

Nov. 13, 1962

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3,063,135

METHOD FOR CONSTRUCTING AN ELECTROSTATIC SHIELD

Filed March 4, 1957

3 Sheets-Sheet 1

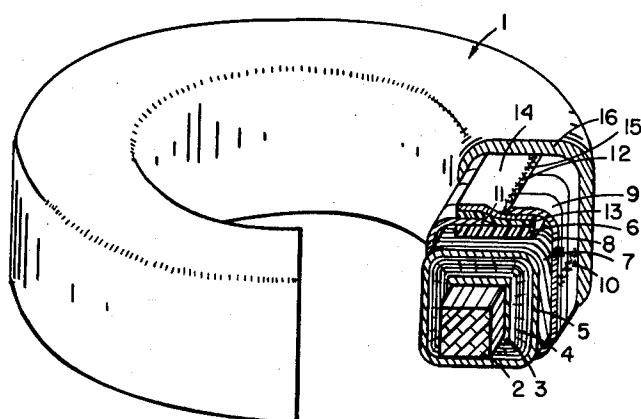


FIG. 1

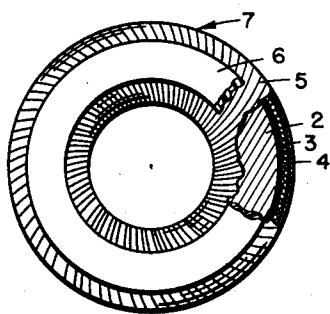


FIG. 2

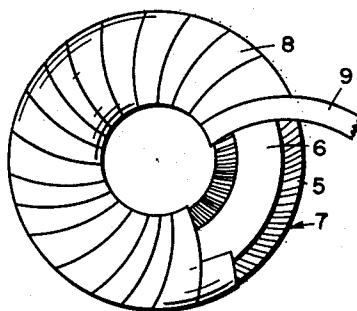


FIG. 3

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3 Sheets-Sheet 2

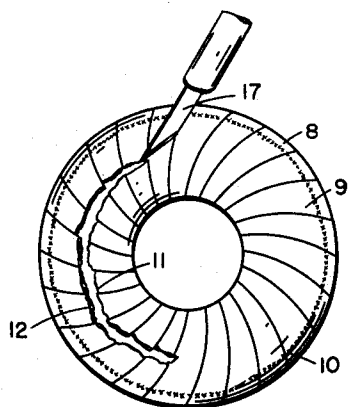


FIG. 4

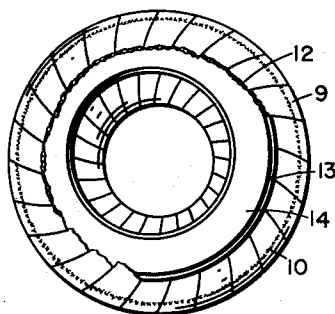


FIG. 5

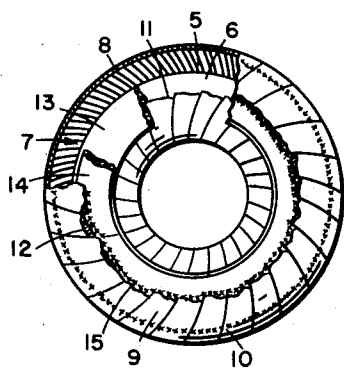


FIG. 6

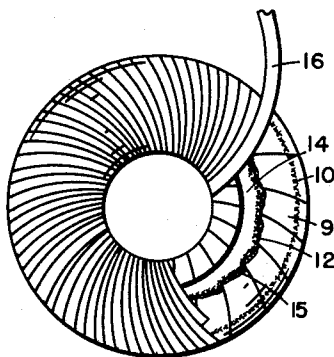


FIG. 7

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3 Sheets-Sheet 3

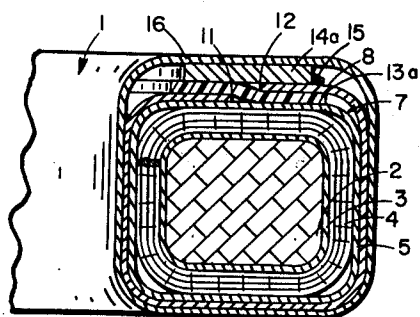


FIG. 8

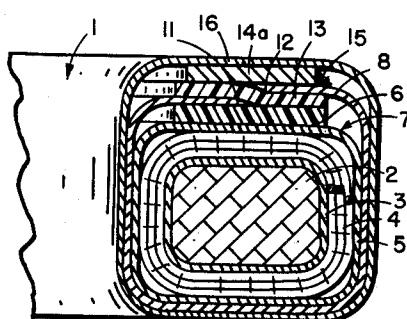


FIG. 9

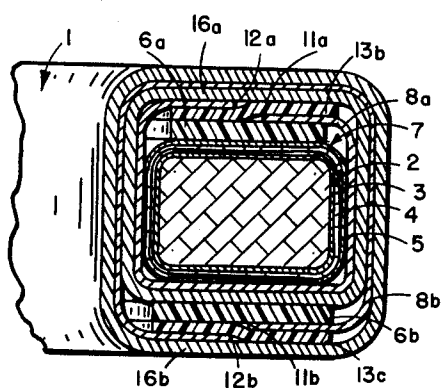


FIG. 10

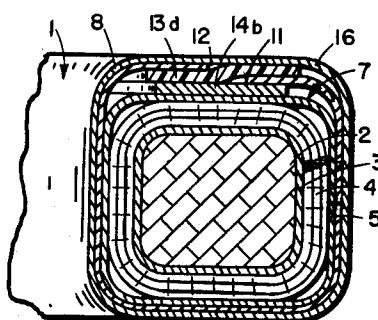


FIG. 11

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1

3,063,135

METHOD FOR CONSTRUCTING AN ELECTROSTATIC SHIELD

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4 Claims. (Cl. 29—155.57)

This invention relates to electrostatic shielding and more particularly to an electrostatic shield in combination with an electrical component and method for constructing same.

Electrostatic shields are commonly used to prevent capacitive coupling between windings of a transformer or other electrical components or between a component winding and an external electrical field. These shields are ordinarily constructed of a conductive member such as copper, a continuous conductive member providing the most effective shield. However, it is necessary to prevent interference with the electromagnetic induction between component windings, therefore the formation of a short-circuited turn around the winding must be prevented. It is also desirable that the shield have a very low inductance. These necessary electrical characteristics are particularly difficult problems when the size and shape of the component being shielded impose limitations on the physical size of the shield structure.

It is therefore an object of this invention to provide an improved electrostatic shield.

It is another object of this invention to provide an electrostatic shield having a continuous conductive member.

It is still another object of this invention to provide an electrostatic shield having a very low inductance.

A further object of this invention is to provide an electrostatic shield having a minimum thickness.

It is another object of this invention to provide an electrostatic shield requiring a minimum amount of material.

A further object of this invention is to provide an improved method of constructing an electrostatic shield.

It is another object of this invention to provide a method for constructing an electrostatic shield on an electrical component in which the protection of the component windings is inherent in the method of construction.

It is still another object of this invention to provide a method for constructing electrostatic shields of any size.

A further object of this invention is to provide a method of constructing any number of electrostatic shields on an electrical component.

It is another object of this invention to provide a method of constructing an electrostatic shield particularly adapted for shielding toroidal electrical components.

Briefly, in accordance with the present invention an electrically discontinuous electrostatic shield is provided in combination with an electric component. The method of construction includes locating protection and conductive shielding members on the electrical component. An electrical discontinuity is formed in the shielding member by cutting a slot therein while using the protection member as a cutting board.

Also, in accordance with this invention, the edge portions formed by the slot may be additionally insulated from each other. In one aspect of the invention the protection member also serves as an insulating member between the edge portions.

Other embodiments of this invention provide for extending the conductive member thereby forming a continuous conductive shielding member while maintaining the electrical discontinuity.

2

In an additional aspect of the invention the protection member also provides an extension of the conductive shield.

A more thorough understanding of the invention may be obtained by a study of the following detailed description. In the drawings:

FIG. 1 illustrates a toroidal transformer having an electrostatic shield constructed in accordance with this invention;

FIGS. 2, 3, 4, 5, 6 and 7 illustrate successive steps in the method of constructing the electrostatic shield assembly of FIG. 1;

FIGS. 8 and 9 are cross-sectional views illustrating modified forms of the invention;

And FIGS. 10 and 11 are cross-sectional views illustrating further embodiments of the invention.

In FIG. 1 is shown a toroidal transformer 1 having an insulated coil assembly 7. The insulated coil assembly 7 includes a magnetic core 2, and a coil 4 having any desired number of turns. Suitable insulation is provided between the core and coil as shown at 3 and also covering the coil as shown at 5. An annular protection member 6 having inner and outer diameters larger and smaller respectively than those of the insulated coil assembly 7 is located on one face of the insulated coil assembly 7 and concentrically with the circumference of the toroidal core 2. For the shield assembly illustrated in FIG. 1 annular member 6 is constructed of a non-conductive insulating material. The protection function of member 6 will be explained subsequently. An electrically discontinuous conductive member 8 surrounds the insulated coil assembly 7 and annular member 6. This conductive member may be formed of a spirally wound copper tape 9. A solder tinning 10 of the bottom or side of the conductive member maintains the overlapping or adjacent sections of the copper tape in position. A narrow slot, defined by the edge portions 11 and 12, is formed in the conductive member 8 longitudinal to the core 2. This slot provides the electrical discontinuity in the conductive member, thereby preventing a short-circuited turn around the coil 4. In a transformer of the toroidal type the slot may conveniently be circular in shape as viewed axially of the core, the slot thereby being located concentrically with the circumference of the toroidal core 2. The slot is preferably located so that the edges 11 and 12 will overlie the annulus 6; therefore, the length of the slot diameter should be approximately midway between the length of the inner and outer diameters of annulus 6.

Annular member 13 is constructed of a flexible insulation material and forms an insulated joint in the conduction member 8. Annular extension member 14, constructed of a thin conductive material, serves to extend the conductive member 8 completely over the insulated joint. As shown in FIG. 1 the slotted conductive member 8 is overlapped with annular members 13 and 14. Annular members 13 and 14 have inner and outer diameters substantially equal to annulus 6, the former members also being located concentrically with the annular core 2. Thus edge portions 11 and 12 of the conductive member 8 may be positioned on opposite sides of the insulating annulus 13 thereby forming the insulated joint. Conductive member 8 and conductive annulus 14 may be soldered together as shown at 15 thus insuring an effective electrical connection and a strengthening of the end portion of the conductive member. In a conductive member formed from a spirally wound copper tape the solder fillet 15 provides an effective means for retaining the individual tape ends. A suitable insulating covering 16 completes the shield structure.

FIGS. 2, 3, 4, 5, 6 and 7 illustrate the method of constructing the novel electrostatic shield assembly shown in

3

entirety in FIG. 1. In FIG. 2 is shown a cut-away view of the insulated coil assembly 7. A coil 4 is wound on a core 2, core 2 having an insulating layer 3. The coil is covered by the insulating layer 5. The initial step in constructing the electrostatic shield is illustrated in FIG. 2 and comprises locating the insulated annular protection member 6 on one face of the insulated coil 7. In FIG. 3 is shown the surrounding of the insulated coil assembly 7 and annulus 6 by a conductive member 8, the conductive member comprising a spirally wound tape 9 of copper or other suitable electrically conductive material. FIG. 4 illustrates a further step in constructing the electrostatic shield in which a circular slot, defined by mutually spaced edge portions 11 and 12, is cut through the conductive member by a knife 17. This slot is cut directly over the protection annulus 6, thereby permitting the conductive member 8 to be completely cut through while protecting the windings of the coil 4 shown in FIG. 2. Annulus 6 should be of a thickness and/or toughness so as to be sufficiently cut resistant thereby serving as an effective cutting board while protecting the coil windings. Before the cutting operation a solder tinning may be applied on the bottom and side of the copper tape, the side solder tinning being shown at 10. This solder tinning maintains the spiral tape in position during and after the cutting operation. As a substitute for, or in addition to, the solder tinning an adhesive tape may be applied to the bottom and side of the conductive covering.

After cutting the slot, an insulated joint is formed in the conductive member 8 by insulating edge portion 11 from the edge portion 12. This insulating step is shown in FIGS. 5 and 6. Edge portion 11, while hidden by the annular members 13 and 14 in FIG. 5, is shown in the cut-away view of FIG. 6. This insulating step may be performed more easily if the outer edge portion 12 is raised from the annular member 6 (member 6 shown in FIG. 6). FIG. 5 illustrates the partially completed insulating step in which the annular members 13 and 14 are being inserted between the edge portions. Part of the edge portion 12 is shown covered by the annular members. At the completion of the insulating step, edge portion 12 completely overlies the annular members 13 and 14, and the annular members are positioned substantially concentrically with the toroidal transformer. The completed assembly is shown in FIG. 6 wherein the edge portions 11 and 12 are overlapped with members 13 and 14.

FIGS. 5 and 6 also illustrate the method of extending the conductive member 8 completely over the insulated joint structure. Conductive member 14 is overlapped between the edge portions 11 and 12 simultaneously with the overlapping of insulating member 13. At the completion of the insulating step, as illustrated in FIG. 6, the extension conductive member 14 is in electrical contact with edge portion 12, and conductive member 14 and edge portion 12 are insulated from edge portion 11 by the insulating annulus 13. Edge portion 12 may be soldered to conductive member 14 as shown at 15, thereby providing a good electrical connection and a strengthening of the shield assembly. FIG. 7 illustrates the covering of the electrostatic shield assembly with a layer of suitable insulating tape 16.

This invention provides an electrically discontinuous electrostatic shield assembly composed of conductive members 8 and 14. It will be understood that an electrostatic shield could be provided by member 8 alone, its effectiveness being determined by the spacing of the edge portions. However, conductive extension member 14 provides an overlapped continuous conductive member between the winding 4 and additional transformer windings not shown in FIG. 1, or an external electrical field. Thus a substantially 100% effective electrostatic shield is provided.

An additional feature of this invention resides in con-

4

structing an electrostatic shield having a very small thickness. This is an especially important requirement for shields used on toroidal transformers since the inner diameter of the toroidal core imposes a definite limitation on the number of coils and shields which may be located on the core. As illustrated in FIG. 1 the only shield material required within the inner diameter of the toroid is the single layer of conductive tape 9, the insulated joint being provided entirely on an outer face of the toroid where the thickness requirement is not critical. Of course, where a component of minimum overall dimensions is required the protection member 6 may be removed at the completion of the slot cutting operation illustrated in FIG. 4. With the spirally wound conductive member 8 being held in place by a solder tinning and/or adhesive tape both edge portions 11 and 12 may be raised thereby permitting the removal of member 6.

Another important characteristic of an ideal electrostatic shield is that of low electrical inductance. The single layer of conductive material used in this invention provides such a low inductance shield.

Although the shield assembly has been described and illustrated in combination with a toroidal electric component it is obvious that a shield constructed according to the teachings of this invention could be used in combination with an electrical component of any shape.

FIGS. 8 and 9 illustrate cross-sectional views of modifications of the shield shown in FIG. 1. The core and coil structure may be the same as described above. In FIG. 8 an insulating annulus 13a is the only insulating member used in forming the insulated joint. The initial steps in constructing the shield shown in FIG. 8 are the same as those illustrated in FIGS. 2, 3, and 4 with the exception that the flexible annular member 13a is used in place of annular member 6. After the slot is cut in the conductive member 8 as shown in FIG. 4, edge portion 11 of the conductive member is raised, thereby permitting the inner half of the annulus to be deformed upwardly. Edge portion 11 of the conductive member is then inserted beneath the annulus thus resulting in the overlapping relationship shown in FIG. 8. Thus annular member 13a functions both as the protection means and the insulating means. Conductive annulus 14a overlies both edge portions of the conductive member 8 thereby extending the conductive member 8 over the insulated joint. Conductive member 8 and 14a may be soldered together as shown at 15.

It may be noted that the configuration of FIG. 8 also differs from that shown in FIG. 1 as regards the location of the conductive annulus, the latter figure showing edge portion 12 being superimposed on annulus 14a. FIG. 9 illustrates this type of construction applied to the shield shown in FIG. 1. As in the shield shown in FIG. 1 annulus 13 overlies annulus 6, the annulus 13 forming the insulated joint. However, as in FIG. 8 the conductive annulus 14a overlies both edge portions of the conductive member 8.

The electrostatic shield illustrated in the cross-sectional view of FIG. 10 serves to demonstrate the applicability of this invention to multiple shields on a single toroidal core. The insulated coil assembly 7 may be the same as is shown in FIG. 1. A first conductive member 8a covers the insulated coil 7 and an insulated joint is formed therein by an insulating annulus 13b. A first insulation covering 16a may be located on conductive member 8a. A second conductive member 8b covers the insulated conductive member 8a, the insulated joint in this second conductive member being formed on the toroid face opposite the face on which the joint was formed in member 8a. A second annular member 13c forms the insulated joint in conductive member 8b. Additional conductive annular members functionally similar to element 14 of FIG. 1 are unnecessary in the arrangement shown in FIG. 10 since the conductive members 8a and 8b serve to cover the insulated joints in each other thereby forming a continuous conductive member.

5

FIG. 11 illustrates an electrostatic shield assembly in which the conductive extension annulus serves as the protection member during the cutting of the slot in the conductive member 8. The core and coil structure may be the same as shown and described previously. However, conductive annulus 14b is located on the insulated coil 7 in place of the insulating annulus 6. After annulus 14b and insulated coil 7 are surrounded by the conductive member 8, a slot longitudinal to the core 2 is cut in the conductive member 8 and over the conductive annulus 14b, conductive annulus 14b thereby protecting the winding 4 during this step. Annulus 14b should be of sufficient thickness so as to serve as an effective cutting board while protecting the winding 4. The insulating annulus 13d may now be inserted between the edge portions 11 and 12 formed in the conductive member. It will be seen that edge portion 11 is in electrical contact with conductive annulus 14b and that the edge portion 11 and conductive annulus 14b are insulated from edge portion 12 by the insulating annulus 13d. As shown in FIG. 11 the annulus 13d preferably has a larger outer diameter and smaller inner diameter than annulus 14b so as to negate the possibility of an electrical contact between edge portion 12 and the conductive annulus 14b. A suitable covering of insulation 16 completes the electrostatic shield structure.

Although several embodiments of the invention have been described and illustrated in detail, it is to be clearly understood that the same are by way of illustration and example only and are not to be taken by way of limitation, the spirit of this invention being limited only by the terms of the appended claims.

I claim:

1. A method for constructing an electrostatic shield for the conductive elements of a toroidal electrical component comprising the steps of: Positioning an annular cut-resistant member on said component, spirally winding a conductive strip about said component and said cut-resistant member, and cutting a continuous slot in and through said conductive strip around the circumference of said toroidal electrical component using said cut-resistant member as a cutting board to prevent said com-

6

ponent from being cut, said slot being positioned to prevent a short circuit turn around said component.

2. A method as recited in claim 1 and further comprising the step of: Inserting insulating material between the edges of said slot.

3. A method as recited in claim 1 and further comprising the step of: Insulating one edge of said slot from the other edge of said slot to form an insulated joint in said conducting means and to retain a conductive extension of said strip in an overlapping relationship with said insulating joint.

4. A method as recited in claim 1 and further comprising the steps of: Mounting an electrically conductive extension member in contact with one cut edge of said slot, and inserting an electrically non-conductive material between the other cut edge of said slot and said extension member.

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