Aug. 17, 1954 H. S. FEDER 2,686,904

CORONA SHIELDING INSULATION

Filed Dec. 13, 1950

FIG. 1

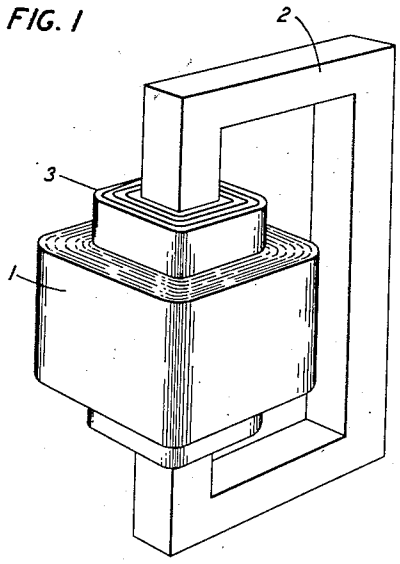


FIG. 2

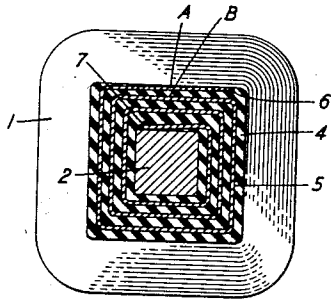


FIG. 3

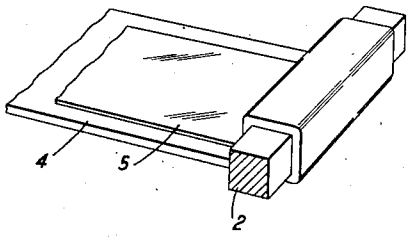


FIG. 4

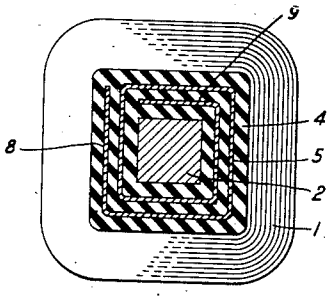
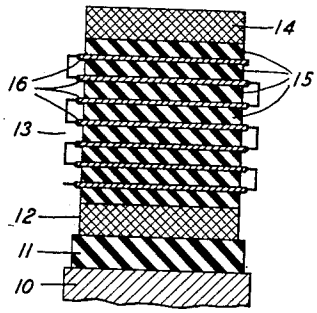


FIG. 5



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Patented Aug. 17, 1954

2,686,904

UNITED STATES PATENT OFFICE

2,686,904

CORONA SHIELDING INSULATION

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Application December 13, 1950, Serial No. 200,592

10 Claims. (Cl. 336—70)

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This invention relates to electrical coils and more particularly to such coils intended for high voltage operation and including a winding disposed about and insulated from a metallic core.

In addition to the premature failure of insulating material used in dry type coil assemblies caused thereby, the operation of coils at voltages sufficiently high to cause corona produces circuit noise which is intolerable in some installations. Substantially corona free operation at high voltages has been achieved in the past by the use of large quantities of insulation, by the use of air insulated windings, or by the use of oil impregnation. The economic and space factor disadvantages in such devices are obvious.

One general object of this invention is to improve the performance characteristics and the structure of high voltage electrical coils. More specifically, objects of the invention are to substantially prevent corona effects in electrical coils, to facilitate the manufacture of such coils and to simplify the structure of coils particularly adapted for high voltage operation.

In one illustrative embodiment of this invention, a continuous sheet of insulating material, having a conducting layer on one side thereof, is wound about the core of a coil, separating the core from the winding. The extremities of the conducting layer are electrically coupled, for example directly connected, to the core, which may be at ground potential, and to the winding, which may be at a high potential with respect to ground. Alternatively, the conducting coating may be coupled to the core, the winding, or both by a condenser, thus preventing the leakage of a direct-current component.

In accordance with one feature of this invention, two bodies at a large difference of potential, which are to be separated by a substantially corona free insulating member, in one embodiment the core and a coil winding, are connected by a continuous conducting shield which separates adjacent sections of the insulating member, thereby providing a voltage across any individual section which does not exceed the corona free voltage for that section.

In accordance with another feature of this invention, a substantially uniform voltage gradient along the continuous conducting shield provides a substantially uniform voltage gradient across the insulating member.

The invention, together with the above-noted and other features thereof, will be understood more clearly and fully from the following detailed description read with reference to the accompanying drawing in which:

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Fig. 1 is a perspective view of a coil assembly having an insulating member illustrative of one embodiment of this invention;

Fig. 2 is a partial sectional view of the device of Fig. 1;

Fig. 3 is a perspective view of a core having an insulating member, which is illustrative of one embodiment of this invention, partially formed thereon;

Fig. 4 is a partial sectional view of a coil assembly similar to Fig. 2 having an insulating member illustrative of another embodiment of this invention; and

Fig. 5 is a schematic representation of a transformer having the windings thereof separated by an insulating member illustrative of yet another embodiment of this invention.

Referring now particularly to Figs. 1 and 2 of the drawing, the winding 1 of a coil assembly is separated from the core 2 by an insulating member 3. The insulating member 3 is comprised of a sheet or ribbon 4 of insulating material, such as kraft insulating paper, having a conducting layer 5 thereon, wound about the core 1.

In one preferred embodiment, the conducting layer 5 is a carbon deposited paper resistance strip wound interjacent the turns of the sheet or ribbon 4 and held in place by friction as shown in Fig. 3. The conducting layer 5 should have sufficient resistance so that the current leakage between the winding and core is negligible.

The conducting layer 5 is electrically connected to the winding 1 at 6 and to the core 2 at 7 for example by mechanical contact. Since the resistance per unit length of the conducting layer is substantially uniform, when a large difference of potential exists between the winding 1 and the core 2, the voltage gradient along the conducting layer is substantially uniform. The length of the sheet or ribbon 4 and the conducting layer 5 thereon and the thickness of the sheet or ribbon 4 are made such that the voltage between any two general points A and B on opposite sides of the sheet or ribbon 4 does not exceed the corona free voltage. For example, if the core 2 is at ground potential and the winding 1 is at a potential of 2000 volts with respect to ground, and a single thickness of the insulation material used in the sheet or ribbon 4 is corona free when subjected to 500 volts, ten turns of the sheet or ribbon 4 with the conducting layer 5 thereon will be wound about the core, whereby a nominal voltage of 200 volts will be applied

across any single thickness of the sheet or ribbon 4. The difference between the nominal applied voltage and the permitted voltage is required (*a*) to give a factor of safety and (*b*) to account for the fact that the voltages across all points of the sheet or ribbon 4 are not absolutely identical due to the fact that the circumferential length of the individual turns increases radially outward.

In another embodiment shown in Fig. 4, the conducting layer 5 is not electrically connected conductively to the winding 1 and the core 2 but the capacitive effect between the outer end 8 of the conducting layer 5 and the winding 1, and of the capacitive effect between the inner end 9 of the conducting layer 5 and of the core 2 couples the conducting layer 5 to the core 2 and to the winding 1 whereby a voltage gradient along the conducting layer 5 is provided and the leakage of a direct-current component is prevented. The conducting layer may be electrically connected to the winding and capacitively coupled to the core or electrically connected to the core and capacitively coupled to the winding. The resistance of the conducting layer 5, the capacitance between the layer 5 and the core 2, and the capacitance between the layer 5 and the winding 1 must be made such that the voltage across any section does not exceed the corona free voltage.

The transformer shown schematically in Fig. 5 is comprised of a core 10, an insulating member 11, which may be constructed in accordance with this invention as described hereinabove, a winding 12 and an insulating member 13 separating the first winding 12 from a second winding 14. The structure of the insulating member 13 is similar to the embodiments described hereinabove, comprising a sheet or ribbon 15 of insulating material, such as kraft insulating paper, having a conducting layer 16 thereon wound about the first winding 12. The conducting layer 16 may either be electrically connected to or capacitively coupled to the two transformer windings 12 and 14 in a manner similar to that employed in the embodiments described hereinbefore.

Although specific embodiments have been shown and described it is understood that they are but illustrative and in no wise limit the scope of this invention. For example, although the conducting layer is advantageously a carbon deposited paper resistance strip wound interjacent the sheet or ribbon of insulating material it may be a conducting coating on the sheet or ribbon of insulating material applied thereto by methods that are well known in the art.

What is claimed is:

1. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a sheet of insulating material, a resistive layer of substantially uniform resistance per unit length on one side of said sheet of insulating material, said sheet and resistive coating wound about said core to form a plurality of insulating sections separated by the resistive layer, the extremities of said resistive layer being coupled electrically to said core and to said winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

2. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a single sheet of insulating material, a resistive coating of substantially uniform resistance per unit length on one side of said sheet of insulating material, said sheet and resistive layer each comprising a continuous strip wound about said core to form a plurality of insulating sections separated by the resistive layer, one extremity of said resistive layer being connected electrically to said core and the other extremity of said resistive layer being separated from said winding by a single layer of said sheet of insulating material, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

3. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a sheet of insulating material, a single continuous carbon deposited resistance layer of substantially uniform resistance per unit length on one side of said sheet of insulating material, said sheet and carbon deposited resistance layer wound about said core to form a plurality of insulating sections separated by the resistive layer, one extremity of said resistive layer being connected electrically to said winding and the other extremity of said resistive layer being separated from said core by a portion of said sheet of insulating material, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

4. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a sheet of insulating material, a continuous resistive layer of substantially uniform resistance per unit length on a substantial portion of one face thereof, wound about said core to form a plurality of insulating sections separated by the resistive layer, the extremities of said resistive layer being capacitively coupled to said core and to said winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

5. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a sheet of insulating material, a continuous resistive layer of substantially uniform resistance per unit length on one side thereof, wound about said core to form a plurality of insulating sections separated by the resistive layer, the extremities of said resistive layer being connected electrically to said core and to said winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

6. A transformer comprising a core, a primary winding, an insulating member separating said core from said primary winding, a secondary winding, and a second insulating member separating said secondary winding from said primary winding, said second insulating member comprising a continuous sheet of insulating material, a resistive layer of substantially uniform resistance per unit length on one side thereof, wound about said primary winding to form a plurality of insulating sections separated by the resistive layer, the extremities of said resistive layer being electrically connected to said primary winding and to said secondary winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

7. A coil assembly comprising a winding, a

core, and an insulating member separating said core from said winding, said member comprising a sheet of kraft insulating paper wound about said core, and a strip of uniformly carbon deposited resistance paper wound interjacent said sheet to form a plurality of insulating sections separated by said strip, the extremities of said strip being connected electrically to said core and to said winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

8. A coil assembly comprising a winding, a core, and an insulating member separating said core from said winding, said member comprising a sheet of kraft insulating paper wound about said core, and a strip of uniformly carbon deposited resistance paper wound interjacent said sheet to form a plurality of insulating sections separated by said strip, the extremities of said strip being capacitively coupled to said core and to said winding, said plurality of sections being of such number that the voltage across adjacent sections is less than the corona free voltage.

9. An inductive device comprising a pair of conducting elements adapted for operation at different potentials, one of said elements encompassing the other, a continuous insulating sheet comprising a plurality of turns disposed about the inner of said members, and a resistive layer of substantially uniform resistance per unit length on one face of said sheet, each end of said resistive layer being coupled electrically to a respective one of said elements, said plurality of

turns being of such number that the voltage across adjacent turns is less than the corona free voltage.

10. In an inductive device including two conductive elements operable at high potential differences, a corona discharge prevention member between said elements comprising a continuous dielectric sheet wound in a series of convolutions over the first of said elements, and a resistive coating of substantially uniform resistance per unit length on one side of said dielectric sheet, the second element being wound over said series of convolutions, each end of said resistive coating being electrically coupled to one of said elements, the number of convolutions being such that the voltage gradient between adjacent convolutions is less than the corona free voltage between said convolutions.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,235,373	Peek, Jr.	July 31, 1917
2,439,859	Muller	Apr. 20, 1948
2,441,047	Wall	May 4, 1948
2,521,513	Gray	Sept. 5, 1950
2,547,371	Brennan	Apr. 3, 1951

FOREIGN PATENTS

Number	Country	Date
355,291	Great Britain	Aug. 21, 1931
617,834	Great Britain	Feb. 11, 1949
930,287	France	Apr. 4, 1947