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ELECTROSTATIC SHIELD FOR INDUCTIVE WINDINGS

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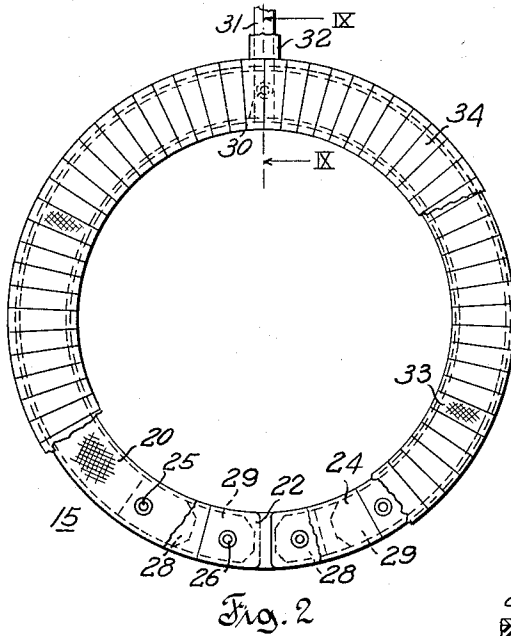


Fig. 2

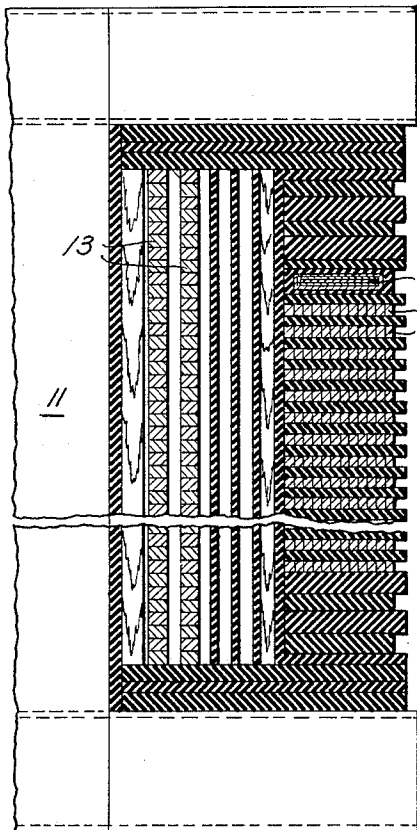


Fig. 1

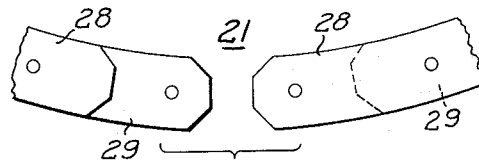


Fig. 3

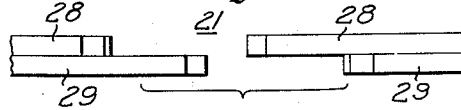


Fig. 4

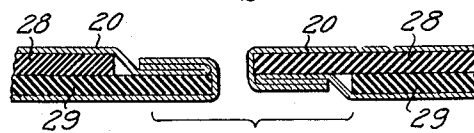


Fig. 5

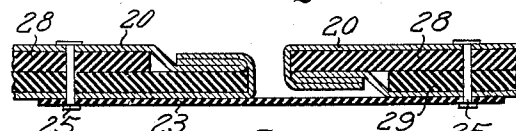


Fig. 6

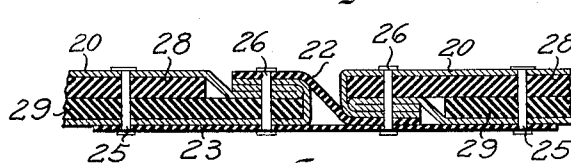


Fig. 7

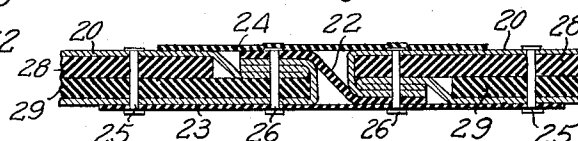


Fig. 8

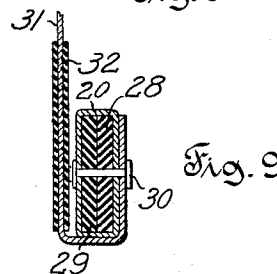


Fig. 9

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ELECTROSTATIC SHIELD FOR INDUCTIVE WINDINGS

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10 Claims. (Cl. 174—35)

This invention relates to electrical induction apparatus and, in particular, to electrostatic shields for the windings of such apparatus.

As is well known, stationary induction apparatus such as transformers may include electrostatic shields which distribute surge voltages by electrostatically imposing the surge voltage relatively uniformly across the first coil of the winding of such apparatus as a result of the close electrostatic coupling between the shield and the first coil. The surge voltages otherwise may be almost entirely carried by the first turn of the coil of the winding, imposing very high voltage stresses on that first portion of the coil. Electrostatic shields formed as rings of conductive material are open circuited in order that short circuit currents may not be induced therein by the magnetic flux. It has been proposed that the conductive plate or ring of these shields be made from one piece or strip of conductive material, either a flat ring of solid material or a spiral winding of a noninsulated conductor forming a disk coil similar to the coils of the windings of the transformer. In either case, of course, the shield is insulated from the other conductive parts of the apparatus except for the terminal lead to which it is electrically connected.

In order to more efficiently produce electrostatic shields and at the same time provide an improved electrostatic shield for embodiment in transformers, in accordance with this invention, the shield is fabricated and includes a supporting form of insulation material, a braided sleeve of conductive material adapted to and firmly secured to the supporting form, and insulating elements which prevent physical distortion of the shield from causing abutment of the ends of the conductive material at the gap in the shield.

The primary object of this invention is to provide an improved electrostatic shield for stationary induction apparatus.

Another object of this invention is to provide a fabricated electrostatic shield.

Still another object is to make components of an electrostatic shield so that the shield can be fabricated by relatively simple shop handling yet insuring a strong shield in which the assembly of components positively insures a permanent gap in the electrostatic shield.

It is still another object to provide an electrostatic shield constructed of components which can be fabricated utilizing relatively simple shop practices with the fabricated components making a substantially smooth surfaced finished electrostatic shield.

Objects and advantages other than those above set forth will be apparent in the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a longitudinal view in section of part of a transformer embodying an electrostatic shield constructed in accordance with this invention;

Fig. 2 is an enlarged plan view of the electrostatic shield shown in Fig. 1 with parts of the shield broken away.

Figs. 3 to 8 are enlarged views in cross section across the gap in the electrostatic shield showing component parts. In particular, Fig. 3 is a plan view showing the insulating

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form for the braided conductive sleeve of the shield, and Fig. 4 is a section of the member shown in Fig. 3. Fig. 5 is a view in section of the insulating form of Fig. 4 with its enclosing braided conductive sleeve. Figs. 6 to 8 are sectional views similar to Fig. 5 showing how the insulating components of the gap are added in the electrostatic shield.

Fig. 9 is an enlarged sectional view taken along line IX—IX of Fig. 2 with the outside insulating tape removed.

In Fig. 1 the portion of the transformer shown in section includes the core of which the member 11 represents a leg around which are the windings 12 and 13. The high voltage winding 12 has disk or pancake coils which have conventional insulation separating them from each other as well as from the core of the transformer. Associated with the high voltage winding is the electrostatic shield 15.

The shield represented in Fig. 1 is better shown in the other figures of the drawing from which it can be seen that the component parts thereof are so constructed that the shop assembly or fabrication of the shield may be relatively easily accomplished.

In particular, the shield is made of any suitable conductive material such as copper. An improved, easily constructed and assembled conductive member for the shield is provided by utilizing braided copper material reducing the amount of conductive material necessary for making the split ring and also avoiding the winding time and waste of material resulting from making the split ring by spirally winding a noninsulated conductor and then cutting an air gap therein.

In this instance, the flexible braid is given its circular form or shape by a ring-shaped insulating form 21 inserted inside the braid. A sleeve of braided copper 20 is pulled over the insulating form 21. Then the sleeve is cut to the proper length and fastened to the insulating form.

In the illustrated example, the insulating form is especially constructed so that the ends of the braided sleeve may be securely fastened thereto. The construction of the end portions of the insulating form is such that the spaced ends of the braided sleeve at the air gap will be substantially permanently separated and insulated.

The end portions of the insulating form are step shaped, one end, that shown on the left hand side in Figs. 3 and 4, having its upper face stepped while the right hand end portion has its lower face stepped. In the preferred embodiment this step shaped construction is accomplished by providing a pair of split insulating rings 28, 29 of identical size and shape of suitable material such as fullerboard. One of the insulating rings, 28, is placed over the other and may be glued thereto with the gaps in the two rings circumferentially offset a distance less than the width of the gaps, to provide the insulating form shown in Figs. 3 and 4 with its step-shaped spaced end portions.

The reduced cross sectional portions adjacent the ends of the insulating form 21 serve several purposes and make it possible to well construct the electrostatic shield at the gap and end portions adjacent thereto. For example, for best results it is desirable to stretch the braided sleeve when pulling it over the form to make it apply itself tightly to the form. To securely fasten the stretched sleeve and to insure that the sleeve is uniformly stretched over the insulating form, each end of the braided sleeve is pulled beyond the corresponding end of the form. Then, the extending end portions of the sleeve are folded back on the corresponding end portions of the form to which they are fastened by suitable means. The folded portions of the braided sleeve fit into the end portions of reduced thickness of the form 21. With the sleeve stretched and pulled over the end of the form, simple fastening means such as rivets may be utilized and the sleeve being folded back as described will be kept

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stretched over the end of the form. By stretching the braid over the end of the form, a smooth and even conductive surface defines the ends of the conductive ring at the gap in the shield. The gap can be accurately determined and no loose ends of conductive braid will be able to bridge the gap. The portions of the braided sleeve when folded back on the form will not in this instance increase the thickness of the shield because the end portions of the insulation form have sufficiently reduced thickness to accommodate the folded braid.

The shield further includes insulating components cooperative with the structure hereinbefore described by which the ends of the conductive braid are insulated and the gap set in a mode facilitating the shop assembly of the electrostatic shield. In particular, there is provided an insulating strip 23 which may be fastened to the under face of the braided ring and which bridges the air gap. This strip 23 is longer than the distance between the steps on the end portions of the insulating form, and the rivets 25 extend through both layers of the insulating form and through the insulating strip 23. The desired air gap can be easily and accurately set when one end part or portion of the long insulating strip 23 has been riveted to the form 20 and before the other end part of the strip 23 has been riveted in position.

As can be seen in Fig. 6, there is clearance between the insulating strip 23 and the copper braid in the area corresponding to the right hand side reduced portion of the insulating form 21. One end part or portion of a crossover insulating strip 22 is inserted into that clearance space. The other end part of the crossover strip 22 rests on the upper face of the folded braid on the left hand side of the gap. When the crossover strip is properly positioned, it is also fastened to the braid and insulating form preferably by rivets 26. After the crossover strip is fastened in position, a third insulating strip, 24, is placed across the upper face of the ends of the braided sleeve bridging the gap to add mechanical strength to the connection between the ends of the shield. Suitable means are provided to hold this upper strip, 24, to the shield; in this instance the strip 24 is held in place by gummed paper tape (not shown) which also will strengthen the connection between the ends of the shield.

The crossover strip being attached at its opposite ends to the opposite faces of the braid and the intermediate portion of the strip crossing the gap between the ends of the braid provides positive insulation separating the ends of the conductive braid and also firmly maintaining the proper gap. Under some conditions the assembly of the transformer may result in some wires of the braided sleeve loosening or in the conductive braid being disturbed so that conductive material may tend to bridge the gap. However, with the crossover insulation herein provided, the gap cannot be bridged by any of the conductive material.

The terminal lead 31 shown enlarged in section in Fig. 9 is attached to the shield at a point diametrically opposite the insulated gap. Preferably, the lead 31 is braided copper, and the end thereof is suitably attached to the shield, in this instance by rivet 30. Preferably the lead is pulled radially outwardly from the shield after having been fastened to the upper face of the braided sleeve, pulled down the inner edge and radially across the lower face of the braided sleeve. The lead 31 is covered with insulation material 32, such as crepe paper tape.

After the terminal lead is attached the entire shield is insulated. Insulation, such as cable paper 33, is wrapped around the braided sleeve, ring-shaped element of the shield by an overlapping wrapping operation. The number of layers of insulation paper depends on the required dielectric strength. Then a layer of protective cotton tape 34 is wrapped over the insulation paper thereby increasing the mechanical strength of the wrapping.

Although but one embodiment of the present inven-

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tion has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. An electrostatic shield comprising a ring shaped insulating form having a gap, a braided sleeve of conductive material, said form inserted into said sleeve with the end portions of said sleeve spaced from each other at said gap, and means insulating the end portions of said sleeve from each other including an insulating strip having one of its end portions over a first end portion of said sleeve and having the other of its end portions under the second end portion of said sleeve with said strip crossing over from the upper face to the lower face of said sleeve at said gap between the ends of said sleeve.

2. An electrostatic shield comprising a ring shaped insulating form having a gap, a braided sleeve of conductive material, said form inserted into said sleeve with the end portions of said sleeve spaced from each other at said gap, and means for insulating the end portions of said sleeve from each other including a plurality of insulating strips, a first of said strips bridging said gap and fastened to the lower faces of both end portions of said sleeve, a second of said strips bridging said gap between the ends of said sleeve with the opposite ends of said second strip on opposite faces of said sleeve, a third of said strips bridging said gap and fastened to the upper faces of both end portions of said sleeve.

3. An electrostatic shield comprising a ring shaped insulating form having a gap, a braided sleeve of conductive material, said form inserted into said sleeve with the end portions of said sleeve spaced from each other at said gap, and means for insulating the end portions of said sleeve from each other including a plurality of insulating strips, a first of said strips bridging said gap across the lower faces of both end portions of said sleeve, a second of said strips bridging said gap and crossing between the ends of said sleeve with the opposite ends of said second strip on opposite faces of said sleeve.

4. An electrostatic shield comprising a ring shaped insulating form having a gap between its spaced ends, a braided conductive sleeve into which said form is inserted, end portions of said sleeve extending beyond the ends of said form and being folded back over the corresponding end portions of said form, said sleeve at the folds forming spaced ends of a split conductive ring, and means insulating said end portions of said sleeve including an insulating strip having one of its end parts over a first of said end portions of said sleeve and having the other of its end parts under the second of said end portions of said sleeve.

5. An electrostatic shield comprising a ring shaped insulating form having a gap, the end portions of said form having reduced thickness, a first end portion of said form being stepped on its upper face and a second end portion of said form being stepped on its lower face, a braided conductive sleeve into which said form is inserted, portions of said sleeve extending beyond the ends of said form being folded over corresponding ends of said form, one of said folded portions of said sleeve being disposed over said first portion of said form and being confined to the area of reduced thickness thereof, the other of said folded portions of said sleeve being disposed under said second end portion of said form and being confined to the area of reduced thickness thereof.

6. An electrostatic shield comprising a form including a pair of substantially identical ring shaped insulating elements each having a gap, one of said elements being laid over the other of said elements with the gaps in said two elements being circumferentially offset a distance less than the width of said gaps to provide said form with first and second step shaped end portions circumferentially spaced from each other, a braided conductive sleeve into

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which said form is inserted, end portions of said sleeve extending beyond the ends of said form, a first end portion of said sleeve being folded over one end of said form and confined to said first step shaped portion and the other end portion of said sleeve being folded under the other end of said form and being confined to said second step shaped portion, and means for insulating from each other the said end portions of said sleeve.

7. An electrostatic ring comprising a form including a pair of substantially identical flat ring shaped insulating elements each having a gap, one of said elements being laid over the other of said elements with said elements circumferentially offset a distance less than the width of said gaps to provide said form with spaced first and second end portions of reduced thickness stepped on opposite faces of said form, a braided conductive sleeve into which said form is inserted, said sleeve being longer than said form, end portions of said sleeve folded at the ends of said form, one folded end portion of said sleeve being confined to the reduced thickness area of said first end portion and the other folded end portion of said sleeve being confined to the reduced thickness area of said second end portion, and an insulating strip between the ends of said sleeve, one end of said strip extending over the upper face of said sleeve and the other end of said strip extending under the lower face of said sleeve.

8. An electrostatic shield comprising a ring shaped conductive member having a relatively short axial dimension and a relatively long radial dimension with a gap between adjacent ends thereof, said ends lying within the radially spaced edges and within the axially spaced faces of said member, means for preventing flow of current between said ends by way of said gap comprising insulating means between said ends including an insulating strip confined within said edges and within said faces, said strip having one of its end parts over a first end portion of said member and having the other of its end parts under the second end portion of said member with its intermediate part extending transverse said ends, and fastening means securing said insulating means to said member.

9. An electrostatic shield comprising a ring shaped conductive member having a relatively short axial dimension

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and a relatively long radial dimension with a gap between adjacent ends thereof, the end portions of said member lying within the radially spaced edges and within the axially spaced faces of said member, means for preventing the flow of current between said end portions by way of said gap comprising insulating means between said end portions including a plurality of insulating strips, a first of said strips confined within said edges and within said faces of said member bridging said gap and crossing between said ends with the opposite end parts of said first strip fastened to opposite faces of said end portions, a second of said strips bridging said gap and fastened to the lower faces of said end portions, and a third of said strips bridging said gap and fastened to the upper faces of said end portions, and fastening means securing said insulating means to said member coacting with the end portions of said member and said insulating strips to hold said ends in place and to maintain the proper gap.

10. An electrostatic shield comprising a ring shaped conductive member having a relatively short axial dimension and a relatively long radial dimension with a gap between adjacent ends thereof, end portions of said member lying within the radially spaced edges and within the axially spaced faces of said member, means for preventing the flow of current between said ends by way of said gap including a plurality of insulating strips, a first of said strips confined within said edges and within said faces of said member bridging said gap and crossing between said ends with the opposite end parts of said first strip being on opposite faces of said end portions, a second of said strips bridging said gap and fastened to the common faces of said end portions, and fastening means securing said insulating means to said member coacting with said end portions and said insulating strips to hold said ends in place maintaining the proper gap therebetween.

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