

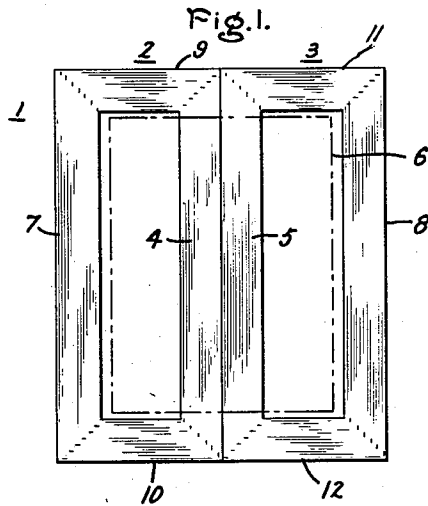
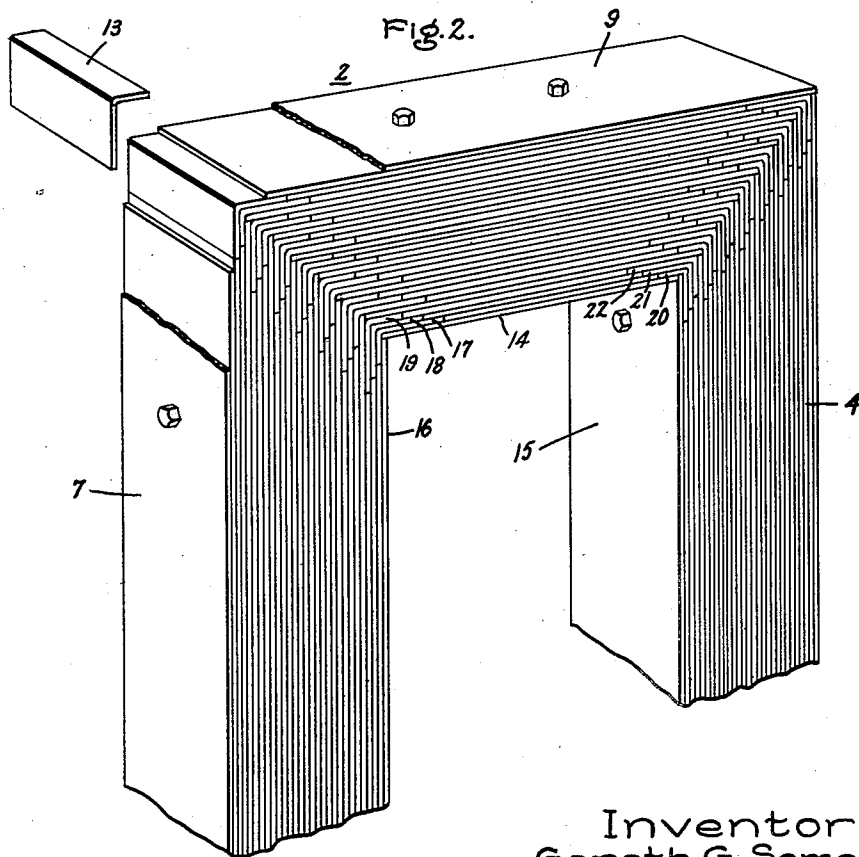
March 24, 1953

G. G. SOMERVILLE
SQUARE CORNER JOINT CORE

2,632,798

Filed Dec. 17, 1949

3 Sheets-Sheet 1



Inventor:
Gareth G. Somerville
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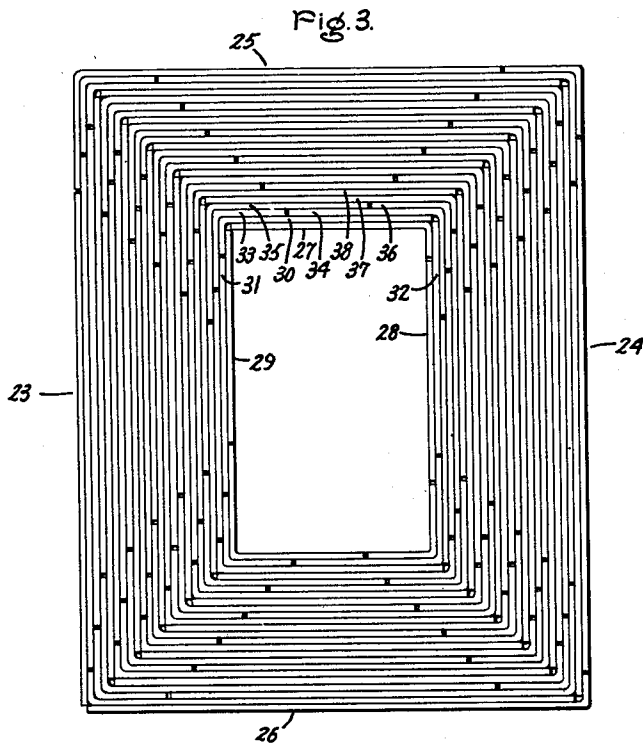
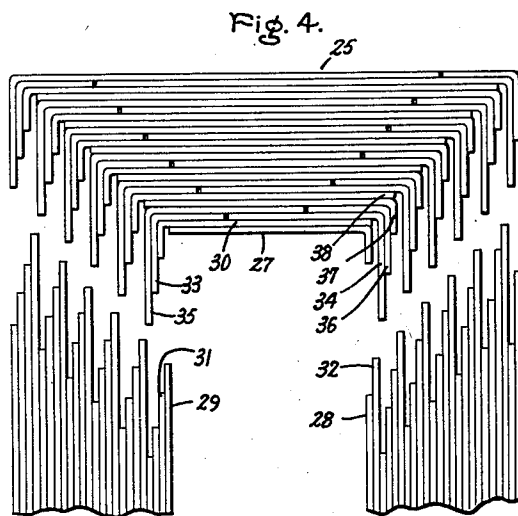
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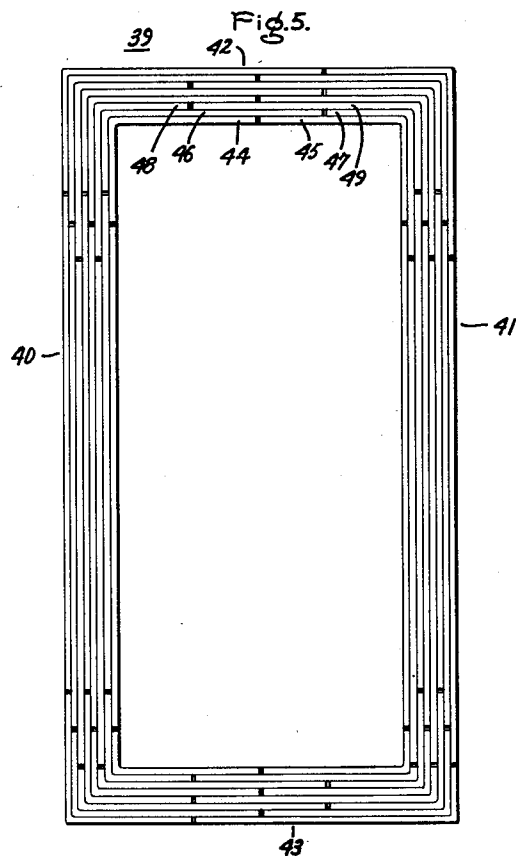
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,632,798

SQUARE CORNER JOINT CORE

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Application December 17, 1949, Serial No. 133,627

1 Claim. (Cl. 175—356)

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This invention relates to stationary electrical induction apparatus and more particularly to the construction of magnetic cores for such apparatus.

In the construction of laminated magnetic cores from strip magnetic material, such as rolled silicon steel, for example, it is common practice to stack a plurality of strips which have been cut to the necessary lengths, and then to bend the strips into a closed loop to form the core section. Due to this construction, the outer corners of the core are rounded in shape. An example of the type of magnetic core construction just described will be found in my copending application, Serial No. 655,961, filed March 21, 1946, and assigned to the same assignee as the present invention, which is now Patent No. 2,548,628.

It has been found that particularly in the case of very large capacity transformers the curved outer corners of magnetic cores formed of strip magnetic material are sometimes not sufficiently strong to support the heavy weight upon them, particularly under the strain of shipment.

An object of this invention is to provide a new and improved magnetic core construction for a stationary electrical induction apparatus.

A further object of this invention is to provide a new and improved corner construction for laminated magnetic cores of stationary electrical induction apparatus.

In accordance with these objectives, this invention provides a magnetic core construction in which the corners of each of the respective lamination layers are formed of L-shaped right-angle laminar insert members in a predetermined stepped arrangement which gives increased mechanical strength to the corners of the magnetic core. In a modified form of my invention, I provide laminated yoke members having right-angle corner bends rather than using corner insert members.

The features of this invention which I believe to be novel are set forth with particularity in the appended claim. 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 a front elevation view of a magnetic core comprising two magnetic sections each of which is assembled in accordance with my invention; Fig. 2 represents an enlarged view of one of the sections of Fig. 1 to show the details of my insert

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corner construction; Fig. 3 represents a front elevation of a modified type of magnetic core construction in accordance with my invention in which the individual yoke laminations are bent at right angles at the corners of the core instead of using insert members; Fig. 4 is a disassembled view of the core of Fig. 3 to illustrate more clearly the interleaved laminated structure; while Fig. 5 uses a modified joint pattern in which all of the leg laminations are of the same length.

Referring now to the drawing and more particularly to Fig. 1, there is shown a magnetic core 1 comprising two hollow rectangular core sections 2 and 3. In the view shown in the drawing, the right-hand side of rectangular core section 2 abuts against the left-hand side of rectangular core section 3, and these two sides, which have been numbered 4 and 5, respectively, together constitute the center winding leg of the composite magnetic core which results from placing core sections 2 and 3 in abutting relation. An electrical winding 6 may be placed about the composite center leg, as indicated by the dotted lines surrounding the composite center leg. The outer legs of core sections 2 and 3 are indicated at 7 and 8, respectively. Legs 4 and 7 of core section 2 are connected by upper and lower yoke members 9 and 10, respectively, while legs 5 and 8 of core section 3 are connected by upper and lower yoke members 11 and 12, respectively.

Referring now to Fig. 2, which shows an enlarged view of core section 2, it will be noted that the corners of the individual lamination layers are formed by special right-angle insert laminations in a manner which will be hereinafter more fully described.

In accordance with my invention, the laminations of yokes 9 and 10 of core section 2 are joined to the laminations of legs 4 and 7 by L-shaped right-angle insert members, one of which is shown in detail at 13. I arrange the L-shaped right-angle insert members in a stepped sequence in which the general pattern comprises having a first laminated layer in which no right-angle inserts are used and succeeding layers having right-angle projections with progressive changes of length for a predetermined number of steps after which the sequence is repeated again. While my insert members change in length within the sequence, becoming progressively longer or shorter, as the case may be, corresponding insert members for repeated sequences are always of the same length. Thus, for example, the

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insert lamination comprising the third step in my pattern is always of the same length. As a result, the leg laminations become increasingly longer in progressing toward the outer edge of the core.

In the embodiment of my invention shown in Fig. 2, by way of example, I have arranged L-shaped right-angle insert members 13 in accordance with a four-step pattern, which pattern is repeated a plurality of times, depending upon the number of laminations used in building up the core. However, it will be understood that the use of right-angle insert members in accordance with my invention is not restricted to a four-step pattern but may be used equally well with patterns having a different number of steps.

In the first step of the four-step pattern, as seen in Fig. 2, the right-angle insert members are not used. It will be seen that lamination 14, the bottommost lamination of yoke 9, that is, the lamination nearest to the hollow center or window of the core, extends all the way across the width of the core window and is butt-jointed to the innermost lamination 15 of leg 4. The other end of lamination 14, that is, the left-hand end with respect to the view shown in Fig. 2, is butt-jointed to the top edge of lamination 16, which is the innermost lamination of core leg 7. The arrangement of laminations 14, 15 and 16 with respect to one another may be designated as step one in the four-step joint arrangement illustrated in Fig. 2. That is, the first step in my four-step sequence comprises having a yoke lamination, such as lamination 14, extend all the way across the window width, being butt-jointed at each end to a leg lamination. It should be noted that in forming butt joints on opposite sides of the core window, leg lamination 15 extends to the top of yoke lamination 14 on the right-hand side of the core window, whereas leg lamination 16 extends to the bottom surface of the yoke lamination 14 on the left-hand side of the core window.

The second, third and fourth steps of my four-step joint arrangement, which I have shown by way of example, utilize L-shaped right-angle insert members to join the respective yoke and leg laminations, with a right-angle insert member being used to join each end of the appropriate yoke laminations to the corresponding leg laminations. Thus, right-angle insert members 17, 18 and 19, respectively, are used on the left-hand side of the core, and right-angle insert members 20, 21 and 22 are used on the right-hand side of the core. These right-angle insert members are of the same width as the laminations which constitute the yoke and leg members and are arranged in such manner that their sides form a stepped arrangement. In accordance with this stepped arrangement, right-angle insert laminations 17, 18 and 19 become progressively shorter in the yoke section of the core and progressively longer in the leg section of the core. That is, the respective sides of right-angle laminations 17, 18 and 19 which are butt-jointed to the corresponding laminations of yoke 9 become progressively shorter while the sides of these same insert laminations 17, 18 and 19 which are butt-jointed to the laminations of leg 7 become progressively longer. This four-step sequence just described is repeated a plurality of times on the left-hand side of the core, as viewed in Fig. 2, the number of repetitions depending upon the number of laminated layers used in the core.

A stepping pattern almost opposite to that just described for the left-hand side of the core

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is used on the right-hand side of the core. While the first step of the sequence is the same in that bottom lamination 14 extends all the way across the core window and is butt-jointed to innermost lamination 15 of core leg 4, insert laminations 20, 21 and 22 become progressively longer in the yoke portion of the core and progressively shorter in the leg portion of the core.

The joint construction at the opposite end of the core between yoke 10 and legs 4 and 7, respectively, is not shown in Fig. 2 but is similar to that shown for the upper portion of the core. The order of stepping of the joints at the lower end of the core may be the same as that at the upper end of the same core side, or the order of stepping may be reversed from that of the upper end of the same core side. In the latter case, diagonally opposite corners of the core would have the same joint pattern.

Referring now to Figs. 3 and 4, there is shown therein a modified form of my invention in which instead of using short right-angle insert pieces to join the yoke and leg laminations, as shown in Figs. 1 and 2, I instead bend the yoke laminations at the corners into right angles and join these right-angle yoke laminations to the corresponding leg laminations. Furthermore, I arrange these bent yoke laminations in a stepped sequence in a manner which gives maximum mechanical strength to the composite core joints. In accordance with my invention, I arrange stacked yoke laminations in a stepped sequence in which the general pattern includes a first laminated layer having a single yoke lamination which is bent at right angles at one end only, with the bent end and the unbent end respectively butting against laminations in opposite core legs, and a second laminated yoke layer having a single lamination with a right-angle bend at one end only and at the opposite side of the core as compared to the bend of the first yoke layer. Succeeding yoke laminations within the sequence are arranged with two laminations to each layer, the two laminations being butt-jointed to each other end-to-end intermediate of the yoke, one lamination having a right-angle bend at the right-hand side of the core and the other having a right-angle bend at the left-hand side of the core. Successive right-angle bends which butt against laminations of the same core leg have progressive changes of length for a predetermined number of steps after which the sequence is repeated again.

Referring now to Figs. 3 and 4 of the drawing, there is shown a core section having leg members 23 and 24 connected at the top and bottom, respectively, by yoke members 25 and 26. In the embodiment of my invention shown in these figures, I have used a four-step sequence as an illustration. It will be noted that innermost yoke lamination 27 is bent at a right angle at the right-hand edge of the core window with the right-angle projection butting against the upper portion of innermost right leg lamination 28. Lamination 27 extends all the way across the core window to the left, with respect to the view shown in Fig. 4, to butt up against innermost left leg lamination 29.

The second step in the sequence of yoke laminations in accordance with my invention is shown by yoke lamination 30 which lies directly above yoke lamination 27. While yoke lamination 27 is bent at right angles at its right-hand end, yoke lamination 30 is bent at right angles at its left-hand end with the bent-down portion engaging

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with left leg lamination 31 in a butt joint. The right-hand end of yoke lamination 30 meets in a butt joint with leg lamination 32 of the right-hand core leg.

The third step in the yoke lamination sequence is illustrated by yoke lamination members 33 and 34 which together constitute the third lamination layer above the core window. Whereas the first and second layers in the sequence were formed using only one continuous lamination, namely, laminations 27 and 30, respectively, the third layer is comprised of two yoke laminations 33 and 34. With respect to the view shown in the drawing, yoke lamination 33 is shown at the left and is bent downwardly at its left-hand end in the form of a right angle, whereas yoke lamination 34 is at the right end of the layer and is bent down at its right-hand end in the form of a right angle. The right angle extensions of yoke laminations 33 and 34 form butt joints with the corresponding leg laminations of the left- and right-hand core legs, respectively.

Yoke laminations 33 and 34 are butt-jointed to each other intermediate of the core window width, and to the left of the midpoint or center-line of the core section.

The fourth step in the yoke lamination sequence is analogous to the third step just described in that two yoke laminations, designated as 35 and 36, respectively, are butt-pointed to each other intermediate of the core window width. In the view shown in the drawing, yoke lamination 35 is at the left-hand end of the layer comprising the fourth step in the sequence, and yoke lamination 36 is at the right-hand end of the same layer. Laminations 35 and 36 are butt-jointed to the right of the center line of the core window, whereas yoke laminations 33 and 34 are butt-jointed to the left of the center line of the core window. Laminations 35 and 36 each have a right-angle extension, the respective extensions being butt-jointed to the corresponding leg laminations in the left- and right-hand core legs.

It will be observed that the joints in both the leg and the yoke sections of the core are arranged in a stepped or staggered relation in order to provide maximum mechanical strength in the composite core. This staggering of the joints in the leg sections of the core is accomplished by having the yoke extensions in the left-hand core leg become progressively longer during the four-step sequence in progressing toward the outer edge of the core. This is illustrated by yoke laminations 27, 30, 33 and 35, respectively, with lamination 27 having a zero projection in the left-hand core leg while the projections of laminations 30, 33 and 35 into the left leg become progressively longer. On the other hand, the yoke extensions on the right-hand side of the core become progressively shorter during the four-step sequence in progressing toward the right-hand outer edge of the core. This sequence is best illustrated by the projections of yoke laminations 34, 36, 37 and 38 into the right leg which become progressively shorter, with yoke lamination 38 having a zero projection in the right-hand core leg. This sequence is repeated a plurality of times, the number of repetitions depending upon the number of laminations in the core.

It will be noted that the joint pattern in the yokes 25 and 26 is different from that just described for the core legs. The joints in each yoke define two 45 degree lines transverse of the stacked yoke laminations, with the two lines respectively radiating angularly to the right and

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left of a perpendicular to the plane of the yoke laminations at the midpoint of the yoke. As has been previously mentioned, the third step of my four-step sequence comprises having two yoke laminations such as laminations 33 and 34 jointed at a point to the left of the midpoint of the yoke, while the fourth step comprises having two yoke laminations such as laminations 35 and 36 jointed at a point to the right of the midpoint of the yoke. It will be seen, therefore, that each third and fourth layer has a short yoke member and a long yoke member. All of the short yoke members are made of the same length, and the joints on the same side of the yoke between the respective short and long yoke members are offset from one another due only to the displacement caused by the intervening laminated leg and yoke layers, which causes the displaced joints in the yokes to define lines at a 45 degree angle.

The jointing arrangement between lower yoke section 26 and the lower end of legs 23 and 24, respectively, is similar to that just described for upper yoke section 25 and the upper ends of core legs 23 and 24, except that the length progression of the yoke extensions into the core legs may be reversed from that for the upper end of the core, so that diagonally opposite corners of the core will have the same leg joint pattern.

There is shown in Fig. 5 a further modification of my invention which differs principally from the structure shown in Figs. 3 and 4 in that the pattern of the joints between the yoke and leg laminations is so arranged that all of the leg laminations are of uniform length, which is not true of the structure shown in Figs. 3 and 4.

A feature of the construction of Fig. 5 is that I use a joint sequence having a plurality of steps, in which corresponding joints for each repetition of the series define a straight line perpendicular to the core element in which the joints lie, such as the respective leg and yoke sections of the core. Thus, for example, all of the joints representing repeated first steps in my joint sequence define a line perpendicular to the core yoke or core leg in which they lie. Similarly, the joints representing the second steps, third steps, etc., in my joint sequence each respectively define lines perpendicular to the core elements in which they lie. This is accomplished by having the legs of successive yoke laminations become increasingly longer so that despite the increasing thickness of the core, corresponding joints for successive repetitions of my joint pattern will all lie on the same line perpendicular to the core leg or yoke.

Referring now to Fig. 5, there is shown a laminated magnetic core 39 of generally rectangular configuration comprising two leg members 40 and 41 connected at their upper and lower ends respectively by yoke members 42 and 43. Each of the yoke members is built up of a number of layers of laminated magnetic material, with each yoke layer having two laminated members each of which has a right-angle bend which is butt-jointed to a corresponding leg lamination on one of the two sides of the magnetic core section. In this figure, I have shown a three-step joint pattern by way of example, although in accordance with my invention I could use a pattern having a different number of steps.

Thus, considering the upper yoke section 42 by way of example, it will be seen that the innermost yoke layer towards the core window has two laminations 44 and 45 which are butt-jointed

to each other at the midpoint of the yoke 42. Laminations 44 and 45 each have a right-angle bend which is butt-jointed to a corresponding leg lamination of core legs 40 and 41, respectively. The joints which laminations 44 and 45 respectively make with their corresponding leg laminations are on the same level with respect to the longitudinal dimension of the core legs.

The second layer in the sequence has two laminations 46 and 47 which are butt-jointed to one another along a line which is to the right of the center axis of the core section, with respect to the view shown in Fig. 5. Each of these laminations 46 and 47 also has a right-angle bend which is butt-jointed to a corresponding leg lamination of core legs 40 and 41, respectively. It will be noted that the butt joints which laminations 46 and 47 make with their corresponding leg laminations are displaced longitudinally of the core section from the butt joints which laminations 44 and 45 make with their corresponding leg laminations. The butt joint between the right-angle bend of yoke lamination 46 with its corresponding leg lamination is displaced above the corresponding joint for yoke lamination 44; while the joint which yoke lamination 47, which is in the same layer with yoke lamination 46, makes with its corresponding leg lamination is displaced below the joint which yoke lamination 45 makes with its corresponding leg lamination.

Referring now to the third layer in the sequence, it will be seen that this layer is comprised of yoke laminations 48 and 49, which are butt-jointed to each other along a line which is to the left of the center axis of the magnetic core section. Each of these lamination members has a right-angle bend which is butt-jointed to a corresponding lamination of legs 40 and 41, respectively. The joint between yoke lamination 48 and its corresponding leg lamination is displaced below the corresponding joint for lamination 44 in core leg 40, while the joint between lamination 49 and its corresponding leg lamination is displaced above the corresponding joint for lamination 45 on core leg 41.

This three-step sequence just described is repeated a plurality of times, the number of repetitions depending upon the number of laminated layers in the core.

The arrangement of the yoke laminations with respect to the leg laminations at the bottom of the core between lower yoke section 43 and legs 40 and 41, respectively, is similar to that just described for the upper yoke member 42. The only difference is that the position of the joints between the right-angle bends of the various yoke laminations and the corresponding leg laminations in the lower end of the core is such that all of the leg laminations will be of the same length. Thus, the highest joint in the upper yoke-leg joint group is in the same lamination layer as the highest joint in the lower yoke-leg joint group. Similarly, the lowest joint in the upper yoke-leg joint group is in the same lamination layer as the lowest joint in the lower

yoke-leg joint group, while the intermediate joint of the upper yoke-leg joint group is in the same lamination layer as the intermediate joint of the lower yoke-leg joint group. Due to this arrangement, all of the leg laminations are of the same length, thereby simplifying the manufacturing and assembly operations required in the construction of this magnetic core.

While I have indicated in the specification and drawing the use of one lamination for each step in my various lamination patterns, this is merely by way of example, and I may choose to use a plurality of laminations for each step.

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:

A magnetic core of generally hollow rectangular shape and formed of radially nested strips of magnetic material, two sides of said core comprising the legs of said core and two sides of said core comprising the yoke members of said core, said radially nested strips of magnetic material for successive layers of said core being arranged in a pattern in which the first step consists of having a straight yoke lamination butt-jointed at each end to a straight leg lamination, with subsequent steps in which straight leg and yoke laminations extend for a distance slightly less than the length of the respective leg and yoke members at the layer in which said straight laminations are positioned, the straight laminations of said subsequent steps for intersecting leg and yoke members being joined by separate short L-shaped right angle corner members of bent strip magnetic material, the opposite ends of each of said L-shaped corner members being respectively butted against the end of a straight lamination lying in one member of a given pair of intersecting leg and yoke members, the corresponding sides of adjacent L-shaped corner members at any given intersection of said leg and yoke members having their respective lengths repetitively progressively stepped in the same direction for a predetermined number of steps.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,380,300	Gaston	July 10, 1945
2,477,350	Somerville	July 26, 1949
2,479,302	Bondley	Aug. 16, 1949
2,486,220	Somerville	Oct. 25, 1949
2,548,624	Sclater	Apr. 10, 1951