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C. STONEHILL
VARIABLE TRANSFORMER
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2,214,864

Fig. 7

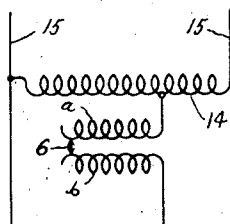


Fig. 1.

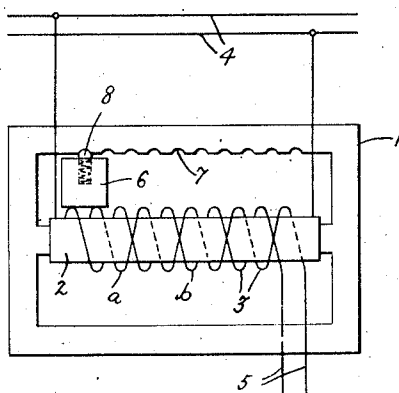


Fig. 2.

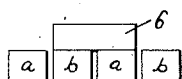


Fig. 3.

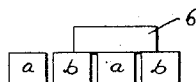


Fig. 4.

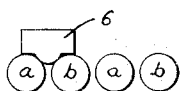


Fig. 5.

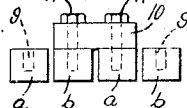
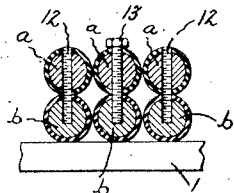


Fig. 6.



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UNITED STATES PATENT OFFICE

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VARIABLE TRANSFORMER

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Application August 16, 1938, Serial No. 225,109

13 Claims. (Cl. 171-119)

This invention relates to variable voltage transformers and it has for an object the provision of a new and improved arrangement for varying the voltage ratio of a transformer.

The invention is characterized by dividing at least one of the transformer windings into two sections which are interconnected by a contact member which makes direct electrical contact with both of the sections. This movable contact member is not normally electrically connected with any other part of the transformer circuit so that no pigtailed or flexible leads are employed. By means of a novel relation between the winding sections themselves and between the winding sections and the contact member the contact member normally does not short circuit any turns of the winding. Present commercial core designs and winding methods may be employed in the construction of the transformer.

The invention may be used with any transformer or autotransformer requiring variable voltage input or output, such as buck and boost transformers and autotransformers to maintain constant voltage by manual or automatic means. It may also be used with variable voltage transformers carrying heavy secondary currents, such as furnace transformers, heating transformers and welding transformers. It is also of use with testing transformers, such as testing transformers for small motors and for luminous tube signs. Still other applications of the invention are to toy transformers and motor speed controllers.

In one form of the invention the two winding sections are interwound in a single layer and in another form of the invention the two winding sections are wound one on top of the other. In both cases the two sections may be wound on the same leg of the core.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 illustrates diagrammatically an embodiment of the invention in which the two sections of an insulated secondary winding are interwound in a single layer over the primary winding of a transformer provided with a shell type core, Figs. 2 and 3 illustrate different positions of the movable contact in relation to the conductors of winding sections for carrying a heavy current, Fig. 4 illustrates a modified contact and winding arrangement which is well adapted for toy transformers and transformers requiring small outputs, Fig. 5 is another modification employing a connecting block and studs for use with heavy current transformers, Fig. 6 is a modification employing different layer winding sections different points of which are selectively interconnected by means of a stud threaded into any one of a plurality of threaded registering

holes in the conductors of the sections, and Fig. 7 illustrates diagrammatically an application of the invention to a buck and boost autotransformer for regulating the voltage of a circuit.

Referring now to the drawing and more particularly to Fig. 1, there is shown therein a transformer having a shell type core 1 provided with a primary winding 2 and a two-section secondary winding 3, the sections of which are designated respectively *a* and *b*. The primary winding is connected to be energized by any suitable source of alternating current, such as by a supply circuit 4 and one terminal of each of the secondary sections is connected to a load circuit 5.

For making electrical connection between the sections *a* and *b* there is provided a contact member 6 which may be made of any suitable conducting material; thus, it may be made of metal, in which case it will have a relatively low resistance or it may be made of carbon or the like, in which case it will have a relatively high resistance. It need only to be as wide as the distance between two adjacent conductors. However, if it is not desired to interrupt the circuit at any time it should be at least as wide as the distance between three adjacent conductors.

The sections are wound in opposite directions. Thus, looking along the core from right to left the section *a* is wound in the direction of a left hand screw thread and the section *b* is wound in the direction of a right hand screw thread. Furthermore, the sections are interwound so that at the top and bottom, as viewed in the drawing, the adjacent conductors are alternately those of the sections *a* and *b*, the necessary cross-overs occurring at the front and back, as viewed in the drawing. The left hand terminals of the sections *a* and *b* are preferably left free and unconnected so as to avoid a short circuit of the portions of the sections to the left of the contact in any of its positions. However, this is not necessary as these left hand terminals could be interconnected through a suitable current limiting impedance or they might even be connected to another load circuit.

Spaced index notches 7, shown by way of example for the sake of simplicity as formed in the core 1, cooperate with a spring biased member 8 carried by the brush, so as to facilitate locating the brush in its illustrated non-short-circuiting position relative to the winding sections.

If the winding sections are composed of insulated wire the insulation thereof is removed by scraping or in any other suitable way from the tops of the turns so as to provide an uninsulated path along which the contact 6 may slide.

In the operation of Fig. 1 the brush 6 is merely moved from left to right or from right to left along the bared or insulated portion of the wind-

ing sections. In the illustrated position of the brush the secondary voltage is a maximum and as the brush is moved toward the right, successive turns of the sections are removed from the circuit, thereby successively reducing the secondary voltage. The index notches 7 and cooperating member 8 serve to facilitate centering the brush in successive positions in which it makes contact only with two adjacent turns of the different sections. In intermediate positions of the brush adjacent turns of the same winding section will be momentarily short circuited as the brush moves between the index notches. However, as will be seen more clearly from Fig. 3, only a relatively small portion of the area of the brush can contact adjacent turns of the same section and furthermore the length of the conducting path through the brush from adjacent turns of the same section will be a maximum, thus automatically offering substantially maximum brush resistance to the short circuit current which can flow in the short circuited turn of any section when the brush is in such an intermediate position.

By reason of the opposite directions of winding of the two sections, their polarities will be additive in the secondary circuit.

While the two-section winding has been described as the secondary winding of the transformer, it will, of course, be obvious to those skilled in the art that the functions of the two windings may readily be reversed so that if circuit 5 is connected to a suitable source of current supply the winding 3 may be used as a primary winding to induce current in the winding 2 which will then supply energy to the circuit 4.

In Figs. 2 and 3 cross sections are shown through the brush and conductors of sections a and b which are constructed of relatively heavy copper bars so as to be able to carry relatively high currents. These bars produce a surface very similar to that of a commutator. In Fig. 2 the brush is shown in its normal position making a bridging connection between sections a and b, whereas in Fig. 3 the brush is shown in a transitional position in which adjacent turns of the section b are bridged by the ends of the contact 6. As mentioned above, the brush in this position offers substantially a maximum resistance to short circuit current which tends to flow in the short circuited turn of the section b.

In Fig. 4 a relatively narrow brush provided with a ball point is used with winding sections made of conventional circular conductors. By this construction the brush never produces a short circuit between adjacent conductors of section a or adjacent conductors of section b, as it can only make a bridging connection between the conductors of sections a and b, as shown. Such a construction is well adapted for use with toy transformers or other relatively small current carrying transformers where there is no objection to a momentary interruption of current when the transformer ratio is being changed.

In Fig. 5 the substantially rectangular conductors of a heavy current carrying transformer are provided with tapped holes 9 and connection is made selectively between the sections a and b by means of a low resistance metallic conducting block 10 securely fastened to the conductors by means of studs 11 screwed into the openings 9.

Fig. 6 shows another modification suitable for use with heavy current carrying transformers such as furnace transformers and heating trans-

formers required for various electrolytic processes. In this modification the sections a and b are wound concentrically so that section b, for example, forms the inner layer and section a forms the outer layer with the conductors of section a directly above corresponding conductors of section b. In such large transformers the conductors are relatively massive and thus lend themselves readily to drilling and tapping and as shown registering tapped holes 12 are provided for each turn of section b and its overlying turn of section a. Selective connection between the sections a and b is made by means of a stud 13 which is screwed into any one of the holes 12.

In Fig. 7 the sections a and b form a buck and boost portion of an autotransformer 14 for regulating the voltage of an alternating current circuit 15. Thus, if the power flow through the circuit 15 is considered as being in a downward direction, as viewed in the drawing, the contact 6 will be in the position for producing maximum voltage boost and as this contact is moved toward the right the output voltage of the regulating transformer will progressively decrease until it equals and then becomes less than the supply voltage. Contact 6 may either be operated manually or by any suitable voltage responsive automatic operating mechanism such as may be found in standard and well known step voltage regulators.

While there have been shown and described particular embodiments of this 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 claims 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:

1. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a contact member movable along said path for making a bridging connection between any two adjacent turns of the two different sections.

2. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a metallic contact member movable along said path for making a bridging connection between any two adjacent turns of the two different sections.

3. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when

viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other and being electrically disconnected from each other, and a contact member slidable along said path for making a bridging connection between any two adjacent turns of the two different sections.

4. In an electrical transformer, a shell type magnetic core provided with a center leg and a plurality of outer legs, a first winding wound on said center leg, a single layer second winding wound on said center leg over said first winding, said second winding being in two sections which are wound in opposite directions, the turns of said sections lying between each other except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a contact member slidable along said path for making an adjustable bridging connection between said sections.

5. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a contact member slidable along said path for making a bridging connection between any two adjacent turns of the two different sections, said contact member having a maximum width in its direction of motion which is shorter than the distance between four successive turns and having a minimum width in its direction of motion which is greater than the distance between adjacent turns.

6. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, a contact member slidable along said path for making a bridging connection between any two adjacent turns of the two different sections, and mechanical positioning means tending to maintain said contact member in positions in which it simultaneously contacts a maximum of two winding conductors.

7. In an electrical transformer, a shell type magnetic core provided with a center leg and a plurality of outer legs, a primary winding wound on said center leg, a single layer secondary winding wound on said center leg over said first winding, said secondary winding being in two

sections which are wound in opposite directions, the turns of said sections lying between each other except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a contact member slidable along said path for making an adjustable bridging connection between said sections.

8. In an electrical transformer, a magnetic core having a portion for carrying a winding, a winding section on said portion wound in the direction of a right hand screw thread when viewed in one direction along said core, a second winding section on said portion wound in the direction of a left hand screw thread when viewed in the same direction along said core, the turns of said second section lying between the turns of said first section except at cross over points, said sections being bare of outer insulation along a path where their turns lie between each other, and a rounded point contact member slidable along said path for making a bridging connection between any two adjacent turns of the two different sections.

9. In an electrical transformer, a magnetic core for carrying a winding, a pair of winding sections linking said core, one terminal of each section being for connection to an electric circuit, tapped holes drilled in the conductors of said sections, and means including a conducting screw for selectively interconnecting different tapped holes in said different sections by engaging the threads thereof, said sections being wound in such relative directions that a current flow therethrough from one of said terminals to the other by way of said screw will cause said sections to produce cumulative magnetic effects in said core.

10. In an electrical transformer, a pair of concentric insulated winding sections the conductors of said sections being provided with a plurality of registering holes, and means for selectively interconnecting different points on said sections comprising a conducting plug insertable in any one of said holes.

11. In an electrical transformer, a pair of concentric insulated winding sections the conductors of said sections being provided with a plurality of registering screw threaded holes, and means for selectively interconnecting different points on said sections comprising a metal screw for engaging the threads of any preselected hole.

12. In an electrical transformer, a magnetic core having a portion thereof for carrying a winding, a pair of serially connected winding sections mounted on said winding portion and being wound to produce respectively magnetomotive forces in the same direction, the coil sides of one winding section being arranged to alternate with the coil sides of the other winding section along a given path extending over said winding sections, conducting portions of each coil side being exposed, and an adjustable contact member for making a bridging connection between any two adjacent turns of the two different sections.

13. A transformer having a magnetic core, a pair of overlapping windings wound in opposite directions around the same part of said core, and means for connecting variable and equal turns of said windings in series comprising a unitary movable electrical conducting member for connecting any turn of one winding directly to an adjacent turn of the other winding.

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