Oct. 24, 1950 L. C. WHITMAN 2,527,236

COMBINED COIL SPACER AND TERMINAL BOARD
FOR DRY TYPE TRANSFORMERS
Filed March 29, 1949

Fig. 1.

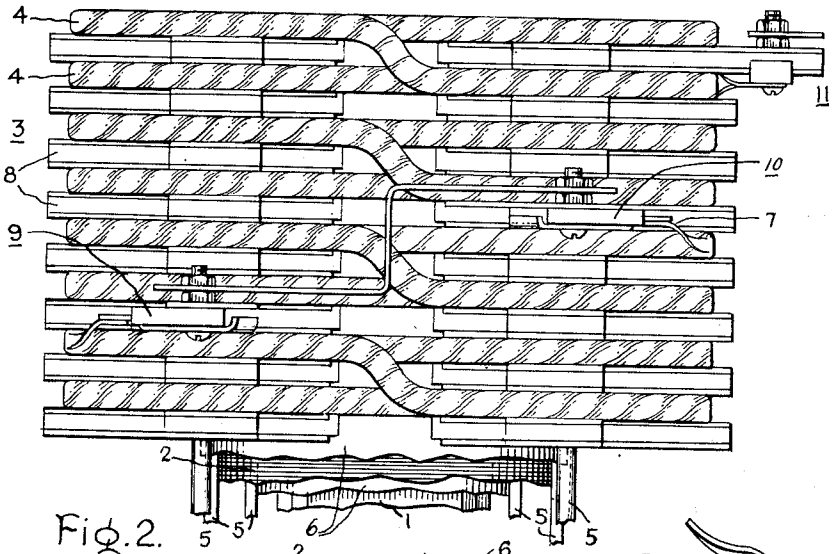



Fig. 2.

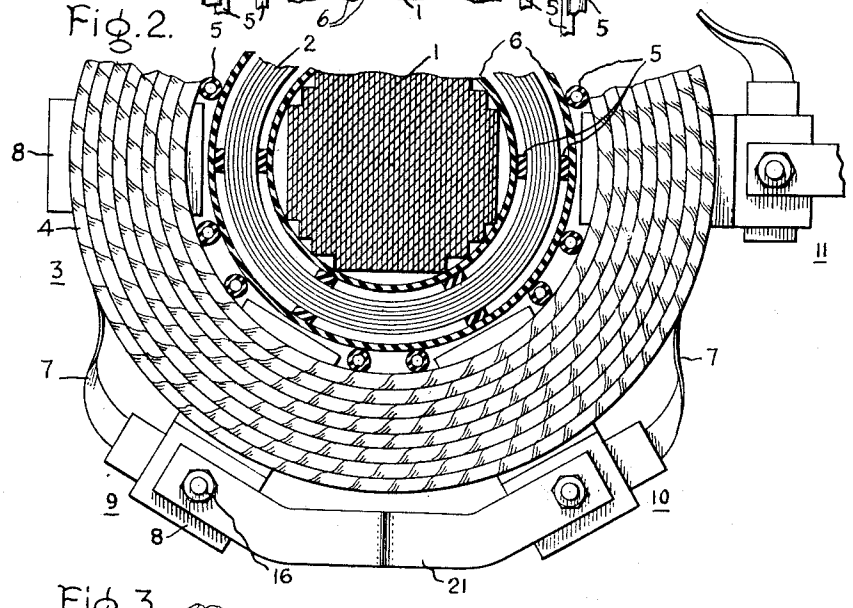
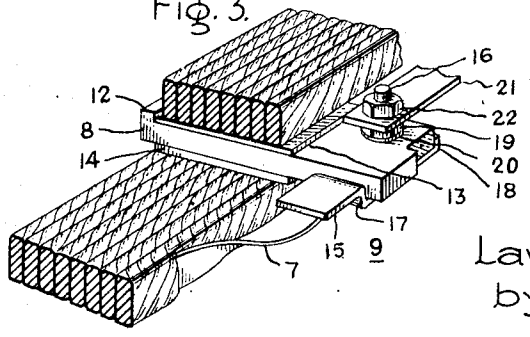



Fig. 3.




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## COMBINED COIL SPACER AND TERMINAL BOARD FOR DRY TYPE TRANSFORMERS

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1 Claim. (Cl. 175—362)

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This invention relates to electrical induction apparatus and more particularly to terminal connections for such apparatus.

In electrical transformers of the type having a continuous winding, it has been common practice to attach taps at various points on the winding and to connect those taps to an external terminal board where desired electrical connections may be made. By means of such taps, various parts of the winding might be cut out, thereby permitting a variation in the voltage ratio of the transformer.

This invention relates more particularly to terminal connections for dry type transformers, as distinguished from oil-immersed transformers, of the type having a high voltage winding arranged as a plurality of layers of disc coils. In such windings, each disc coil is formed of a number of spirally-wound turns in the same horizontal plane, and the high voltage winding of the transformer is comprised of a plurality of such coils arranged in a stacked relationship. The low voltage winding on such transformers is usually in the form of a cylinder, surrounding and adjacent to the magnetic core. The high voltage disc-type winding in turn surrounds the low voltage cylinder winding. However, this invention relates only to the disc-type winding and terminal connections therefor.

In transformers of the type just described, adequate ventilation for the windings is obtained by the use of ventilating ducts comprised of the space between the various disc coils constituting the high voltage winding. In order to maintain the coils spaced apart so as to adequately maintain the ventilating ducts, it is customary to provide radial spacer members symmetrically arranged between the coils. Such spacer members may be made of any suitable insulating material.

In addition to their spacing function, the plurality of radial spacer members which are conventionally used form convenient rigid columns to which suitable clamping means may be applied to hold the transformer in tightly assembled relation.

It is an object of this invention to provide a radial coil spacer which, in addition to its use as a spacer, also serves as a mounting means for a coil tap terminal, so as to eliminate the use of an external terminal board for the coil taps.

It is a further object of this invention to provide a terminal structure for a dry type transformer which is more economical and compact than previous constructions.

In accomplishment of the foregoing objectives,

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a feature of this invention is the provision on a dry-type transformer of a group of radial coil spacers which serve as mounting means for coil tap terminals, and which may be interconnected by means of conducting links in order to achieve various desired electrical relationships between the transformer coils.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and use, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Figs. 1 and 2 show, respectively, a front elevation view and a top plan view of a transformer equipped with my terminal connections, while Fig. 3 shows a perspective view, partly in cross-section, of a coil tap terminal in accordance with my invention.

In the drawing, Fig. 1 shows a central magnetic core 1, surrounded by a low-voltage cylinder-shaped winding 2 which is, in turn, surrounded by a high-voltage winding 3. The high-voltage winding 3 comprises a plurality of disc-shaped coils 4, each of which respectively comprises a number of turns spirally wound in the same horizontal plane. Both the cylinder-shaped low-voltage winding 2 and the disc-type high-voltage winding 3 may each be respectively formed by a single continuous conductor. Axial spacer members 5 and insulating cylinders 6 are provided between the magnetic core and the cylindrical-shaped low-voltage winding, and also between the low-voltage winding 2 and the high-voltage winding 3.

At certain points, short tap leads 7 are connected to the high-voltage disc winding, and are brought out for purposes of connection, as will be hereinafter described. The use of these taps permits cutting out of part of the transformer winding, in order to obtain different ratios of transformation.

Between each coil layer and the coil layer above and below it are a plurality of radial separator or spacer members 8 arranged at symmetrical points around the circumference of the coils.

As mentioned before, spacer members 8 serve the dual function of spacing the coils to assure adequate ventilation, and also constitute rigid columns which cooperate with clamping means (not shown) to hold the transformer structure in assembled relation.

In the construction shown in Fig. 1, some of the coil spacers 8 serve only the functions just de-

scribed; namely, that of suitably spacing the horizontal disc coils to assure proper ventilation; and secondly, that of providing a column to which a clamping means may be applied to hold the transformer in assembled relation.

However, at various symmetrical locations, certain of the spacer members, in accordance with my invention, are employed as mounting members for the attachment of terminal connections for the tap leads 7 connected to the windings, thereby facilitating the making of certain desired electrical arrangements or connections between the various coils of the transformer, without the necessity of an external terminal board. Furthermore, the use of a spacer as a terminal mounting means for the coil tap provides a rigid support for the coil tap, with only a very short tap lead being necessary from the coil to the spacer.

In order to provide adequate space for the attachment of the terminals, spacers serving as terminal mounts are made longer than those which do not serve that purpose, and extend further beyond the coil circumference than do the other spacers. One of these terminal assemblies is shown at 9 and several other similar terminals are shown at 10 and 11. The terminal assembly 9 comprises a radial spacer member 8 having a hole drilled near its outer edge. A stud and several nuts are positioned in and above this hole, respectively, to hold the various parts connected to the spacer in assembled relation as will be hereinafter described. Each spacer member, whether equipped for a terminal connection or not, is provided with an inner lip 12 which abuts against the interior surface of the coil above the spacer and prevents the spacer from sliding radially outwardly.

As will best be seen in Fig. 3, insulation strips 13 and 14, which may be made of mica or other suitable material, are placed above and below the spacer strip 8, respectively. The purpose of using insulation strips 13 and 14 is that if spacer 8 should become broken strips 13 and 14 may be removed on either side, after which spacer 8 itself may be easily removed and replaced without disturbing the adjacent coils. Insulation strips 13 and 14 are not fastened in any positive manner, upper strip 13 resting on the upper surface of spacer 8, and lower strip 14 resting on the coil surface below spacer 8.

The combined thickness of the spacer 8 and its attached lip member 12 is made less than the height of the air duct which is to be maintained between the disc coils. The additional thickness necessary to raise the lip member into its abutting and locking position above the lower surface of the coil immediately above the spacer 8 is provided by the use of the auxiliary insulation strips 13 and 14, as has been explained. When these auxiliary strips are removed, spacer 8 may easily be removed.

In order to connect coil tap 7 to the terminal on the spacer 8, the tap is brought out and attached to a metal connector member 15 which is affixed at the spacer member to terminal stud 16. The connection between coil tap 7 and metal connector member 15 may be by a brazed joint or by any other suitable means. It will be noted that connector member 15 has a U-shaped portion, formed by edges 17 and 18, into which spacer member 8 fits. This U-shaped portion retains the spacer in position and keeps it from turning when connections are changed at terminal stud 16. A nut 19 and washer 20 are placed in position on the stud 16 above the spacer in order to hold the connector 15 and spacer 8 rigidly connected.

After the tap lead has been connected to the terminal as just described, the transformer may be later subjected to coating operations such as, for example, the customary varnish treatment, with the tap lead already in the final position which it will occupy during the operation of the transformer. This is a considerable advantage over the situation which prevails when an external terminal board is used, as has been the conventional practice. An external terminal board, although an integral part of the transformer structure, is customarily mounted after the winding and coating operations have been completed. When the coil tap connections are made to such an external terminal board after the coating operations just mentioned have been completed, there is always the possibility of electrical or mechanical trouble due to the necessary manipulation of the coil taps. This possibility is eliminated by the use of my invention.

If it is desired to make electrical connections between various of the terminals, such as 9, 10, or 11, in order, for example, to cut out certain sections of the transformer winding, such connections may be made by means of connector links between the terminals.

As will be seen in Figs. 1 and 2, angular connector link 21 may be used to electrically connect terminals 9 and 10. Link 21 is rigidly attached to terminal stud 16 by means of nut 22, and is attached at its other end to terminal 10 by a similar stud and nut.

The various tap leads from the transformer windings may be connected together in any desired manner by means of link connectors similar to link 21. Thus, the combination of the terminals mounted on the radial spacers, plus the link connections between the various spacer terminals in accordance with my invention, takes the place of an external terminal board such as has heretofore been used quite generally on transformers of this type. The tap leads may be connected together by means of the links in any desired arrangement in the same manner as a similar connection could be made if the leads were instead brought to a terminal board. As can be seen, my invention provides a much more compact and economical arrangement than has heretofore been achieved with the use of an external terminal board, and, at the same time, the spacer terminal mounts provide a rigid and secure support for the coil taps.

While there have been shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

In a stationary electrical induction device, a winding comprising a plurality of coaxially arranged disc coils, a plurality of tap leads connected to different points of said winding, and a plurality of circumferentially separated insulated radial spacers between adjacent coils, each of said spacers having a lip member at its radially inmost portion for engagement with the radially inmost surface of an adjacent disc coil,

and auxiliary shim members cooperating with each of said spacers to position said lip portion in engaging relation with said adjacent coil surface, the combined height of the main body portion of each of said spacers plus the shim members being greater than the height of the main body portion of the spacer plus the lip member attached to the spacer, to permit easy removal of the spacer members, certain of said radial spacers being provided on their radially outermost portion with a terminal stud, each of said tap leads being conductively connected to one of said terminal studs by a rigid connector member having a U-shaped portion which embraces two opposite sides of the outer portion of the respective radial spacer member to which it is attached.

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