May 18, 1948. O. T. FARRY 2,441,804

WINDING FOR ELECTRICAL APPARATUS

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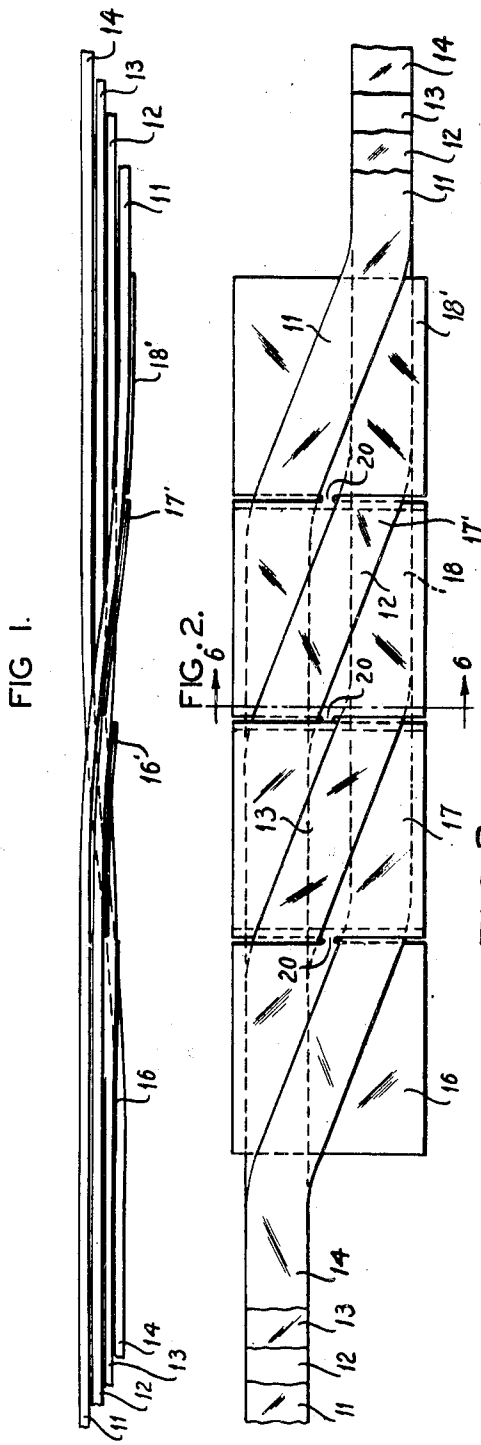


FIG. 1.

FIG. 2.

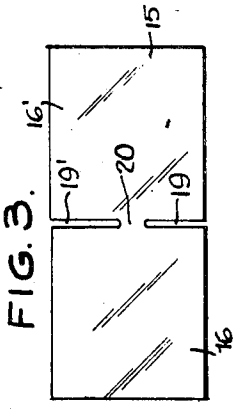


FIG. 3.

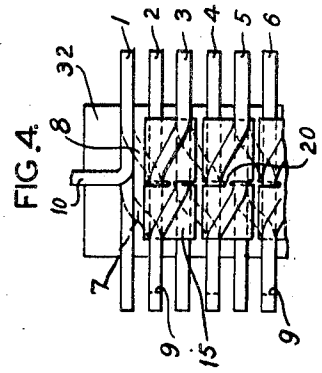


FIG. 4.

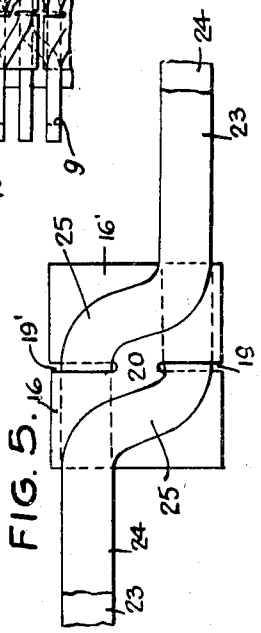


FIG. 5.

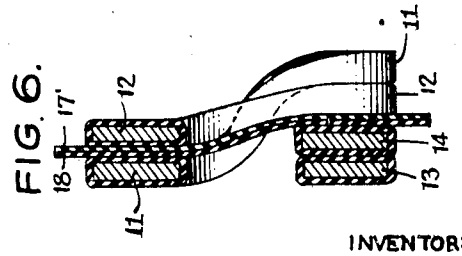


FIG. 6.

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WINDING FOR ELECTRICAL APPARATUS

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6 Claims. (Cl. 175—356)

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This invention relates to windings for transformers, reactors, and the like, in which there are a suitable number of transpositions of conductor elements, one of its objects being to provide an economical method and means of preventing short circuits between conductor elements at cross-over points which might otherwise result from damage to the insulation on the elements due to relative motion of said elements either during the formation or handling of the winding or parts thereof, or during operation of the apparatus.

In alternating current inductive apparatus, such as choke coils, transformers, and the like, it is often necessary to employ a conductor having a large cross-sectional area in order to carry the desired current without undue heating. If a single conductor of large cross section were used, heavy eddy currents would be set up in the conductor with resultant losses. For this, as well as mechanical reasons, it has been customary to employ a composite conductor composed of a number of insulated smaller conductors or strands connected in parallel.

If such strands were of flat "ribbon" and wound concentrically, the strands would be of differing length with the result that the total current would not be dividided evenly among them, and this unequal division would be augmented by the fact that the self-inductance caused by leakage flux is different in the various strands. To avoid this condition it is common practice to make "transpositions" to even the length of the strands of the conductors.

By transposing adjacent strands, pressure points between them may be created at one or both sides of the point of crossing, and also relative motion between strands adjacent cross-over points may be produced not only in the process of forming the winding, but on account of unequal heating of the individual strands and varying magnetic forces effective thereon in the operation of a transformer or other device embodying the winding. It is accordingly necessary that insulating material, in addition to the insulation covering of the strands, be provided whereby abrasion of the latter due to such relative motion, may not establish short circuits between adjacent strands at transposition points. My invention is directed to improved means for this purpose.

In the drawings Figure 1 is a diagrammatic illustration of a transposition in a 4-strand conductor;

Figure 2 is a side elevational view of a 4-strand conductor showing insulation inserts positioned at transposition points in accordance with my invention;

Figure 3 is an elevational view of one of said inserts;

Figure 4 illustrates a section of a transformer or reactor coil;

Figure 5 is a side elevational view of a transposition in a 2-strand conductor and showing application of my improved insulating means; and

Figure 6 is a sectional view taken substantially along the line 6—6 of Figure 2.

The drawings indicate windings of the disc or "pancake" type and parts thereof, Figure 4 illustrating a part of a common form of transformer winding made up of spaced apart coils of this type.

A suitable form of insulation insert is illustrated in Figure 3 and consists of a sheet 15 of paper or cloth, preferably varnish impregnated, and provided with laterally opening slots 19 and 19' dividing the insert into segments 16 and 16' connected by the tongue element 20. Figure 5 illustrates the application of such an insert at the transposition point of strands 23 and 24 of a 2-strand conductor, the transposition being made at the offset bends 25 in the conductor elements formed after winding one coil and preparatory to winding the adjacent coil. After forming these bends the elements are transposed, during which operation the insulation insert is placed in position, each slot receiving one of the conductor elements, segment 16 of the insert extending between the conductor elements at one side of the transposition point, and segment 16' extending between said elements at the other side of said point. It will be noted that the connecting tongue 20 of the insert is of such dimension relative to the spacing between the inner edges of the conductor element at the point of transposition that after the insert is placed in position and the transposition completed, substantial displacement of the insert, either laterally or longitudinally from the desired position, is prevented.

Figure 4 illustrates a portion of a transformer winding consisting of coils formed from 2-strand conductors. Coils 1 and 2 are wound on a machine capable of winding two disc coils from a single length of conductor. The numerals 7 and 8 indicate the portions of the conductor constituting the connection between these coils, which connectors are transposed and provided with an insulation insert, showing of this insert at this

particular point being omitted from Figure 4 for the purpose of clarity. The adjoining pair of coils 3, 4 are formed in the same manner and pair 1, 2 of the connecting elements being transposed and provided with insulation insert 15 as shown. These connecting extensions are secured, by soldering or otherwise, to the conductor of the previous pair at the point indicated by dotted line 9. The numeral 10 indicates an extension of the initial turn of coil 1 for connection to the apparatus terminal and the transposition 7, 8, which may be referred to as the "inside" transposition, is adjacent the transformer core insulating tube 32. The transposed connection between coil pair 1, 2 and coil pair 3, 4 is on the outside of the winding. In the manner described a winding can be constructed embodying any number of coils.

Figures 2 and 6 illustrate the assembly with the strands of a 4-strand conductor of the three insulation inserts of the kind illustrated in Figure 3, which are required at the transposition point in such a conductor. In this figure the segments of the left-hand insert, which receives and insulates strands 13 and 14, are designated by the numerals 16 and 16'; the segments of the insert to the right (for strands 12 and 13) by the numerals 17 and 17'; and the segments of the remaining insert (for strands 11 and 12) by the numerals 18 and 18'. As indicated, segment 17 overlies segment 16' and segment 18 overlies segment 17'. This results in double thickness of insulation at two areas but if it should be preferred that this be avoided in forming a transposition in a multi-strand conductor, a sheet of insulation may be employed which corresponds to that shown in Figure 3 except that it is longer and is provided with the requisite number of pairs of slots properly positioned to receive each two adjacent strands at the points where they cross each other.

If the dotted lines in Figure 2, which indicate the ends of insulation segments 16' and 17', were omitted this figure would illustrate the extended insert above mentioned.

This invention is not limited to transposition in windings consisting of disc coils but it is adaptable to any winding arrangement requiring transposition and located in plane or cylindrical surface. For example, the cross connectors between points of equal potential in a large D. C. armature winding may be insulated as indicated in Figure 2.

Having fully described my invention, that which I claim as novel and desire to protect by Letters Patent of the United States is:

1. An inductive winding comprising a plurality of spaced apart disc coils connected together and formed of a multi-strand conductor, the strands of the conductor being transposed in the connections between the coils and having inserts of insulating material in sheet form disposed between adjacent strands at each side of their cross-over points, said inserts being provided with portions engaging the strands to maintain the material in position.

2. In an electrical conductor comprising two individually insulated strands which are transposed at one or more points and which lie side by side throughout their length between transposition points, a sheet of insulating material having parts positioned between the strands at each side of a transposition point to prevent contact between said strands in areas immediately adjacent said point at each side thereof.

3. In a winding for an electrical apparatus in which at least two conductor elements of the winding lie side by side and are transposed at one or more points, a sheet of insulating material having parts positioned between said conductor elements at each side of a transposition point to prevent contact between said elements in areas immediately adjacent said point at each side thereof, said insulating sheet having two spaced apart openings each receiving one of said conductor elements.

4. In a winding for an electrical apparatus in which at least two conductor elements of the winding lie side by side and are transposed at one or more points, a sheet of insulating material having parts positioned between said conductor elements at each side of a transposition point to prevent contact between said elements in areas immediately adjacent said point at each side thereof, said insulating material being provided with a portion engageable with a conductor element to prevent movement of the insert in one direction and engageable with the other conductor element to prevent movement in the opposite direction.

5. In a winding for an electrical apparatus in which at least two conductor elements lie side by side and are transposed at one or more points, a sheet of insulating material having parts positioned between said conductor elements at each side of a transposition point to prevent contact between said elements in areas immediately adjacent said point at each side thereof, said sheet being provided with oppositely disposed slots positioned at the point of crossing of the conductor elements and through each of which one of said elements extends, each conductor element having a portion engageable by the portion of the sheet between the inner ends of said slots to prevent longitudinal movement of the insulating sheet in one direction.

6. In an electrical conductor comprising two ribbon-shaped strands which are transposed at one or more points and faces of which lie side by side throughout their length between transposition points, each of said strands being bent at a transposition point, a sheet of insulating material having parts positioned between said strands at each side of a transposition point to prevent contact between said strands in the areas immediately adjacent said point at each side thereof, said insulating sheet being provided with slots each receiving one of said strands and positioned at a point adjacent a bend therein.

OTIS T. FARRY.

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