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(54) Encapsulated capacitor and method of assembling same

(57) Capacitor bodies 13 are inserted between two channel member 11,12 of L-shaped cross-section with the capacitor cathodes electrically connected to one channel member and the anodes to the other, thus providing terminals; the resulting assembly is filled with insulating encapsulant 16 which is then cured, and the cured assembly is then separated into individual chip capacitors.

Fig.1.

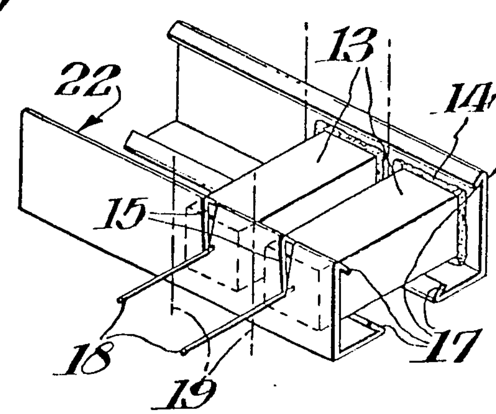

Fig.3.

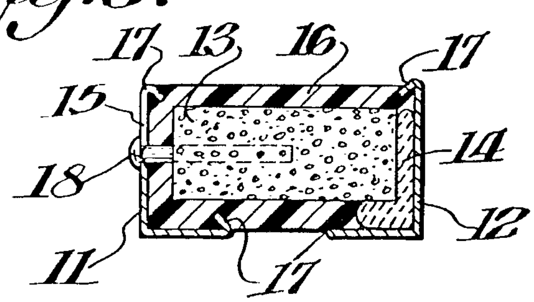

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Fig.1.

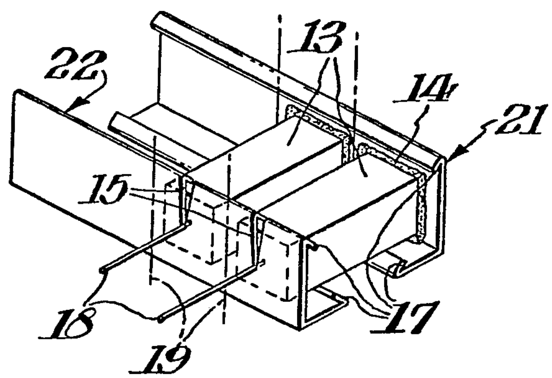


Fig.2.

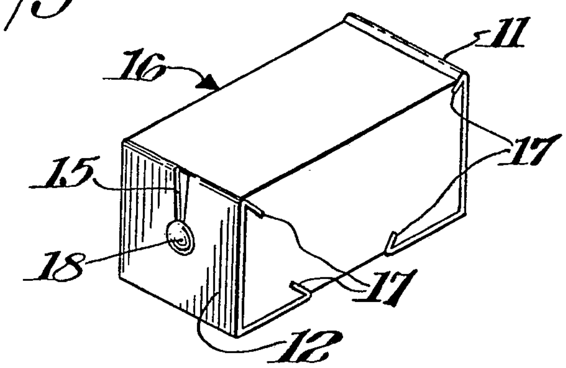
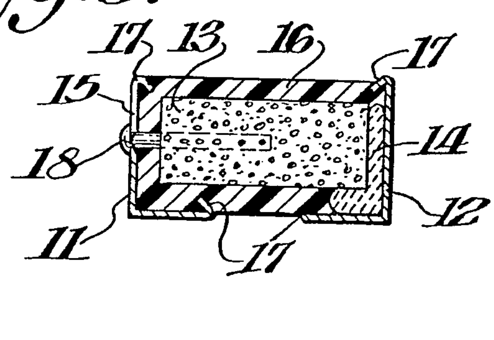


Fig.3.



SPECIFICATION

Encapsulated capacitor and method of assembling same

This invention relates to encapsulated capacitors and to a method of assembling them. More particularly, the invention relates to an encapsulated solid electrolyte chip capacitor having external terminals.

Encapsulated chip capacitors with external terminals are known. Generally, these terminals are in the form of end caps which are fitted over the ends of the unit. With very small chip capacitors, however, the alignment and connection, both electrical and mechanical, of the end caps become a problem. Various methods have been proposed to overcome this problem including the use of jigs, for example as taught by Sobozenski and Stupak in US 4,064,611 issued December 27, 1977, which permits semi-automation of the assembly process.

Another previously proposed termination method is the placing of a capacitor body in a metal casing, making the electrical connections, filling the casing with encapsulating material, and finally cutting away a section of the casing. Still another method involves inserting the leads through holes in the bottom of a non-conducting U-shaped channel which served as the package, filling the channel with encapsulating material, and finally separating the units. In two of these methods at least one lead is threaded through a hole, which becomes more difficult as the size of the unit decreases. In the other method, a groove must be cut in the case to separate it into two sections which function as terminals. This cutting or grooving becomes more difficult with small units.

The present invention provides an encapsulated capacitor comprising two terminals each formed from a member of L-shaped cross-section, a capacitor body with an anode having an anode lead extending therefrom and a cathode, said body being encapsulated in an insulating material, one of said terminals being electrically connected to said cathode and the other to said anode, one arm of each of said terminals extending partway along the same side of said encapsulated body and said one arms being spaced from each other, the other arms of the terminals extending along opposite ends of said body with the said other arm connected to said anode being provided with a slot partway from its free edge toward the angle of the L-shape receiving said anode wire.

The present invention further provides a method for assembling and encapsulating capacitors comprising providing two elongate metal channel members each of substantially L-shaped cross-section, aligning said channel members in facing relationship to each other, placing a plurality of capacitor bodies in side-by-side relationship spaced from each other between said channel members, electrically connecting the cathode of each capacitor body to one of said channel members, electrically connecting the anode of each capacitor body to the other of said channel members, filling space between the channel members with an insulating material to encapsulate said bodies, and separating the encapsulated capacitors into individual units.

A feature of the preferred embodiment of this invention is the provision of a method for encapsulating chip capacitors that is amenable to automation. Another feature is the provision of an encapsulated chip capacitor with terminals so designed as to not only function as terminals on the final capacitor, but also to have served as channels for the encapsulating material.

In order that the present invention be more readily understood, an embodiment thereof will now be described by way of example with reference to the accompanying drawing, in which:—

Figure 1 is a perspective view of capacitor bodies in channel terminals before encapsulation;

Figure 2 is a perspective view of a completed capacitor showing the anode terminal; and

Figure 3 is a lengthwise cross-sectional view of the preferred chip capacitor of Fig. 2.

According to the presently preferred process, two metal channel members of substantially L-shaped cross-section are placed on a base facing each other and spaced from each other for the admission of solid electrolyte or other capacitor bodies. The base is a processing fixture constructed of material that is non-adherent to the encapsulating material. It may be a plate with a spacer between the channel members. Alternately, the fixture may be of one piece and formed with a raised portion down the middle to accomplish the same ends.

The channel member which will serve as the anode terminal is provided with slots along its length to receive anode lead wires of the capacitor bodies, and the slot spacing along the channel member corresponds to the spacing of the capacitors and anode wires attached to a conventional capacitor processing bar. Thus, the slots serve also as alignment points for later separation of the units. The capacitors attached to their processing bar are inserted into the channels, and the cathode attachment is made by affixing conductive adhesive or solder to the channel member which will serve as the cathode terminal or/and the cathode end of the capacitor before insertion into the channel member assembly of the cathode channel member. The anode leads pass down through the slots, and the leads are welded adjacent the bottom of the slots. If laser welding is used, the lead is cut at the same time as it is welded. The capacitor processing bar may be removed at this time. Next, encapsulant is admitted to the channel member assembly containing the plurality of capacitors in side-by-side relationship. The encapsulant is cured, and finally the individual units are separated, preferably by dicing, intermediate each slot. The slots on the anode channel not only assure good metal-to-metal contact for the anode connection, particularly for welding, but also serve as reference points for the dicing operation.

Figure 1 shows a perspective view of a channel member assembly during a step in the process of assembling capacitor bodies 13 between elongated channel members 21 and 22, sections of which provide anode terminals 11 and cathode terminals 12. The cathode attachments 14 are made to channel member 21 by conductive adhesive or solder. The anode lead wires 18 while still attached to a common capacitor processing bar (not shown), are combed through slots 15 in channel member 22 and are welded to the channel adjacent the bottom of each slot, thus aligning the capacitor bodies; and the portions of the wires 18 which extend beyond the member 22 are removed. The edges or lips 17 of the channel members 21 and 22 are preferably bent so that they become embedded in the later applied encapsulant and lock the capacitor elements together. Subsequently, the capacitors are separated, e.g., by cutting or dicing between the encapsulated bodies, as indicated by dashed lines 19 using anode slots 15 as offset alignment points.

Figure 2 shows cathode and anode terminals 11 and 12, respectively, of substantially L-shaped cross-section which face each other. They each have a horizontal and a vertical portion joined in a right angle along a common edge. A capacitor body 13 is disposed between them and electrically connected to them as in Fig. 1. Anode terminal 12 has a slot 15 to receive anode lead 18. In the preferred embodiment, the top and bottom edges of both terminals are bent inwardly forming lips 17 which are embedded in the encapsulant 16.

Figure 3 shows anode terminal 11 and cathode terminal 12 of substantially L-shaped cross-section, which face each other but are spaced from each other. A capacitor body 13 is positioned between terminals 11 and 12. Anode terminal 11 has a slot 15 in the back (vertical) portion thereof through which the anode lead 18 passes, and the anode attachment is made at the bottom portion of slot 15. The cathode attachment 14 is made to the other terminal 12. The capacitor body 13 and that portion of the anode lead 18 to the interior of the anode terminal 11 are surrounded by encapsulating material 16, with bent portions 17 of the terminals embedded in it. The encapsulant 16 is not flush with the bottom portions of the terminals, but is slightly elevated between them.

The process permits the assembly of a plurality of units at a time and lends itself readily to automation.

The final capacitor itself has terminals 11 and 12 which can be attached to circuits by usual means, e.g., reflow soldering, and which, because of the locking lips 17 embedded in the encapsulant 16, do not peel away or otherwise separate from the encapsulant. Briefly, each capacitor has two terminals 11 and 12 of substantially L-shaped cross-section, facing each other; the vertical portion of the anode terminal 12 is slotted through the top edge partway down this portion. The top and bottom edges of both terminals 11 and 12 are bent inwardly forming locking lips 17. Preferably, each capacitor body 13 is attached to its cathode terminal 12 via solder or conductive adhesive, and to its anode terminal 11 by welding the anode lead 18 to the slot 15 adjacent its lower end. However, the anode connection may also be made by conductive adhesive or soldering. The entire body is encapsulated, with the locking lips 17 embedded in the encapsulant 16.

At the present time, encapsulating materials with the desired properties for use with capacitors do not adhere well to the metal of the terminals. The requirements the metal must meet are that it is solderable and weldable, e.g., nickel, copper alloys, goldplated nickel, iron-nickel alloys, etc. The encapsulant must have a high enough viscosity to be retained by the channels on and around the capacitor bodies but still be able to flow into crevices and around corners. Alternately, a transfer molding process may be used to encapsulate the units. The edges of the terminals need not be bent into the lips if the encapsulating material bonds well to metal, thus simplifying the manufacture of the terminals.

In the drawings, the L-shaped members have vertical and horizontal portions of substantially equal length. This is not necessary in all instances and the horizontal portions can be made very much shorter than the vertical portions or vice versa.

CLAIMS

1. An encapsulated capacitor comprising two terminals each formed from a member of L-shaped cross-section, a capacitor body with an anode having an anode lead extending therefrom and a cathode, said body being encapsulated in an insulating material, one of said terminals being electrically connected to said cathode and the other to said anode, one arm of each of said terminals extending partway along the same side of said encapsulated body and said one arms being spaced from each other, the other arms of the terminals extending along opposite ends of said

body with the said other arm connected to said anode being provided with a slot partway from its free edge toward the angle of the L-shaped receiving said anode wire.

2. An encapsulated capacitor according to claim 1 wherein the free edges of the arms of each terminal opposite the angle of the L-shape are bent inwardly forming locking lips, and said lips being embedded in said insulating material.

3. An encapsulated capacitor according to claim 2 wherein said locking lips of each terminal are embedded in said insulating material on the opposite sides of the capacitor.

4. An encapsulated capacitor according to claim 2 or 3 wherein said slot also extends through said locking lip, and said anode wire is welded to said terminal adjacent the lower end of said slot.

5. An encapsulated capacitor according to any one of the preceding claims wherein said cathode is connected to its terminal by solder or conductive adhesive.

6. A method for assembling and encapsulating capacitors comprising providing two elongate metal channel members each of substantially L-shaped cross-section, aligning said channel members in facing relationship to each other, placing a plurality of capacitor bodies in side-by-side relationship spaced from each other between said channel members, electrically connecting the cathode of each capacitor body to one of said channel members, electrically connecting the anode of each capacitor body to the other of said channel members, filling space between the channel members with an insulating material to encapsulate said bodies, and separating the encapsulated capacitors into individual units.

7. A method according to claim 6 wherein the elongate edges of each channel member are bent inwardly forming lips that become embedded in said material to lock the channel members to the encapsulating material.

8. A method according to claim 6 or 7 wherein said capacitor bodies each have an anode lead wire extending from an end thereof, and said channel member to which the anodes of the capacitor bodies is attached has slots from one elongate edge partway toward the angle of the L-shape to receive said anode wire.

9. A method according to claim 8 wherein said slots are spaced along said anode channel to conform with the spacing of said anode wires attached to a capacitor processing holder for said plurality of capacitor bodies.

10. A method according to any one of claims 6 to 9 wherein said channels are temporarily mounted facing each other along each horizontal plate to a spacing fixture prior to the insertion of said capacitor bodies.

11. A method for assembling and encapsulating capacitors substantially as hereinbefore described with reference to the accompanying drawings.

12. A capacitor when made by the method according to any one of claims 6 to 11.

13. An encapsulated capacitor substantially as hereinbefore described with reference to the accompanying drawing.

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