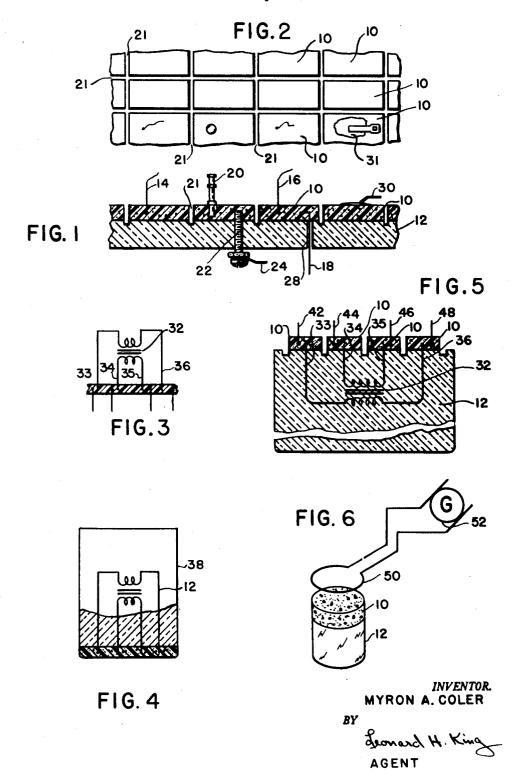
METHOD OF MAKING ELECTRICALLY CONDUCTIVE TERMINALS

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METHOD OF MAKING ELECTRICALLY
CONDUCTIVE TERMINALS Myron A. Coler, New York, N.Y. (56 Secor Road, Scarsdale, N.Y.) Filed Sept. 3, 1954, Ser. No. 454,127 8 Claims. (Cl. 29—155.55)

This invention relates to containers for electrical purposes and particularly to electroconductive feed through 10 terminals for such containers.

This application is a continuation in part of my copending application entitled "Containers and Related Devices," Serial Number 256,518 filed approximately November 15, 1951, now abandoned.

A problem which has long plagued designers of electrical equipment and of packages for the same has been the one of finding methods for effecting electrical contact through walls of insulating plastic material. This is a particular case of the still more general problem of 20 securing a tight casing through which electrical contact may be made to material or equipment inside said casing.

Attempts to fabricate tight casings for electrical equipment generally break down into instances where the

In the former case it is usually necessary to introduce more than one electrical connection to the interior of the casing. Usually at least one such connection must be insulated from the main casing body. The presence of the insulator invariably introduces problems associated with differences between the physical properties, especially the thermal expansion, of insulator and metal.

In some cases rubber insulated wire is passed through holes in the metal casing after which an attempt is made to tighten the seal by means of various kinds of clamps or packing glands. Such glands involve screwed or split parts which are seldom completely tight. The point of clamping the wire is a site for wear and fatigue. Flexible insulation and packing materials are subject to 40 fairly rapid deterioration.

In another attempted solution of the problem, the parts of a metal casing are themselves used to carry electrical energy to or from the interior of the casing. This necessarily implies that certain parts of the casing are insu- 45 lated from one another. Thus, for instance, two halves of a metal casing for an electrochemical cell system may be shaped from sheet metal and the edges of the two halves crimped together over an insulating gasket. Such seals are found in practice to be subject to rather fre- 50 quent failure.

In general, the longer the line of contact between metal and insulator material, the greater the difficulty in obtaining a tight seal. Thus, the common method of sealing a Leclanche cell by casting an insulating wax into the top of a zinc case is particularly subject to leakage under the stress of changing temperature.

The attempt to seal a structure which is made predominantly of insulator material with metal contacts likewise meets with practical difficulties.

The passage of metal contacts, such as wires, through a plastic body meets with the same difficulties due to differences in thermal expansion as exist in the converse ar-

For certain applications tight graded seals can be obtained between glass and metal wires. The seals are made by very exacting techniques and the resulting casings are obviously fragile.

There is disclosed herein a simple, effective and economical means for securing electrical connection across 70 a tight casing wall by creating an integral bond between an electrically conductive composition plastic material

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and an insulator plastic thus avoiding the many cited drawbacks of the prior art.

It is therefore an object of this invention to provide tight casings through which electrical connection can be 5 made.

It is a further object of this invention to provide uninterrupted plastic bodies through which electrical connections can be made.

It is a still further object of this invention to provide all-plastic structural elements which can be assembled with other plastic elements by various methods into tight casings through which electrical energy can be passed.

It is a more general object of this invention to provide all-plastic structural elements which contain electrically 15 conductive portions.

A particular object of this invention is to provide an electrical terminal for hermetically sealed containers.

Another particular object of this invention is to provide an electrically conductive leakproof feed through terminal for barriers.

Other general and specific objects of this invention will become apparent upon perusal of the appended specifications.

For a more complete understanding of my invention, casing is predominantly metallic or predominantly insula- 25 reference should now be made to the accompanying description taken in conjunction with the drawings in which:

FIGURE 1 shows in cross-section a plurality of electro-conductive terminal members of this invention.

FIGURE 2 shows in plan the members of FIGURE 1. FIGURE 3 shows partly schematically and partly in cross-section a transformer connected to an electro-conductive plastic element.

FIGURE 4 shows the transformer and conductive element of FIGURE 3 positioned in a container adapted to receive casting resin.

FIGURE 5 shows a potted transformer provided with an electro-conductive plastic terminal.

FIGURE 6 shows pictorially the combining of an insulator plastic and electrically conductive plastic sheet by induction heating.

As is well known, there exist numerous electrically conductive plastic compositions which are made by blending finely divided electrically conductive materials such as graphite and metals with insulator plastics. I have found that these materials correspond closely in their physical properties (aside from appearance and electrical conductivity) with the parent insulator plastics from which they are made. Of course, if the loading with conductive filler is very high, the strength and certain other properties of the plastic will be materially affected just as they will by the inclusion of more common

In any case, I have found that the conductive plastic compositions can be securely bonded by various methods 55 detailed below to the corresponding insulator plastic from which they were made. Such bonds, being between materials possessing very similar coefficients of thermal expansion, are not subject to great stress when passed through cycles of changing temperature.

Electrically conductive plastics made according to the co-pending application of Myron A. Coler entitled "Metallized Plastics," Serial Number 735,553, filed March 18, 1947, are particularly suited to the purposes of the present invention because they possess much higher conductivity for a given content of conductive material than other known electrically conductive plastic compositions. Consequently, their general physical properties depart less from those of their parent plastics than do the properties of other conductive plastic compositions possessing the same degree of electrical conductivity.

Furthermore, be it noted that, by the use of techniques described in the copending application of Myron A.

Coler and Arnold S. Louis entitled "Composite Plastic Articles and Method of Making Same," filed approximately November 15, 1951, the all-plastic seals of this invention need not necessarily be made between a conductive plastic composition and the insulator plastic from which it was made. It can, indeed, involve a joint between chemically quite different substances. Of course, the two plastic materials, conductive and insulator should be chosen so as to have similar thermal coefficients of expansion or else undue strains may be set up in the joint 10 during service. The required degree of similarity will be determined by the conditions of temperature cycling to which the joint will be exposed. In any particular case the determination of a reasonable correspondence of thermal coefficient of expansion will call for the use of ordinary engineering judgment. In this connection it is well to note that if one of the plastics is relatively yielding or is comparatively thin, a large difference in coefficient of expansion can be tolerated.

in my latter named copending application) for bonding together chemically dissimilar plastics, any of several methods may be used to secure a bond between an electrically conductive plastic composition and its corresponding parent insulator plastic or one chemically similar to it.

For instance, the two molding powders may be compression molded together by laying down the two powders one above the other or side by side in the mold. I speak of this process as "co-molding."

Again, one plastic may be molded by any convenient technique against an insert of the other.

As is later pointed out in greater detail, the conductive and non-conductive plastic portions may be combined by conventional casting techniques.

Already molded pieces of the two plastics may be effectually joined by wetting the faces to be joined with a solvent, pressing the two faces together and keeping them under pressure until the solvent dries out sufficiently to make a firm bond.

In another process, molded pieces of thermoplastic type may be joined by heat sealing. Heat may be applied by contact with a heated tool or by any convenient method of generating localized heat. Particularly useful is the high frequency induction heating technique. By this means heat may be generated directly in the conductive plastic or it may be more strictly localized to the joint area by locating there small isolated pieces of metal.

In FIGURE 1 there is shown a number of electro-conductive plastic members 10 co-molded to an insulator plastic sheet 12. For purposes of illustration there is shown a variety of means for making electrical and mechanical contact with the electro-conductive plastic members. These include wire leads 14, 16 and 18 and terminal lug 20 which have been insert-molded. Screw 22 may be inserted by conventional drilling and tapping operations. Lug 24 is shown attached to screw 22. If desired, the contact between screw 22 and conductive plastic 10 can be improved by butting into the bottom of the tapped hole before insertion of screw 22 a small amount of conductive lacquer or adhesive. A hole 28 may be provided in the insulator plastic to receive a lead. Lug 30 is shown attached by solder path 31 directly to electro-conductive plastic 10 which method of assembly is suitable with some types of electro-conductive plastic. In other cases, a metallic coating may be applied to the surface of conductive plastic 10 by any of several well known techniques such as metal spraying, electroplating, thermal evaporation or by application of a conductive lacquer. To this coating, contact may be made, for instance, by pressure contact or by soldering.

Referring now to FIGURE 2 it may be seen that a number of discrete electro-conductive plastic areas 10 are provided. This is accomplished by attaching a continuous sheet of the electro-conductive plastic to a continuous

sheet of the insulator plastic and then milling or sandblasting off undesired portions of the electro-conductive plastic. This results in the forming of isolated conductive elements 10 separated by slots 21.

An important feature of this invention is that a wire lead does not continuously pass through the plastic barrier, although continuous electrical connection is main-Thus terminal 20 is electrically connected to screw 12 through conductive plastic 10, but there is no continuous mechanical path to provide a leakage path for liquids or vapors. This is of importance in applications wherein components of an electrical system are hermetically sealed off from the atmosphere.

The procedure of making a hermetically sealed elec-15 tronic unit of the potted type is shown in FIGURES 3-5. In FIGURE 3 transformer 32 is shown connected to leads 33, 34, 35 and 36 which are embedded in conductive plastic 10.

The transformer 32, other associated components, and Aside from the use of the special technique (described 20 conductive plastic 10 are then inserted in container 38 and the container is filled with the insulator plastic 12 in the form of a casting resin as shown in FIGURE 4. There are many casting resins which may be poured into a mold in liquid form and then polymerized or otherwise hard-25 ened. Many such resins are clear in color so that the embedded components may be observed in operation. After the insulator plastic hardens, container 38 may be removed and slots 21 milled to form the structure shown in FIGURE 5 wherein transformer 32 is potted in insula-30 tor plastic 12. Transformer 12 is connected to leads 33, 34, 35 and 36 which are electrically connected to, but mechanically isolated from leads 42, 44, 46 and 48 by isolated conductive plastic areas 10.

In FIGURE 6 there is shown the assembly of an electro-conductive plastic sheet and an insulator sheet by induction heating. A sheet of conductive plastic 10 is compressed against insulator plastic 12. Coil 50 which is electrically connected to high frequency generator 52 is positioned in the vicinity of the conductive plastic 10. The resulting induced currents in the conductive plastic 10 heats the material sufficiently to bond the two layers together.

Obviously the various methods of obtaining electrical contact which have been described and others which will occur to those skilled in the art may be used in any convenient combination.

What is essential to the practice of this invention is that there be an uninterrupted wall of plastic material constituting the structural element of this invention, that at least part of this wall be composed of conductive plastic. and that means be provided on either side of said structural element for making electrical contact with said conductive plastic, said means in no instance passing completely through said structural element or making contact with one another within the element.

Structural elements of this invention may be incorporated into open or closed containers or packages of any shape or size whatsoever. They may be joined to other structural elements of said containers by bonding methods previously described or by any other method consonant with the degree of tightness and other properties required in the finished article. Alternatively, the formation of the bond between insulator and conductive portions may be the final act in assembling or closing an article or package. The plastic portions of the structural elements of this invention or of remaining structural elements comprising larger assemblies or packages are not restricted as to optical or mechanical properties except as these are limited by the nature of available materials and the conditions to which the finished article will be exposed.

The many embodiments of the invention disclosed herein are intended to be descriptive of what I currently believe to be the best mode presently contemplated for carrying out my invention and are not intended to be limiting 75 in any sense for it is appreciated that those skilled in the

art may make many changes and adaptations without departing from the spirit of the invention and it is therefore my intent that the appended claims cover all such changes and adaptations as fall within the spirit and scope of the present invention.

I claim:

1. The process of making an electrical terminal assembly comprising the steps of forming a composite all-plastic member including an electrically conductive plastic layer having an exposed first face and a second face bonded to 10 conductive layer. an electrically non-conductive plastic layer, forming a plurality of intersecting slots through said exposed face of said conductive plastic layer and extending completely through said conductive plastic layer, so as to produce isolated conductive plastic elements supported by said 15 is a casting resin. insulator plastic and partially embedding at least one twoended electric circuit connecting means into each of a selected number of said resulting isolated conductive plastic elements so that one end of said electric circuit connecting means extends outwardly of said selected plastic element and the other said end of said means extends only partially into said conductive plastic element.

2. The method of claim 1 wherein the composite member is formed by co-molding of a layer of electrically insulating and a layer of electrically conductive plastic mold-

ing powders.

3. The process of claim 1 wherein said slots extend

partially into said insulator plastic layer.

4. The process of making an electrical terminal assembly comprising the steps of forming a composite all-plastic member including an electrically conductive plastic layer having an exposed first face and a second face bonded to an electrically non-conductive plastic layer, forming a plurality of intersecting slots through said exposed face of said conductive plastic layer and extending completely through said conductive plastic layer, so as to produce isolated conductive plastic elements supported by said insulator plastic and inserting a pair of electric contact making means partially into a selected number of said conductive plastic elements through opposite faces thereof and maintaining said pair of contact making means mechanically separated.

5. The process of claim 1 wherein said composite member is formed by co-molding of a layer of electrically insulating plastic molding powder and a layer of electrically

conductive plastic molding powder.

6. The process of hermetically sealing electrical apparatus, including leads for connection to external circuits. comprising the steps of embedding the ends of said leads in spaced relationship in a layer of conductive plastic. co-molding said layer of conductive plastic and said electrical apparatus with an electrical insulator plastic so that said apparatus is completely encapsulated by said insulator plastic and forming isolating slots surrounding each of said encapsulated lead ends and extending through said

7. The process of claim 6 including the step of inserting electric contact making means partially through said con-

ductive layer.

8. The process of claim 6 wherein said insulator plastic

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