United States Patent

[11] **3,569,884**

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[73] Assignees **Westinghouse Electric Corporation Pittsburgh, Pa.**

[54] **TRANSFORMER COIL WOUND FROM SHEET CONDUCTOR AND CAST IN A RESIN HOUSING**
4 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **336/96,** 336/192
[51] **Int. Cl.** **H01f 15/10,** H01f 27/04
[50] **Field of Search** 336/96, 205, 192, 232

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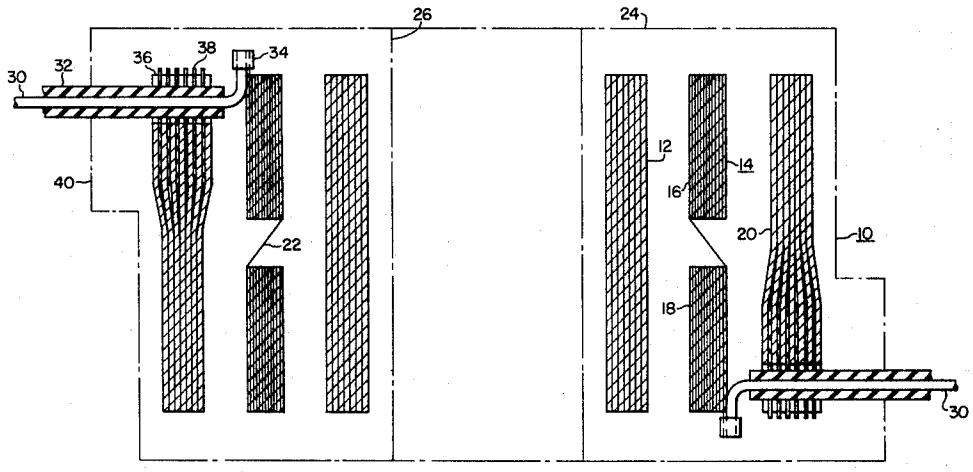
ABSTRACT: A transformer coil comprising a low voltage winding and an inner concentric high voltage winding. The windings being provided by winding on itself a plurality of layers of sheet conductor having a thin insulation coating thereon. Leads for the high voltage winding are brought out of the coil through an opening in the low voltage winding or closely adjacent the low voltage winding and the windings are cast into a resin housing so that the resin housing surrounds the windings and the high voltage leads. The cast resin braces the high voltage leads against the low voltage windings and provides a long leakage path from the voltage leads to points of a different ground potential.



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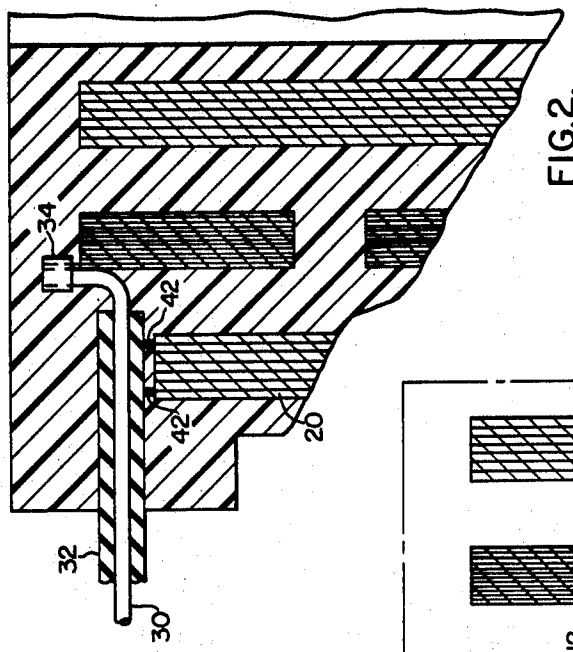

FIG. 2.

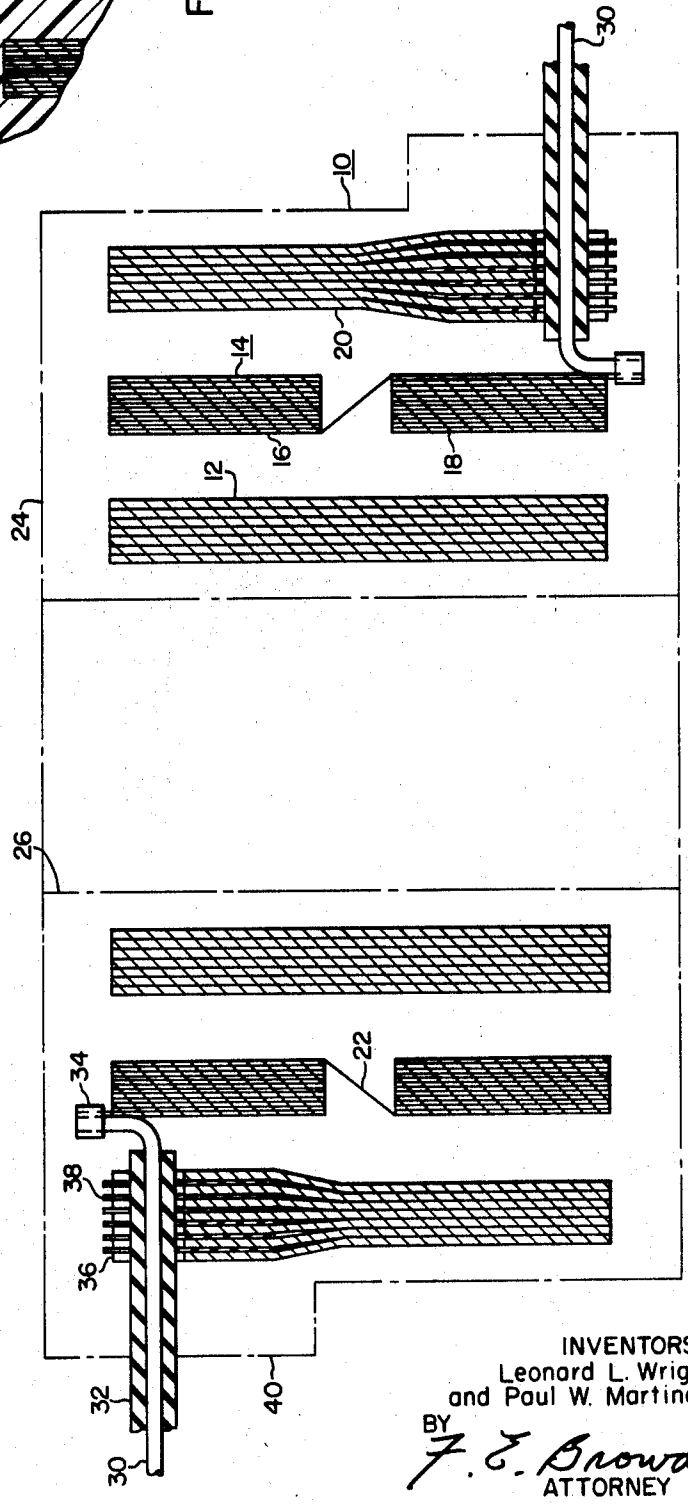

FIG. 1.

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F. E. Browder
ATTORNEY

2 Sheets-Sheet 2

FIG.4.

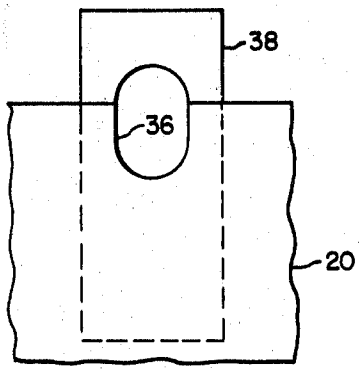


FIG.5.

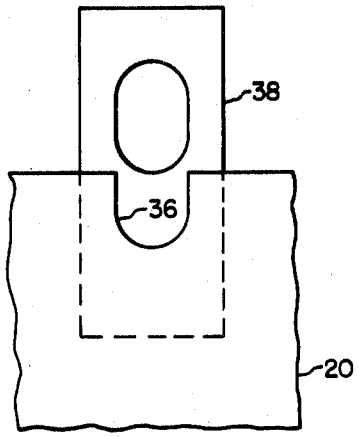
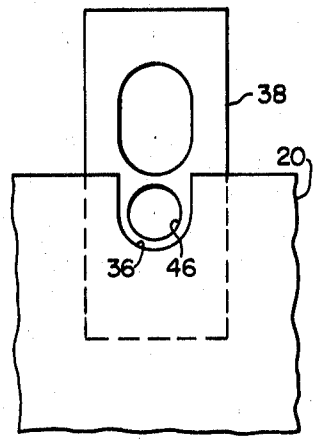


FIG.6.



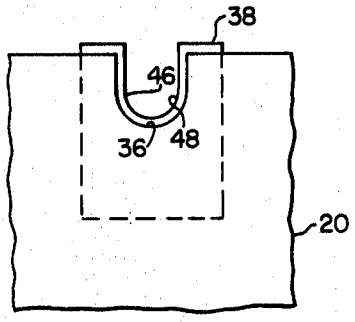


FIG.7.

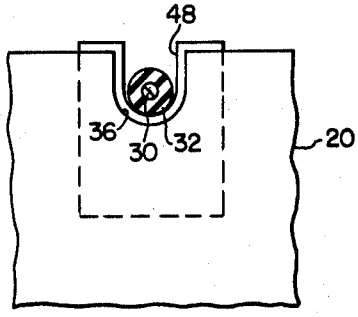


FIG.8.

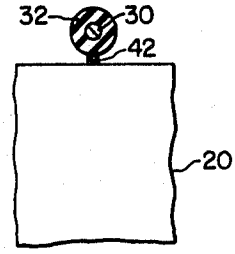


FIG.9.

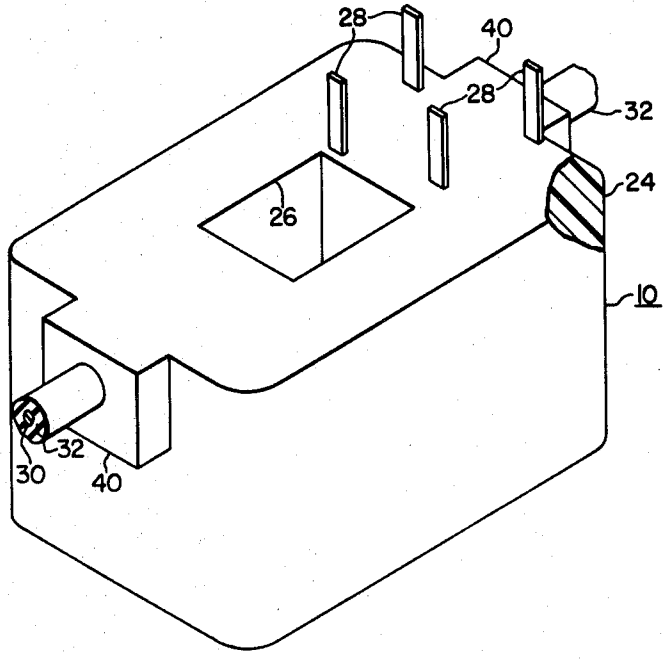


FIG.3.

TRANSFORMER COIL WOUND FROM SHEET CONDUCTOR AND CAST IN A RESIN HOUSING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical coils and more particularly to an electrical coil for use in electrical transformers, said coil comprising a low voltage winding and a high voltage winding encapsulated in a resin housing with leads from the windings extending through the resin housing.

2. Description of the Prior Art

In the prior art transformer coils comprising a high voltage winding and a low voltage winding formed from sheet conductor, when the windings are encapsulated in a resin housing all of the leads from the windings are usually brought out through the same side of the resin housing. This requires that the side of the housing through which the high voltage leads are brought out must of necessity be thicker than the other sides of the housing to provide strength to prevent cracking, and the entry of moisture into the housing, because of stress due to vibration or voltage stress at the high voltage leads. This thick wall also causes nonuniform stressing of the other walls of the housing when the coil is thermocycled. This nonuniform stressing often causes cracking and failure of other walls of the resin housing. Cracks in the resin housing cannot be tolerated in transformer windings of this type because corona will often start in the cracks. Furthermore, coils of this type may be installed under water for cooling and a crack in the resin housing would permit moisture to enter the coil and cause short circuits which would destroy the coil. This invention eliminates the above objections to the prior art by bringing the high voltage leads out of the housing closely adjacent the low voltage winding and bracing the high voltage leads against the low voltage winding by filling the space between the high voltage lead and the low voltage winding with dense cast resin. This effectively braces the high voltage winding against the low voltage winding, and stresses set up due to forces or potentials applied to the high voltage leads are distributed over a large region of the resin housing by the low voltage winding. This distribution of stress prevents cracking of the resin housing. This arrangement permits all of the walls of the resin housing to be made the same thickness, so that all parts of the resin housing are stressed uniformly during thermocycling. A large knob or projection of resin is provided around the high voltage leads where they leave the resin housing to provide extra strength at these points and also to provide a long creep path from the high voltage leads to ground or other point of a different potential.

SUMMARY OF THE INVENTION

This invention provides an improved coil for transformers. The coil comprises a low voltage winding and a high voltage winding assembled concentrically. The windings are wound from sheet conductor having an enamel or resin coating thereon for insulating the turns from each other. The windings are encapsulated in resin which provide a hermetically sealed housing for the coil. Low voltage terminals are brought through one side of the housing. High voltage terminals are brought through the ends of the housing. The high voltage terminals are located closely adjacent the ends of the low voltage winding and braced against the low voltage winding by casting high density resin between the high voltage leads and the low voltage winding. This bracing system for the high voltage leads distributes the stress which may be set up bending at the high voltage leads throughout a large part of the coil in such a manner as to eliminate cracking of the housing. This arrangement also permits all walls of the housing to be cast with the same thickness of resin and permits more uniform stressing of all sections of the housing upon thermocycling of the coil. A large knob or projection of resin is provided around each high voltage lead where it leaves the resin housing to provide a long creepage path from the high voltage leads to point of a different potential.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of one embodiment of a coil provided according to this invention;

FIG. 2 is a fragmental sectional view of a second embodiment of a coil provided according to this invention;

FIG. 3 is a perspective view of a complete coil provided by this invention;

FIGS. 4 through 8 illustrate the details for one method of insulating the high voltage leads from the low voltage winding; and

FIG. 9 illustrates a second method for insulating the high voltage leads from the low voltage winding.

DESCRIPTION OF PREFERRED EMBODIMENTS

Throughout the description which follows like reference characters refer to like parts in the various FIGS. of the drawing.

FIG. 1 represents a sectional view of a transformer coil **10** as provided by this invention. The coil **10** comprises an inner low voltage winding **12**, a high voltage winding **14** comprising sections **16** and **18**, and an outer low voltage winding **20**. The windings **12**, **14** and **20** are provided by winding a plurality of turns of sheet conductor on itself to provide the desired number of turns in each winding. The sheet conductor has an insulation layer of resin or enamel thereon to provide insulation between the turns of the windings. The high voltage winding sections **16** and **18** are connected in series circuit relationship by some suitable connection illustrated by a jumper **22**. The windings **12**, **14** and **20** are arranged concentrically to each other and spaced from each other and cast in a resin housing **24**. The casting resin completely fills the spaces between the windings **12**, **14** and **20** and provides a hermetically sealed casing or housing **24** for the coil **10**. During the process of casting the housing **24**, a window **26** is provided in the housing for mounting magnetic cores (not shown) in the coil **10**.

Leads **28** from the low voltage windings **12** and **20** are brought through the top of the housing **24** as indicated in FIG. **3**.

Leads **30** from the high voltage winding **14** are brought through the ends of the housing **24**, as shown in FIGS. **1** and **3**. The high voltage leads comprise a conductor member **30** having its own insulation **32** thereon. The conductor member is attached to the high voltage winding **14** with a crimp type terminal member **34**.

As seen in FIG. **1** the high voltage lead extends from the high voltage winding **14** substantially transverse to the low voltage winding **12** and is located in a hole or slot **36** in the low voltage winding **20**.

During winding of the low voltage winding **20** additional solid insulation spacers **38** are wound between layers of the winding **20** adjacent the area of the hole or slot **36**. These spacers may be of commercially available material known as Mylar, Nomex or other good insulating material. The spacers **38** supports the insulation **32** of the high voltage lead **30** spaced from the bottom of the slots or holes **36** during the assembly of the coil **10** preparatory to casting the housing **24**. When the housing **24** is cast around the windings the casting resin completely fills the space between the insulation **32** on the high voltage lead **30** and completely surrounds the insulation **32** on the high voltage lead **30**. The resin from which the housing **24** is cast is quite dense and when cured the high voltage lead **30** is securely braced to the end of the low voltage winding **20**. Stresses caused by movement of the high voltage lead **30** due to manipulation thereof or by high potential applied thereto will be distributed fairly evenly to the housing **24** throughout the length of the low voltage winding **20** because the high voltage lead **30** is effectively braced to or tied to the low voltage winding **20**, although electrically insulated from the low voltage winding **20**. A large projection or lump of resin **40** is provided around the high voltage leads **30** at the points where the high voltage leads **30** exit from the housing **24**. The purpose of the projection **40** is to provide additional strength

to the housing 24 at these points and also to provide a long creepage path from the high voltage leads 30 to points of a different potential. This method of bringing the high voltage leads 30 through the resin housing 24 reduces the possibility of cracking the resin housing 24 by stresses set up at the high voltage leads 30 and also permits all of the major wall portions of the resin housing 24 to be made the same thickness. This is an important advantage, since if the resin housing 24 cracks corona will probably start and moisture will enter the housing 24. A corona level which is unacceptable or moisture inside the housing 24 will render the coil 10 useless.

In the embodiment described in FIG. 1 the low voltage winding 12 is coextensive with the high voltage winding 14 and the leads are brought through an opening 36 in the low voltage winding 20. However, FIG. 2 illustrates a second embodiment for bringing the high voltage leads 30 out of the housing 24 and effectively bracing the high voltage leads 30 against the low voltage winding 20. In the embodiment of FIG. 2, the low voltage winding 20 is shorter than the high voltage winding 14. In the assembly of the coil 10 the high voltage leads 30 are placed across the end of the low voltage winding 20 and spaced therefrom by insulation spacers 42. When the coil 10 is cast into the resin housing 24, the casting resin fills the space between the high voltage leads 30 and the ends of the low voltage winding 20 and the resin also completely surrounds the high voltage leads 30 and its insulation 32. This construction effectively ties the high voltage leads 30 to the ends of the low voltage winding 20 and braces the high voltage leads 30 to the low voltage winding 20. In all other respects the embodiment of FIG. 2 is identical to the embodiment previously described for FIG. 1.

FIG. 3 is a perspective view showing a completed transformer coil 10 as provided by this invention with low voltage leads 28 brought out of the top of the resin housing 24 and with a high voltage lead 30 brought out of each end of the housing 24, as described hereinbefore. The resin used to cast the housing 24 may be any suitable casting resin, such as filled epoxy resin.

FIGS. 4 through 8 illustrate details of how the hole or slot 36 is provided in the low voltage winding 20 for the embodiment previously described in connection with FIG. 1. To provide the hole or slot 20 and maintain good turn to turn insulation between the turns of the winding 20 solid insulation strips 38 of Teflon, Mylar, Nomex or other good insulation material are placed between the turns as the winding 20 is wound. After the winding 20 has been wound with the desired number of turns, an oblong hole 36 is punched or drilled through all of the turns of the winding 20 and all of the insulating strips 38. After the oblong hole 36 has been provided, the strips 38 are pulled upwardly to a position indicated in FIG. 5. After the strips 38 have been pulled up to the position of FIG. 5 another hole 46 is drilled or punched through all of the strips 38. After the hole 46 has been provided all of the strips 38 are trimmed as indicated in FIG. 7. It is seen that after the strips 38 have been trimmed a portion 48 of each of the strips 38 extend upwardly into the hole or slot 36 in the turns of the winding 20. These projections 48 of the strips 38 serve to support the high voltage lead 30 and its insulation 32 spaced from the bottom of the holes or slots 36. This spacing of the high voltage leads 30 from the bottom of the holes or slots 36 permits resin to completely surround the high voltage lead 30 when the windings are cast into the resin housing 24.

FIG. 9 is a detail view illustrating the method of spacing the high voltage lead 30 from the low voltage winding 20 prior to the step of casting the resin housing 24 for the embodiment shown in FIG. 2.

From the foregoing description taken with the drawings it is seen that this invention provides an improved transformer coil comprising low voltage windings and high voltage windings cast in a hermetically sealed cast resin housing. The high voltage leads are braced against the low voltage windings which reduces the possibility that stresses applied to the housing through the high voltage leads will cause cracking, or other damage to the housing, such as to permit the entry of moisture into the housing. The bracing of the high voltage terminals provided by this invention also eliminates the necessity of having to provide a very thick wall of resin on the side where the high voltage leads exit from the housing to prevent stresses caused by the high voltage leads from damaging the housing. This structure also has an advantage over the prior art structures in that all major sides of the housing may be made of the same thickness of resin, since the sides are not used for bracing the high voltage leads. This feature permits the use of less resin to construct the housing than with the prior art structures and therefore a more economical structure than the prior art structures.

We claim:

1. A coil for a transformer comprising at least one low voltage winding and at least one high voltage winding, said windings each comprising a plurality of layers of sheet conductor with insulation between each layer of said windings, said windings being positioned concentrically with said at least one high voltage winding inside said at least one low voltage winding and spaced from said at least one low voltage winding, said at least one low voltage winding having an opening substantially transverse therethrough, a high voltage lead connected to said at least one high voltage winding and extending through said opening in said at least one low voltage winding, said high voltage lead being spaced from said at least one low voltage winding, resin encapsulating said at least one high voltage winding and said at least one low voltage winding and filling the space between said at least one high voltage winding and said at least one low voltage winding and providing a unitary enclosure for said coil, said resin filling the space in said opening in said at least one low voltage winding between said high voltage lead and said at least one low voltage winding to brace said high voltage lead against said at least one low voltage winding.

2. A coil as defined in claim 1, wherein insulation between turns of said at least one low voltage winding extends into said opening to insulate said high voltage lead from the turns of said at least one low voltage winding.

3. A coil as defined in claim 1, wherein the turns of sheet conductor comprising at least one low voltage winding has additional sheet insulation between adjacent turns adjacent said opening and said sheet insulation extends into said opening to maintain said high voltage lead spaced from the turns of said at least one low voltage winding.

4. A coil for a transformer comprising a first low voltage winding, a high voltage winding surrounding said first low voltage winding, a second low voltage winding surrounding said high voltage winding, each of said windings comprising a plurality of turns of sheet conductor wound upon itself, layer insulation between each turn of said windings, said windings being spaced from each other, high voltage leads connected to said high voltage winding, said second low voltage winding having openings therein, said high voltage leads extending through said openings in said second low voltage winding substantially transverse to said second low voltage winding, said high voltage leads being spaced in said openings from the turns of said low voltage winding, resin encapsulating said coil and filling the space between said windings, said resin filling the space between said high voltage leads and said low voltage winding to brace said high voltage leads to said second low voltage winding, said high voltage leads projecting beyond said resin encapsulation, said resin encapsulation providing an enclosure for said coil with a projection of resin around each of said high voltage leads where said high voltage leads project from said encapsulation, said projection of resin providing strength to said encapsulation in the area where said high voltage leads project from said encapsulation and also providing a long creepage path from said high voltage leads to points having a different potential.