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ELECTRICAL INDUCTIVE APPARATUS WITH WIRE
CLOTH SHIELDING MEANS
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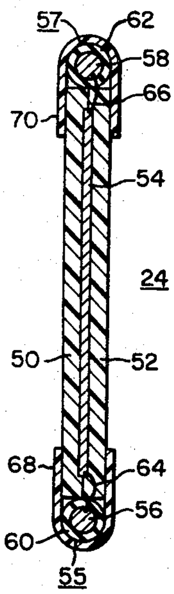
FIG.2.



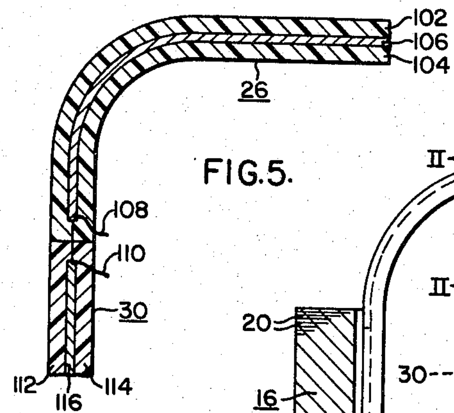


FIG.1.

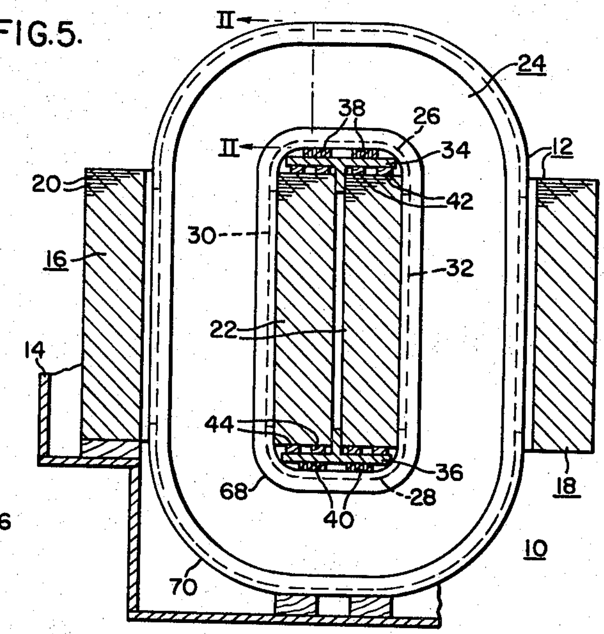
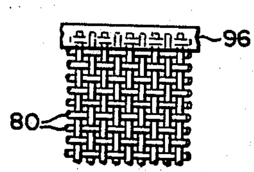
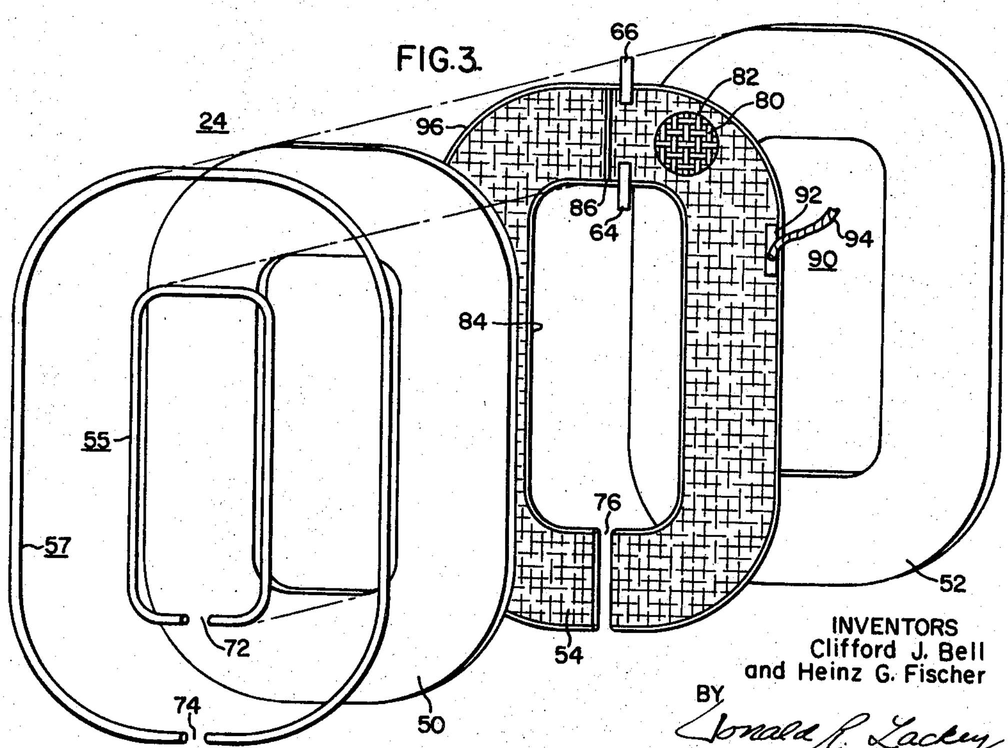


FIG.4.





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ELECTRICAL INDUCTIVE APPARATUS WITH WIRE CLOTH SHIELDING MEANS

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8 Claims. (Cl. 336—70)

ABSTRACT OF THE DISCLOSURE

An electrical transformer having shielding means which includes an electrically conductive portion disposed between electrical insulating members. The electrically conductive portion is formed of wire cloth having an electrical resistivity between .02 and 2 ohms per square.

This invention relates in general to electrical inductive apparatus, such as transformers, and more particularly to new and improved shielding means for electrical inductive apparatus, such as static plates and corona shielding means.

There are many locations in electrical inductive apparatus, such as transformers of the shell and core-form type, which require the use of static plates and other types of shielding means. For example, shell-form transformers may utilize static plates disposed adjacent the line end pancake coils, and also on each side of any tapped coil sections, as well as corona shields disposed in the window opening of the pancake coils, between the window opening and the portion of the magnetic core which is disposed therein.

Core-form transformers may utilize shielding means, flat or cylindrical, depending upon the winding structure, to shield tapped coil sections and to enforce a favorable surge voltage distribution across the windings.

Regardless of the function of the shielding means, i.e., corona shielding or enforcing favorable surge voltage distributions by establishing predetermined capacitive characteristics, or both, and regardless of whether the shielding means is connected to an elevated potential or to ground, the problems associated with these shielding means are essentially the same. If the electrical resistance of the shielding means is too low, eddy current flow in the conductive portion of the shield becomes excessive in areas of high leakage flux, which increases the losses, as well as causing undesirable heating of the shielding means. If the resistance of the shielding means is too high, its usefulness is impaired. For example, when the shielding means is used to distribute surge voltages by electrically charging the adjacent coils through capacitive relationships, the charging time becomes too long, and surge potentials are not uniformly distributed. When using the shielding means as a corona shield, too high a resistance will not effectively reduce concentrations of electrical stress, and the shielding means will not remain at ground potential.

Shielding means for these applications were first made of copper foil. It is not possible to obtain copper foil thin enough, however, to increase the electrical resistance of the foil to the magnitude required to prevent excessive heating due to eddy currents. The heating problems with copper foil led to shielding arrangement using an aluminum coating, sprayed on a sheet of insulating material, such as pressboard. While this arrangement is superior to arrangements utilizing copper foil, the resistance of the sprayed aluminum coating is still too low, which results in overheating of the aluminum coating due to I^2R loss, in areas of high leakage flux, where the direction of the leakage flux is perpendicular to the coating of aluminum.

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In an effort to break up the eddy current paths, in the areas of high leakage flux, strips of masking tape are applied to the sheet of insulating material at spaced intervals, which are removed after the spray coat of aluminum is applied. While this procedure reduces heating due to eddy currents, the sprayed aluminum exhibits other undesirable characteristics under the influence of high voltages, due to the relatively irregular or rough surface which the process of spraying aluminum inherently provides. This relatively rough surface lowers the corona inception level of the shielding means, as electrical stress concentrates on the relatively rough surface, increasing the potential gradient to the corona level. This problem was solved by coating the sprayed surface with a liquid resinous material, such as an epoxy resin, which holds all the particles of aluminum, and then the coating of resinous material and sprayed aluminum are polished to provide a smooth surface. While this procedure provides acceptable shielding means, such as static plates and corona shields, the masking required to reduce eddy currents, and the epoxy coating and subsequent polishing, substantially increases the manufacturing time and cost of the shielding means. Further, the sprayed aluminum coating is fragile and subject to cracking when its backup sheet of electrical insulation is bent or otherwise stressed, and also when the aluminum coating is heated during the process of attaching electrical connections thereto. Therefore, extreme care must be taken in the manufacturing, handling, and assembly of the shielding means, which adds to the manufacturing cost.

Thus, it would be desirable to provide a new and improved shielding means which has the desired electrical resistance without resorting to masking, which is smooth enough to make it unnecessary to coat the conductive portion of the shield with epoxy, and then polish it, and which has a high mechanical strength and resistance to cracking. It would also be desirable to provide shielding means, which has the hereinbefore mentioned desirable characteristics, and which also allows electrical leads to be attached to the conductive portion of the shielding means before it is attached to the backup sheets of electrical insulation.

Accordingly, it is an object of the invention to provide new and improved shielding means for electrical inductive apparatus.

Another object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has the desired electrical resistance, and whic hwill suppress eddy current losses and heating without resorting to the formation of predetermined patterns designed to breakup eddy current flow paths.

Still another object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has an electrical resistance of sufficient magnitude to minimize heating due to eddy currents, but low enough to function properly in its intended shielding application.

A further object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has the desired electrical resistance, and a smooth surface which prevents electrical stresses from concentrating thereon.

Another object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has a predetermined electrical resistance, high mechanical strength and resistance to cracking, and a construction which promotes rapid cooling.

Still another object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has a predetermined desired resistance, and which facilitates the making of excellent electrical connections to the conductive portion thereof, before it is associated with the electrical insulating means, and without danger of cracking the electrically conductive portion.

Another object of the invention is to provide new and improved shielding means for electrical inductive apparatus which has a predetermined desired electrical resistance, which has properties facilitating the formation of an excellent bond when glued between two sheets of electrical insulating means, and which will permit the penetration of the insulating and cooling dielectric of the electrical inductive apparatus, completely through the shielding means, including the conductive layer, to supplant all of the air in the shielding means.

Briefly, the present invention accomplishes the above cited objects by forming the conductive portion of the shielding means of an electrically conductive wire cloth, mesh or screen. Wire cloth constructed, for example, of 145 mesh stainless steel, provides an electrical resistance which minimizes eddy currents without interfering with its intended shielding function, has a smooth surface which prevents corona discharges, has a large surface area which promotes fast cooling when exposed to high charging currents and/or a high stray flux, has a high mechanical strength and resistance to cracking, facilitates the formation of excellent solder joints for making electrical connections thereto, allows electrical connections to be made thereto before attaching to solid insulation, facilitates excellent adhesion when sandwiched between electrical insulation and glued thereto, allows oil and other liquid dielectrics to freely pass through the electrically conductive portion to supplant all air trapped therein, and allows the finished shielding means to be bent or otherwise mechanically stressed to fit its intended location, without danger of cracking the electrically conductive portion of the shielding means.

In addition to the above advantages, the use of wire cloth as the electrically conductive portion of the shielding means substantially reduces manufacturing time and cost, as the time consuming and costly procedures of masking, coating with epoxy, and polishing, are completely eliminated.

Further objects and advantages of the invention will become apparent from the following detailed description, taken in connection with the accompanying drawings, in which:

FIGURE 1 is an elevational view, in section, partially cut away, of an electrical transformer illustrating a static plate and corona shielding means which may utilize the teachings of the invention,

FIG. 2 is a cross-sectional view of a portion of the static plate shown in FIG. 1, taken along the line II—II,

FIG. 3 is an exploded perspective view of the static plate shown in FIGS. 1 and 2,

FIG. 4 is a magnified view of the wire cloth which is used in constructing shielding means according to the teachings of the invention, and

FIG. 5 is an enlarged, fragmentary cross-sectional view of the corona shielding means shown in FIG. 1.

Referring now to the drawings, and FIG. 1 in particular, there is shown an elevational view, partially cut away, in section, of a transformer **10** which may utilize the teachings of the invention. Transformer **10**, for purposes of example, is illustrated as being of the shell-form type, but any electrical inductive apparatus, such as transformers of the core-form type, electrical reactors, and like apparatus, may equally utilize the teachings of the invention.

Transformer **10** includes a core-coil assembly **12** disposed in a tank or casing **14**, which is shown partially cut away. Tank **14** may be filled to a predetermined level with a suitable insulating and cooling dielectric fluid, such as oil. As is customary in transformers of the shell-form type, the core-coil assembly includes first and second magnetic core sections **16** and **18**, respectively, each formed of a plurality of stacked metallic magnetic laminations **20**, arranged to form at least one opening for receiving electrical coils, and with the magnetic core sections being disposed in side-by-side relation to form a common winding leg portion **22**. Transformer **10** may be single or polyphase, and may be of the isolated winding, or autotransformer type. The core-coil assembly **12** also includes a stack of pancake type coils all arranged on a common center line, and connected to form the high and low voltage windings. Transformer **10** has been sectioned adjacent the high voltage winding, in order to illustrate static plate **24**. Therefore, the pancake coils which make up the windings are not illustrated in FIG. 1, but have the same general shape as static plate **24**, and are all stacked in alignment, such that their openings for receiving the magnetic core are aligned, with the pancake coils being disposed about winding leg **22**.

Static plate **24** may be positioned at the end of the line end pancake coil of the high voltage winding and electrically connected to the pancake coil or to the high voltage terminal, in order to provide one plate of a capacitor, with the adjacent line end coil providing the other plate. When an electrical surge potential is applied to the high voltage terminal, such as caused by lightning or switching transients, the static plate quickly charges the line end coil and distributes the surge potential more uniformly across the line end coils. Static plates are also used adjacent any tapped coil sections, and may be used in many other arrangements, such as those taught in copending application Ser. No. 545,649, filed Apr. 27, 1966, which is assigned to the same assignee as the present application.

The space between winding leg **22** and the upper and lower portions of the window openings in the pancake coils and static plate **24**, includes corona shielding means **26** and **28**, respectively, which are electrically connected to ground, for example, to the magnetic core sections **16** and **18**, in order to provide a smooth equipotential surface for shielding the sharp edges and corners of the magnetic core and prevent corona from forming. Additional corona shielding means **30** and **32** may be disposed between the magnetic core sections and sides of the window openings in the pancake coils if necessary, to prevent corona at the sharp edges of the core laminations **20**, in the event the laminations **20** are not accurately aligned.

In addition to the corona shields, support means may be included at the upper and lower spaces between the pancake coils and core leg **22**. For example, metallic T-beams **34** and **36** may be provided, along with stacked magnetic laminations **38** and **40** for magnetically shielding the T-beam, and wedges **42** and **44** at the upper and lower spaces, respectively.

Like the static plate **24**, corona shielding means **26**, **28**, **30** and **32** must have an electrical resistivity high enough to minimize heating due to eddy currents, and low enough to remain at ground potential and effectively prevent concentrations of electrical stress about sharp corners and other points conductive to the buildup of electrical stress.

Since the construction of static plate **24** and corona shielding means **26**, **28**, **30** and **32**are representative of the construction of many types of shielding means for all types of electrical inductive apparatus, their construction will be explained in detail by the way of examples or embodiments of the invention, with no intention of limiting the application of the teachings of the invention to these specific embodiments.

FIG. 2 is a cross-sectional view of static plate **24**, taken along the line II—II. In this embodiment of the invention, static plate **24** includes first and second sheet-type insulating members **50** and **52**, formed, for example, of pressboard, which have the same general configuration as the pancake coils. In other words, each sheet of insulating material has first and second major sides, each sheet is relatively thin, for example, .125 inch thick, and each has an opening sized to receive core leg **22** of magnetic core sections **16** and **18**. The conductive portion **54** of the static plate is disposed between the two insulating sheet members **50** and **52**, and secured in position by gluing. The conductive portion **54** is purposely sized to provide a small space between its edges and the inner and outer edges of the insulating sheet members, to insure that the conductive portion of the static plate is completely covered by electrical insulation. In order to provide a rounded equipotential surface adjacent the inner and outer edges of the conductive portion **54**, to prevent electrical stress from concentrating on these edges, electrically conductive wire structures **55** and **57** may be disposed in radially spaced relation about the inner and outer edges. Wire structures **55** and **57** have a conductive strand **56** and **58**, respectively, formed of copper, or other suitable electrical conductor, which are wrapped with suitable insulating means **60** and **62**. Conductive strands **56** and **58** are electrically connected to conductive portion **54** by electrical leads **64** and **66**, respectively, and are held in position by insulating channel members **68** and **70**, which may be formed of pressboard and glued to the insulating sheet members **50** and **52**.

The electrically conductive portion **54** of the static plate **24** has presented many problems in the past, with many prior art constructions being very costly to manufacture and/or unreliable due to overheating. Metallic foils of electrically conductive material are not commercially available which are thin enough to provide the desired electrical resistance, and the other necessary characteristics of the shielding means. For example, the resistance of the thinnest copper foil available is much too low, as eddy currents caused by leakage flux perpendicular to the major plane of the static plate provides a substantial I^2R loss, resulting in overheating of the foil. Even the resistance of sprayed aluminum is too low to prevent excessive heating in an area of high leakage flux. The heating problem of sprayed aluminum has been solved in the prior art, but the solution is time consuming and thus costly. The insulating sheet material on which the aluminum is sprayed is first masked to provide an intricate pattern of parallel spaced, electrically conductive strips. This arrangement also requires that the electrical conductor be attached to the conductive portion after it has been sprayed or coated on the insulating sheet member, which results in burning of the insulating sheet when electrical leads are not carefully soldered to the conductive portion. The sprayed aluminum conductive portion also requires that the areas where electrical leads are to be soldered be sprayed with copper, to facilitate a good solder connection. Sprayed aluminum is relatively brittle, with cracks occurring when electrical leads are soldered thereto, or when the final structure is bent or stressed during handling and installation. Sprayed aluminum also, by its nature, is a mass of small particles which present a relatively rough surface, causing localized areas of high potential gradient with its resultant corona. Therefore, in the prior art, the sprayed aluminum is often coated with a resinous insulating material, such as an epoxy resin, and then the sprayed aluminum is polished. While this procedure provides an adequate structure, it will be apparent that the manufacture of the static plate, using this process, is time consuming, costly and subject to a high percentage of rejects.

This invention solves these problems of the prior art, and provides an excellent static plate, by constructing the electrically conductive portion **54** of a wire cloth, screen or mesh, having an electrical resistance between .02 and 2 ohms per square. Resistances in this range are available in wire cloth, such as those made of stainless steel, and the wire cloth possesses all of the physical characteristics desirable in the construction of the static plate.

In order to more clearly describe static plate **24**, constructed with a wire cloth conductive portion **54**, static plate **24** shown in FIGS. 1 and 2 is illustrated in an exploded perspective view in FIG. 3, in which conductive portion **54** is separately shown.

FIG. 3 illustrates wire structures **55** and **57**, insulating sheet members **50** and **52** and electrically conductive portion **54**. Channel members **68** and **70** are not shown in this view. Wire structures **55** and **57**, as well as electrically conductive portion **54**, each have at least one circumferential discontinuity or gap **72**, **74** and **76**, respectively, in order to prevent the formation of shorted turns about leg **22** of magnetic core sections **16** and **18**.

Electrically conductive portion **54** is formed of wire cloth, screen, or mesh **80**, shown in the magnified insert **82**, which is formed of a plurality of woven metallic wires. Wire cloth is available which will provide the desired electrical resistivity, which solves the eddy current heating problem without resorting to the expedient of breaking up the eddy current paths by masking or stripping, and also possesses desirable physical characteristics. Stainless steel cloth, of the type commonly used for sieves and filters, has been found to provide excellent results. Other metallic cloths having an electrical resistance in the range of .02 to 2 ohms per square, however, would also be suitable.

Stainless steel wire cloth of 145 mesh, which uses .0022 inch diameter wire, 250 mesh, which uses .0016 inch diameter wire, and 325 mesh, which uses .0011 inch diameter wire, all provide excellent results. There is no theoretical limitation on the fineness of the wire cloth; however, since the higher mesh numbers are more costly, it is desirable to use the lowest mesh number which will provide the desired electrical resistance, and also present a substantially smooth surface to the electric stress. It is not desirable to use a coarse screen, such as the common 12 to 18 mesh screens, even though they may have the desired resistivity, as the wires of the screen react to the electric field as individual wires, instead of the screen reacting as a smooth surface. Therefore, the lower limit on mesh size, assuming the electrical resistivity is in the desired range, is where the wire cloth no longer has a cloth-like appearance. In general, it is desirable to use at least 80 mesh wire cloth, with 145 mesh stainless steel wire cloth, which has an electrical resistance of .0613 ohm per square at 75° C. giving excellent results with very little heating, and rapid cooling characteristics. However, it is to be emphasized that there is no sharp demarcation between the mesh sizes of what is, and what is not suitable. It depends upon the particular application of the shield and the electrical stresses which will be encountered.

The mesh number refers to the number of openings per inch. Thus, a 100 mesh wire cloth would have 100 openings per inch, in both directions, or 100 wires per inch in both directions, resulting in 10,000 openings in one square inch. The commonly available cloth which has a different mesh number in two perpendicular directions would also be suitable. For example, wire cloth having 100 mesh in one direction and 40 mesh in the other, would be suitable if its electrical resistance is in the desired range.

Conductive portion **54** shown in FIG. 3 may be very easily constructed. Since wire cloth is available up to at least 48 inches wide, it is possible to form the electrically conductive portions for certain static plates in one piece, by cutting out opening **84** and gap **76**. If the static plate is wider than the available wire cloth, or if in the interest of lowering the manufacturing cost it is desirable to minimize scrap, the electrically conductive portion **54** may be easily formed of a plurality of precut sections. Joints, such as the joint shown at **86**, may be very easily made by overlapping the pieces to be joined, and then soldering, spot or seam welding. Stainless steel wire cloth will solder very well using a stainless steel flux, and conventional lead-tin low temperature solder, by using a conventional soldering iron. The solder will only wet the stainless steel cloth where it has been fluxed, which permits strong accurate joints to be formed with a thin bead of solder.

The wire cloth also allows the connection of the various electrical conductors to be made to conductive portion 54 before it is associated with the insulating sheet members. Thus, the overheating of the insulating members 50 or 52, which may accompany the prior art method of spray coating, is completely eliminated. Electrical conductors, such as electrical connectors 64 and 66 for connecting conductive portion 54 to wire structures 55 and 57, and electrical conductor 90 for connecting conductive portion 54 to an adjacent pancake coil or the high voltage terminal, may be made in any of several ways. For example, electrical conductors 64 and 66 are shown as thin strips of metallic foil, such as copper, which may be soldered to conductive portion 54. Electrical conductor 90 may be formed by first soldering a piece of copper foil 92 to conductive portion 54, and then spot welding a cable 94 to the copper foil 92. Cable 94 may be constructed of a type of cable having a plurality of twisted strands. These strands may be untwisted and flared at one end, and then spot welded to the copper foil, or the flared strands may be soldered directly to conductive portion 54. The plurality of openings in the cloth enable excellent solder joints to be obtained, as the solder enters the openings and forms a very high strength joint.

Since the edges of the wire cloth are sharp after conductive portion 54 has been cut to shape, comprising a large plurality of cut ends of the individual wires, it is necessary to smooth or round the edges in order to prevent electrical stress from concentrating thereon and causing corona. This may be easily accomplished by running a bead of solder, such as bead 96, completely around the inner and outer edges of conductive portion 54. This bead of solder is more clearly shown in the magnified view of wire cloth 80 shown in FIG. 4. By controlling the application of the flux, solder bead 96 may be formed to any desired width.

After the electrical connections 64, 66 and 90 have been made, and the edges of conductive portion 54 rounded by solder bead 96, a suitable adhesive is applied to the sheet insulating members 50 and 52, or to the electrically conductive portion 54, or both, and conductive portion 54 is "sandwiched" between insulating members 50 and 52 and the resulting structure is pressed until the adhesive has cured. A suitable adhesive which may be used is the casein type glue, which will allow the static plate structure 24 to be completely impregnated by the insulating and cooling dielectric fluid in the transformer, insuring that any air trapped therein will be supplanted by the fluid.

After conductive portion 54 is protected by the sheet insulating members 50 and 52, wire structures 55 and 57 are disposed about the inner and outer edges of the structure, "tacked" in position by glass tape or other suitable means, and then insulating channel members 68 and 70, shown in FIG. 2, may be applied and glued in the position shown in FIG. 2. Electrical connectors 64 and 66 may be wrapped about the electrically conductive strand portion of wire structures 55 and 57, which then completes static plate 24.

Static plate 24, constructed according to the teachings of the invention, whereby the electrically conductive portion 52 is constructed of a wire cloth having a predetermined electrical resistance in the range of .02 to 2 ohms per square, greatly simplifies manufacturing procedures as it may be used without resorting to breaking up eddy current paths, and without coating and polishing the surface. The use of wire cloth permits the conductive portion of the shielding means to be completely prepared as a subassembly, while it is separate from the insulating support and protective members, including the addition of the necessary electrical leads or connectors. This precludes the possible burning of the insulation members when the electrical leads are attached.

The wire cloth has a very high strength for its weight and is not brittle or subject to cracking or tearing. It is very flexible, due to the small diameter wires used in the

manufacture of the cloth, which permits the structure to be bent during handling and installation without danger of cracking the electrically conductive portion.

In addition to minimizing eddy currents, any heating produced in the static plate is quickly dissipated, as the surface area of the wire cloth is substantially greater than the surface area of metallic foil or a metallic coating. The very fine openings in the wire cloth facilitate solder connections, facilitate gluing the wire cloth to the backup insulating members, and promote complete impregnation of the shielding structure by the fluid dielectric when disposed relative to the electrical inductive apparatus.

The use of the teachings of the invention is not limited to static plates. For example, the corona shielding structures 26, 28, 30 and 32 shown in FIG. 1 have substantially the same manufacturing problems as static plate 24, and the use of the teachings of the invention provides additional benefits in the manufacture of curved or specially shaped shielding means, such as the curved shielding means 26 and 28.

FIG. 5 is a fragmentary cross-sectional view of corona shielding means 26 and 28 shown in FIG. 1. Because of the cracking problem associated with sprayed metallic coatings, the curved corona shielding member 26, when using sprayed aluminum, has to be formed of pre-curved insulating members 102 and 104. The sprayed aluminum coating is then applied to one of the members and the two insulating members 102 and 104 are then glued together. Because of manufacturing tolerances, it is difficult to obtain a perfect fit between the two curved members, which results in a high number of rejects and time consuming, costly manufacturing procedures. After corona shielding means 26 is formed, it is further bent or otherwise stressed while assembling it relative to the core winding leg and plurality of pancake coils, which may crack the metallic coating.

By utilizing the teachings of this invention, the electrically conductive coating 106 may be formed of metallic wire cloth having the desired electrical resistivity. Corona shielding member 26 may then be formed in the same manner as hereinbefore described relative to static plate 24, by cutting the wire cloth 106 to shape, rounding the cut edges with a solder bead, and attaching electrical lead 108. The wire cloth 106 may then be glued between insulating members 102 and 104 while these insulating members are in the form of flat sheets. After the adhesive has cured, the resulting structure may be curved to the desired configuration without danger of cracking the wire cloth. The corona shielding structure 26 may also be stressed and bent while assembling it in position in the inductive apparatus, without cracking the wire cloth.

Corona shielding member 30, which has electrical lead 110 attached thereto, is a substantially flat structure having two insulating sheet members 112 and 114, which contain a wire cloth conductive portion 116 constructed as hereinbefore described relative to static plate 24.

All of the advantages of the invention, hereinbefore described relative to static plate 24, are equally applicable to corona shielding means 26, 28, 30 and 32, plus the advantage of being able to completely form the shielding means while flat and then form it to the desired shape.

While the invention has been specifically described by using the static plate and corona shielding embodiments, it will be obvious that the teachings of the invention are applicable to any shielding means structure for electrical inductive apparatus, which includes an electrically conductive portion of predetermined electrical resistance, disposed between two insulating members.

Since numerous changes may be made in the above-described apparatus and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. An electrical transformer comprising a plurality of pancake coils having openings therein for receiving a magnetic core, said plurality of pancake coils being electrically connected to provide high and low voltage windings, and being stacked in side-by-side relation with their openings in alignment, magnetic core means having a winding leg disposed through the aligned opening provided by said pancake coils, at least one static plate disposed adjacent a predetermined pancake coil and electrically connected thereto, said static plate having an electrically conductive portion disposed between two insulating sheet members, said electrically conductive portion being formed of metallic wire cloth having an electrical resistance between .02 and 2 ohms per square, a tank, said plurality of pancake coils, said magnetic core means, and said at least one static plate being disposed within said tank, and fluid insulating and cooling means disposed to a predetermined level in said tank.

2. An electrical transformer comprising a plurality of pancake coils having openings therein for receiving a magnetic core, said plurality of pancake coils being electrically connected to provide high and low voltage windings, and being stacked in side-by-side relation with their openings in alignment, magnetic core means having a winding leg disposed through the aligned opening provided by said pancake coils, corona shielding means disposed between said magnetic core means and said plurality of pancake coils in the aligned opening provided by said plurality of pancake coils, said corona shielding means having an electrically conductive portion connected to ground, said electrically conductive portion being disposed between two insulating members, said electrically conductive portion being formed of metallic wire cloth having an electrical resistance between .02 and 2 ohms per square.

3. The electrical transformer of claim 1 including solder means, said solder means being in the form of a solder bead disposed about the edges of said metallic wire cloth.

4. The electrical transformer of claim 1 wherein said metallic wire cloth is at least 80 mesh, in at least one direction.

5. The electrical transformer of claim 1 wherein said metallic wire cloth is formed of stainless steel, and is at least 80 mesh.

6. The electrical transformer of claim 2 including solder means, said solder means being in the form of a solder bead disposed about the edges of said metallic wire cloth.

7. The electrical transformer of claim 2 wherein said metallic wire cloth is at least 80 mesh, in at least one direction.

8. The electrical transformer of claim 2 wherein said metallic wire cloth is formed of stainless steel, and is at least 80 mesh.

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