TRANSFORMER CORE AND LAMINATION THEREFOR

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The present invention relates itself to electromagnetic induction apparatus, and more particularly to the form and manufacture of laminations for stacked transformers. Every electromagnetic induction device is a flux generator and from every flux generator there is a certain amount of flux leakage. Flux leakage is a continuing problem in electrical circuits in that leakage from the plurality of inductive devices therein link up to form stray flux fields that influence and interfere with other functions in the circuit. In one particular example, in television circuits, flux leakage mainly from transformer cores form stray flux fields that interfere directly with the electron beam deflection system. With the current trend toward compactness in television design using smaller and more closely positioned components, shorter necked television tubes and more highly stressed deflection systems; the problem created by flux leakage is critical. It is to this general problem of preventing flux leakage from transformer cores in the most effective and least expensive way that the present invention directs itself.

There are several ways of controlling the leakage flux so as to avoid stray flux fields, one of which is to decrease the flux density in a transformer by increasing the core size. But, of course, this is contrary to the trend toward compactness and results only in a larger and more expensive transformer. Copper bands around the core tend to contain the flux lines and reduce flux leakage and orientation of the transformer core on the television chassis may also avoid stray flux fields but these solutions are limited in their effectiveness. None of the best methods that has been devised for solving this problem of flux leakage is to completely enclose the transformer in a shield or "can" whereby all the flux lines are contained within the can. Although effective, this manner of solution is expensive.

It has now become a practice to make power transformers in radio and television circuits of stacked interleaved U and laminations, which transformer is enclosed in a can. Such construction is expensive not only in that it includes the extra element of a can but also in that in making the interleaved stacking it is necessary that the laminations be individually handled. Thus, although the resulting core transformer is effective for reducing component size, it is considerably more expensive in material cost and in labor expense than is preferred for television power transformer usage.

A general object of the present invention is to provide a new and improved stacked lamination transformer core structure and lamination therefor permitting of relatively inexpensive construction, ease of assembly and minimum flux leakage.

A further object of the invention is to provide a lamination form adapted for use in a stacked lamination transformer core structure and which lamination is of a configuration so as to permit the stapling out of the metal strip with no substantial loss in magnetic material.

An additional object of the invention is to provide a method of making the novel lamination in accordance with the invention from a single strip of magnetically permeable metal and without the wasting of any significant amount of metal material.

A specific object of the invention is to provide a modified U shaped lamination including two leg portions joined by a bight portion wherein the legs may be of any length within the limitation that one leg is shorter than the other leg by approximately the width of the bight portion. Accordingly, in stamping out this lamination from a rectangular portion of a magnetic strip it is possible to interdigitate the positions of the modified U blanks so that in the punching of one blank from the strip, that which is left is an identical modified U blank. Laminations so formed are stacked into two complementary stacks, windings, inserted over the legs of one stack and the two stacks are clamped thereby to form a butted U-U core transformer for which the distributed windings overlap the butted joints thereby reducing of flux leakage and substantially avoiding stray flux lines. It is obvious that a shelf type can be formed from two core type structures with the same advantages in ease of assembly and reduction of flux leakage.

Further objects and features of the invention pertain to the particular arrangement and structure whereby the above identified and other objects of the invention are attained. The invention, its structure, its method of manufacture and its arrangement for use will be better understood by reference to the following specification and drawings forming a part thereof, wherein:

FIGURE 1 is a view in perspective of a modified U lamination in accordance with the present invention;
FIGURE 2 is a perspective view of two complementary stacks of laminations as shown in FIGURE 1 split and arranged for butting so as to form a core type transformer;
FIGURE 3A is an elevational view of a core type transformer made from the laminations of FIGURE 1;
FIGURE 3B is an elevational view of a core type transformer made from the laminations of FIGURE 1;
FIGURES 4A and 4B illustrate two methods for stapling blanks in accordance with the invention from a strip of magnetically permeable material; and,
FIGURE 5 illustrates another method of stapling blanks in accordance with the invention from a strip of magnetically permeable material.

Referring first to FIGURE 1, there is shown therein in perspective view a lamination 10 made up of integrally formed leg portions 12 and 14 and a bight portion 16. The lamination 10 is a blank stamped from a thin sheet of magnetically permeable metallic material for which the magnetic grain may or may not be oriented depending upon the cost requirements and the magnetic circuit standards to be met. The leg 12 is of a length l and the bight portion 16 is of a width a. Preferentially then the leg portion 14 is of a length l—a, with the legs 14 and 12 each being of a width b. The bight portion 16 is of a length 3b, as shown. Where grain oriented material is employed it may be that it will be preferred to compensate for the difference between in-grain and cross-grain permeability by making the cross-grain dimension larger than the in-grain dimension. For example, if the lamination 10 were a blank of material grain oriented in the direction indicated by the arrow 18 and if it were desired to compensate for the difference between the magnetic permeability of the in-grain and cross-grain areas, the dimension a would be greater than the dimension b by an amount substantially in proportion to the difference between in-grain and cross-grain permeability of the magnetic material.

The manner in which the laminations 10 illustrated in FIGURE 1 are stacked in order to form a butted core is illustrated in FIGURE 2. Therein the laminations 10 are arranged in a first stack 22 and in a second stack 24 wherein the stack 22 provides a butting face 26 associated with the leg portions 12 and a butting face 28 associated with the leg portions 14, and the stack 24 provides a butting face 36 associated with the leg portions 14 and a butting face 38 associated with the leg...
portions 12. In actual practice the laminations 16 may be arranged in the stacks 22 and 24 and potted with any suitable resin, or clamped, or wired or pinned through mounting holes, not shown, so as to hold the laminations in stacks during assembly and mounting of the transformers.

The manner in which the transformer of the type otherwise illustrated in FIGURE 2 is finally assembled is illustrated in FIGURES 3A and 3B. In FIGURE 3A there is shown a core type transformer assembled from stacks 22A and 24A of laminations as shown in FIGURE 2 and including transformer windings 40 and 42 overlying the abutting faces 26A-36A and 28A-38A, respectively. The exact nature of the windings 40 and 42 is not important as the consideration that they do overlie the abutting faces thereby substantially reducing the leakage flux and confining the lines of stray flux to the transformer configuration. The stacks 22 and 24 may be secured into place by any convenient bracket means which will bring the abutting faces into intimate contact configuration. Of course, the smoother and the more intimate the association between the abutting faces the less the air gap and the less the flux leakage.

In FIGURE 3B there is shown a shell type transformer assembled from stacks 22B and 24B and stacks 22C and 24C and arranged to provide a common central leg 46 and two legs 45 and 49. The center leg 46 has overlying it and the abutting faces thereof a transformer winding 52 and the legs 48 and 49 have overlying them and the abutting faces thereof transformer windings 54 and 56. The manner of mounting is optional, it being important only that the stacks be arranged to provide a substantially gapless and intimate mating between abutting faces.

FIGURE 4A illustrates the procedural steps that take place in stamping the laminations 16 from a strip of magnetically permeable material 50. In this particular arrangement and in keeping with the definition set forth relative to FIGURE 1, the strip of material is selected to be of a width 46. It is fed into a punch press provided with two simultaneous punching operations at consecutive punching stations. Thus, at the first stamping station, as illustrated in FIGURE 4A, the strip 50 is operated upon to punch out the blank 60 corresponding to the laminations 16 as shown in FIGURE 1. Therefore, the punch press operates so as to shift the punched strip to station 2 whereat the final punching operation takes place to sever the blank 62 from the strip 50 and complete the punching operation. At the same time that blank 62 is being punched at station 2 another blank 66 is being punched at station 1. Thus, the punching operation is quick and efficient and produces blanks for laminations without waste of any strip material. FIGURE 4B illustrates another punching arrangement where a strip of material 50 of a width 41-a is subjected to a single punching operation whereby the blank 64 is stamped out leaving as a residual the blank 66, each blank configuration as in FIGURE 1.

A similar but more complicated punching operation is illustrated by the representation of FIGURE 5. Therein in the selected punch press is designed to have at least four active punching stations whereby punching operations can be carried out simultaneously. Specifically, again a strip 50 of a width 4b is fed into the punch press, not shown, and progresses therethrough in seven stations. At station A, guide slots 70, 72, 74, 76, 78 and 80 are punched into the strip, which slots serve not only for alignment purposes during the subsequent stamping operations but accurately position and identify the abutting faces of the laminations product. At station B, the blank stamping operation takes place where the blank 82 is punched from the strip. At station C a second punching operation takes place wherein the blank 84 is punched from the strip and at station D a final stamping operation takes place wherein the blank 86 is stamped from the strip leaving in addition the blank 88.

In the stamping operation of FIGURE 5 the punching of the guide slots does create some nominal waste but it does permit a better alignment and does provide for a greater exactitude in the punching of the faces that will form the abutting faces of the transformer core stacks. Other punching operations may be performed such, for example, as mounting holes in the laminations, if desired, and a shaving operation on the face of the guide slots that will form abutting faces of the transformer core. The first operation may be completed in either of the arrangements of FIGURES 4 and 5 by the inclusion of an extra preliminary punching station. Similarly, the shaving operation may be added to the arrangement of FIGURE 5 by including between station A and station B a separate shaving station.

In practice, laminations suited for use in the construction of television power transformers have been stamped from strip steel of AISI grade M27 and of a 24 or 26 gauge. Core type transformers constructed in accordance with the scheme of the present invention are approximately three inches square with a one inch central aperture. This physical size may be varied according to the permeability of the selected material and the desired power capacity of the transformer to be constructed from the core.

From the foregoing it is clear that there has been provided herein a new and improved core construction and lamination therefor whereby a core type transformer can be constructed from laminations stamped from a strip of magnetic permeable material without waste of that material and wherein, specifically, the laminations are of a modified U shape with one leg shorter than the other leg by a dimension corresponding to the width of the bight portion thereof. Additionally, through use of such laminations it is possible to derive a transformer construction wherein windings carried on opposite legs of the transformer enclose and encompass the abutting faces of the lamination stacks in a manner so as to substantially reduce flux leakage and prevent the formation of stray flux lines. Thus, there is provided not only a simple and efficient lamination and method of making the same, but there is formed a transformer which can be made of relatively inexpensive permeable material. The principles described herein may also be employed in larger dimensions for the purpose of making laminations for high kva, power transformers.

Although the arrangement described herein is considered at present to be preferred, it is understood that it merely exemplifies of the principles of the invention and that variations and modifications may be made therein. It is intended to cover in the appended claims all such variations and modifications as fall within the true spirit and scope of the invention.

We claim:

1. A core type transformer which comprises a first stack of laminations including a first leg portion, a second leg portion and a bight portion joining said first and second leg portions; said first leg portion of said stack being longer than said second leg portion by an amount corresponding substantially to the width of said bight portion; said laminations of said first stack being joined so that the free ends of said stacked first and second leg portions define a planar mating face; a second stack of laminations including first leg portion, a second leg portion and a bight portion joining said leg portions and structured so as to completely support said first stack of laminations; said laminations of said second stack being joined so that the free ends of said stacked first and second leg portions define a planar mating face that complements the mating face defined by the free ends of said stacked leg portions of said first stack of laminations; said mating faces of said first and second
leg portions of said respective stacks being intimately abutted so that a substantially rectangular core configuration is defined by said abutted stacks; and first and second transformer windings overlying and encompassing respective ones of said abutted mating faces and adjacent segments of said stacked leg portions so as to minimize leakage flux and confine lines of stray flux to said core type transformer during the operation thereof.

2. A shell type transformer which comprises a first stack of laminations including a first leg portion, a second leg portion and a bight portion joining said first and second leg portions; said first leg portion of said stack being longer than said second leg portion by an amount corresponding substantially to the width of said bight portion; said laminations of said first stack being joined so that the free ends of said stacked first and second leg portions define a planar mating face; a second stack of laminations including a first leg portion, a second leg portion and a bight portion joining said leg portions and constructed so as to complement the configuration of said first stack of laminations; said laminations of said second stack being joined so that the free ends of said stacked first and second leg portions define a planar mating face that complements the mating face defined by the free ends of said stacked leg portions of said first stack of laminations; said mating faces of said first and second leg portions of said respective stacks being intimately abutted so that a substantially rectangular core configuration is defined by said abutted stacks; third and fourth stacks of laminations being joined to said first and second stacks so as to provide a rectangular transformer configuration having a center leg of greater width than the two end legs thereof and having the planar mating faces of said leg portions of said first and second abutted stacks that define a portion of said transformer center leg offset from the planar mating faces of said leg portions of said third and fourth stacks that define the remaining portion of said center leg of said transformer; and a plurality of transformer windings overlying and encompassing respective ones of said abutted mating faces and adjacent segments of said stacked leg portions that define said transformer legs so as to minimize leakage flux and confine lines of stray flux to said core type transformer.

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