thereof.

2. The method of preforming a Teflon encapsulated rod magnet comprising in combination, the steps of: providing means defining a transversely elongated mold cavity having a closed lower end; depositing a first quantity of granular Teflon on said end so as to provide an increased height of the upper surface of the Teflon at the transverse ends of the cavity; depositing a rod magnet on the deposited Teflon in a centered position transversely of the cavity to extend between said increased height portions of the Teflon upper surface; depositing a second quantity of granular Teflon over said first quantity and magnet in the mold cavity, the depositing of the second quantity being controlled to deliver a greater amount of the Teflon to opposite portions of the cavity than to the portion therebetween; inserting a core pin through the upper end of the mold cavity to abut the upper surface of said second quantity of Teflon; and urging said core pins relatively toward said lower end to compact the Teflon about said magnet without substantial flow thereof.

5. The method of preforming a Teflon encapsulated rod magnet comprising in combination, the steps of: depositing a second quantity of granular Teflon over said first quantity and magnet in the mold cavity, the depositing of the second quantity being controlled to deliver a greater amount of the Teflon to opposite portions of the cavity than to the portion therebetween; inserting a core pin through the upper end of the mold cavity to abut the upper surface of said second quantity of Teflon; and urging said core pins relatively toward said lower end to compact the Teflon about said magnet without substantial flow thereof.

4. The method of preforming a Teflon encapsulated elongated element comprising in combination, the steps of: providing means defining a transversely elongated mold cavity; closing the lower end of the mold cavity with a lower core pin; depositing a first quantity of granular Teflon in the mold cavity on the core pin so as to provide an increased height of the upper surface of the Teflon at the transverse ends of the cavity to extend between said increased height portions of the Teflon upper surface; disposing a rod magnet on the deposited Teflon in a centered position transversely of the cavity; depositing a second quantity of granular Teflon over said first quantity and magnet in the mold cavity, the depositing of the second quantity being controlled to deliver a greater amount of the Teflon to opposite portions of the cavity than to the portion therebetween; inserting a core pin through the upper end of the mold cavity to abut the upper surface of said second quantity of Teflon; and urging said core pins relatively together to compact the Teflon about said magnet into a preform element without substantial flow of the Teflon; removing the preform element from the mold cavity; and sintering the unenclosed preform.

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