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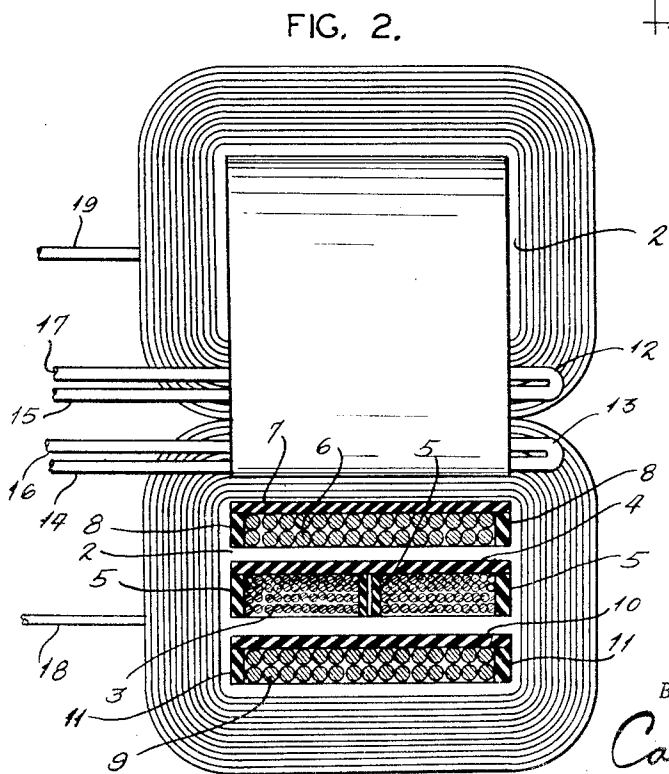
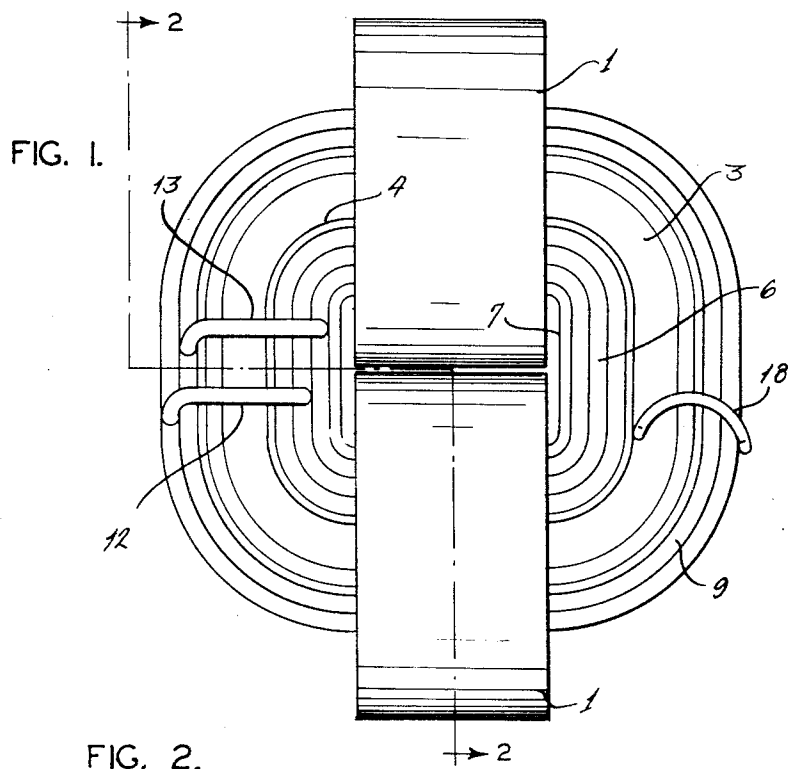
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METHOD OF FORMING TRANSFORMER COILS

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METHOD OF FORMING TRANSFORMER COILS

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This invention relates to shell type power transformers in which the low voltage winding is divided and positioned on opposite sides of the high voltage winding, and is more particularly directed to a method of winding the coils so that no splices or joints are required between the sections of the transformer windings.

One of the objects of the invention is to produce transformer windings of different cross sectional area so that one coil is a continuation of the other and which may be nested one within the other.

Another object of the invention is to produce a transformer coil made up of two or more sections without joints between the windings thereon and in a more rapid manner.

A further object of the invention is to produce a sectionalized transformer winding using less conductive material than coils wound with joints or splices therebetween.

Still another object of the invention is to produce sectionalized transformer coils in such manner that they may be more rapidly and more easily insulated one from the other.

The invention consists in winding two or more coils of different cross sectional area in which the windings are continuous and so disposed relative to each other that they may be nested without the necessity of using soldered or other types of joints and which may have sectionalized insulation inserted between the coil sections during the nesting operation.

In the drawings:

Fig. 1 is an end view of a shell type transformer showing the windings in place,

Fig. 2 is a sectional view taken substantially along the line 2—2 of Fig. 1,

Fig. 3 is a diagrammatic illustration showing the relative position of the coils as they are being wound,

Fig. 4 is a view similar to Fig. 3 but with the smaller coil being rotated at 180°,

Fig. 5 is a view similar to Fig. 4 but showing one of the coils in position for nesting; and

Fig. 6 shows both coils coaxially disposed and nested one within the other.

Referring to Figs. 1 and 2, a complete transformer is disclosed which consists of two similar cores 1 through the windows 2 of which is placed a sectionalized high voltage winding 3. Each winding section is wound on an insulating sleeve 4 provided with end insulating elements 5. The high voltage winding may be a single coil if so desired. Between the insulating sleeve 4 and the adjacent legs of cores 1 is a section 6 of the low voltage winding which is wound on an insulating sleeve 7 provided with end insulating elements 8. Between the high voltage winding 3 and the outer legs of cores 1 is located a second section of the low voltage winding 9 wound on the insulating sleeve 10 provided with end insulating elements 11.

The low voltage winding of the transformer is made up of two windings consisting of a single layer, each winding disposed one on top of the other on each of the sleeves 7 and 10. It is, therefore, necessary that there be two connecting leads 12 and 13 between the inner and outer sections 6 and 9 of the low voltage windings. The ends 14 and 15 of one of the low voltage windings are brought out in the manner shown, and the ends 16 and 17 of the other winding are also brought out in the manner shown. The ends of the high voltage winding are brought out at 18 and 19. The internal leads at the center of the high voltage winding are not shown but would normally come out to a tap changer.

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It is important that connecting leads 12 and 13 between the two sections of the low voltage winding have good conductivity and adequate insulation and not be liable to failure since they are normally placed at the bottom of the transformer tank where they are not readily available for inspection by removal of the tank cover.

The preferred method of winding the two sections of the low voltage winding wherein there is no joint in the conductor therebetween, is shown in Figs. 3, 4, 5 and 6. The low voltage coil forms are placed on coaxial mandrels 20 located adjacent each other with just sufficient axial distance between them to produce the proper length of connecting leads 12 and 13 when the sections of the windings are assembled. The turns of these windings, in the diagrams of Figs. 3 to 6 inclusive, are shown wound side by side instead of one on top of the other, as in the actual transformer construction, in order that the construction may be clearly shown. This representation of the windings does not alter the unique properties of this method and, therefore, transformers may well be wound in this manner.

After the sleeves 7 and 10 for the two sections of the windings are mounted on their respective mandrels 20 in the positions shown in Fig. 3, the operator anchors the ends 14 and 15 of the conductors to the sleeve 10 at 21 and 22, then rotates the sleeves in a clockwise direction on the mandrels 20 until the required turns are placed thereon, after which the conductors are anchored to sleeve 10 at 23 and 24. The conductors are now carried over to sleeve 7 and anchored securely at 25 and 26. It is to be noted that the conductors are now crossed and the carry-over action forms the connecting leads 12 and 13. The mandrel is again placed in rotation but in a counter-clockwise direction for reasons to be explained later, and the required number of turns, usually the same as on sleeve 10, wound thereon. Upon completion of the winding turns on sleeve 7, the ends are anchored at 27 and 28, after which the conductors are cut to the required length for leads and the coils then removed from the mandrels.

The sleeves 7 and 10 and their windings 6 and 9 are removed from the mandrels 20 after which the sleeve 7 is rotated counter-clockwise about a line in the plane of the top or lead side of the sleeves shown in Fig. 3 to the position shown in Fig. 4. This action places the connecting leads 12 and 13 and sleeve 7 parallel to each other and displaced upwardly from the axis of sleeve 10.

The next operation on the coil assembly is to rotate the sleeve 7 downwardly about the edge 29 (Fig. 5) so that the end, including the edges 30, 31, 32 and 33, enters the end of sleeve 10 which includes the edges 34, 35, 36 and 37, as shown in Fig. 5. After placing sleeve 7 in the position shown in Fig. 5, it is a simple matter to continue the movement of this sleeve to the position shown in Fig. 6, which is the final position of sleeve 7 with relation to sleeve 10 in the completed transformer.

After performing the operation just described, the coils 6 and 9 on the sleeves are circumscribed in the same direction, this being the condition illustrated in Figures 5 and 6. The total voltage across the terminals of the coils is now the sum of the voltage induced in each coil.

Any extra insulation required for the connecting leads 12 and 13 is placed on these leads in the form of flexible tubes pre-cut to the proper length prior to starting the winding operation and slides along the conductors until the turns on sleeve 10 are in place, positioned and anchored as the windings are secured to sleeves 7 and 10 at points 23, 24, 25 and 26 for the two conductors. The only difference between winding the coils consisting of the two conductors shown in Figs. 3 to 6, inclusive, with the conductors side by side, and as shown in Fig. 2, one conductor being on top of the other, is that in the former the operator handles two conductors simultaneously, while in the latter the coils are usually wound consecutively so that any inter-coil insulation deemed necessary may be inserted. In either case, extra insulation is applied at the start to the connecting leads and the ends of the conductors placed and anchored in position, as described above.

A modification in producing the above two-coil low voltage winding consists in making the mandrel set-up exactly as described, but instead of starting the winding

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at the end of sleeve 10 opposite sleeve 7, the required length of conductor for one of the sleeves is unreel from the supply reel onto an auxiliary reel, at which time the connecting lead 12 of Fig. 3, for example, is anchored at points 23 and 25 on sleeves 10 and 7, after which both sleeves are wound simultaneously by rotating the mandrel, in the case shown, in a counter-clockwise direction. This method requires more equipment and, due to the necessity of handling a part of the conductor twice, is slower notwithstanding that only half as many revolutions of the winding machine would be required to produce a given coil.

Another modification of this method of producing coils is possible where either a two-section single layer, single conductor coil, or a two-conductor side-by-side double coil is to be made. This modification consists of winding the conductor or conductors on the smaller of the two sleeves and anchoring the same thereto; placing the larger sleeve over the smaller and holding it in place by any desired means so that it can be driven by the winding machine; anchoring the connecting lead to the larger sleeve; and finally winding the conductor or conductors on the larger sleeve in the usual manner. After the low voltage windings have been wound and assembled, as above described, it is only necessary to insert the high voltage winding 3 on its sleeve 4 which has been separately wound, in the space between the inner and outer sections of the low voltage winding and secure it in place; and then assemble the core iron therewith, as shown in Figs. 1 and 2, to produce the complete core and coils of a transformer.

Other modifications of this invention will be apparent to those skilled in the art and, therefore, the scope of the invention is limited only by the claims appended hereto.

What I claim is:

1. In winding transformers of the type including a low voltage coil in two sections, one section being nested within the other with the connecting conductor portion for the two coil sections being substantially entirely without the low voltage coil, and a high voltage coil received in the space between the nested low voltage coil sections, the process of winding and nesting the two-section low voltage coil from a pair of continuous conductors so as to obviate wire connections in each of the conductor portions connecting the coil sections and so as to avoid disposition of the connecting conductor portion between the coil sections, which process comprises anchoring the pair of conductors to one end portion of a sleeve, simultaneously winding the pair of conductors on the sleeve and anchoring the conductors to the other end portion of the sleeve, crossing the conductors and anchoring the same to an adjacent end portion of a second sleeve having a smaller diameter than the first mentioned sleeve, simultaneously winding the conductors on the second sleeve in a direction opposite to that on the first mentioned sleeve, and anchoring the conductors to the other end portion of the second sleeve, rotating the second sleeve about its longitudinal axis to uncross the conductors and then rotating the second sleeve about its transverse axis to insert the last wound end of the second sleeve into the last wound end of the first mentioned sleeve so as to provide a two-section, two-conductor nested coil from a pair of continuous conductors with the connecting conductor portions for the two-coil sections being disposed substantially entirely without the resulting nested coil.

2. In winding transformers of the type including a low voltage coil in two sections, one section being nested within the other with the connecting conductor portions for the two coil sections being substantially entirely without the low voltage coil, and a high voltage coil received in the space between the nested low voltage coil sections, the process of successively winding the two-section low voltage coil from a pair of continuous con-

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ductors and nesting the two sections so as to obviate wire connections in each of the conductor portions connecting the coil sections and so as to avoid disposition of the connecting conductor portions between the coil sections, which process comprises anchoring the conductors to one end portion of a sleeve, winding the conductors on the sleeve and anchoring the conductors to the other end portion of the sleeve, crossing the conductors and anchoring the same to an adjacent end portion of a second sleeve having a smaller diameter than the first mentioned sleeve, winding the conductors on the second sleeve in a direction opposite to that on the first mentioned sleeve, and anchoring the conductors to the other end portion of the second sleeve, rotating the second sleeve about its longitudinal axis to uncross the conductors and then rotating the second sleeve about its transverse axis to insert the last wound end of the second sleeve into the last wound end of the first mentioned sleeve so as to provide a two-section, two-conductor nested coil from a pair of continuous conductors with the connecting conductor portions for the two-coil sections being disposed substantially entirely without the resulting nested coil.

3. In winding transformers of the type including a low voltage coil in two sections, one section being nested within the other with the connecting conductor portion for the two coil sections being substantially entirely without the low voltage coil, and a high voltage coil received in the space between the nested low voltage coil sections, the process of winding and nesting the two-section low voltage coil from a continuous conductor so as to obviate a wire connection in the conductor portion connecting the coil sections and so as to avoid dispositions of the connecting conductor portion between the coil sections, which process comprises anchoring the conductor to one end portion of a sleeve, winding the conductor on the sleeve and anchoring the conductor to the other end portion of the sleeve, anchoring the same to an adjacent end portion of a second sleeve having a smaller diameter than the first mentioned sleeve, winding the conductor on the second sleeve in a direction opposite to that on the first mentioned sleeve and anchoring the conductor to the other end portion of the second sleeve, rotating the second sleeve about its longitudinal axis and then rotating the second sleeve about its transverse axis to insert the last wound end of the second sleeve into the last wound end of the first mentioned sleeve so as to provide a two-section, single conductor nested coil from a single continuous conductor with the connecting conductor portion for the two-coil sections being disposed substantially entirely without the resulting nested coil.

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