

[72] Inventor **Lucian Bercovici**
Wilbraham, Mass.
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 [73] Assignee **General Instrument Corporation**
Newark, N.J.

3,533,036 10/1970 Wood..... 336/208 X

Primary Examiner—Thomas J. Kozma
 Attorney—James and Franklin

[54] **EMBEDMENT-TYPE COIL ASSEMBLY**
18 Claims, 4 Drawing Figs.

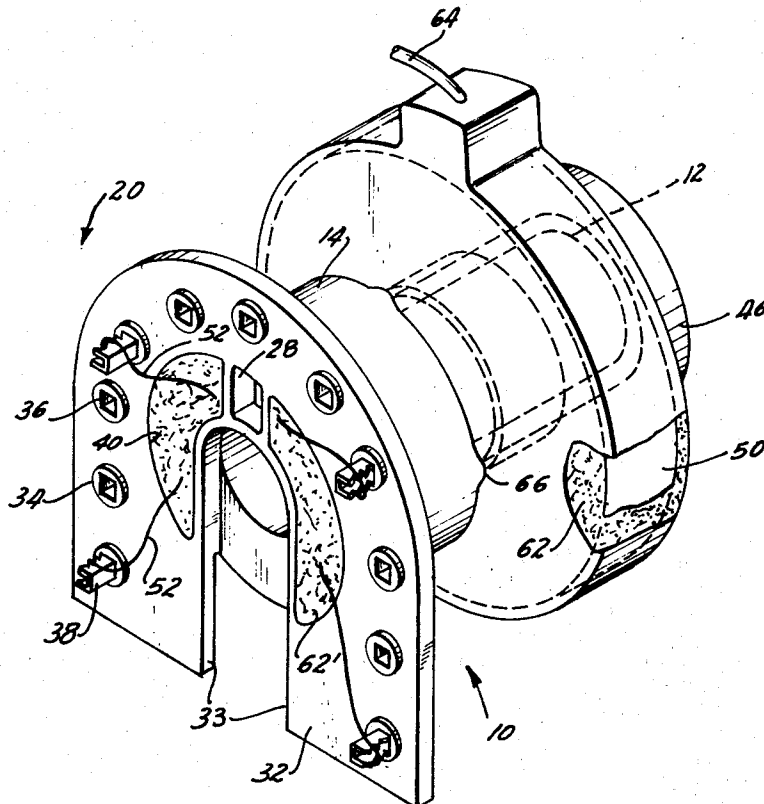
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H01f 27/30
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205, 198, 208, 192; 264/272, 263, 267; 29/602,
605; 242/118.7

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ABSTRACT: An embedment-type transformer coil assembly is disclosed particularly suited for a transformer application, together with a novel method and coil form for embedding the primary and secondary transformer windings within a unitary embedment material. An inner elongated tubular member is connected by means of a top panel skeletal structure to an outer shorter tubular member defining a minor molding space therebetween. The top panel skeletal structure defines spaces through which embedment material can be conducted, thereby to embed leads from the windings which extend into the minor molding space. The top panel may comprise a plurality of terminal lugs to which the leads can be connected. In the embedding process, the form is placed in an upstanding position in an open mold cavity which is filled to its upper level with embedment material. Embedment material can then be added to the minor molding space between the tubular members, thereby to embed the leads and form a unitary embedment structure, thus providing full protection for the primary and secondary transformer windings and their associated leads.



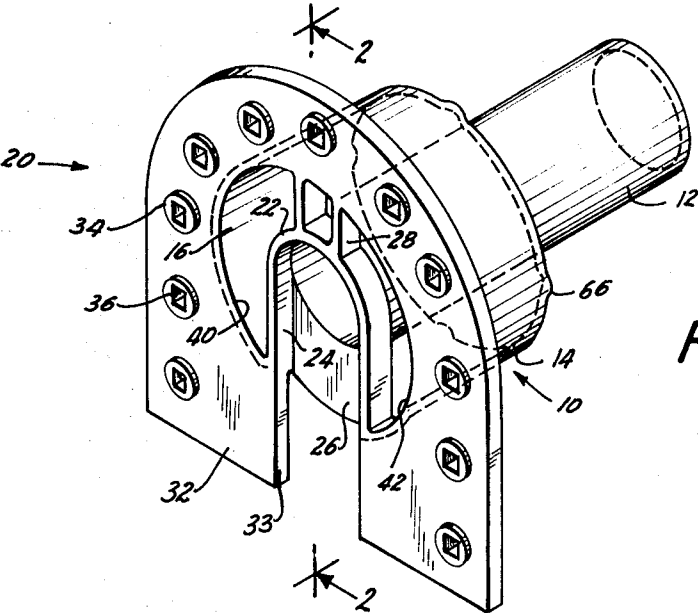


FIG. 1

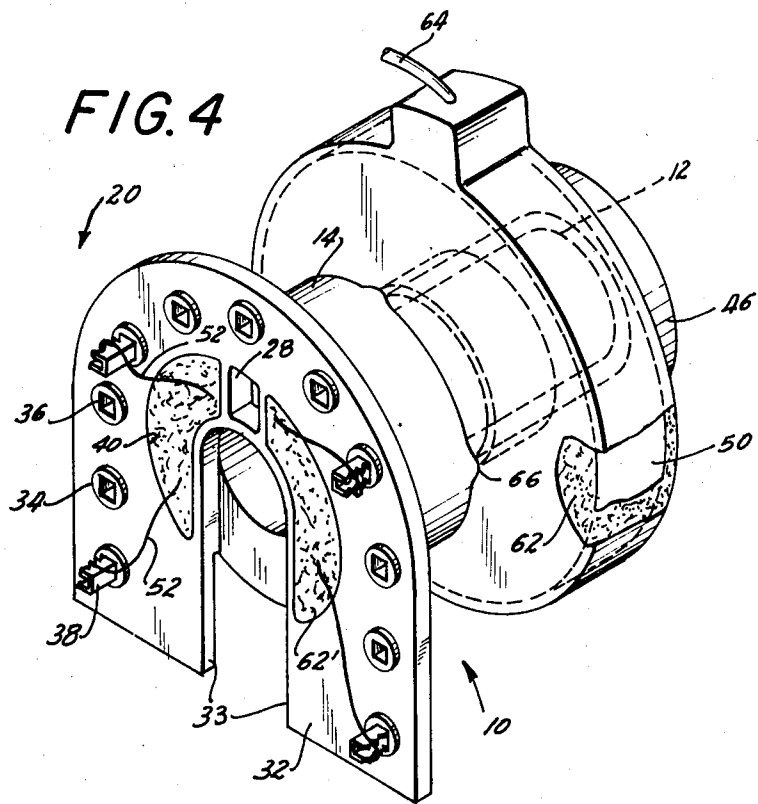
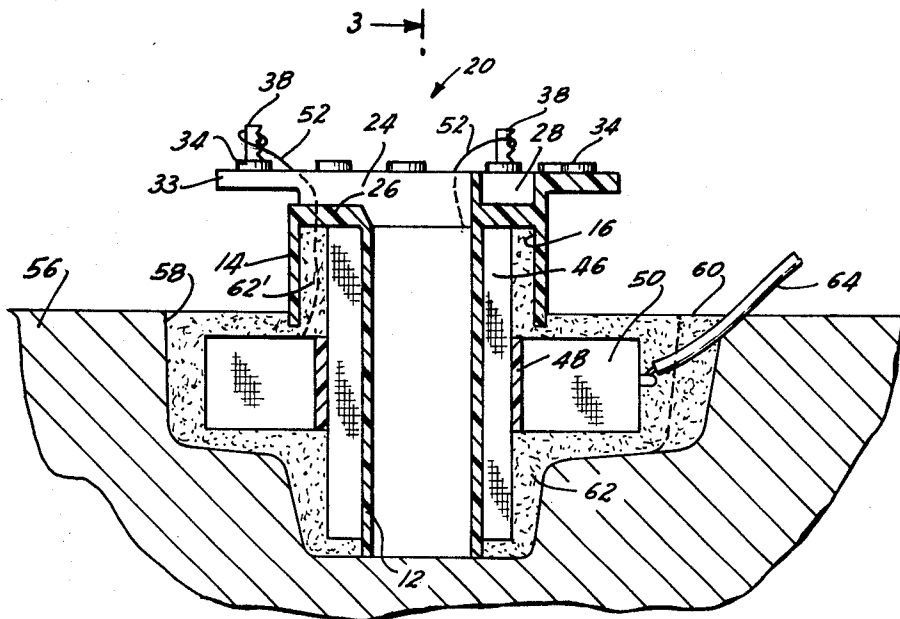
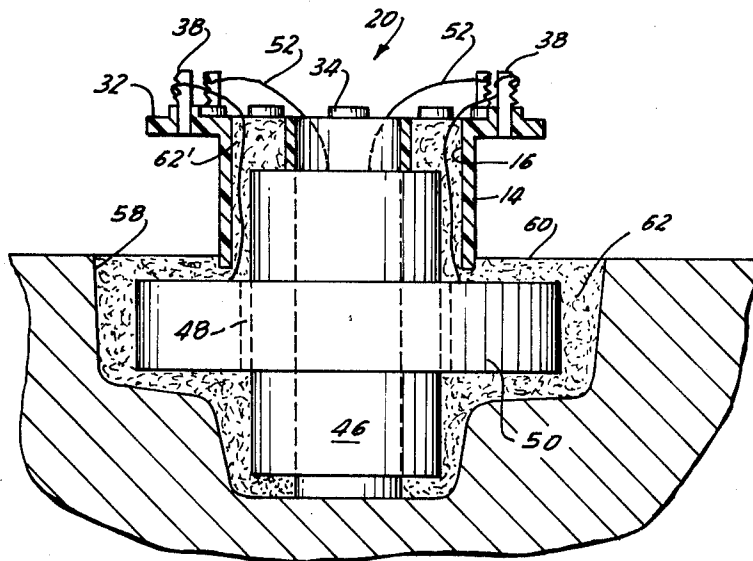


FIG. 4

INVENTOR.
LUCIAN BERGOVICI
BY *James and Franklin*
ATTORNEY



INVENTOR.
LUCIAN BERCOVICI
BY *James and Franklin*
ATTORNEY

EMBEDMENT-TYPE COIL ASSEMBLY

The present invention relates to an embedment-type coil form, particularly well adapted for transformer applications, and to the use of such a form in a manner which facilitates the controlled production of winding configurations such as those required in a television display system which utilizes a non-sinusoidal, high-frequency high-voltage transformer.

A television display system, or "flyback" transformer generally has a cylindrical multilayered primary winding which forms the center of the winding configuration. The primary may contain a multitude of leads which tap the windings at various places, and also may include galvanically independent windings which may lie within the confines of the primary and which also may be tapped. Consequently the number of leads emerging from the primary is usually considerable, and maintaining their correct order is critically important.

It has been a standard practice to surround the primary winding by a generally less wide, but frequently many more layered, secondary winding, called "the high-voltage winding," which winding extends radially outwardly from the primary.

Since voltages of the order of tens of thousand of volt and complex current wave forms are generated within the transformer structure, high-voltage engineering principles must be applied throughout the structure, and as previously stated lead positions must be maintained precisely. Lead breakage, a particularly hazardous condition, must be inhibited for satisfactory transformer operation. In addition, operating temperature and humidity problems play a significant role; dissipation of the internally generated heat must be provided for, and the high voltages generated in such a transformer make flammability control a particularly important consideration.

Accordingly, the above requirements make embedment of the transformer windings necessary. The embedment material is normally a protective-type material such as a thermoplastic or a thermosetting plastic. The coil form of the instant invention permits successful embedment of the transformer windings in a most direct manner, is less expensive, and ameliorates the various production difficulties normally encountered.

To embed the transformer successfully, requires that the embedment material envelop the windings and leads completely, that is, form a unitary embedment structure, and provide an outline and thickness of insulating material called for by the voltages existing in the various sections and terminations. In the prior art, an embedment structure as heretofore described has been produced by utilizing a two-section mold with the expenses and complexities concomitant therewith. The coil form as hereinafter described permits the formation of a unitary embedment structure utilizing a less expensive and simplified one-piece mold casting system.

Accordingly, it is a primary object of the present invention to provide an embedment-type coil form which permits the formation of a unitary embedment structure about transformer windings and leads within a one-piece mold casting system.

A further object of the present invention is the provision of an embedment transformer coil form, in combination with an embedding process, which ensures that the individual winding leads maintain their correct order, and which protects against their breakage.

An inner elongated tubular member is connected by means of a top panel skeletal structure to an outer shorter tubular member. A primary winding is placed about the inner tubular member and extends into the space between the inner and outer tubular members. The secondary winding is placed about the primary winding and extends outwardly radially past the outer tubular member but is longitudinally spaced therefrom. The individual windings leads, which tap the windings, extend into the space between the tubular members, and are connectable to terminal lugs on the top panel skeletal

structure. When the coil form is placed in an upstanding position in an open mold cavity, protective material can be conducted to the cavity, thereby to embed the secondary winding and a portion of the primary winding. Then additional protective material can be conducted to the cavity, thereby to embed the secondary winding and a portion of the primary winding. Then additional protective material can be conducted into the space between the inner and outer tubular members, thereby to embed the leads within that space, and to embed the remainder of the primary winding. Since the secondary winding and outer tubular member are spaced from each other, the protective material in the mold cavity and in the space between the tubular members are unitized.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to an embedment-type transformer coil form and the method of embedding, as defined in the appended claims, and as described in the specification, taken together with the accompanying drawings in which:

FIG. 1 is a perspective view of the coil form prior to the assembly thereon of the primary and secondary windings;

FIGS. 2 is a cross-sectional view of the coil form taken along the line 2-2 of FIG. 1, and illustrating the form and having the primary and secondary windings assembled thereon within the mold cavity subsequent to the addition of the protective material in the space between the tubular members;

FIG. 3 is a cross-sectional view of the coil form, with the primary and secondary windings thereon, and within the mold cavity, taken along the line 3-3 of FIG. 2; and

FIG. 4 is a perspective view of the embedded transformer as shown after removal from the mold cavity.

Referring to FIG. 1, the coil form 10 which may be fabricated from a plastic or other suitable material, is illustrated prior to assembly thereon transformer primary and secondary windings. An elongated tubular member 12 is adapted to receive in its tube bore a ferromagnetic core, and is connected to an outer shorter tubular member 14. In the representative form here illustrated, the inner and outer tubular members 12 and 14 are in the relation of radially spaced concentric cylinders. The inner and outer tubular members 12 and 14 define between them a minor molding cavity or space 16, and are connected at their uppermost ends by the top panel skeletal structure 20, the various functions of which will be apparent as the description continues.

The central portion of skeletal structure 20 comprises a yokelike member 24 which partially surrounds, and is integral with, the inner tubular member 12. The ends of that yokelike member 24, extend toward the outer tubular member 14 finally integrating therewith. The flat connecting member 26 is integral with the top portion of the inner tubular member 12, and connects both ends of the yokelike member 24. To provide a stable and balanced connection between the inner and outer tubular members 12 and 14, a connecting member 28, shown here as a boxlike structure, is integral with both the yokelike member 24 and the outer tubular member 14, and is substantially diametrically opposite the connecting member 26. The boxlike configuration of member 28 both conserves form material and reduces the weight of the coil form 10. Similar advantages obtain by making the thickness of the connecting member 26 substantially less than that of the yokelike member 24. The top panel 32 is integral with the outer tubular member 14, and except for the circumferential section defined by the connecting member 26, extends entirely around that outer member. The thickness of the top panel 32 is less than that of the yokelike member 24, and this, in combination with the space between the panel ends 33, also conserves form material and reduces weight. A plurality of bosses 34 are formed on the top surface of the panel 32 and provide openings 36, shown here as square shaped, which are adapted to receive conductive terminal lugs 38. It is to be noted that the top panel skeletal structure 20 defines the openings 40 and 42 which provide fluid access to the molding space 16.

Referring now to FIG. 2, the coil form 10 is shown with transformer primary and secondary windings 46 and 50 respectively assembled thereon. The primary windings extend substantially the length of the inner tubular member 12 (here shown contiguous the top panel skeletal structure), but may extend any distance into the molding space 16 as is desired. The primary and secondary windings 46 and 50 are insulated from each other by a spacer 48. The secondary winding 50 extends outwardly radially past the outer tubular member 16, and it is preferable, as will be evident as the discussion continues, that there be a space between the secondary winding 50 and the outer tubular member 14.

The primary winding 46, which may contain the galvanically independent windings confined therewithin, may be tapped in a number of places by leads 52 which extend into the molding space 16 and pass through the openings 40 and 42. Additionally, the secondary winding 50 may be tapped in various places and the leads 52 therefrom likewise may extend into the molding space 16 and through the openings 40 and 42. All the leads 52 are connectable to the various terminal lugs 38 on the top panel 32. It should be noted that the leads 52 need not be connected to the lugs 38 prior to molding, but probably they would be at least temporarily connected thereto for testing before molding. Since the various leads 52 have been dressed according to their electrical significance, it is important that the individual leads 52 are located in such a manner that they emerge through the openings 40 and 42 in a correct order for subsequent soldering to the individual lugs 38. Further, it is essential to avoid lead failure or breakage; embedding the leads 52 within the molding space 16 will not only locate them in their proper order, but will also provide the necessary breakage protection.

By employing the form 10, the primary and secondary windings 46 and 50, including the leads 52, may be embedded by employing a one-piece open mold casting system, rather than a conventional two-piece mold system which is both more expensive and more complex. The coil form 10 in its fully assembled condition, that is, with the primary and secondary windings 46 and 50 mounted thereon, and the leads 52 extending into the molding space 16, and through the openings 40 and 42 (and if desired connected to the terminal lugs 38), is placed in the mold cavity 58 in an upstanding position such that that outer tubular member 14 extends about the upper level 60 of that mold cavity (see FIG. 2). The molten embedment material 62, which may be a thermoplastic or thermosetting plastic material, or adequate substitute therefor, is then conducted into the mold cavity 58 in any appropriate manner. The molten material fills the cavity 58 to its upper level 60, which is preferably at a somewhat higher level than the bottom end of the outer tubular member 14, thereby embedding all of the secondary winding 50 and a large portion of the primary winding 46. At this point the material 62 may, if desired, be partially cured or set to harden before proceeding to embed the remainder of the primary winding 46 and the leads 52. Upon satisfactory hardening of the material 62 within the mold cavity 58, additional embedment material 62 is conducted into the minor molding space 16 through one or the other, or both, of the openings 40 and 42. This material 62 merges with the material 62 already in the mold cavity 58, and upon pouring to a desired level and thereafter curing or setting, the entire primary and secondary windings 46 and 50 and the various leads 52 are embedded in a unitary embedment structure. As should be noted in FIGS. 2 and 3, the lower end of the outer tubular member 14 extends slightly into the mold cavity 58, thus ensuring that the molten material poured into the molding space 16 will not leak out through the space between the bottom of the outer tubular member 14 and the secondary winding 50, into the area above the upper level 60 of the cavity 58. That space also ensures that in the event the pour into the cavity 58 does not entirely fill that cavity, the material 62 which enters through the openings 40 and 42 can pass through that space, thereby filling the remainder of that cavity and providing a unitary embedment structure.

Referring to FIG. 1, it is to be noted that there are slight protrusions 66 at the lowermost end of the outer tubular member 14 which ensure that there will be a space between the outer tubular member 14 and the secondary winding 50. Even if the secondary winding 50 is placed so high about the primary winding 46 so as to actually touch the protrusions 66, there will still be sufficient space between the outer tubular member 14 and the secondary winding 50 for molten material 62 to pass therethrough into the cavity 58, in the event that cavity has not completely filled upon the first pour.

Upon curing the molten material in the molding space 16, a unitarily embedded transformer emerges as illustrated in FIG. 4. The entire surface areas of the primary and secondary windings 46 and 50 are coated with a substantial thickness of the protective material 62, but equally as important, the leads 52 are embedded within the molding space 16, and emerge therefrom in correct order for subsequent soldering to the terminal lugs 38 (if they were not soldered to the lugs prior to the embedding). Thus, the leads 52 are protected from breakage and their correct order is assured. The primary and secondary windings 46 and 50 are provided with the necessary protective coating to fully protect them under the high voltage generated within the transformer.

The open mold, one-piece casting system of the present invention is less expensive and less complex than the conventional two-piece molding system, and produces an end product of superior quality.

While but a single embodiment of the present invention is herein disclosed, it will be appreciated that many variations may be made in the details thereof, without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. An embedment-type coil form comprising an elongated tubular member, a shorter outer tubular member in surrounding relation thereto and radially spaced from said elongated tubular member, and a top panel skeletal structure connecting the tubular members at their tops, the skeletal connecting structure being formed with open spaces between the tubular members.

2. In the coil form of claim 1, an integrally formed panel board at its top provided with a plurality of spaced terminal lugs.

3. In combination with the coil form of claim 2, primary and secondary transformer windings on the elongated tubular member and spaced from said outer tubular member.

4. The combination of claim 3, comprising a unitary embedment material completely enveloping the exterior of said primary and secondary windings inclusive of filling of their spacing from the outer tubular form and uniting the same to said coil form.

5. In combination with the coil form of claim 1, primary and secondary transformer windings on the elongated tubular member and spaced from said outer tubular member.

6. The combination of claim 5, comprising a unitary embedment material completely enveloping the exterior of said primary and secondary windings inclusive of filling of their spacing from the outer tubular form and uniting the same to said coil form.

7. The combination of claim 3, wherein said secondary transformer winding extends radially outwardly past said outer tubular member of the form.

8. The combination of claim 7, comprising a unitary embedment material completely enveloping the exterior of said primary and secondary windings inclusive of filling of their spacing from the outer tubular form and uniting the same of said coil form.

9. The combination of claim 3, said windings having leads passing through said spacing between said inner and outer tubular members to the terminal lugs of said panel board.

10. The combination of claim 4, said windings having leads passing through said spacing between said inner and outer tubular members to the terminal lugs of said panel board.

11. In the combination of claim 10, embedment material filling said spacing thereby to embed said leads within said embedment material.

12. In the combination of claim 10, embedment material filling said spacing thereby to embed said leads within said embedment material.

13. The method of completely embedding the primary and secondary coils of a transformer coil of an embedment-type transformer coil structure, which comprises taking a coil form comprising an elongated tubular member, a shorter outer tubular member in surrounding relation thereto and radially spaced from the elongated tubular member, and a top skeletal structure connecting the tubular members at their tops, the skeletal connecting structure being formed with open spaces between the tubular members, placing primary and secondary transformer windings on the elongated tubular member, both transformers windings being spaced from the outer tubular member of the coil form, then placing the same in an open mold cavity in an upstanding position, conducting plastic material into the mold cavity substantially up to the outer tubular member, and conducting plastic material into the spacing between the tubular members, thereby completely embedding the primary and secondary coils of the transformer.

14. In the method of claim 13, the further step of causing the protective material in the mold cavity to at least partially harden prior to conducting protective material into said spacing.

15. The method of completely embedding a coil of a coil structure, which comprises taking a coil form comprising an elongated tubular member, a shorter outer tubular member in

surrounding relation thereto and radially spaced from the elongated tubular member, and a top skeletal structure connecting the tubular members at their tops, the skeletal connecting structure being formed with open spaces between the tubular member, placing a winding on the elongated tubular member, said winding being spaced from the outer tubular member of the coil form, placing the same in an open mold cavity in an upstanding position, conducting plastic material into the mold cavity substantially up to the outer tubular member, and conducting plastic material into the spacing between the tubular members, thereby completely embedding said coil.

16. In the method of claim 15, the further step of causing the protective material in the mold cavity to at least partially harden prior to conducting protective material into said spacing.

17. The method of embedding a winding in protective material using the coil form of claim 5, which comprises placing said coil form and winding in an open mold cavity in an upstanding position, conducting protective material into said mold cavity substantially to the cavity upper level, and conducting protective material into the spacing between the tubular members, thereby completely embedding said primary winding.

18. In the method of claim 17, the further step of causing the protective material in the mold cavity to at least partially harden prior to conducting protective material into said spacing.

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