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R. W. SQUIBB

2,267,955

TRANSFORMER

Filed Feb. 29, 1940

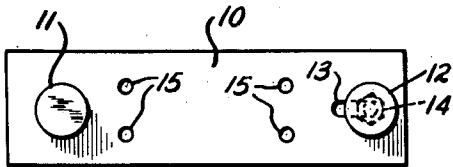


FIG. 1.

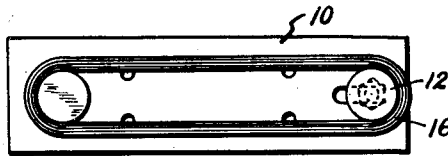


FIG. 2.

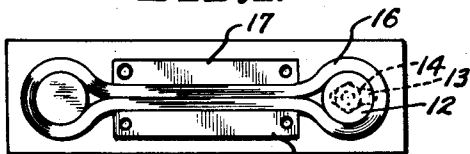


FIG. 3.

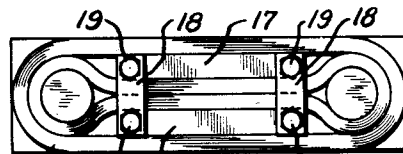


FIG. 4.

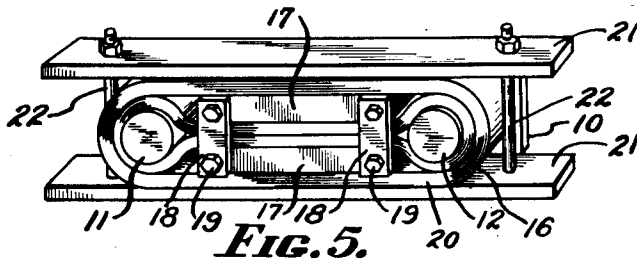


FIG. 5.

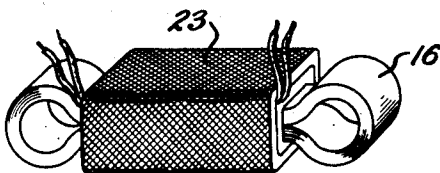


FIG. 6.

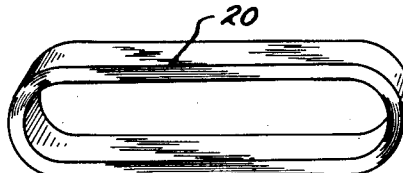


FIG. 7.

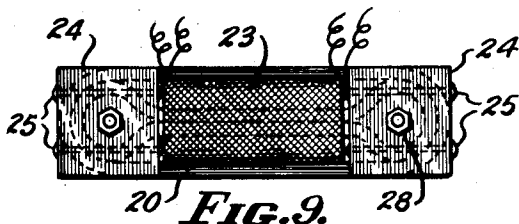


FIG. 9.

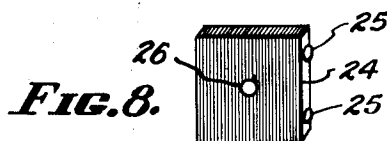


FIG. 8.

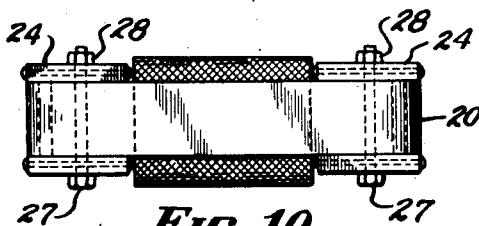


FIG. 10.



FIG. 11.

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2,267,955

TRANSFORMER

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Application February 29, 1940, Serial No. 321,526

10 Claims. (Cl. 175—356)

This invention relates to transformers, and particularly to transformers of the type which are made up from strip material in order to take advantage of the directional properties of such material. It is known to be advantageous to form the parts of a transformer of strip material which is wound upon itself in the direction of rolling, thereby to enhance the efficiency of the apparatus. However, all such devices with which I am familiar have been characterized by difficulties in manufacture.

It is an object of my invention therefore to provide a novel transformer construction and method which is characterized by numerous advantages.

It is an object of my invention to provide a transformer in which the windings are placed near the magnetic circuit with no loss of space beyond what is required for insulation.

Another object of my invention is to provide a transformer which may be wound simply and economically without complicated shuttle winding machines.

A still further object of my invention is to provide a transformer which will give superior regulation at full load by reason of the nearness of all parts of the winding to the magnetic core.

Other objects of my invention include the provision of a transformer which will occupy very small space and which may be readily modified to give any desired magnetic characteristics, and which involves a minimum of shearing, machining and assembling operations whereby the cost thereof is greatly reduced.

These and other objects of my invention which will be described hereinafter or which will appear to one skilled in the art upon reading this specification, I accomplish by that certain construction and by that series of method steps of which I shall now describe exemplary embodiments.

Reference is now made to the drawing forming a part hereof, and in which:

Figure 1 is a plan view of a jig upon which the members of the transformer may be wound.

Figure 2 is a view similar to Figure 1 showing the first step in the manufacture of the transformer.

Figure 3 is a view similar to Figure 2 but showing the second step.

Figure 4 is a view similar to Figure 3 showing the third step.

Figure 5 is a perspective view of the transformer at the point in its manufacture where it is ready for annealing.

Figure 6 is a perspective view of the center leg member with the windings thereon.

Figure 7 is a perspective view of the outer member.

Figure 8 is a perspective view of the clamping and magnetic bridging member which may be used with the transformer.

Figure 9 is a plan view of a complete transformer.

Figure 10 is a side elevation of the same.

Figure 11 is a plan view of the slightly modified type of clamping or magnetic bridging block.

Briefly, in the practice of my invention I provide a transformer comprising essentially two parts, one of which constitutes the center leg and the other of which constitutes an outer member. Both of these parts are made by winding relatively narrow strip material upon itself, the strip material being wound in the direction of rolling whereby to enhance the magnetic properties thereof. In Figure 1 I have shown a jig comprising a plate 10 provided with a fixed stud 11 and a stud 12 having a threaded portion passing through a slot 13 in the plate and held in position by means of a nut 14. The plate may be provided with four holes 15 for a purpose to be described hereinafter. The center leg member which I shall indicate generally by the numeral 16 is wound upon the studs with the stud 12 in the position farthest removed from the stud 11 as shown in Figure 2. The stud 12 is then released and the central portion of the member 16 is clamped together by means of blocks 17 as shown in Figure 3. The blocks 17 are preferably held in position by means of tie bars 18 and four bolts 19 which pass through the holes 15 heretofore mentioned. Preferably the slot 13 is of an appropriate length so that when the stud 12 is released for the clamping operation of Figure 3, the stud 12 will occupy the nearest position to the stud 11.

The outer member which I shall indicate generally at 20 is now wound upon the assembly as shown in Figure 4, and the entire assembly is then clamped together in any desired manner, as for example by means of plates 21 and bolts 22 as shown clearly in Figure 5. In this condition the transformer parts are ready for annealing and the entire assembly shown in Figure 5 is placed in the annealing furnace. The annealing treatment will be such as within the skill of the metallurgist having in mind the desired properties of the finished transformer.

After annealing the parts are disassembled and the windings are wound upon the center leg mem-

ber 16 as shown in Figure 6. Preferably primary and secondary windings are wound right on top of each other, although as will be clear, for certain purposes it may be desirable to wind the high voltage windings in sections and that the primary and secondary windings may therefore be split up. The combined windings, however, will ultimately occupy a space such as indicated generally at 23 in Figure 6. As will be clear, the assembly of Figure 6 may now be slipped into the outer member 20 and the windings will occupy substantially the entire space between the members 16 and 20.

In order to hold the two members together, I prefer to provide clamping or magnetic bridging plates such, for example, as that indicated at 24 and shown in detail in Figure 8. Such a plate may be made up as shown in Figure 8 of a plurality of laminations fastened together by means of bolts or rivets or the like as indicated at 25, and a central hole 26 is provided for fastening purposes. The members 24 are part of the magnetic circuit, and form a bridge between the members 16 and 20, thereby greatly reducing the joint reluctance therebetween. In this way the ferric induction of the joints is made so low, that desirable characteristics are present throughout the entire transformer. As shown in Figures 9 and 10, a pair of plates 24 is used at each end of the transformer and each pair is held to the transformer by means of a bolt 27 passing through the loop in the end of the member 16 and the hole 26 in the member 24 and secured by means of a nut 28.

In Figure 11 I have shown a modified clamping plate or magnetic bridge 24a which is made from strip material wound upon itself, and provided with a central hole 26a for the same purpose as the hole 26 in the member 24. The member 24a may be reinforced with some non-magnetic material such as Bakelite strip, or it may be bonded with a plastic bonding material whereby the member 24a, or for that matter the member 24, is bonded into a rigid structure. While the member 24 of Figure 8 would not have to be reannealed after shearing, the member 24a of Figure 11 would require heat treatment. Therefore if the member 24a is to be bonded as above set forth, such bonding would have to be done after annealing, since present bonding practice would not be capable of withstanding the annealing temperatures necessary to remove strains.

It will be noted that since the member 16 is independent of and removable from the member 20, the windings are added with the member 16 disassembled from the member 20, and it is therefore unnecessary to leave space beyond the extent of the windings for the passage of a bobbin or shuttle which would have to be used if the center leg had to be wound in situ. The use of a bobbin or shuttle necessitates a considerable space which is thus eliminated by my construction. Since the member 20 is an essential path of the magnetic circuit, it will be clear that the windings are very near to the magnetic circuit throughout their extent.

Since the regulation of a transformer is determined largely by the distance from any conductor to the active magnetic core, it will be clear that since all conductors are at a minimum of distance from the active core material, there is a superior voltage regulation at full load with a transformer according to the present construction. It will also be noted that the member 20 may be made with as many convolutions of strip

material as are necessary to get the desired magnetic properties. An enlargement in cross sectional area of the member 20 reduces the ferric induction which in turn lowers the watt loss and exciting current, both of which are factors covered in maximum guarantees by transformer manufacturers.

Having now fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of making a transformer which comprises winding strip material upon itself to form a convoluted loop, maintaining the curvature at the ends of said loop but bringing the central portions toward each other to form a generally dumbbell-shaped structure, clamping said structure in position, forming an outer member to enclose said dumbbell-shaped structure in a generally oval configuration, clamping said whole assembly together, and heat treating said assembly.

2. A method of making a transformer which comprises winding strip material upon itself in generally oval form, maintaining the curvature at the ends of said oval but bringing the central portions toward each other to form a generally dumbbell-shaped structure, clamping said structure in position, winding an outer member over said dumbbell-shaped structure in a generally oval configuration, clamping said whole assembly together, heat treating said assembly, separating said dumbbell-shaped member from said outer member, winding primary and secondary windings upon said dumbbell-shaped member, and reassembling said members.

3. A method of making a transformer which comprises winding strip material upon itself in generally oval form, maintaining the curvature at the ends of said oval but bringing the central portions toward each other to form a generally dumbbell-shaped structure, clamping said structure in position, winding an outer member over said dumbbell-shaped structure in a generally oval configuration, clamping said whole assembly together, heat treating said assembly, separating said dumbbell-shaped member from said outer member, winding primary and secondary windings upon said dumbbell-shaped member, and reassembling said members, and clamping said members together in assembled position.

4. A transformer comprising at least two core members, each formed from strip metal wound upon itself in the direction of rolling to form a convoluted loop, the central region of one of said members being pinched together to constitute a center leg of the transformer core, said center leg being adapted to carry electrical windings, said member being slidable within the other of said members along the axes of both, and having contact with the outer of said members at points such that said outer member may form part of a magnetic circuit of which said inner member is also a part.

5. A transformer comprising core members, at least two of which are formed from strip metal wound upon itself in the direction of rolling to form a convoluted loop, one of said members being slidable into the other along the axes of both members, the inner one of said members being shaped to form a center leg for the core of said transformer, which center leg is adapted to carry electrical windings, said members being in assembly, the inner member having contact with the outer member at points such that said outer member may form part of a magnetic circuit of

which said inner member is also part and clamping plates for said core engaging the inner and outer members at the points of contact, said clamping plates being in the form of laminated metal structures of flattened form with laminae disposed in edgewise relationship to the edges of the laminae in said first mentioned members.

6. A transformer comprising at least two core members each formed from strip metal wound upon itself in the direction of rolling to form a convoluted loop, one of said loops being flattened to juxtapose convolutions therein throughout the greater part of its length, leaving at its ends rounded configurations, the second of said members being in the form of an oblong loop, the first member being slidable into the second member in the direction of the axes of both, whereby the rounded configurations of the first member engage within the ends of the oblong loop of the second member.

7. A transformer comprising at least two core members each formed from strip metal wound upon itself in the direction of rolling to form a convoluted loop, one of said loops being flattened to juxtapose convolutions therein throughout the greater part of its length, leaving at its ends rounded configurations, the second of said members being in the form of an oblong loop, the first member being slidable into the second member in the direction of the axes of both, whereby the rounded configurations of the first member engage within the ends of the oblong loop of the second member, said members being in assembly and the ends thereof affixed together by means including clamping plates comprising each a laminated metal structure placed against contacting portions of said members, there being bolts passing through the rounded portions of said first mentioned member and through oppositely disposed clamping plates to fasten said plates and members together.

8. A structure as claimed in claim 7 in which the laminae in certain of said members are bonded together.

9. A method of making a transformer which

comprises winding strip material upon itself in generally oval form, maintaining the curvature at the ends of said oval but bringing the central portions toward each other to form a generally dumbbell-shaped structure, clamping said structure in position, winding an outer member over said dumbbell-shaped structure in a generally oval configuration, clamping said whole assembly together, heat treating said assembly, separating said dumbbell-shaped member from said outer member, winding primary and secondary windings upon said dumbbell-shaped member, and reassembling said members, and clamping said members together in assembled position by means of clamping plates each comprising a laminated metal structure, said plates being located on each side of the points of contact of said first mentioned structure with bolts attaching said clamping plates to each other.

10. A transformer comprising at least two core members, each of which is formed from strip metal wound upon itself in the direction of rolling to form a convoluted loop, one of said loops comprising arcuate end portions and relatively long substantially straight portions connecting said end portions, and the other of said loops having curved end portions adapted to fit within the curved end portions of the first mentioned loop, and substantially straight connecting portions which, intermediate the ends of said loop, are substantially juxtaposed whereby when said last mentioned loop is passed within the first mentioned loop in the direction of the axes of both, the intermediate portions of the second mentioned loop will be interspaced from the intermediate portions of the first mentioned loop sufficiently to accommodate opposite portions of windings encircling the intermediate portions of said second mentioned loop, the curved end configurations of both loops substantially conforming over substantially the entire face area of the curved end portions of the first mentioned loop.

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