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H. B. FLEMING

2,885,643

TRANSFORMER CONSTRUCTION

Filed Dec. 31, 1956

2 Sheets-Sheet 1

Fig. 2.

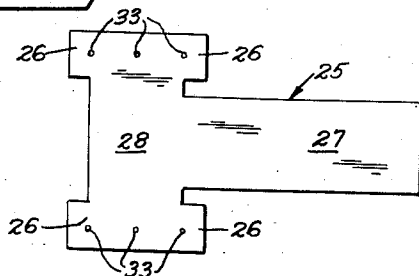


Fig. 3.

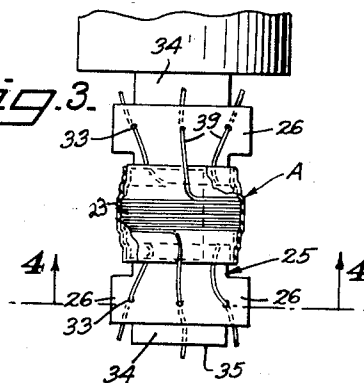


Fig. 1.

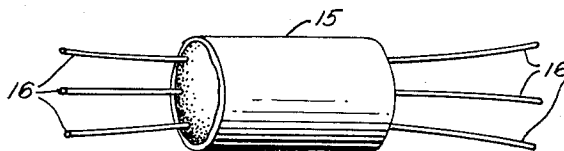


Fig. 5.

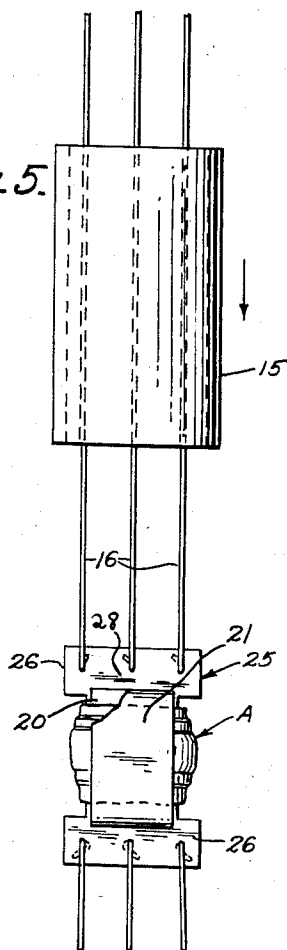
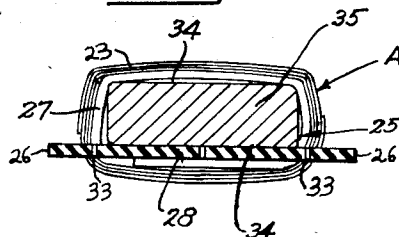


Fig. 4.



INVENTOR.
HUGH B. FLEMING
BY

Townsend and Townsend
ATTORNEYS

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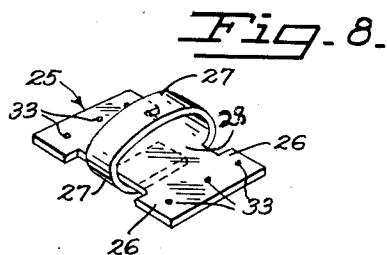
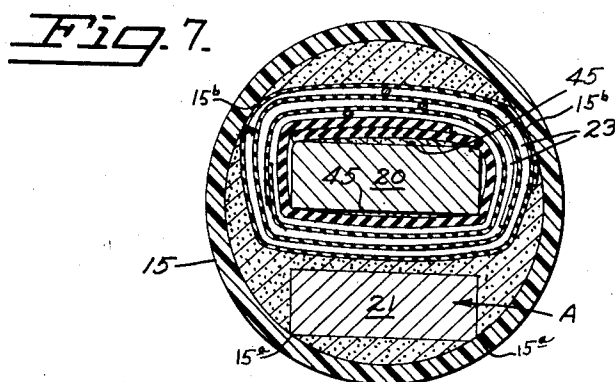
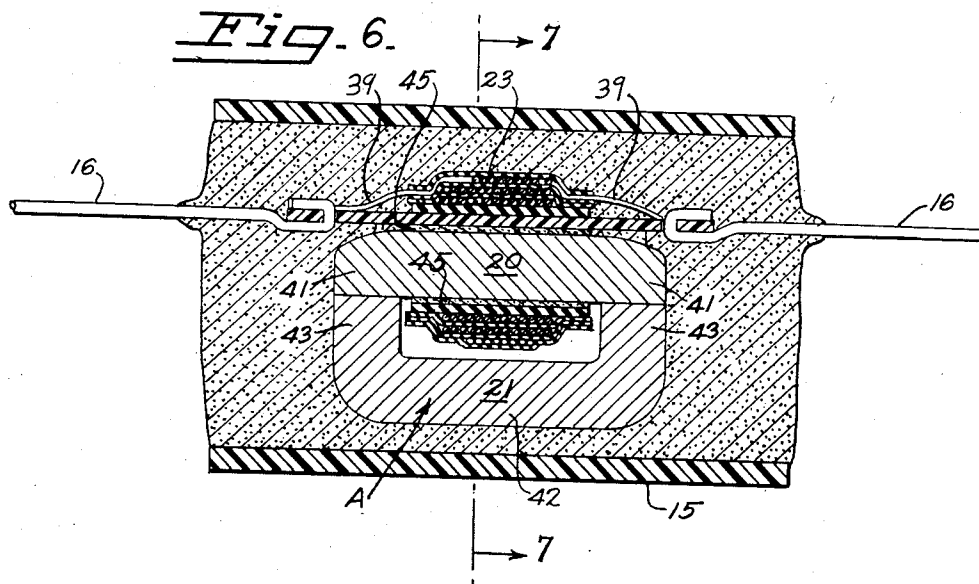
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INVENTOR.
HUGH B. FLEMING
BY

BY

Townsend and Townsend
ATTORNEYS

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TRANSFORMER CONSTRUCTION

Hugh B. Fleming, Burlingame, Calif.

Application December 31, 1956, Serial No. 631,909

6 Claims. (Cl. 336—96)

This invention relates to a method of and means for constructing miniature transformers.

In the art of transformer construction with the advent of ferrite cores and the need for low inductance transformers there has been an increasing tendency towards miniaturization of transformer components. The aforesaid miniaturization has caused obvious difficulties in the fabrication of inductive equipment which has made their construction difficult and costly.

This invention has for its principal object method of and means for transformer construction which greatly simplifies fabrication of transformers and which is particularly adaptable for obtaining improved miniaturized transformers.

In this invention there is provided a novel transformer coil form formed of a single piece of resilient dielectric material which is bent in a novel way to provide terminal blocks, a core support base and a coil form into which a core member may be inserted after the winding has been wound on the form.

One principal object of this invention is to provide a coil form comprising a blank which may be formed around a mandrel and wound with selected windings. The coil and form can be removed from the mandrel and one core member can be inserted into the coil form in a position previously occupied by the mandrel and another core member can fit around the outside portion of the winding in contact with the first core.

Another object of this invention is to provide an exterior sleeve housing which deforms the coil and form to hold a two piece core of the transformer in tightly compressed alignment with each other and with the transformer windings.

A feature and advantage of this invention is that upon assembly of a transformer having a core comprising an "I" and a U-shaped core member the sleeve housing co-acts with the coil structure to urge the legs of the U-core tightly against the end portions of the I-shaped core member in rigid alignment so that there is obtained a fixed electrical relationship between the two core members and the coil which is maintained under pressure.

Another object of this invention is to provide a method of holding two core members and a coil member of a transformer structure in relative fixed alignment during the interval the three members are incased or filled in a molten plastic substance such as epoxy resin.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

Fig. 1 is a perspective view of an embodiment of the transformer of the invention.

Fig. 2 is a top plan view of the blank for the coil form of the transformer.

Fig. 3 is a top plan view of the transformer in position on a winding mandrel.

2

Fig. 4 is a sectional view of Fig. 3 taken at line 4—4.

Fig. 5 is a top plan showing the transformer in position to be inserted into its sleeve housing.

Fig. 6 is an enlarged section of the completed transformer structure.

Fig. 7 is a cross-section of Fig. 6 taken at line 7—7.

Fig. 8 is a perspective view of the blank of Fig. 2 looped over to provide a coil form annulus.

Referring now to the drawings it can be seen that the completed transformer assembly A is housed in a casing, as shown by Fig. 1, similar to paper capacitors and the like. The transformer casing is formed of a tubular member forming a sleeve housing 15 with pigtail leads 16 connected to the transformer windings and projecting from each of the two opposite ends of the sleeve. The entire unit ordinarily is constructed small enough to be mounted directly on pluggable units or wired to tube sockets under conventional electronic mounting chassis.

The transformer assembly A comprises an "I" shaped ferrite core 20 and a U-shaped ferrite core 21 with one or more coils 23 disposed around the I-shaped core 20 on a coil form 25. The pigtails 16 are mounted on terminal tabs or flanges 26 of coil form 25 and are connected to the respective coils 23 by lead wires 39. The coil form 25 is formed of resilient dielectric material shaped in a T-shaped blank with a stem 27 looped over in an oval annulus to provide a form for the coil windings 23 and an arm 28 projecting outwardly from two opposite sides of one end of stem 27. The stem is formed with the tab flanges 26 forming the two opposite end edges of the arm. Apertures 33 are formed in the flanges 26 to facilitate mounting of pigtails 16 thereto and the connection of lead wires 39 from windings 23 to the pigtails.

In the first steps of construction of the transformer assembly A the blank of form 25 is placed with arm 28 adjacent a flat surface 34 of a mandrel 35 which is substantially the same size and shape in cross-section as the I-shaped core 20. Thereafter the stem 27 is looped around the mandrel 35 to form an annulus substantially circumscribing arm 28 and with said arm defining a substantially flat base piece with its opposite end extremities extending beyond the ends of the annulus. The looped over stem 27 thus defines an annular or oval coil mounting form. Various dielectrical adhesives may be applied to hold the form in position. However, it has been found that "Mylar" tape with a thermosetting adhesive applied thereto is particularly suitable to hold the various components of the transformer in alignment. "Mylar" tape is a trade name of the Du Pont Company and is generally characterized as being a plastic tape with an adhesive coating on one side thereof which is in its first state pressure sensitive, but which after being heated cures to form a relatively infusible, hard bond between the adhesive coated surface of the tape and the adjoining surface adhered thereto.

A coil 23 is wound on form 25 around the oval formed stem 27 by rotating the mandrel in a lathe. Additional windings 23 may be wound around the periphery of stem 27 by separating the windings with a dielectric tape. The "Mylar" tape above described with a thermosetting adhesive has been found particularly useful for this purpose. Such tape with a heat setting adhesive applied thereto facilitates binding the windings 23 in place by heat after the coil has been wound and inserted in the sleeve as will be hereinafter described.

After completing the windings each terminal lead 39 is aligned with a respective aperture 33. Pigtails 16 are then inserted in the apertures 33, cinched thereto, and soldered to the terminal leads 39.

Upon completion of the windings 23 the form 25 is removed from the mandrel 35 and "I" core 20 is then

placed on arm 28 of the form within the bore defined by the looped over stem or annulus 27 of the form. The "I" core 20 is longer than the width of the looped stem 27 so that the two end portions 41 of "I" core 20 project outwardly beyond the ends of the looped over stem.

The U core 21 is dimensioned with the inside length of its web 42 approximating the width of stem 27 and the outside distance between the ends of the two legs 43 of the U-core 21 equal to the length of "I" core 20 so the terminal ends of leg 43 can be placed on the top surface of the end portions 41 of the "I" core 20 projecting beyond stem 27. The legs 43 of the U core 21 are long enough to provide a small amount of clearance between the web 42 and the coils 23. In this position the edges of stem 27 abut the inside of legs 43 to hold the U core 21 from moving longitudinally with respect to the form 25. However, if desired the U core can be held in place by a thermosetting adhesive to prevent longitudinal movement of the core with respect to the form.

In the order of assembly of the transformer prior to the insertion of "I" core member 20 into the bore of stem 27 the inner wall of the stem is coated with a suitable thermosetting or other kind of adhesive 45 which is of a type that will not set-up until after the component parts have been properly assembled within sleeve 15 as will be described hereinafter. The U core 21 is then placed in position over the coil 23 against the "I" core 20.

In the next step of construction the entire transformer assembly A is inserted into the bore of sleeve 15 with pigtailed 16 projecting outwardly from the two opposite ends of the sleeve. The outer surface of web 42 is positioned adjacent one portion of the interior wall as at 15^a of sleeve 15 and the coils 23 and coil form 25 are arranged to abut the opposite portion of the interior wall of the sleeve as at 15^b. The sleeve 15 is dimensioned small enough so that the coil 23 and form 25 must be deformed in order to fit within the sleeve. The coil form 25, coil 23 and the flanges 26 engage with the interior wall surfaces as at 15^b of sleeve 15 to force the "I" core 20 against the U core 21 to forcefully urge and continually bias the connecting end portions of the two core members together. In this type of transformer construction it is highly desirable and often absolutely necessary that the adjoining edges of two core members be urged together under pressure to obtain a proper electrical union. The action of the coil and form against the sleeve provides ample pressure to form a proper electrical union between the two cores.

After the transformer assembly A is positioned in the sleeve midway between the ends, the entire unit is subjected to sufficient heat to cure the heat setting adhesive to bind the winding of the coils and lock the "I" core 20 in the bore of the stem 27 against longitudinal movement therein.

In the next step of construction the transformer is filled at both ends of sleeve 15 with an epoxy resin such as epichlorohydrin-bisphenol-A polymers. The resin filler fills in the voids within the sleeve and seals the transformer A from contact with the atmosphere. It has been found that it is desirable to heat set adhesives binding the core and the coil subsequent to being inserted into sleeve 15 but prior to the application of the epoxy resin to allow sufficient flexibility and resiliency of the coil form to facilitate alignment of the transformer components under compression.

It is desirable to cure or set the adhesive 45 prior to the step of filling the sleeve with epoxy resin in view of the fact that when the resin is first applied as a filler there is a tendency for it to act as a lubricant and seep between the various engaging surfaces of the core members and the coil form. In prior art manufacturing techniques the lubricant effect of the liquid resin has been found to occasionally result in some relative movement of the "I" core 20 with respect to the coil form and U

core 21 even though the two cores were held with the ends biased together under pressure. The heat cured adhesive holds the "I" core in place in form 25 and prevents misalignment of the "I" core with respect to the coil form. The U core is held in alignment by its legs 43 being compressed against the edges of stem 27. Thus all three components, coil form and the two cores are held in relatively fixed position. This is quite important in transformer construction where the precise alignment of core members is a critical factor in the proper electrical characteristics of the transformer.

After the epoxy resin has been applied and cured the transformer is completed and is sealed on the sides by sleeve 15 and on the ends by the epoxy resin so that the transformer is completely isolated from fluid communication with the outer atmosphere. This protects it from variations of humidity and harmful gases and also provides a certain amount of insulation from ambient heat variations.

It can thus be seen by this invention that a complete miniature transformer can economically be constructed in which the outside casing—i.e., sleeve 15—performs the multiple functions of holding the various components of the transformer under compression to force alignment during and after the assembling of the transformer, as well as forming a protective covering for the transformer and mold for the epoxy resins.

By the steps of applying the thermo-curing adhesive during the first step of construction and curing same during a subsequent step, that is, after the transformer unit has been inserted in sleeve 15, the maximum flexibility of components is retained until a desired alignment of parts is obtained and the cores can not slide out of alignment during the final step while the unit is filled with the epoxy resin material.

It is also within the broad scope of the invention that other types of adhesive including relatively quick drying single stage adhesives may be utilized. The basic requirement of any adhesive employed in the method of manufacturing is that the inner core and coil remain relatively movable with one another after the adhesive is applied at least until such time as the entire "I" core assembly is fabricated and snugly positioned within the sleeve housing 15. After assembling the adhesive must be capable of functioning as a bonding agent between the inner core and coil particularly during the interval that the housing is filled with a filler.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

What is claimed:

1. A transformer structure comprising; a resilient annular coil form, exterior coil windings around said form, a first core member axially disposed within the bore of said form having end portions projecting outwardly from the two ends of said form, a second core member mounted exteriorly of said coil and disposed with its terminal ends in contact with opposite end portions of said first core member, a rigid sleeve snugly housing said form and core members, said sleeve dimensioned to compress said resilient form within the bore of said sleeve urging the contacting portions of said first and second core members tightly against each other and a dielectric filler completely encasing said core members, coil and form in the bore of said sleeve to seal the encased elements from atmosphere and hold them in rigid encasement in the sleeve.

2. A transformer structure comprising; an annular coil form, exterior coil windings around said form, a first core member axially disposed within the bore of said form having end portions projecting outwardly from the two ends of said form, a second core member mounted

5

exteriorly of said coil and disposed with its terminal ends in contact with opposite end portions of said first core member, and a sleeve snugly housing said form and core members, said sleeve dimensioned to snugly engage said form to maintain said form, and first and second core members in bias contact with one another within said sleeve.

3. A transformer structure comprising; a resilient annular coil form, exterior coil windings around said form, a resilient flat base member disposed within the bore of said form having flange members projecting laterally adjacent two opposite ends of the said base member, a first core member disposed within the bore of said form on said base member and having end portions projecting outwardly from the two ends of said form, a second core member mounted exteriorly of said form and disposed with its terminal ends in contact with the top surface of opposite end portions of said first core member, and a rigid sleeve snugly housing said form and core members, said second core member and flanges of said base member each urged against oppositely facing sides of the interior wall of said sleeve snugly enough to deform said base member to create a continuous pressure urging said first and second core members toward the portion of the sleeve wall adjacent said second core member, whereby the contacting end portions of said core members are maintained in biased contact with one another within said sleeve.

4. A transformer structure comprising a resilient coil form having an annulus with a substantially flat base member axially disposed within said annulus and projecting outwardly from the ends of said annulus, said base member having transversely extending flanges adjacent the two opposite ends of said base member, windings around the exterior of said annulus, a first core member mounted on the base member axially aligned in the bore of said annulus and extending exteriorly of the ends of said annulus but terminating inwardly of said flange members, a U-shaped second core member having a web adjacent the exterior of the coil windings on said annulus and two depending arms each abutting the top surface of two of the opposite end portions of said first core member, and a rigid sleeve snugly housing said form and core members, said second core member engaging

6

a first interior portion of said sleeve and said form and windings engaged with a second interior wall portion of said sleeve oppositely facing said first interior wall portion, said sleeve dimensioned small enough to deform said base member, coil and form to create continuous pressure urging said first and second core members toward each other whereby the contacting end portions of said core members are maintained in biased contact with one another in said sleeve.

5. A transformer structure according to claim 4 and wherein the legs of said U-shaped core member engage the end edges of said annulus to limit relative longitudinal movement between said second core member and form.

6. A transformer structure comprising; a coil form made of sheet material which in blank form defines a T-shaped section having a stem with an arm projecting transversely from two opposite sides of one end of the stem, said stem looped to form an annulus substantially circumscribing said arm with said arm defining a substantially flat base piece within said annulus with opposite end extremities extending beyond opposite ends of the annulus, coil windings around the exterior of said annulus, a first core member having a length greater than the length of the annulus disposed axially within the bore of the annulus on said base piece with opposite ends of said first core member extending outwardly from the both opposite ends of said annulus but terminating inwardly of the ends of said arm, a second core member mounted adjacent the exterior of the annulus and coil, the two opposite terminal ends of said second core member in contact with opposite end side portions of said first core member and a sleeve dimensioned to snugly receive and resiliently deform said annulus and base piece to cause said first and second core members to be biased with their contacting end portions tightly forced toward each other.

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