

Feb. 10, 1953

G. G. SOMERVILLE

2,628,273

MAGNETIC CORE

Filed Dec. 17, 1948

Fig. 1.

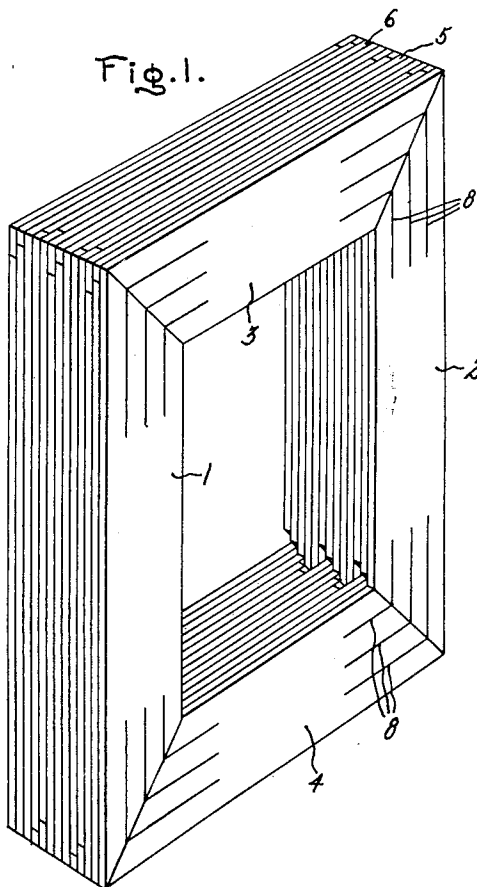


Fig. 2.

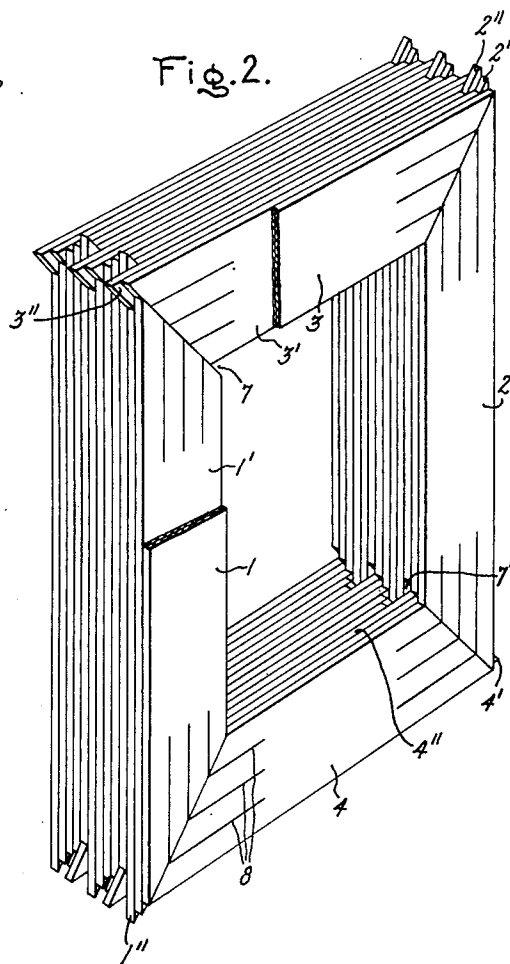
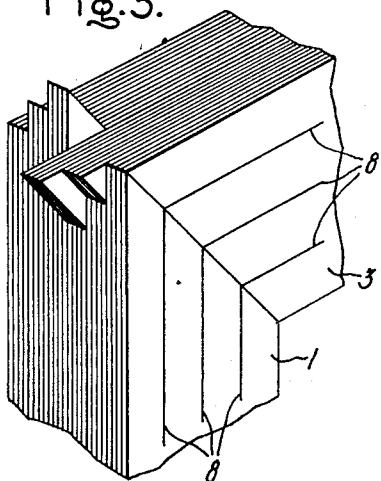


Fig. 3.



Inventor:
Gareth G. Somerville,
by *Ernest C. Britton*
His Attorney.

UNITED STATES PATENT OFFICE

2,628,273

MAGNETIC CORE

Gareth G. Somerville, Pittsfield, Mass., assignor
to General Electric Company, a corporation of
New York

Application December 17, 1948, Serial No. 65,939

6 Claims. (Cl. 175—356)

1

This invention relates to magnetic cores and more particularly to improvements in mitered joint cores for stationary electric induction apparatus.

Modern material for magnetic core laminations has highly directional magnetic properties. Thus high reduction cold rolled silicon steel strip has minimum hysteresis loss and reluctance when the direction of magnetic flux through it coincides with the direction of rolling, i. e., with the lengthwise dimension of the strip, and there is a maximum loss and an increase in reluctance when the flux direction is at right angles thereto. This has led to mitering or beveling the corner joints of flat stacked plate cores in order to minimize cross grain travel of the flux in the corners of the core. In order to provide a lapped miter joint, numerous ways of cutting the ends of the laminations have been devised but they require expensive cutting dies and the production of numerous differently shaped ends for the laminations in any one core, and in some cases they require that the width of the lamination pieces in the leg and yoke parts of the core be different.

In accordance with this invention the lamination ends are all cut alike in the simplest possible way, namely in a straight line, and the overlapping of the joints in adjacent layers is achieved by adjusting the relative position of the superposed laminations longitudinally but not laterally. This longitudinal offsetting effectively removes some steel from the corners of the core window and this, in combination with the natural tendency of the flux to hug the inner sides of the core corners, tends to raise the flux density at the inside of the core corners somewhat above the average flux density of the core. In order to counteract this effect I provide a plurality of spaced slits in the ends of each lamination which slits extend parallel to the length of the lamination and therefore parallel to its most favorable magnetic direction.

An object of the invention is to provide a new and improved magnetic core.

Another object of the invention is to provide a new and improved mitered joint type flat stacked plate core.

A further object of the invention is to provide a mitered joint core in which the flux density tends to be uniform in the joints.

A further object of the invention is to provide a core in which flux crowding at the inner portions of the mitered joints is minimized.

The invention will be better understood from

2

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 is a perspective view of a magnetic core embodying a preferred form of the present invention, which core is suitable for use with stationary electric induction apparatus such as transformers and reactors, Fig. 2 is a similar view with the first core layer partly broken away and with the corners unfinished, and Fig. 3 is an enlarged detailed view of a corner of the core shown in Fig. 2.

Referring now to the drawing and more particularly to Fig. 1, the core has been illustrated as being square as this is its simplest form because then all of the lamination pieces will be identical and this, of course, has certain manufacturing advantages. However, as the description of the invention proceeds it will be obvious that the invention is in nowise limited to a square core and the core may have an elongated rectangular shape or may even have more or less than four sides if that should be desirable. Furthermore, even in the square shape it is not essential that all of the lamination layers be identical, and in certain instances it may be desirable to provide a magnetic gap or an air gap in one or more parts of the core in which case the laminations would of course be severed to provide this gap so that they would no longer all be identical.

The core shown in Fig. 1 may have almost any number of lamination layers, there being 13 illustrated. The layer shown in Fig. 1 are also arranged in a repeating pattern each consisting of five layers, although as will become apparent as the description proceeds, the number of layers in the repeating pattern is not necessarily five and may be less than or greater than 5 if desired.

The first layer as viewed in the drawing may be described as a picture frame layer and it will be seen that it consists of two vertical members 1 and 2 and two horizontal members 3 and 4. All of these members are identical and have their ends beveled or cut in a straight line at an angle of 45 degrees and these beveled ends are fitted together throughout their entire length so as to constitute mitered butt joints and so as to produce a square configuration corresponding to the way the sides of a picture frame are put together. By reason of the repeating five-layer pattern in Fig. 1, the sixth layer 5 and the eleventh layer 6 are identical with the first layer.

Referring now to Fig. 2, the second layer con-

3

sists of 4 pieces 1', 2', 3', and 4' which are all identical with each other and with the members 1, 2, 3 and 4 constituting the first layer. However, the member 1' has been displaced downwardly slightly relative to member 1 without displacing this member laterally from member 1; similarly, the member 4' has been displaced longitudinally to the right the same amount relative to member 4 without displacing it laterally with respect to member 4 so that as shown in the drawing the right hand tip of the member 4' extends out beyond the main body of the core. Likewise the member 2' has been displaced upwardly slightly relative to the member 2 and the member 3' has been displaced to the left slightly relative to member 3. In other words, the four mitered joints in the second layer are all displaced slightly in a counterclockwise direction around the magnetic circuit of the core relative to the joints in the first layer. This displacement of the joints and members constituting the second layer also causes a partial offsetting of the adjacent cut ends of the members 1', 2', 3' and 4' so that one outer corner of each member extends out beyond the main body of the core and there is a corresponding notch 7 at the inside of each corner adjacent the window formed by the core. The outwardly projecting points of the laminations are unnecessary to its magnetic performance and, therefore, if desired, they may be cut off or ground down flush with the outer surfaces of the core as indicated in Fig. 1, however, this is not at all necessary.

The notches 7, however, represent a reduction in the amount of steel for carrying the flux around the inside portion of the corner joints and as the flux naturally tends to take the shortest path around the corners, the flux density at the inner part of the corners tends to be raised somewhat above the average flux density in the core.

In order to minimize this effect, the lamination layers are provided with slits 8. These slits are parallel with the lengthwise dimension or grain direction of the steel and they thus have practically no effect on flux which travels in the most favorable direction through the steel; however, they have the effect of air gaps with respect to flux which tends to travel across the grain, which will be the direction of any flux which tends to crowd the inner corners of the core. In this manner the inside crowding of the flux is minimized. While the slits 8 are particularly useful with a core having mitered joints of the type herein described in which some of the core material has been removed from the inner corners of the core, it will of course be obvious that my invention in this respect is not limited to such mitered joints and that these slits can be used with any mitered joint core for the purpose of minimizing flux crowding at the inner corners of the core.

The third layer of the core comprises members 1'', 2'', 3'', and 4'' which are the same as the other members but they have been offset from the members of the second layer by the same amount and in the same direction as the members of the second layer have been offset from the members of the first layer. This, of course, causes the outer tips or corners of the members to project still further from the core and cause still larger empty spaces or notches 7' at the inner corners of the core. The fourth layer is like the third layer only reversed so that its joints are offset from the picture frame type joints of the

4

first layer by the same amount as the joints of the third layer but in the opposite direction. The fifth layer corresponds to the second layer reversed so that its joints are offset from the picture frame type joints of the first layer in the same amount as the joints of the second layer but in the opposite direction. The sixth layer is the same as the first layer and starting with this layer the pattern repeats as many times as is desired.

In actual practice it is usually desirable to have more than one lamination in each layer. In other words, the core layers are themselves laminated and as shown in Fig. 3 there are four laminations per layer. However, this is not at all critical and any number of laminations may be employed in each layer of the core.

It will be seen that by this construction the ends of all of the laminations may be cut in a simple straight line at the same angle and that the offsetting or lapping of the mitered joints is accomplished by merely shifting the lamination pieces longitudinally while keeping them superposed laterally so that their longitudinal center lines are all in the same plane parallel to an axis through the core window. This has the advantage that all the leg punchings, such as 1, 1', 2, 2', etc., can be of equal length and all the yoke punchings, such as 3, 3', 4, 4', etc., can be of equal length, but it should be understood that this is not essential to the formation of my novel joints and that the desired amount of overlap between the joints in adjacent layers can be obtained in any suitable way, such as by using different length leg punchings and different length yoke punchings in the various layers.

By having a five layer or five step pattern in each core joint the maximum number of layer joints in any one corner which are in any one plane will be only one-sixth of the number of layers in the core, so that for any one plane through the corner of the core there is five-sixths of the thickness of the core available for carrying flux and only one-sixth of this thickness constitutes gaps or butt joints. In certain cases it will not be necessary to have as many steps or layers in the repeating pattern. For example, a symmetrical joint having good properties could be produced by omitting the doubly offset layers, namely, the third and fourth layers in each of the five step patterns shown in Figs. 1 and 2; likewise, almost any other combination of a lesser number of layers may be used if desired.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may 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. A magnetic core for electric induction apparatus, a yoke portion and a leg portion each comprising a plurality of laminations of magnetic material having a most favorable magnetic direction coinciding with the lengthwise direction of the laminations, said yoke and leg portions each having an end abutting the other which together form an angular core joint, the ends of the laminations in said joint being beveled at an angle to their length which is half the angle

of said joint, and a plurality of spaced slits in the ends of said laminations extending from said joint parallel to the most favorable magnetic direction of said laminations.

2. In a flat stacked laminated magnetic plate core having at least one mitered corner joint, means for minimizing flux crowding at the inner corner of said joint comprising a plurality of slits in the core laminations, extending from said joint and parallel to the lengthwise dimension of the core laminations, whereby high reluctance gaps are presented to flux which travels crosswise of said laminations in an attempt to take a short cut through said joint.

3. A magnetic core comprising a layer of assembled laminations, said laminations having their most favorable magnetic characteristics in their lengthwise directions, two adjacent said laminations being abutted to form a substantially mitered joint in a corner of said magnetic core with the lengthwise directions of said two laminations at 90° to each other, said corner including at least one slit extending from said joint into one of said adjacent laminations in a direction substantially parallel to the lengthwise direction of said one adjacent lamination and at least one slit extending from said joint into the other of said adjacent laminations in a direction substantially parallel to the lengthwise direction of said other adjacent lamination.

4. A magnetic core comprising a layer of assembled laminations, said laminations having their most favorable magnetic characteristics in their lengthwise directions, two adjacent said laminations being abutted to form a substantially mitered joint in a corner of said magnetic core with the lengthwise directions of said two laminations at 90° to each other, said corner including at least one slit extending from said joint into one of said adjacent laminations in a direction substantially parallel to the lengthwise direction of said one adjacent lamination and at least one slit extending from said joint into the other of said adjacent laminations in a direction substantially parallel to the lengthwise direction of said other adjacent lamination, said slits extending into said laminations for a distance which is short compared to the length of said laminations.

5. A magnetic core for electric induction apparatus, a yoke portion and a leg portion each comprising a plurality of laminations of magnetic material having a most favorable magnetic direction coinciding with the lengthwise direction of the laminations, said yoke and leg portions each having an end abutting the other which together form an angular core joint, the ends of the laminations in said joint being beveled at an angle to their length which is half the angle of said joint, and a plurality of spaced slits in the ends of said laminations extending from said joint parallel to the most favorable magnetic direction of said laminations and for a distance which is short compared to the length of said laminations.

6. In a flat stacked laminated magnetic plate core having at least one mitered corner joint, means for minimizing flux crowding at the inner corner of said joint comprising a plurality of slits in the core laminations, extending from said joint and parallel to the lengthwise dimension of the core laminations, said slits extending for a distance which is short compared to the length of said laminations, whereby high reluctance gaps are presented to flux which travels crosswise of said laminations in an attempt to take a short cut through said joint.

GARETH G. SOMERVILLE.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,313,054	Berry	Aug. 12, 1919
2,382,172	Putman et al.	Aug. 14, 1945
2,393,038	Forbes	Jan. 15, 1946
2,467,823	Gordy	Apr. 19, 1949
2,467,824	Granfield	Apr. 19, 1949
2,486,220	Somerville	Oct. 25, 1949

FOREIGN PATENTS

Number	Country	Date
8,997 of 1908	Great Britain	Jan. 21, 1909
108,862	Austria	Feb. 10, 1928
592,020	Great Britain	Sept. 4, 1947