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T-JOINT FOR A MAGNETIC CORE

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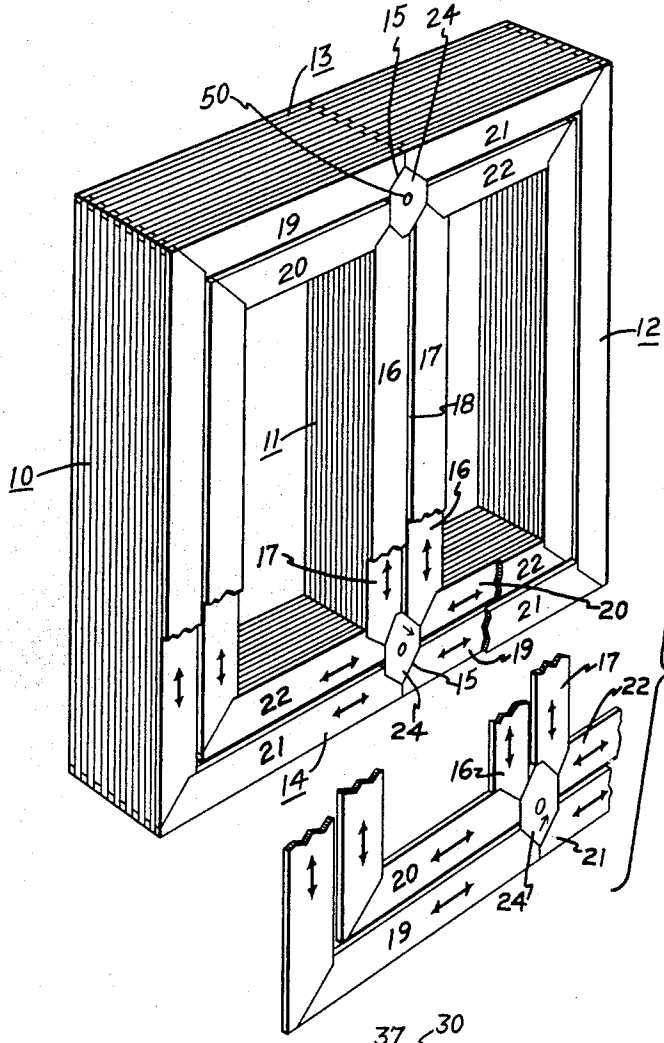


Fig. 1.

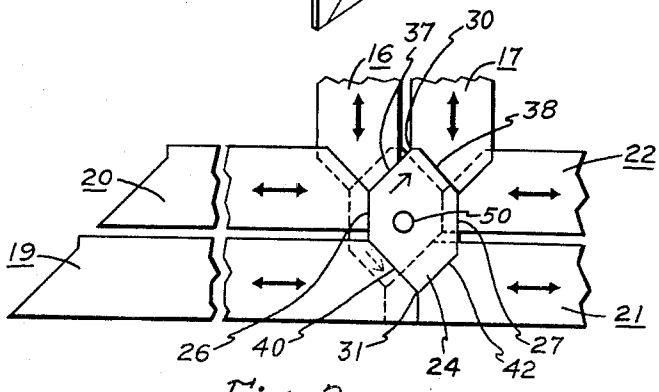


Fig. 2.

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T-JOINT FOR A MAGNETIC CORE

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This invention relates to stationary electrical induction apparatus, and more particularly to an improved T-joint between the center leg and yoke members of a magnetic core of the flat stacked lamination or plate type.

Magnetic cores for stationary electrical induction apparatus are frequently comprised of a plurality of groups of flat stacked magnetic strips, the groups being arranged to form a plurality of winding leg members extending between and perpendicularly joining at their respective ends a pair of parallel yoke members. This type of core is known as the flat stacked lamination or plate type as distinguished from the wound type.

It has been previously found that reduction in losses in a magnetic core can be obtained by employing grain oriented magnetic material, the grain orientation of the material being parallel to the lengthwise direction of the magnetic strips of the core. Cores employing such material have also been provided with mitered joints at the corners, in order to reduce the core losses by having the magnetic lines of flux run substantially parallel in all sections of the core to the grain orientation of the laminations.

Still further reduction in core losses have been obtained by employing laminations of the split or divided type, wherein each layer of the leg and yoke members is divided longitudinally into two or more parallel strips lying in the same plane. This construction provides for more uniform clamping pressure on the leg members which results in lower core loss and noise level. Such construction also provides the advantage that the magnetic flux is better distributed throughout the core, eddy current losses are reduced in the laminations, and the split laminations may be separated to form cooling ducts.

In a three phase core of the split type, means must be provided for obtaining a common junction for the multiple magnetic flux paths set up by the three phase windings in order to provide full flux transfer between any two paths. It is desirable that such a junction take advantage as much as possible of the oriented characteristics of the magnetic material forming the core, taking into consideration the fact that the direction of the magnetic flux passing through the common junction changes from one instant to another due to the phase displacement of the magnetic fluxes in the respective winding legs.

Such a common junction has been provided in the T-joint between the central leg and yoke members disclosed in U.S. Letters Patent 2,698,924, which issued on application of T. D. Gordy and is assigned to the assignee of the present invention. In the T-joint of the Gordy patent, a four sided magnetic insert is provided in each layer of laminations, the inserts are positioned with their four side edges obliquely arranged with respect to the longitudinal axis of the yoke and leg members at the T-joint.

In the arrangement of the above-mentioned Gordy patent, each outer core section yoke member makes a butt joint with a separate side of the insert, and each inner core section yoke member also makes butt contact with a separate side of the insert member. The leg member parts make butt contacts with the inner core section yoke member parts and the sides of the insert member joining the inner core section yoke member parts. While this arrangement has been found to have satisfactory magnetic characteristics, it has been found that certain difficulties arise in the fabrication thereof.

In fabricating a three phase split magnetic core, the three winding leg members, both magnetic insert members and one of the yoke members are usually assembled horizontally and clamped together. Then the partially formed core is raised to a vertical position and windings are assembled on the winding legs. The strips of the remaining yoke member are then placed in their respective positions.

In the magnetic core disclosed in the above-mentioned Gordy patent, the ends of the inner yoke strip laminations must be inserted in a notch defined by one side of the four sided insert and the leg member lamination. Since the yoke strip could not be inserted directly into position, the end sheeting of the core was difficult. The difficulty may be better appreciated when it is realized that the joints and the core are overlapped, and the required manipulation of the one end of the thin elongated yoke strip into the overlapped notch joint followed by manipulation of the other end of the yoke strip into the overlapped corner mitered joint was time-consuming. While it was mechanically possible to reduce the size of the insert to eliminate the presence of the notch, this would have resulted in an undesirable increase in the cross flux at the inner strips at the joint.

It is therefore an object of my invention to provide an improved T-joint arrangement between the yoke and leg members of a grain oriented split lamination type magnetic core.

It is a further object to provide means for reducing the difficulty of end sheeting of a magnetic core of the grain oriented plate type having split laminations.

Briefly stated, in accordance with one aspect of my invention, I provide a T-joint between perpendicularly disposed winding leg and yoke members in the lamination layers of a plate type magnetic core for stationary electrical induction apparatus. The leg member has two elongated parallel sections, and the yoke member has two parallel sets of two elongated yoke sections extending in opposite direction from and perpendicular to an end of the winding leg. Hexagonal shaped insert members are provided for joining the winding leg and yoke sections. In each layer of laminations the hexagonal shaped insert has a pair of diametrically opposite sides parallel to the lengthwise direction of the winding leg, and these parallel sides make butt joints with the yoke section of each pair of parallel yoke sections nearest the winding leg. The insert has a first apex extending toward the winding leg and a second apex extending away from the winding leg. The outer sections of the yoke members make butt joints with the sides of the hexagonal insert adjacent the second apex, and the winding leg sections make butt joints with the sides of the insert adjacent the first apex. The leg member sections also make butt joints with the yoke sections nearest the winding leg. All the parts of the core are formed of magnetic strip material having grain orientation, the orientation of the leg and yoke member strips being parallel to their lengthwise directions.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed that the invention will be better understood from the

following description taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is a perspective view of a grain oriented split lamination plate type magnetic core having a T-joint according to my invention, a portion of the outer lamination being separated from the core to illustrate the next adjacent layer.

Fig. 2 is an enlarged elevation of the T-joint of the outer lamination of the core of Fig. 1 and illustrating in dashed lines the joints of the next adjacent layer.

Referring now to the drawing, and more in particular to Fig. 1, therein is illustrated a magnetic core for stationary electrical induction apparatus, the core having three parallel winding leg members 10, 11 and 12 joined at their respective ends by a pair of yoke members 13 and 14. The core of Fig. 1 is of the plate type, comprised of a plurality of layers of flat stacked strips of magnetic material, and the magnetic material has a grain orientation parallel to the lengthwise direction of the strips as illustrated by the arrows in the drawing. The central winding leg 11 is disposed between the outer winding legs 10 and 12, and forms a "T-joint" 15 with each of the yoke members 13 and 14.

The outer lamination layer of central winding leg member 11 is comprised of parallel strips 16 and 17 of elongated flat magnetic material, the parallel stacks preferably being separated by a gap 18. The outer lamination layer of the yoke members 13 and 14 is comprised of two parallel strips 19 and 20 of elongated flat magnetic material extending in one direction away from the T-joint 15, and two parallel strips 21 and 22 of magnetic material extending in the opposite direction from the T-joints 15. The yoke member strips 19, 20, 21 and 22 are perpendicular to the leg member strips 16 and 17, and the individual lamination strips of the yoke member are coplanar with the individual lamination strips of the leg member.

A hexagonal shaped insert 24 is provided in the T-joints in the outer layer of laminations of the core. The hexagonal shaped insert, which may be more clearly seen in Fig. 2 of the drawing, has diametrically opposite sides 26 and 27 parallel to the lengthwise direction of leg member strip 16 and leg member strip 17. The hexagonal shaped insert 24 has one apex 30 generally toward the leg member 11, and another apex 31 generally away from the leg member 11.

The side 26 of the insert 24 makes a butt joint with outer lamination layer yoke strips 20, and the hexagonal insert side 27 makes a butt joint with outer lamination layer yoke member strip 22. One side 37 of the hexagonal insert 24 adjacent the apex 30 makes a butt joint with the outer lamination layer leg member strip 16, and the other side 38 of the hexagonal insert 24 adjacent the apex 30 makes a butt joint with the outer lamination layer leg member strip 17. A portion of the end of the leg member strip 17 also makes a butt joint with a portion of the end of yoke strip member 22.

One side 40 of the hexagonal insert 24 adjacent the apex 31 makes a butt joint with outer lamination layer yoke member strip 19, and the other side 42 of the hexagonal insert adjacent the apex 31 makes a butt joint with outer lamination layer yoke member strip 21. A portion of the end of yoke member strip 19 also makes a butt joint with a portion of the end of yoke member strip 21, the joint between these two lamination strips being preferably perpendicular to the lengthwise direction of the strips 19 and 21.

The grain orientation of the hexagonal insert 24 is generally between the side 38 adjacent the apex 30 and diametrically opposite side 40 adjacent the apex 31.

The joints between the lamination strips and between the lamination strips and insert are preferably overlapped in adjacent layers in order to improve the magnetic characteristics of the core. For example, the layer

adjacent the outer layer may be comprised of strips and inserts identical to the strips of the outer layer but reversed in position. Thus, as illustrated in Fig. 1, strips 16 and 17 of the outer layer cover respectively strips 17 and 16 of the next adjacent layer. Similarly, yoke strips 19, 20, 21 and 22 of the outer layer cover respectively strips 21, 22, 19 and 20 of the next adjacent layer. The strips of the core have such a shape that the hexagonal shaped inserts are offset with respect to the longitudinal axis of the center leg member 11, so that the joints of the core at the T-joint will be overlapped in adjacent layers, as more clearly seen in Fig. 2. This manner of overlapping the joints of adjacent layers employs a minimum number of sizes and shapes of lamination strips without requiring offsetting of entire layers. The overlap of the joints in successive layers may alternately be provided by varying the size of the hexagonal shaped inserts, as is disclosed in the above-mentioned Gordy patent with reference to four-sided inserts, or similarly the adjacent layers of the core may be identical and offset from each other to provide overlap of the joints.

The insert 24 does not necessarily have the shape of a regular hexagon. For example, the side 27 may be longer than diametrically opposite side 26, and the side 40 may be longer than the side 42 in order to facilitate fabrication of the magnetic strips. Similarly, one or more of the corners of the insert, such as the corner at the apex 30, may be trimmed to facilitate forming and assembly of the magnetic strips. It shall be understood, however, that even with such trimming the insert still retains a generally hexagonal shape.

A hole 50 may be provided extending through the hexagonal shaped inserts in order that a bolt may pass therethrough to clamp the core according to conventional practice.

As has been previously stated, in the fabrication of a magnetic core, the winding legs, inserts and one yoke are generally assembled in a horizontal position and then raised to a vertical position to receive windings on the winding legs. Finally the core is end sheeted by positioning the laminations of the remaining yoke. In the arrangement of my invention, the lamination strips of the inner yoke stacks, i.e., yoke strips 20 and 21, may be inserted without the necessity of manipulating their two ends separately. The arrangement therefore greatly reduces the difficulty and time of the end sheeting operation.

It will be understood, of course, that, while the form of my invention herein shown and described constitutes the preferred embodiment of the invention, it is not intended herein to illustrate all of the possible equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes may be made without departing from the spirit or scope of the invention herein disclosed and it is aimed in the appended claims to cover all such changes 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. A T-joint between perpendicular winding leg and yoke members in a lamination layer of a plate type magnetic core for stationary electrical induction apparatus comprising in combination two elongated parallel winding leg parts, two parallel sets of two elongated yoke parts extending in opposite directions from and perpendicular to an end of said winding leg parts, and a generally hexagonal insert for joining said winding leg and yoke parts, said parts all being made of magnetic strip material having grain orientation in their lengthwise directions, said insert having diametrically opposite sides parallel to the lengthwise direction of said winding leg and making butt joints with the yoke part of each pair of parallel yoke part sets nearest said winding leg, said

insert having a first apex toward said winding leg and a second apex away from said winding leg, the other parts of said parallel yoke part sets making butt joints with third and fourth sides of said insert adjacent said second apex, said leg parts making butt joints with fifth and sixth sides of said insert adjacent said first apex and said yoke parts nearest said winding leg.

2. A laminated magnetic core having a T-joint comprised of superimposed layer T-joints each as defined in claim 1, the joints between the parts and insert being overlapped in successive layers of said core.

3. The laminated magnetic core of claim 2 in which the parts and insert of successive layers of said core are substantially identical, said inserts being displaced from the axis of said winding leg member and the parts and inserts being reversed in successive layers to provide overlap between said joints.

4. A T-joint between perpendicular winding leg and yoke members in a lamination layer of a plate type magnetic core for stationary electrical induction apparatus comprising in combination two elongated parallel winding leg parts, two parallel sets of two elongated yoke parts extending in opposite directions from and perpendicular to an end of said winding leg parts, and a generally hexagonal insert for joining said winding leg and yoke parts, said parts and insert all being made of grain oriented magnetic material, the grain orientation of the yoke and leg parts being in their lengthwise directions, said insert having diametrically opposite sides parallel to the lengthwise direction of said winding leg and making butt joints with the yoke part of each pair of parallel yoke part sets nearest said winding leg, said insert having a first apex toward said winding leg and a second apex away from said winding leg, the other parts of said parallel yoke part sets making butt joints with third and fourth sides of said insert adjacent said second apex, said leg parts making butt joints with fifth and sixth sides of said insert adjacent said first apex and said yoke parts nearest said winding leg, the grain orientation of said insert extending generally between diametrically opposite sides thereof.

5. The T-joint of claim 3 wherein the grain orientation of said insert extends generally between said third and fifth sides of said insert, said third and fifth sides being diametrically opposite.

6. A laminated magnetic core having a T-joint composed of superimposed T-joints each as defined in claim 3, the joints between the parts and inserts being overlapped in successive layers of said core, the grain orientation of said insert alternating between said third and fifth sides and between said fourth and sixth sides in successive layers of said core, said third and fifth sides and said fourth and sixth sides being diametrically opposite.

7. A magnetic core for stationary electrical induction apparatus comprising a plurality of groups of flat stacked magnetic strips having lengthwise grain orientation and arranged to form at least one winding leg member perpendicularly joining at one end thereof a yoke member to form a T-joint, said T-joint in a given layer of said strips comprising a generally hexagonal shaped member of magnetic material joining the strips of said leg and yoke members, said insert having a pair of diametrically opposite sides parallel to the lengthwise direction of said leg member, a first apex toward said leg member, and a second apex away from said leg member, the strips of said yoke and leg members in said layer being longitudinally divided to form pairs of parallel spaced apart strip portions, the strip portions of said yoke member toward said leg member joining said parallel sides of said insert, the other strip portions of said yoke member joining the sides of said insert adjacent said second apex, and the strip portions of said leg member joining the sides of said insert adjacent said second insert and the strip portions of said yoke member toward said leg member.

References Cited in the file of this patent

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