Aug. 20, 1957 J. J. KURLAND ET AL 2,803,693

HERMETICALLY SEALED TERMINAL STRUCTURE AND METHOD FOR MAKING SAME

Filed Aug. 8, 1955 2 Sheets-Sheet 1

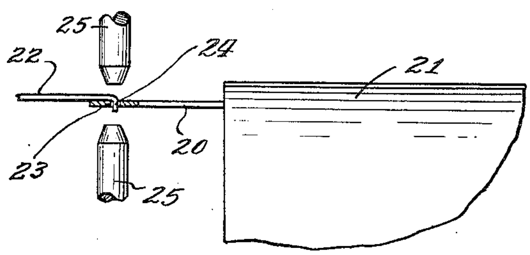


Fig. 1.

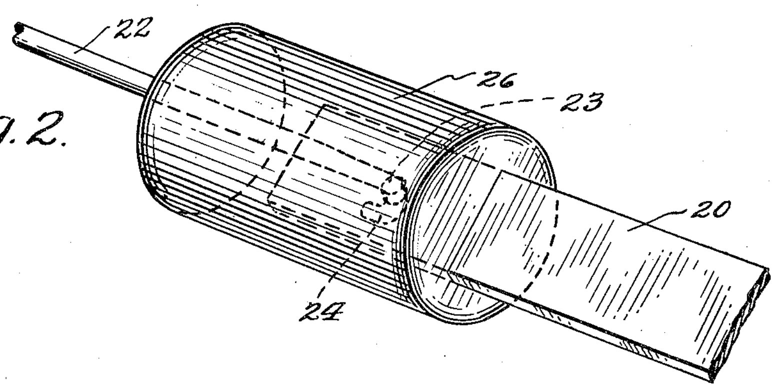


Fig. 2.

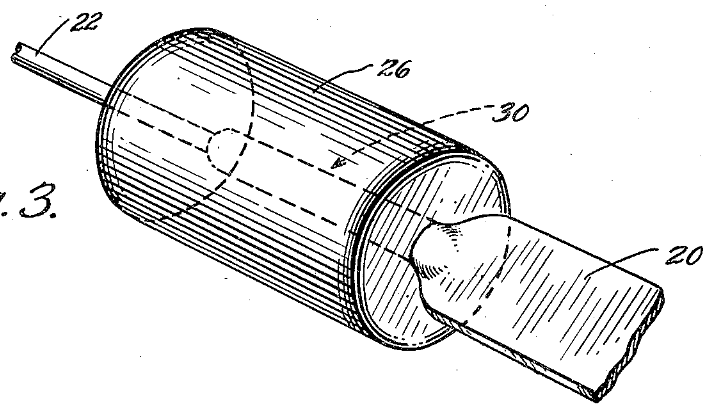
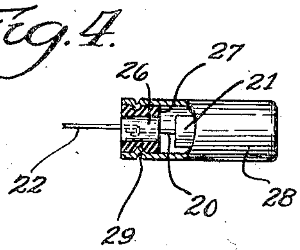


Fig. 3.

Fig. 4.



Inventors
Jerome J. Kurland
Joseph J. Kurland
and Karl G. Rosner
By Mann, Brown and Hansmann
Attys.

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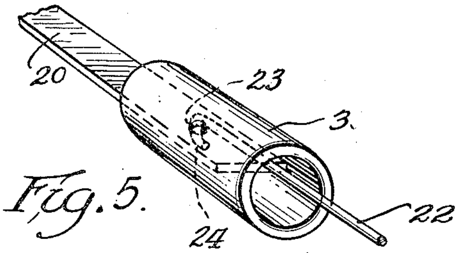


Fig. 5.

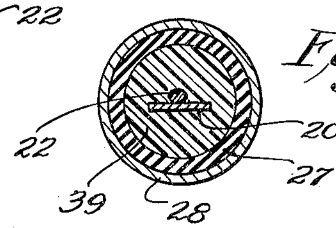


Fig. 6.

Fig. 7.

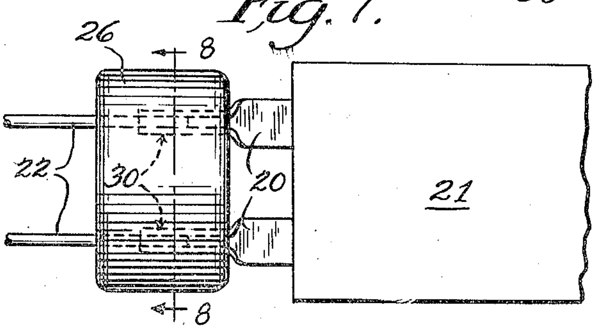
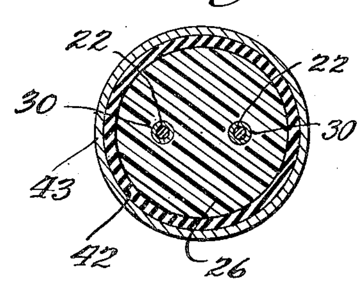


Fig. 8



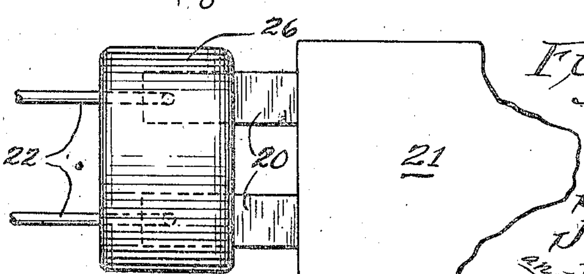


Fig. 9

Inventors
Jerome J. Kurland
Joseph J. Kurland
and Karl G. Rosner
By Mann, Brown and Hansmann
Attys.

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HERMETICALLY SEALED TERMINAL STRUCTURE AND METHOD FOR MAKING SAME

Jerome J. Kurland, Chicago, Joseph J. Kurland, Glencoe, and Karol G. Rosner, Chicago, Ill., assignors to Illinois Condenser Company, Chicago, Ill., a corporation of Illinois

Application August 8, 1955, Serial No. 526,822

4 Claims. (Cl. 174—50.56)

The present invention relates to hermetically sealed terminal arrangements for electrical devices and finds particular application in instances wherein it is desired to bring a conductor through a wall of the device by effecting a connection between an internal terminal and an external lead.

Specifically this invention is concerned with providing an external electrical connection for a capacitor foil that is hermetically sealed within an appropriate container and the techniques employed offer particular advantages in the production of miniature and sub-miniature capacitors.

It is important to understand the serious practical difficulties encountered in producing an effective hermetic seal for the extremely small sized terminal structures employed in the manufacture of miniature and sub-miniature capacitors. It is generally preferred to locate the juncture of the internal terminal and external lead directly within the cap of the terminal structure rather than inside the cap or outside the cap but in any case the electrical conductor passing through the cap is quite small and has a correspondingly small outer circumference.

To produce an effective hermetic seal between a surrounding sleeve and the electrical conductor has been a consistent problem in the miniature capacitor field. Coupled with this is the problem of completing the seal by providing an effective seal between the aforementioned surrounding sleeve and the container for the miniature capacitor.

According to the teachings of patent application No. 444,942, filed July 22, 1954, under the names of Jerome J. Kurland and Joseph J. Kurland, a hermetically sealed terminal structure for a container was provided by encasing a lead wire within a terminal strip, cold-flowing the assembly, telescoping a resilient insulating sleeve over the assembly, and applying lateral sealing pressures by embossing the side wall portions of the surrounding container to compress the resilient sleeve between these side wall portions and the outer surface of the assembly. This arrangement was advantageous in that the cold-flowed assembly of the lead wire and terminal strip presented a substantially cylindrical outer surface of a somewhat larger circumference than the lead wire itself. Both of these factors are of critical importance in obtaining true hermetic sealing with a surrounding gasket. In one embodiment a metallic sleeve was cold-flowed over the basic assembly with the obvious advantage of providing a more truly round surface of even larger size and hence a better surface for effecting the desired seal.

While this previous arrangement offered important advantages over the prior art procedures, it was still subject to certain limitations. With commercially practicable methods, it is not always possible to cold-flow the aluminum terminal strip with the tin-coated copper wire. Frequently there is still only a mechanical connection therebetween with the result that electrolyte finds access to the juncture of the metals and produces an electrochemical reaction.

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In addition it is difficult to provide a truly round outer surface for the cold-flowed assembly and any variations therefrom affect the seal adversely. Furthermore, because of the differences in metals, sharp temperature changes can cause leakages and hence, the seal as a whole, although it could be called hermetic, was certainly not a perfect hermetic seal.

The use of the additional metallic sleeve was also subject to these same limitations.

It is the principal object of the present invention to overcome these limitations and to provide a substantially perfect hermetic seal.

It is a further object to substantially decrease the manufacturing costs for miniature capacitors while simultaneously creating a perfect hermetic seal.

This is accomplished by suitably joining the lead wire and capacitor terminal, encapsulating the juncture with a cylindrical bead of insulating material, and sealing the structure within a suitable container by setting up lateral pressures therebetween. The encapsulation offers no opportunity for air or electrolyte to reach the juncture and, hence, renders the juncture corrosion proof. It is also less subject to sharp temperature changes and is better able to withstand such strains as are developed.

Preferably the encapsulation is of molded plastic material that is substantially incompressible and it may be molded to any size for effecting proper sealing with a surrounding gasket. In addition, with this technique it is relatively easy to form a truly round encapsulation, a very important factor in assuring a continuous sealing contact between the encapsulation and the surrounding gasket and a uniform distribution of the lateral sealing pressures.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Fig. 1 is a side elevational view illustrating the preferred manner for joining a lead wire and terminal strip;

Figs. 2 and 3 are perspective views of encapsuled junctures of lead wires and terminal strips;

Fig. 4 is a side view of a completed miniature capacitor with parts broken away and sectioned;

Fig. 5 is a perspective view illustrating an intermediate step in the construction of a terminal structure in accordance with a modification of the present invention;

Fig. 6 is a sectional view through a completed capacitor involving the modification of Fig. 5;

Fig. 7 is a side elevational view illustrating the application of the present invention to the production of a capacitor having a plurality of terminal strips;

Fig. 8 is a sectional view taken through the cap structure of a completed capacitor, the view being taken at a location corresponding to the line 8—8 of Fig. 9; and

Fig. 9 is a view similar to Fig. 7 but illustrating different means for joining the lead wires and terminal strips.

Referring now to the drawings and particularly to Figs. 1 to 4 which illustrate the successive steps involved in forming a hermetically sealed miniature capacitor in accordance with the principles of the present invention, it is preferred to initially form an encapsulated juncture between an aluminum terminal strip 20 and a tin-coated copper or brass wire 22 (see Figs. 2 and 3) and subsequently to connect this assembly to a capacitor foil 21 (see Fig. 4). The terminal strip is preferably a relatively wide flat strip though other shapes may also be employed as should be apparent to those skilled in the art. In certain circumstances, however, it may be desirable to first attach the terminal strip 20 to the capacitor foil 21 by staking or any other suitable manner and then to effect the encapsulated juncture. This latter arrangement is illustrated in Fig. 1.

A preferred form of juncture is also illustrated in Fig. 1 and is formed by inserting a bent over end portion **24** of the wire **22** through a small hole **23** provided adjacent the extremity of the terminal strip and spot welding the two parts of the assembly so that the bent over end portion takes the shape of a hook. Suitable spot welding electrodes are diagrammatically indicated at **25** in Fig. 1. This arrangement provides a strong mechanical connection in addition to the metallic bond created by the welding.

The assembly is then hermetically sealed by encapsulating the juncture with a suitable insulating material, and this operation is preferably carried out by placing the assembly in position within a suitable mold and introducing a suitable liquid casting resin into the mold to completely encase the juncture with resin. For example, epoxy resins, or certain of the polyesters, acrylates or other suitable resins may be poured into the mold for encasing the juncture. In fact any dielectric material which can be cast to provide a hard, solid bead that is resistant to air and moisture may be employed for encapsulating the juncture and this includes such material as glass.

Other desirable properties which a preferred encapsulation material should possess are high tensile and shock strength, excellent insulation resistance, stability at high temperatures, and stability in the presence of the various capacitor fill materials and other material employed in the capacitor fabrication. One or more of these last-mentioned properties may or may not be required, depending upon the particular application, as will be apparent to those skilled in this art.

The encapsulation bead of plastic or other suitable material that is thus formed can readily be given a smooth cylindrical shape so necessary for completing the hermetic seal between the side walls of the condenser jacket or casing. In addition, the bead may be given a relatively large diameter in order to offer a substantial bearing surface for developing effective sealing pressures that must be transmitted through a resilient gasket. A bead of suitable shape and size is shown at **26** in Fig. 2.

The actual method and apparatus for molding the bead on the juncture may be in accord with any of the well-known prior art techniques and, for the sake of brevity, description of this detail has been omitted since anyone skilled in the art can easily carry out such operations.

After the plastic bead **26** has been formed on the juncture, the capacitor **21** is wound or coiled and a rubber sleeve **27** of silicon, neoprene, or any other hard rubber material that is impervious to the passage of air is snugly telescoped over the bead. The unit is then inserted into a casing **28** having a cylindrical inner surface and a groove **29** is spun into the side wall of the casing adjacent its open end to complete the hermetic seal. Due to clearance problems, it is practically impossible to seal a miniature capacitor by turning the open end of the rim inwardly across the front of the encapsulated bead; however, lateral sealing pressures are effectively developed simply by grooving the casing.

In the completed miniature capacitor of Fig. 4, there are at least three critical sealing areas. The first is the region between the juncture and the encapsulation, the second is the region between the encapsulation and its surrounding gasket, and the third is the region between the gasket and the casing wall. The molded encapsulation actually enhances the sealing action in each of these regions. In the first it absolutely excludes air and/or electrolyte from the juncture. In the second and third it improves sealing by virtue of the fact that it is of relatively large size and is easily made truly round. Therefore, the sealing gasket is compressed between properly contoured surfaces of comparable size and responds in the usual manner to form a proper seal.

From a purely mechanical standpoint, it is important to note that an encapsulated juncture can withstand any stresses and strains that the external lead wire can impose. It is a perfectly rigid structure and is not affected by continued vibration, sharp temperature changes, and the like.

Although the method of attaching the lead wire to the terminal strip illustrated in Figs. 1 and 2 is preferred, other arrangements may be employed since the resulting juncture is to be encapsulated. One such alternative connection which was disclosed in the aforementioned patent application is illustrated in Fig. 3 wherein the lead wire **22** is encased within the terminal strip **20** and the overlapping parts, as indicated at **30**, are united by applying suitable pressures for cold-flowing the materials together.

Various other connection arrangements are contemplated within the skill of the art and the present specific disclosure should not be construed as limiting the scope of the invention. In fact the more general concepts of the invention are not restricted to forming a juncture within the encapsulation.

As shown in Fig. 3 the alternative connection **30** is then provided with an identical plastic bead **26** of cylindrical form and the terminal structure utilizing the juncture construction of Fig. 3 may be completed in the usual manner as described hereinbefore.

Though magnified to some extent for the sake of clarity, the capacitor of Fig. 4 is intended to illustrate a miniature capacitor constructed in accordance with the principles of this invention; by way of example, miniature capacitors in present day use have case diameters ranging from 3/16″ to 1″.

Instead of employing a casting resin or similar material for encapsulating the juncture, it is also possible to use high temperature thermoplastic materials such as nylon which may be made in the form of a sleeve **38** and slipped over the juncture as indicated in Fig. 5. The assembly of Fig. 5 may then be heated and compressed in a suitable mold until the tubular sleeve **38** is compacted into a solid, preferably cylindrical, mass **39** (see Fig. 6) that completely encases the juncture. In such an instance the hermetic seal is completed in the usual manner by providing a rubber sleeve **27** between the encapsulation **39** and the casing **28**.

Thermosetting materials, such as Bakelite, Melamine and the like, could be used in place of the nylon sleeve **38** of Fig. 5.

The invention may also be practiced for providing hermetically sealed terminal structures having a plurality of individually insulated electrical terminals and such an application is indicated in Figs. 7, 8, and 9. Here again the juncture of the terminal strip and lead wire may be effected in a variety of ways; Fig. 7 illustrates a juncture wherein the terminal strip encases the lead wire, and Fig. 9 illustrates an arrangement wherein the bent over portion of the lead wire is spot welded in place within a small hole formed in the terminal strip. In either case a single encapsulation of cylindrical form completely encases both of the junctures **30** and maintains them in proper spaced apart relationship. In these constructions the encapsulation is preferably accomplished by employing suitable casting resins as described previously, and while the structures involved are somewhat different, the molding techniques employed may be generally similar. Fig. 8 illustrates a section through a completed terminal structure and the common encapsulation **26** is provided with a cylindrical sleeve **42** of suitable gasketing material for completing the hermetic seal between the casing **43** and the encapsulation.

The invention finds application in a variety of different types of capacitors such as electrolytic, electrostatic, oil and paper filled capacitors, and similar devices. The jacket or casing may be either of metal or of plastic depending upon the particular application.

It should be understood that the description of the preferred form of the invention is for the purpose of complying with section 112, title 35, of the U. S. Code and that the appended claims should be construed as broadly as the prior art will permit.

We claim:

1. In a capacitor of the miniature type, the combination of a cylindrical metallic casing having an open end, a capacitor body mounted in the casing and having an upstanding terminal member, an elongated conductor mechanically and electrically secured at its lower end to said terminal member to form a juncture, an encapsulation bead of air and moisture-resistant insulating material molded about and encasing said juncture to form a solid, incompressible encapsulation bead that completely envelopes and seals the juncture, said bead having its maximum depth in the region of said juncture to provide mechanical strength, said bead having at least its upper portion thereof of uniform circular cross section to form a cylindrical surface, the diameter of which is slightly less than the diameter of the casing, thereby providing an annular space between the upper portion of said bead and the casing walls near the open end of the casing, an annular resilient sleeve of hard, rubber-like material interposed in said annular space and seating on said upper cylindrical portion of said bead, an annular portion of said casing contiguous to said sleeve projecting inwardly against the resilience of said sleeve backed by the incompressible bead to form an effective hermetic seal for said open end of the casing.

2. In a capacitor of the miniature type, the combination of a cylindrical metallic casing having an open end, a capacitor body mounted in the casing and having an upstanding terminal member, an elongated conductor mechanically and electrically secure at its lower end to said terminal member to form a juncture, an encapsulation bead of air and moisture-resistant insulating material molded about and encasing said juncture to form a solid, incompressible encapsulation bead that completely envelops and seals the juncture, said bead having its maximum depth in the region of said juncture to provide mechanical strength, said bead having at least its upper portion thereof of uniform circular cross section to form a cylindrical surface, the diameter of which is slightly less than the diameter of the casing, thereby providing an annular space between the upper portion of said bead and the casing walls near the open end of the casing, an annular resilient sleeve of hard, rubber-like material interposed in said annular space and seating on said upper cylindrical portion of said bead, an annular portion of said casing intermediate along the upper portion of the bead and contiguous to said sleeve projecting inwardly against the resilience of said sleeve backed by the incompressible bead to form an effective hermetic seal for said open end of the casing.

3. In a capacitor of the miniature type, the combination of a cylindrical metallic casing having an open end, a capacitor body mounted in the casing and having a plurality of upstanding terminal members, a plurality of elongated conductors, one for each terminal member, each conductor being mechanically and electrically secured at its lower end to one of the terminal members to form a plurality of junctures, an encapsulation bead of air and moisture-resistant insulating material molded about and encasing said junctures to form a solid, incompressible encapsulation bead that completely envelopes and seals each juncture and fixes said junctures in spaced apart insulated relationship, said bead having its maximum depth in the region of said junctures to provide mechanical strength, said bead having at least its upper portion thereof of uniform circular cross section to form a cylindrical surface, the diameter of which is slightly less than the diameter of the casing, thereby providing an annular space between the upper portion of said bead and the casing walls near the open end of the casing, an annular resilient sleeve of hard, rubber-like material interposed in said annular space and seating on said upper cylindrical portion of said bead, an annular portion of said casing contiguous to said sleeve projecting inwardly against the resilience of said sleeve backed by the incompressible bead to form an effective hermetic seal for said open end of the casing.

4. In a capacitor of the miniature type that comprises a cylindrical metallic casing having an open end, a capacitor body mounted in the casing, a terminal structure in the open end of said casing and connected to said body, and an annular resilient band of hard, rubber-like material telescoped between said structure and the casing wall near the open end of said casing, an annular portion of said casing contiguous to said sleeve projecting inwardly against the resilience of said sleeve backed by said terminal structure to form an effective seal for the open end of the casing; the improvement wherein said terminal structure comprises an elongated terminal member connected to said capacitor body, an elongated conductor mechanically and electrically secured at its lower end to said terminal member to form a juncture, and an encapsulation bead of air and moisture-resistant insulating material molded about and encasing said juncture to form a solid, incompressible encapsulation bead that completely envelopes and seals the juncture, said bead having its maximum depth in the region of said juncture to provide mechanical strength, said bead having at least its upper portion thereof of uniform circular cross section to form a cylindrical surface, the diameter of which is slightly less than the diameter of the casing, thereby providing an annular space between the upper portion of said bead and the casing walls near the open end of the casing to receive said annular sleeve.

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