

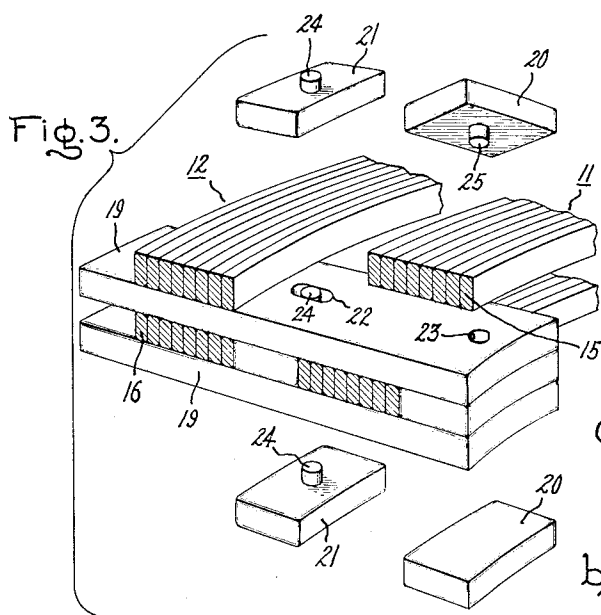
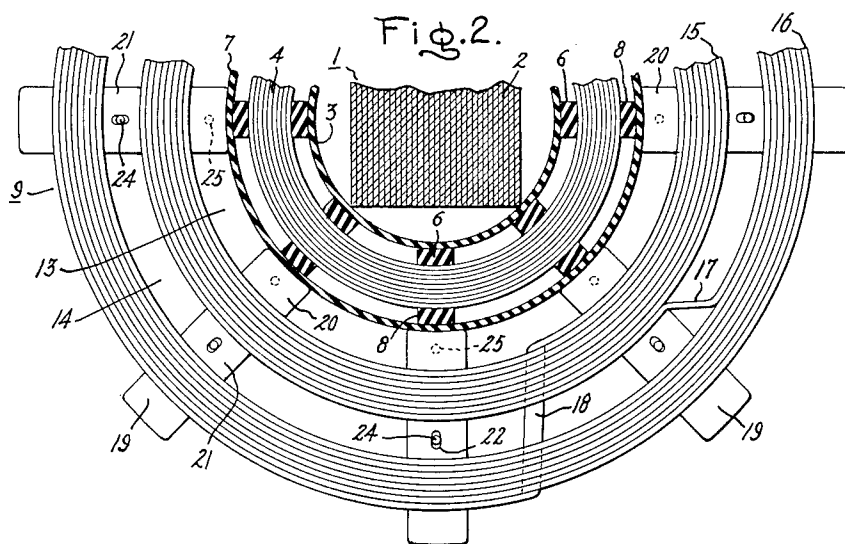
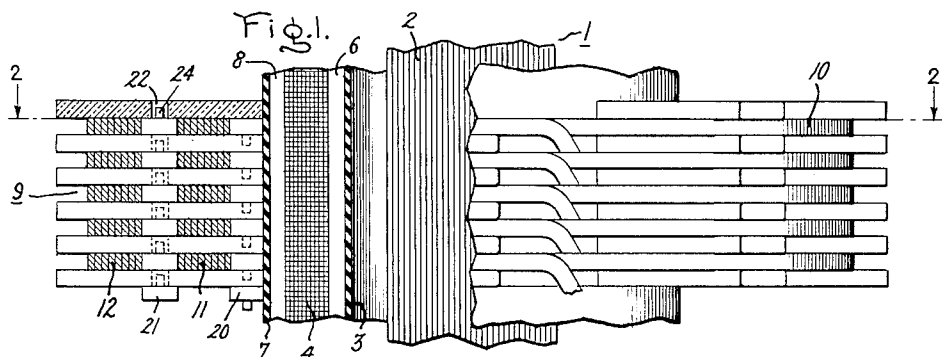
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2,756,397

TRANSFORMER

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1

2,756,397

TRANSFORMER

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4 Claims. (Cl. 336—60)

This invention relates to transformers and more particularly to means for spacing continuous disk-type coils in transformers of the dry type.

In the conventional dry-type transformer construction, a laminated iron core is provided with two or more vertically arranged leg portions and two or more windings are conventionally arranged concentrically around each core leg. Considering only one core leg, it has been the practice to mount a sleeve or cylinder of insulating material on the leg with a low voltage winding being wound thereon. This assembly is in turn surrounded by another cylinder of insulating material on which is wound a high voltage winding. The high voltage winding has conventionally been formed of a plurality of axially spaced apart horizontally arranged disk-shaped annular coils. In order to maintain an air duct between the underside of each coil and the outer cylinder, these continuous disk coils have been wound on axial spacing strips. These strips, in order to meet thermal and electrical requirements, were made from expensive insulating materials. Dry-type transformers are now being constructed with the disk-type coils of the high voltage windings split into radially spaced apart inner and outer sections thereby providing an additional ventilating duct. It is therefore desirable to provide improved means for axially spacing the disk-type coils and for radially spacing the inner coil sections from the cylinder and the outer coil sections from the inner coil sections, such means eliminating the use of axial spacing strips.

An object of this invention is therefore to provide an improved transformer of the dry type having disk-type coils incorporating improved means for axially and radially spacing said coils.

Further objects and advantages of this invention will become apparent by reference to the following description and the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with this invention, there is provided a dry-type transformer having a cylindrical mounting member with a plurality of axially-spaced apart disk-type annular coils wound thereon. Each of these disk-type coils has an inner section radially spaced from the mounting member thereby defining a first ventilating duct and an outer section radially spaced from the inner section thereby defining a second ventilating duct. A plurality of outwardly extending spacing members are respectively arranged between the disk coils extending from the cylindrical member outwardly beyond the outer peripheries of the disk coils. These spacing members serve to axially space the disk coils. In order to provide the radial spacing, a plurality of inner spacing members are arranged between the inner coil sections and the cylindrical member and another plurality of outer spacing members are respectively arranged between the inner and outer coil sections, these inner and outer spacing members being respectively

2

arranged between the outwardly extending spacing members. In order to lock these inner and outer spacing members in position, each outwardly extending spacing member has an opening formed therethrough intermediate the inner and outer coil sections and another opening formed therethrough intermediate the inner coil sections and the cylindrical member. Each of the inner and outer spacing members has a projection formed thereon, these projections extending respectively into the openings in the outwardly extending spacing members. The inner and outer spacing members may be axially thinner than the axial width of the disk coils so that axial clamping pressure applied on the disk coils will not be taken by the inner and outer spacing members. In addition, in order to accommodate variations in the radial build of the inner coil sections, the outer openings in the outwardly extending spacing members may be elongated. Furthermore, the inner and outer spacing members may be arranged with the projections on the inner spacing members extending in one direction and the projections on the outer spacing members extending in the other direction to provide an interlocking construction.

In the drawing, Fig. 1 is a fragmentary side elevational view, partly in section, illustrating the improved transformer construction of this invention;

Fig. 2 is a fragmentary cross-sectional view taken along the line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary exploded view showing the arrangement of the improved spacing members of this invention.

Referring now to the drawing, there is shown a portion of a vertically arranged leg 1 of a transformer core formed of a plurality of relatively thin laminations of magnetic material 2. The leg 1 is surrounded by an inner cylinder 3 formed of suitable insulating material which in turn is embraced by a layer-wound low voltage winding 4 wound on axial spacing members 6 formed of insulating material. An outer cylinder 7, also formed of insulating material, is arranged over the low voltage windings 4 and spaced therefrom by means of outer axial spacing members 8. High voltage winding 9 is wound over the outer cylinder 7 and comprises a plurality of horizontal, axially spaced apart disk-type coils 10.

In order to improve the thermal efficiency of the high voltage winding, the high voltage coils 10 are each divided into an inner section 11 and an outer section 12, the inner section 11 being radially spaced from the cylinder 7 thus defining an annular ventilating duct 13 and the outer section 12 is radially spaced from the inner section 11 thus defining another annular ventilating duct 14. The inner section 11 is formed of a continuous radially coiled conductor 15 and the outer section 12 is similarly formed of a continuous radially coiled conductor 16. A cross-over 17 connects the outer end of conductor 15 of coil section 11 to the inner end of conductor 16 of outer coil section 12. Another cross-over 18 connects the outer end of conductor 16 of outer coil section 12 to the inner end of conductor 15 of inner section 11 of an adjacent coil. It is thus seen that the outer and inner sections of each coil are serially connected while each coil is in turn serially connected to form the high voltage winding of the transformer. This construction is more fully described in co-pending application, Serial No. 300,944, filed July 25, 1952, of G. Camilli and G. H. Halsey, assigned to the assignee of the present application.

In order to provide for the necessary axial and radial spacing of the coil sections 11 and 12, a plurality of outwardly extending spacing members 19, formed of suitable insulating material, such as porcelain, are respectively arranged between the disk-type coils 10. These spacing members extend from the outer cylinder 7 radially out-

3

ward to beyond the outer periphery of the outer coil sections 12. To provide the radial spacing, a plurality of inner spacing members 20 and outer spacing members 21 are provided, also formed of insulating material, such as porcelain. The inner spacing members 20 are arranged between the outer cylinder 7 and the inner coil section 15 while the outer spacing members 21 are arranged between the inner coil section 11 and the outer coil sections 12. The inner and outer spacing members 20 and 21 are also arranged between adjacent outwardly extending spacing members 19.

In order to lock these inner and outer spacing members in position, each of the spacing members 19 has an elongated opening 22 formed therethrough intermediate the inner coil sections 11 and outer coil sections 12 and another opening 23 formed therethrough intermediate the inner coil sections 11 and the outer cylinder 7. The outer spacing members 21 are in turn provided with a pin 24 which extends into the openings 22 in the spacing members 19 on one side of the outer spacing members 21. The inner spacing members 20 are provided with a similar pin 25 which extends into the openings 23 in the spacing members 19 on the other side, i. e. the pins 24 of outer spacing members 21 extend in one direction while the pins 25 of inner spacing members 20 extend in the opposite direction thus providing an interlocking construction. The openings 22 in the spacing members 19 are elongated so that the variations in the radial thickness of the inner cross sections 11 can be accommodated. In addition, the inner and outer spacing members 20 and 21 are slightly thinner than the insulated width of the conductors 15 and 16 of inner and outer coil sections 11 and 12, however, the total thickness of the pins is greater than the insulated width of the conductors. Thus, the inner and outer insulators 20 and 21 cannot fall out of the winding once they are in place, however, axial clamping pressure when applied to the completed windings will not be carried by the inner and outer spacers 20 and 21, but rather by the outwardly extending spacing members 19 and by the conductors.

It will be readily seen that while the pins 24 and 25 of inner and outer spacing members 20 and 21 are shown as extending in opposite directions, the inner and outer spacing members may actually be assembled with the pins extending in the same direction without departing from the spirit of this invention. It will also be seen that the outwardly extending spacing members 19 can be pulled out of the winding and easily replaced in the event of accidental chipping or cracking during manufacture. The interlocking pins 24 and 25 of inner and outer spacing members 20 and 21 are broken off during this removal operation, however, this causes no difficulty since the remaining inner and outer spacing members are still interlocked to each other. Inspection of Fig. 2 of the drawing will show that the inner and outer ducts 13 and 14 are completely unobstructed circumferentially between the spacing members. With the axial spacing strips formerly used, at least 20% of the inner duct was obstructed. It will be readily apparent that the inner locking spacers of this invention provide an inexpensive and practical method for axially and radially spacing the disk-type windings of a dry transformer and further permit the splitting of each coil into inner and outer radially spaced apart sections to establish an additional ventilating duct.

While we have shown and described a particular embodiment of this invention, further modifications and improvements will occur to those skilled in the art. We desire it to be understood, therefore, that this invention is not limited to the form shown and we intend in the appended claims to cover all modifications which do not depart from the spirit and scope of this invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a transformer, a cylindrical mounting member, a plurality of axially-spaced apart disk-type annular coils

4

wound on said mounting member each having an inner section radially spaced from said mounting member thereby defining a first annular ventilating duct and an outer section radially spaced from said inner section thereby defining a second annular ventilating duct, a plurality of outwardly extending spacing members respectively arranged between said disk coils and extending from said cylindrical member outwardly beyond the outer peripheries of said disk coils for axially spacing the same, said outwardly extending spacing members being spaced apart between each pair of adjacent said disk coils and axially aligned with respective outwardly extending spacing members between adjacent pairs of said disk coils, a plurality of inner spacing members respectively arranged between said inner coil sections and said cylindrical member for providing said first ventilating duct, and a plurality of outer spacing members respectively arranged between said inner and outer coil sections for providing said second ventilating duct, said inner and outer spacing members being respectively arranged between said outwardly extending spacing members and axially aligned therewith, each of said outwardly extending spacing members having an outer elongated opening formed therethrough intermediate said inner and outer coil sections and an inner opening formed therethrough intermediate said inner coil sections and said cylindrical member, each of said inner spacing members having a projection formed thereon extending into said inner opening in the outwardly extending spacing member on one side thereof for locking said inner spacing members in position, each of said outer spacing members having a projection formed thereon extending into said outer opening in the outwardly extending spacing member on the other side thereof for locking said outer spacing members in position, said inner and outer spacing members being axially thinner than the axial width of said disk coils whereby said inner and outer spacing members do not carry axial clamping pressure applied to said disk coils.

2. In a transformer, a cylindrical mounting member, a plurality of axially-spaced apart disk-type annular coils wound on said mounting member each having an inner section radially spaced from said mounting member thereby defining a first annular ventilating duct and an outer section radially spaced from said inner section thereby defining a second annular ventilating duct, a plurality of outwardly extending spacing members respectively arranged between said disk coils for axially spacing the same, said outwardly extending spacing members being spaced apart between each pair of adjacent said disk coils and axially aligned with respective outwardly extending spacing members between adjacent pairs of said disk coils, a plurality of inner spacing members respectively arranged between said inner coil sections and said cylindrical member for providing said first ventilating duct, and a plurality of outer spacing members respectively arranged between said inner and outer coil sections for providing said second ventilating duct, said inner and outer spacing members being respectively arranged between said outwardly extending spacing members and axially aligned therewith, each of said outwardly extending spacing members having an outer elongated opening formed therethrough intermediate said inner and outer coil sections and an inner opening formed therethrough intermediate said inner coil sections and said cylindrical member, each of said inner spacing members having a projection formed thereon extending into said inner opening in the outwardly extending member on one side thereof for locking said inner spacing members in position, each of said outer spacing members having a projection formed thereon extending into said outer opening in the outwardly extending spacing member on the other side thereof for locking said outer spacing members in position.

3. In a transformer, a cylindrical mounting member, a plurality of axially-spaced apart disk-type annular coils wound on said mounting member each having an inner

5

section radially spaced from said mounting member thereby defining a first annular ventilating duct and an outer section radially spaced from said inner section thereby defining a second annular ventilating duct, a plurality of outwardly extending spacing members respectively arranged between said disk coils for axially spacing the same, said outwardly extending spacing members being spaced apart between each pair of adjacent said disk coils and axially aligned with respective outwardly extending spacing members between adjacent pairs of said disk coils, a plurality of inner spacing members respectively arranged between said inner coil sections and said cylindrical member for providing said first ventilating duct, and a plurality of outer spacing members respectively arranged between said inner and outer coil sections for providing said second ventilating duct, said inner and outer spacing members being respectively arranged between said outwardly extending spacing members and axially aligned therewith, each of said outwardly extending spacing members having an outer opening formed therethrough intermediate said inner and outer coil sections and an inner opening formed therethrough intermediate said inner coil sections and said cylindrical member, each of said inner spacing members having a projection formed thereon extending into said inner opening in the outwardly extending member on one side thereof for locking said inner spacing members in position, each of said outer spacing members having a projection formed thereon extending into said outer opening in the outwardly extending spacing member on the other side thereof for locking said outer spacing members in position.

4. In a transformer, a cylindrical mounting member, a plurality of axially-spaced apart disk-type annular coils wound on said mounting member each having an inner section radially spaced from said mounting member thereby defining a first annular ventilating duct and an outer section radially spaced from said inner section thereby defining a second annular ventilating duct, a plurality of

6

outwardly extending spacing members respectively arranged between said disk coils and extending from said cylindrical member outwardly beyond the outer peripheries of said disk coils for axially spacing the same, said outwardly extending spacing members being spaced apart between each pair of adjacent said disk coils and axially aligned with respective outwardly extending spacing members between adjacent pairs of said disk coils, a plurality of inner spacing members respectively arranged between said inner coil sections and said cylindrical member for providing said first ventilating duct, and a plurality of outer spacing members respectively arranged between said inner and outer coil sections for providing said second ventilating duct, said inner and outer spacing members being respectively arranged between said outwardly extending spacing members and axially aligned therewith, each of said outwardly extending spacing members having an outer opening formed therethrough intermediate said inner and outer coil sections and an inner opening formed therethrough intermediate said inner coil section and said cylindrical member, each of said inner and outer spacing members having a projection formed thereon respectively extending into said inner and outer openings in said outwardly extending spacing members thereby to lock said inner and outer spacing members in position, the projections of said inner spacing members extending axially in one direction and the projections of said outer spacing members extending axially in the other direction into the openings of said outwardly extending spacing members in each axially aligned group of said outwardly extending spacing members.

References Cited in the file of this patent

UNITED STATES PATENTS

1,159,770	Hyde	Nov. 9, 1915
1,747,953	Roothan	Feb. 18, 1930
2,422,037	Paluev	June 10, 1947
2,702,374	Whitman	Feb. 15, 1955