

Feb. 5, 1957

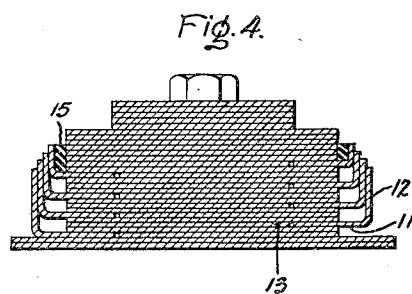
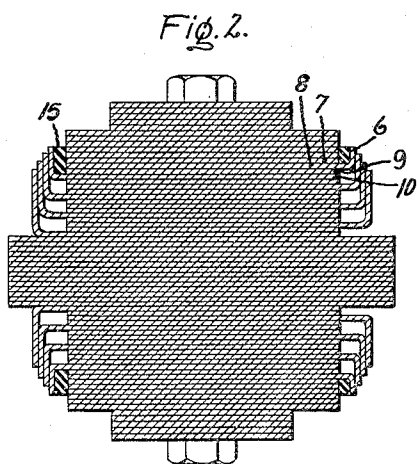
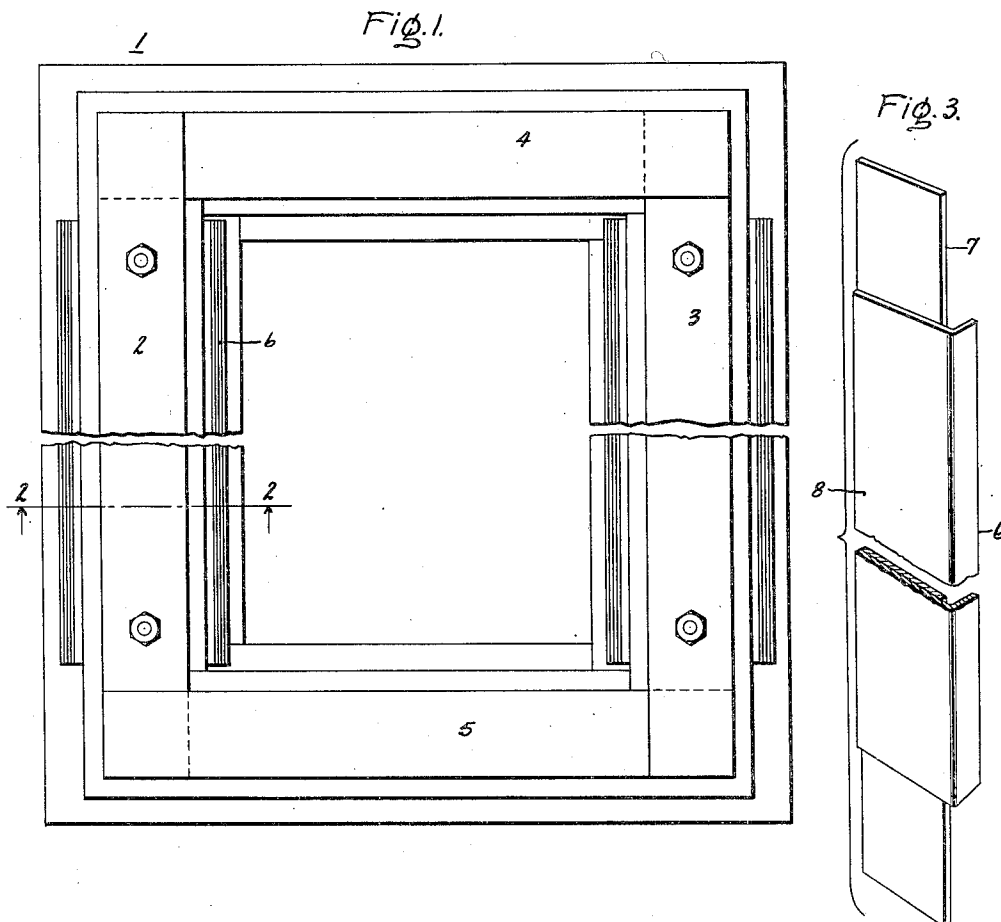
G. G. SOMERVILLE

2,780,787

MAGNETIC CORE CONSTRUCTION

Filed May 21, 1951

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5.

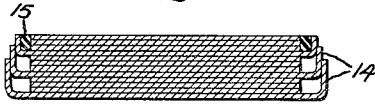


Fig. 6.

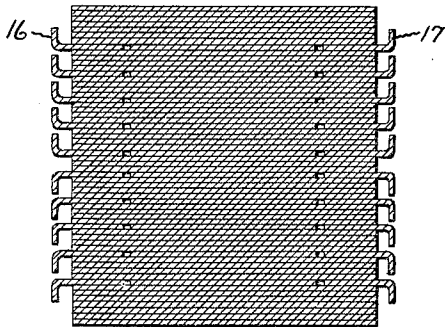


Fig. 7.

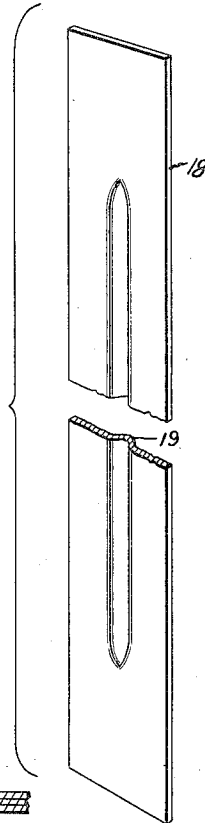


Fig. 9.



Fig. 10.



Fig. 8.

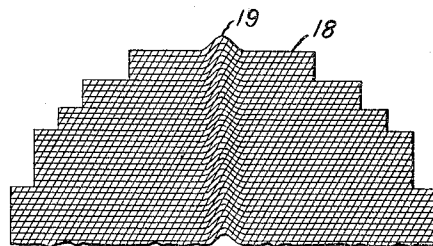
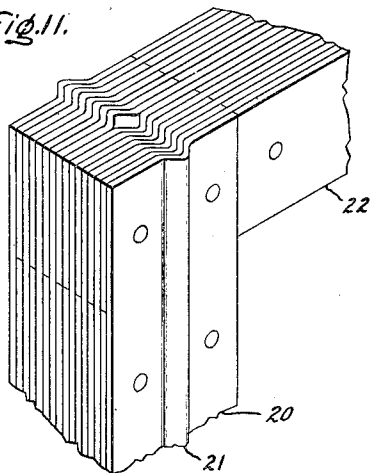


Fig. 11.



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1

2

2,780,787

MAGNETIC CORE CONSTRUCTION

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3 Claims. (Cl. 336—234)

This invention relates to stationary electrical induction apparatus and more particularly to an improved magnetic core construction for such apparatus.

In the construction of magnetic cores for large size stationary electrical induction apparatus, one of the most serious problems encountered is that of providing adequate structural strength in the magnetic core. For example, considerable difficulty has been experienced with the legs of such large size magnetic cores bending in such manner as to interfere with the insulating cylinders which often surround the core legs, and cracked insulating cylinders due to crooked core legs are an ever present danger. However, this problem is not confined to core legs, but also applies to the yoke portions of the core. For example, the standard plate core is structurally weak in a horizontal plane, with the result that the core cannot be laid on its side without the use of many structural steel clamping members.

Furthermore, there is a definite relation between mechanical strain imposed on a magnetic core and the magnetic properties of the core. Mechanical strain lowers the permeability of the magnetic material, with a resulting higher core loss. It can be seen, therefore, that a construction which reduces mechanical strain on magnetic laminations will improve the magnetic characteristics of such magnetic material, and result in lower core losses.

Also, there is a relation between mechanical strain on a magnetic core and the audio noise characteristics of the core. It can be shown that varying permeability in the magnetic core caused by mechanical strain results in harmonics in the magnetic flux which adversely affects the audio noise characteristic of the core.

Accordingly, it is an object of this invention to provide a new and improved magnetic core construction providing increased structural strength in the magnetic core, with a consequent improvement in magnetic and audio sound characteristics of the magnetic core.

It is a further object of this invention to provide a new and improved magnetic lamination construction for the leg or yoke members of laminated magnetic cores which will reduce the danger of bending of the core legs or yokes, thereby providing an improvement in the magnetic and audio sound characteristics of the core.

In accordance with these objectives, this invention provides an arrangement whereby certain of the laminations of a magnetic core are longitudinally bent, either along the edges of the respective laminations or intermediate of the width of the laminations, in order to provide a reinforcing and supporting edge in a longitudinal or axial direction with respect to the particular core element in which the bent laminations are situated.

The features of my 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 a mag-

netic core of generally hollow rectangular shape embodying the structural support members of my invention; Fig. 2 represents a cross-sectional view along line 2—2 of the magnetic core of Fig. 1; Fig. 3 represents a view of several laminations of the type used in the magnetic core of Figs. 1 and 2; Fig. 4 represents a cross-sectional view of a modified embodiment of my invention in which special bent insert members are used in lieu of bending the entire leg or yoke lamination; Fig. 5 is a cross-sectional view of a modified construction in which laminations are bent on both edges; Fig. 6 is a cross-sectional view of a construction in which longitudinally-bent laminations are used in a core element which is rectangular in cross section; Fig. 7 represents a view of a modified type of longitudinally-bent lamination in which the bent portion is positioned intermediate of the width of the lamination, rather than on the edge; Fig. 8 is a cross-sectional view of a magnetic core leg embodying bent laminations of the type shown in Fig. 7; Fig. 9 is a cross-sectional view of part of a magnetic core element having a plurality of longitudinal bends positioned intermediate of the width of the laminations; Fig. 10 represents a cross-sectional view of a modified embodiment of my invention in which the longitudinal bends are obtained by providing each bent lamination with a continuously-curved surface, producing a corrugated effect; while Fig. 11 is a perspective view of a joint arrangement which may be used with laminations bent in accordance with my invention.

Referring now to Fig. 1, there is shown a magnetic core 1 of generally hollow rectangular shape. It will be understood that this particular form of core is shown only because of its simplicity and that my invention may be equally well applied to other types of magnetic core configurations. The magnetic core 1 of Fig. 1 has two leg members 2 and 3 which are connected together at their upper and lower ends respectively by yoke members 4 and 5.

The magnetic core 1 shown in Fig. 1 is of cruciform cross-section and is constructed of flat rectangular strips of magnetic material, such for example as high reduction cold rolled silicon steel, which are stacked in a conventional butt and lap arrangement. While I have illustrated my invention in connection with a core having a cruciform cross-section, it will be understood, and shown later, that my longitudinally-bent laminations may be used with equal facility on cores of rectangular cross-section.

In accordance with the cruciform cross-section of the core which can best be seen in Fig. 2 of the drawing, the magnetic core is constructed of groups or packs of magnetic laminations of varying width, the outermost laminations being narrower and shorter than the centrally positioned laminations. Cores of cruciform cross-section of the type illustrated are widely used with large transformers which have insulating cylinders positioned around the winding legs of the magnetic core. By employing a core of cruciform cross-section, a greater quantity of magnetic material can be concentrated within an encircling cylinder of a given diameter than would be possible with a core of rectangular cross-section. This cruciform cross-section is conventional and forms no part of this invention.

In accordance with my invention, and as will be seen in Figs. 1, 2 and 3, the outer edges of certain of the leg laminations are provided with a bend 6 which extends longitudinally of the respective leg laminations for substantially the entire length of the core window, for the purpose of reinforcing the core leg in an axial or longitudinal direction. The bent edges 6 are preferably at right angles with respect to the main face of the lamination containing the bend, although not necessarily at right angles. While in the particular embodiments shown in

3

Figs. 1, 2 and 4, right angle extensions or bends 6 are provided only in the groups of laminations on either side of the centermost group, I may use longitudinally bent laminations in all of the groups of laminations of the respective core elements.

Laminations having longitudinally-bent portions in accordance with my invention may be arranged in many different ways. The bent portions may be contained either in laminations which extend for the entire width of the particular core element, such as the leg or yoke member, or insert members having longitudinally-bent portions may be used, the insert element having one side which extends for part of the width of the leg or yoke member, with the rest of the width of the core element being covered by a simple unbent lamination.

In the particular embodiment of my invention shown in Figs. 1 and 2, I position the bends in laminations which extend for the entire width of the core leg, these particular laminations being bent only on one edge. I prefer to alternate the use of laminar layers having bent edge members and layers having only flat or unbent members. Thus, as will be seen in Fig. 2, lamination 7 is unbent at either edge, lamination 8, adjacent lamination 7, extends for the entire width of the core leg, and is provided with a bent portion at its right-hand edge, with respect to the view shown in the drawing. Lamination 9, adjacent lamination 8, is unbent at either edge, while lamination 10, adjacent lamination 9, is provided with a bend 6 at its left-hand edge with respect to the view shown in the drawing.

There is shown in Fig. 3 a detailed view of a pair of adjacent leg laminations of the type used in the constructions of Figs. 1 and 2, showing the manner in which the edge of the lamination 8 is provided with a longitudinal bend 6 at right angles to the principal surface of the lamination. It will be noted that the adjacent lamination 7 is unbent, since I prefer to alternate bent and unbent laminations even in the portion of the core containing the longitudinally bent laminations.

There is shown in Fig. 4 another application of my longitudinally-bent laminations in which the bends are contained in insert members which extend for only part of the width of the particular core element, such as the core leg, rather than having the bend in laminations which extend for the entire width of the core element. Thus, there are shown in Fig. 4 a plurality of insert members 11 each respectively having a bent edge 12. Each insert member is provided with a portion extending for part of the width of the core element, such as the core leg, with an unbent lamination 13 being used in the same laminar layer to supplement the insert member by extending across the portion of the width of the core leg or other core element not covered by the insert member.

As shown in Fig. 5, instead of using laminations having bends at one edge only, I may instead use channel-shaped members which are bent at both edges. As will be seen in the cross-sectional view of Fig. 5, the laminations 14 are provided with bends at their respective opposite edges. Preferably, unbent laminations are alternated with the bent laminations, although the bent laminations alone may be used if desired.

Where my bent portions extend laterally across the edges of several unbent laminar edges, it is desirable that the bent portion closest to the unbent laminar edges be spaced away from the adjacent unbent edges, in fact, it is desirable that some suitable insulating material 15 be positioned between the bent edge closest to the adjacent unbent edges and the adjacent unbent edges as shown in Figs. 2, 4, and 5 in order to prevent magnetic short-circuiting of the adjacent unbent laminar edges.

If desired, as shown in Fig. 6, each laminar layer having insert members may be provided with two such insert members in the respective layers, with an insert member being positioned at opposite edges of the given layer, an unbent lamination extending between the respective insert members in each layer having insert members. Thus, in

4

Fig. 6, there is shown a core having bent corner insert members 16 at its left-hand edge with respect to the view shown in the drawing and bent corner insert members 17 at the right-hand edge of each layer, with respect to the view shown in the drawing.

In the embodiment shown in Fig. 6, sufficient unbent layers are positioned between each layer having the bent insert members that successive bent edges do not overlap, thereby permitting a core which is substantially rectangular in cross-section.

There is shown in Fig. 7 a modified type of longitudinally-bent lamination having the bent portion intermediate the width of the lamination, rather than on the edge of the lamination. The lamination 18 of Fig. 7 is provided with a generally V-shaped bend 19 extending for all or the greater part of the length of the lamination and positioned intermediate of the width of the lamination. The longitudinal bend 19 which is positioned intermediate the width of the lamination obviously may have cross-sectional shapes other than the V shape shown in Fig. 7.

There is shown in Fig. 8 a cross-sectional view of a magnetic core embodying laminations of magnetic material of the type shown in Fig. 7, in which the bent portions are positioned intermediate of the width of the respective laminations. When laminations having bends of the type shown in Figs. 7 and 8 are used, the bent laminations are preferably situated in the outer as well as the inner laminar layers of the magnetic core element in which they are situated, as shown in Fig. 8.

As shown in Fig. 9, a plurality of longitudinal bends may be positioned intermediate of the width of the laminations, rather than using only a single intermediate-positioned longitudinal bend such as is shown in Figs. 7 and 8. If desired, as shown in Fig. 9, alternate longitudinally-extending bends in the same sheets may extend in opposite directions.

In another embodiment of my invention, the bends may be obtained by providing the laminations with a continuously curved surface, as shown in Fig. 10. This produces, in effect, a corrugated lamination, with the corrugations extending longitudinally of the respective laminations.

When the longitudinally-bent portions are positioned intermediate of the width of the respective laminations, as shown in Figs. 7, 8, 9, and 10, the bent portions may extend for only a portion of the length of the laminations, as shown in Fig. 7, or they may extend for the entire length of the laminations. When the bent portions extend for only a portion of the length of the respective laminations, with the ends of the laminations remaining unbent, mating leg and yoke laminations may be stacked in a conventional butt and lap assembly.

When the longitudinally-bent portions extend for the entire length of the respective laminations, the mating laminations in the intersecting core element may be provided with mating grooved portions to permit a satisfactory joint between intersecting leg and yoke laminations.

There is shown in Fig. 11 a type of joint structure which may be used when the longitudinally-bent portions extend for the entire length of the bent laminations. A leg member 20 of a magnetic core is provided with longitudinally-extending grooves 21, the grooves in this instance being positioned intermediate of the width of the respective laminations. The laminations of leg 20 extend alternately to the top and bottom edges of the laminations of yoke member 22. The laminations of yoke member 22 extend alternately to the inner and outer edges of the laminations of leg member 20. The yoke laminations which extend to the outer edge of leg member 20 are provided with transverse grooves which mate with the longitudinal grooves 21 of leg member 20. The interlocking between the longitudinal grooves and transverse grooves provides a strong joint between the inter-

5

secting leg and yoke laminations, and is effective in preventing the leg and yoke members from shifting with respect to one another.

In addition to providing reinforcement for the core legs against bending, as has been explained hereinbefore, the use of my longitudinally-bent lamination members also provides certain other advantages. One additional advantage in the case of edge-bent laminations is that it permits the use of more magnetic material within an encircling cylinder of a given radius.

A further advantage of the use of my longitudinally-bent laminations, particularly where the bent portions are at the edges of the respective laminations, is that in certain applications where the stationary electrical induction apparatus is air-cooled, the bent edges serve as cooling fins, in addition to the mechanical strengthening obtained by their use.

While the longitudinally-bent laminations hereinbefore described will probably most generally be used for reinforcing leg members of magnetic cores, they may equally well be used for reinforcing the yoke members, and in a given core either leg or yoke members or both may be reinforced with the use of longitudinally-bent laminations.

It can be seen that the longitudinally-bent laminations in accordance with my invention provide a reinforcement for the legs and yoke members of a magnetic core, thereby reducing tendency to bending of the leg and yoke members, and danger of cracking of any insulating cylinders which may surround the core legs.

It will be understood that while I have illustrated my invention in connection with a magnetic core having a cruciform cross section, my invention may be used equally well with other types of magnetic cores. Also, while I have illustrated my invention in connection with a magnetic core having butt and lap joints, the use of my invention is independent of the particular type of joint structure used. Also, as mentioned previously, while I have shown the use of right angle bends where the laminations are longitudinally bent at their edges, such edge bends need not necessarily be at right angles.

While I have illustrated my invention in connection with a core of the flat stacked type, it will be understood that my longitudinally-bent laminations may also be used with cores of the bent strip type, in which strips of oriented magnetic material are bent into shapes conforming to the core configuration.

Also, it will be obvious that wherever I have used a single laminar layer by way of illustration for a particular longitudinally-bent lamination arrangement, a plurality of laminar layers may be used instead.

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 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 stationary electrical induction apparatus comprising, in combination, a winding leg member having a plurality of flat stacked elongated gen-

6

erally rectangular-shaped laminations, said laminations being divided into groups of laminations of predetermined width having aligned edges between which are interspersed wider laminations, said wider laminations being laterally offset relative to the narrower laminations so that they each have an edge in alignment with an edge of the narrower laminations and an edge extending beyond the other edges of the narrower laminations, said wider laminations being selectively offset laterally in opposite directions, said laterally extending side edges being longitudinally bent in overlapping relation at approximately a right angle to said narrower laminations for stiffening said leg member.

2. A core member of a magnetic core for stationary electrical induction apparatus comprising a plurality of flat stacked generally elongated laminations of magnetic material, said flat laminations being divided into groups of adjacent laminations, the laminations of each group having the same widths and aligned edges, and a plurality of laminations of magnetic material having substantially right angle bends extending longitudinally thereof, said bent laminations having portions interspersed between said flat laminations and portions extending from the edges of said flat laminations, the said interspersed portions lying in planes parallel to the planes of said flat laminations and the bends of said bent laminations extending longitudinally of said core member, said extending portions being bent in overlapping relationship with respect to the extending portions of adjacent said bent laminations.

3. A core member of a magnetic core for stationary electrical induction apparatus comprising a plurality of flat stacked generally elongated laminations of magnetic material, said flat laminations being divided into groups of adjacent laminations, the laminations of each group having the same widths and aligned edges, and a plurality of laminations of magnetic material each having a substantially right angle bend extending longitudinally thereof, said bent laminations having portions interspersed between said flat laminations and portions extending from the edges of said laminations, each of said bent laminations having one edge in alignment with one edge of said flat laminations with said one edge of alternate bent laminations aligned with opposite edges of said flat laminations, said interspersed portions aligned in planes parallel to the planes of said flat laminations, the said interspersed portions lying in planes parallel to the planes of said flat laminations and the bends of said bent laminations extending longitudinally of said core member, said extending portions being bent in overlapping relationship.

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