Feb. 15, 1955 W. M. JOHNSON 2,702,375

TAPERED MITER JOINT MAGNETIC CORE

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Fig.1.

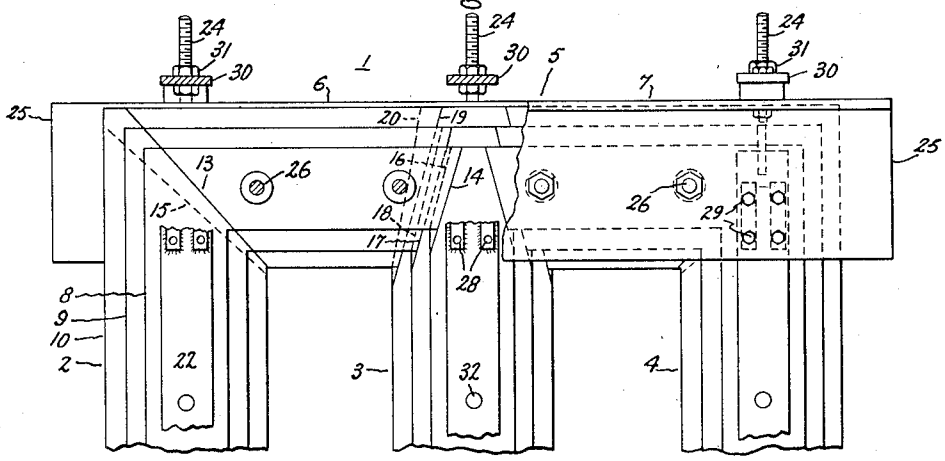


Fig.2.

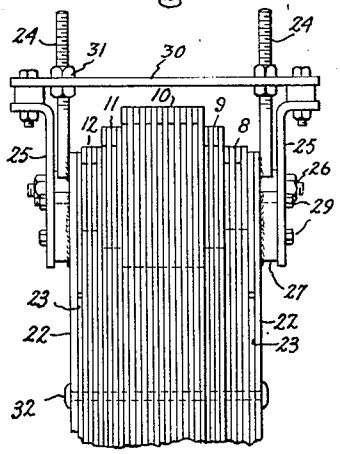


Fig.3.

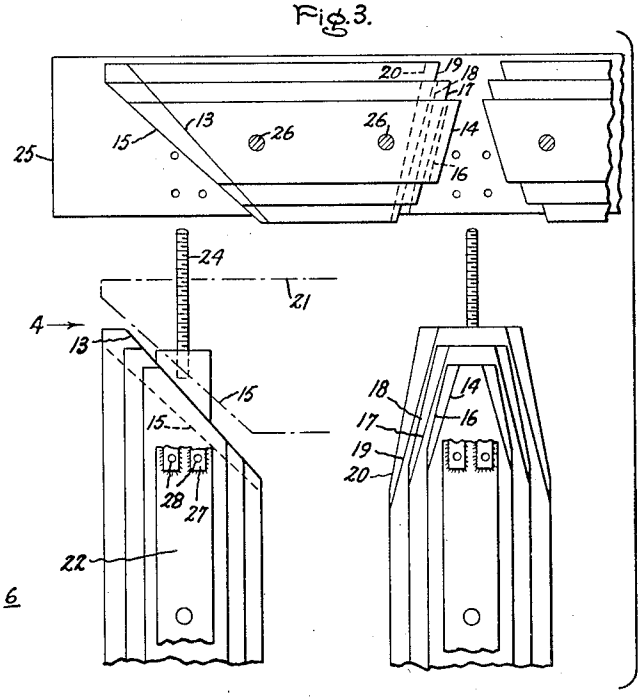
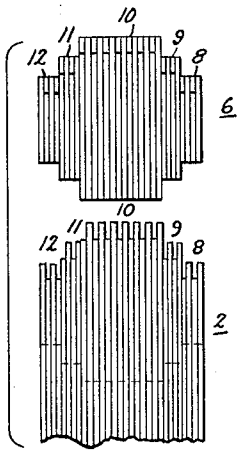


Fig.4.



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TAPERED MITER JOINT MAGNETIC CORE

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2 Claims. (Cl. 336—210)

This invention relates to magnetic cores of stationary electrical induction apparatus and more particularly to magnetic cores having miter joints.

In the construction of magnetic cores of the plate type, and particularly those cores formed of oriented magnetic material in which the grain of the magnetic material is substantially parallel to its longitudinal dimension, miter joints are often used at the junction of laminations lying in the same plane but meeting at substantially 90 degrees with respect to one another in that plane. Such miter joints have the advantage that the magnetic flux passing around the corner of meeting leg and yoke laminations always travels substantially with the grain of the magnetic material.

When such miter joints are used it is common practice to overlap the respective miter joints of adjacent layers in order to improve the mechanical and magnetic properties of the composite joint formed by the joints in the plurality of layers. My invention is particularly applicable to a magnetic core in which the mitered joints for adjacent layers have a tapered overlap with respect to each other.

It is an object of my invention to provide an arrange ment for use with a mitered-joint magnetic core construc tion which facilitates assembly of a mitered joint magnetic core without the necessity of individually interleaving the laminations of intersecting leg and yoke members.

It is a further object of my invention to provide a core positioning device for use with a mitered-joint magnetic core which permits a preassembly of leg and yoke members as units, with subsequent assembly of the unitary leg and yoke members into a completed core.

It is a still further object of my invention to provide an improved method of assembling a mitered-joint magnetic core.

In accordance with these objectives, my invention provides an apparatus for assembling a mitered-joint magnetic core and a method of assembly which permits a unitary yoke to be jacked into position as a unit rather than by using the conventional method of individually interleaving the leg and yoke laminations. Using the apparatus and method of my invention, the core legs and yokes may be preassembled as individual units and the preassembled units may then be assembled with respect to one another, rather than interleaving individual laminations of intersecting core sides as has been the prior practice.

The features of this 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 Fig. 1 represents an elevation view, partially cut away, of a three-phase magnetic core having a tapered overlap miter-joint construction and provided with my core positioning device; Fig. 2 represents an end view of the structure of Fig. 1; while Figs. 3 and 4 are respectively elevation and end views of the structure of Fig. 1 when disassembled.

Referring now to Fig. 1, there is shown therein the upper portion of a three-phase core indicated generally as **1**. Core **1** has three leg members indicated respectively as **2**, **3** and **4** connected together at their upper portions by a yoke member indicated generally as **5**. The yoke member **5** comprises two sections **6** and **7**.

Yoke section **6** joins jeg members **2** and **3** while yoke section **7** joins leg members **3** and **4**.

The illustrated magnetic core **1** is of cruciform cross section, being built up of packs of laminations which are wider and longer at the middle of the core than at the outer faces of the core. However, it will be understood that I have illustrated my invention as embodied in a magnetic core of cruciform cross section by way of example only and that my invention is equally applicable to other types of magnetic cores. As will best be seen in Figs. 2 and 4, each leg and yoke member of the magnetic core is formed of five packs of laminations which have been designated as **8**, **9**, **10**, **11** and **12**, respectively, the same numbers being used for corresponding packs in each of the leg and yoke members. The outermost lamination packs are the shortest and narrowest and the packs become progressively wider and longer in progressing toward the center of the core. Thus the centermost lamination pack **10** is the widest and longest.

In each laminar layer, a lamination lying in each leg is jointed at its upper and lower ends to a lamination lying in the yoke portion by means of a miter joint. Thus, considering the outermost layer of laminar pack **8** of core **1**, it will be noted that the outermost lamination of yoke section **6** is jointed to the lamination of leg **2** along joint line **13**, and the same yoke lamination is jointed to the outermost lamination of leg **3** along joint line **14**. In the laminar layer immediately below the outermost layer, the yoke lamination is jointed to the lamination of leg **2** by a miter joint shown by dotted line **15** while the corresponding miter joint between the same yoke lamination and the lamination of leg **3** for the layer immediately below the uppermost layer is indicated by the dotted line **16**.

Thus, the miter joints for one set of alternate layers at the intersection between the laminations of yoke section **6** and leg **2** lie along the line **13**, while the miter joints for the other set of alternate layers at the intersection of yoke section **6** and leg **2** lie along the dotted line **15**. All of the miter joints for all of the packs of laminations at the corner intersection of the yoke section **6** nad leg **2** lie along one or the other of these two joint lines **13** and **15**. However, as will be explained later, a different pair of joint lines are used for each of the respective packs of laminations at the intersection of the yoke section **6** and center leg **3**. While I have shown the use of only two joint lines where the yoke section **6** and leg **2** meet, with these two joint lines being tapered with respect to each other, more than two joint lines could be used, as long as adjacent overlapped mitered edges are tapered with respect to each other.

The overlap between the miter joints for adjacent layers, such as between the mitered joints **13** and **15**, is tapered in such manner that the amount of overlap progressively diminishes in passing from the outer edge to the inner edge of the core. Thus, the separation between miter joints **13** and **15** is greater at the outer portion of the core than at the inner portion of the core. Similarly, joint lines **14** and **16** between the yoke section **6** and center leg **3** taper in progressing from the outer to the inner edge of the core.

It will be noted that the miter joints between the yoke section **6** and center leg **3** occur along a different pair of joint lines for each pack of laminations. Thus, as has already been described, one set of alternate layers of the outermost lamination pack **8** lie along the miter joint line **14** while the miter joints for the other set of alternate layers for lamination pack **8** lie along the joint line **16**. In the intermediate pack **9**, the miter joints for one set of alternate layers lie along the joint line **17** while the miter joints for the other set of alternate layers in pack **9** lie along dotted joint line **18**. Similarly, in pack **10**, the miter joints for one set of alternate layers lie along joint line **19**, while the miter joints for the other set of alternate layers in pack **10** lie along dotted joint line **20**. The miter joints of packs **11** and **12** preferably conform to the orientation of the joints of packs **9** and **8**, respectively. The respective laminar layers of each pack are jointed along a separate pair of joint lines as just described in order to avoid unnecessarily tapering the lami-

nations of center leg 3 in the inner packs 9, 10 and 11 to conform to the necessarily sharp taper of outer packs 8 and 12.

An advantage of the tapered overlap joint just described is the fact that it permits preassembly of the yoke laminations as a unit, with the preassembled yoke member afterwards being positioned as a unit with respect to the leg members. In the prior art, the practice has been to individually interleave the laminations of the yoke and leg members after the transformer windings are in place. The large power transformers, particularly, this can be a very tedious process since it is necessary to insert the laminations of the top yoke member in position with the core structure in an upright position, when the windings are in position on the core legs. With a large transformer which may stand 10 feet or more in height, it is necessary for a workman to stand on scaffolding erected about the transformer and pound the inserted yoke laminations individually in place.

However, it would be impractical if not impossible to assemble a preassembled yoke as a unit with respect to the core legs when the core is of the mitered-joint type having a conventional uniform overlap between miter joints for adjacent layers. The reason for this is that it would be virtually impossible to align all laminations simultaneously along a full line of contact as would be necessary where the mating leg and yoke members have uniform overlap miter joints. In lowering a preassembled yoke into position, whether the core has conventional uniform overlap miter joints, or tapered overlap miter joints, it is almost impossible to lower the yoke member into position without having non-mating laminations in the respective leg and yoke members coming in contact with each other. In other words, as the yoke member is being lowered into position with respect to the leg members, due largely to the warped characteristic inherent in annealed laminations, there will be a substantial amount of contact between non-mating laminations.

In a core of the type having conventional uniform overlap miter joints, the non-mating laminations of the yoke and leg members coming in contact with each other would meet in a line-to-line contact for the entire length of the miter joint due to the uniform overlap of the miter joints for adiacent layers. When this happens, it is practically impossible to secure proper alignment of the laminations.

However, when a unitary yoke member having tapered overlap miter joints in accordance with my invention is being lowered into position with respect to the leg members, any initial misalignment of the laminations of the yoke and leg members which causes non-mating laminations of the yoke and leg members to be in interference with each other will only cause an initial point-to-point contact of the non-mating laminations, rather than a line-to-line contact, as would occur in the case of a core having a conventional uniform overlap miter joint. As a result, a preassembled yoke member having tapered miter joints can be lowered into position with respect to the leg members much more easily than could a preassembled yoke member having a conventional uniform overlap miter joint, since the individual yoke laminations may be adiusted to be in their proper positions at the time that the yoke and leg first make contact. This advantage is illustrated in the lower portion of Fig. 3 in which a lamination 21 jointed along joint line 15, and shown in dotted outline, is adjacent a lamination jointed along line 13. It can be seen that if the lamination jointed on line 15 comes in contact with the lamination jointed on line 13, there will only be a point contact between these laminations due to the tapered offset between the respective joints, rather than a line contact, as would occur in the case of a conventional uniform overlap miter joint, It is then easy to adjust lamination 21 into its proper position.

I have shown in Figs. 1 and 2 an arrangement in accordance with my invention which may be used for positioning the preassembled yoke sections 6 and 7 with respect to the leg members. A steel plate 22 is positioned adjacent the outermost surfaces of each of the respective core legs 2, 3 and 4, each of the steel plates 22 extending for the entire length of the core from top to bottom. The steel plates 22 lie in planes parallel to the plane of the laminations and are positioned adjacent the opposite faces of each of the core legs. The plates 22 are rigidly attached to the respective legs 2, 3 and 4 by stud members 32. A suitable insulating material, such as a fiber insulation 23, may be interposed between the respective steel plates 22 and the magnetic laminations. This fiber insulation may be removed opposite the joints to relieve the pressure on the joints during assembly of the yoke. At the outer end of each of the respective steel plates 22 is positioned a threaded stud member 24, the stud members being rigidly attached to the ends of the respective steel plate members by any suitable means and extending beyond the ends of the steel plates 22 in a direction substantially parallel to the longitudinal axis of the plates. Steel core clamp members 25 are attached by means of studs or bolts 26 to the laminations of yoke sections 6 and 7, so that the core clamps 25, which are positioned adjacent opposite faces of the yoke sections and the yoke sections 6 and 7 together constitute a unitary structure. Similar core clamps are used at the opposite end of the core but are not shown in the drawing. Lug members 27 are welded or otherwise rigidly attached to each of the plate members 22 adjacent the ends of the respective plate members, the lugs being provided with threaded bores 28. When the yoke 5 is finally assembled in position with respect to the legs 2, 3 and 4 the screws 29 are screwed through clamp members 25 and into the threaded bores 28, serving to hold the clamps in position with respect to plates 22.

Cross bar members 30 extend perpendicularly to the plane of the laminations and are bolted or otherwise rigidly attached at their respective opposite ends to the respective core clamp members 25. The cross bar members 30 are positioned in alignment with each of the respective leg members 2, 3 and 4, and apertures are provided in each of the cross bar members 30 through which stud members 24 may pass.

In assembling the yoke sections 6 and 7 with respect to the leg members 2, 3 and 4 the yoke sections 6 and 7 with their attached core clamps 25 are positioned so that the apertures in cross bar members 30 are in alignment with stud members 24. The yoke member is then pulled down gradually into position with respect to the leg members by tightening nut members 31 positioned on each of the respective stud members 24. Nut members 31 are positioned on each of the studs above and below the surface of cross bar members 30, with respect to the views shown in Figs. 1 and 2. The nuts which are positioned above or outwardly of the cross bar members 30 are used to tighten the yoke assembly into position, whereas the nuts which are positioned adjacent the under surface of the cross bar members 30 are used to remove the yoke assembly from its assembled relation with respect to the leg members 2, 3 and 4, should removal of the yoke assembled be desired.

One procedure which may be used for assembling a transformer incorporating a tapered miter joint core element in accordance with my invention is as follows:

(1) Assemble the core completely with both the top and bottom yokes and the leg members in assembled relation with respect to one another in a horizontal position, and without any electrical windings on the core. The assembly of the yoke sections 6 and 7 at the top of the core and the corresponding yoke sections at the bottom of the core is done by the conventional method of individually interleaving the yoke laminations with respect to the leg laminations. This assures that the yoke sections have the proper number of laminations and that the respective laminations are in correct sequence. It will be understood that when the magnetic core is in a horizontal position flat on a floor and without any windings on the core legs, and when yoke and leg laminations are assembled simultaneously, the interleaving of the yoke laminations with respect to the leg laminations is a relatively simple process. It is generally only when the magnetic core is of a large size and is in upright position with all of the electrical windings in place that the conventional method of individually interleaving the yoke laminations with respect to the leg laminations is such a difficult and tedious process. As has been mentioned before, when the transformer is of large size, such as 10 feet or more in height, and surrounded by scaffolding, the process of individually pounding the yoke laminations in place is quite tedious. During this step of the assembly, the portion of the fiber insulation 23 opposite the joints may be omitted to relieve pressure on the joints during the assembly of the yoke.

(2) With the top and bottom yoke members in fully

assembled position and with the core in a horizontal position, the top and bottom core clamps **25** are placed in position and attached rigidly to the laminations of the yoke members by means of studs **26** as shown in Figs. 1 and 2. The cross bar members **30** and nuts **31** are assembled as shown in Figs. 1 and 2.

(3) The magnetic core is then uprighted and the top yoke member **5** comprising yoke sections **6** and **7** and the core clamps **25** attached to the yoke members are removed as a unit by use of nut members **31** on the threaded stud members **24** as previously described.

(4) The electrical windings are then assembled on the respective core legs in their proper position and the yoke assembly with the attached core clamps **25** is then replaced as a unit, with the yoke being pulled down gradually by means of the nuts **31** on the threaded studs **24**. The portion of the fiber insulation **23** opposite the joints is replaced before the yoke is replaced.

(5) After the top yoke member is pulled down tightly into position the core clamps **25** are rigidly attached to the core plates **22** by the screws **29** which are screwed into the threaded bores **28** in the lug members **27** attached to plates **22**. By bolting the core clamps directly to the lugs on the core plates, the clamping studs **24** do not have to be designed to withstand short circuit forces.

It can be seen from the foregoing that I have provided a new and improved construction for miter joint cores which permits assembly of core elements as units, instead of by individually interleaving the laminations of intersecting leg and yoke members.

While I have shown an arrangement in which adjacent laminar layers have their respective miter joints offset in a tapered arrangement, it will be understood that each layer illustrated in the drawing may actually represent one or more layers.

While there has been shown and described a particular embodiment 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 claims to cover all such changes and modifications which 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 a rectangular-like magnetic core section comprising a plurality of superposed rectangular-like layers, each of said layers having a rectangular-like window opening therein and comprising two parallel spaced leg laminations and two parallel spaced yoke laminations, mitered butt joints formed in each corner of said layers between the ends of the leg and yoke laminations thereof, the mitered butt joints in each corner of said core section offset and divergingly tapered with respect to each other from the inner portion of said core section corner towards the outer portion of said core section corner, all the leg laminations on one side of said core section disposed between a pair of elongated leg clamping plates and clamped therebetween into a unitary core section leg, all the leg laminations on an opposite side of said core section disposed between another pair of elongated leg clamping plates and clamped therebetween into another unitary core section leg, said four leg clamping plates extending for approximately the full length of said core section legs, each end of said four plates having a threaded stud rigidly connected thereto, all of said studs extending parallel to and lengthwise of said core section legs beyond the ends thereof outwardly beyond said core section, all the yoke laminations on one side of said core section disposed between a pair of elongated yoke clamping plates and clamped therebetween into a unitary core section yoke, all the yoke laminations on an opposite side of said core section disposed between another pair of elongated yoke clamping plates and clamped therebetween into another unitary core section yoke, said four yoke clamping plates having portions thereof overlapping the end portions of said four leg clamping plates, cross bars extending perpendicular to said layers connected to said pairs of yoke clamping plates and disposed outward of said core section opposite to each of the adjacent endmost portions of each of said pairs of leg clamping plates, each of said cross bars having apertures therein aligned with said studs and said studs extending through said apertures, each of said studs having a pair of nuts thereon disposed on opposite sides of said cross bars, and said overlapping yoke clamping plate portions and leg clamping plate end portions rigidly but removably connected together.

2. In a rectangular-like laminated magnetic core having two rectangular-like window openings therein, said core having a laminated central leg portion spaced from and parallel to two laminated side leg portions, the opposite ends of said central leg portion connected to the opposite ends of each of said side leg portions by four laminated yoke portions extending perpendicular to said central and side leg portions, the lamination ends of said central and side leg portions and said four yoke portions having mitered butt joints therebetween, the mitered butt joints adjacent each corner of each window of said core offset and convergingly tapered with respect to each other inward of said core, each of said laminated leg portions clamped between a pair of elongated leg clamping plates whereby each of said laminated leg portions is a rigid unitary laminated core leg, said leg clamping plates extending for approximately the full length of said core legs, each end of each of said leg clamping plates having a threaded stud rigidly connected thereto extending lengthwise of said core legs beyond the ends thereof outwardly of said core, the two laminated yoke portions on opposite sides of said core both clamped between a pair of yoke clamping plates extending substantially the full length of said sides, cross bars connected to said pairs of yoke clamping plates, said cross bars positioned outwardly of said core and opposite to each of the adjacent ends of each of said pairs of leg clamping plates, apertures formed in said cross bars, said apertures aligned with said studs and said studs extending through said apertures, each of said studs having a pair of nuts thereon disposed on opposite sides of said cross bars, the end and central portions of said yoke clamping plates overlapping the end portions of said leg clamping plates and rigidly but removably connected thereto.

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