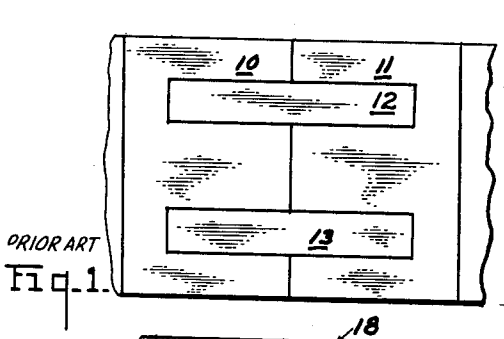
May 4, 1965 D. J. KUCK ETAL 3,181,402

METHOD OF FORMING F-SHAPED AND L-SHAPED LAMINATIONS FOR SHELL-TYPE CORE

Filed April 3, 1963



PRIOR ART

Fig. 1.

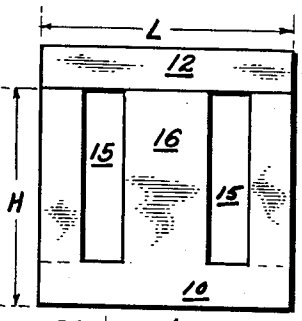
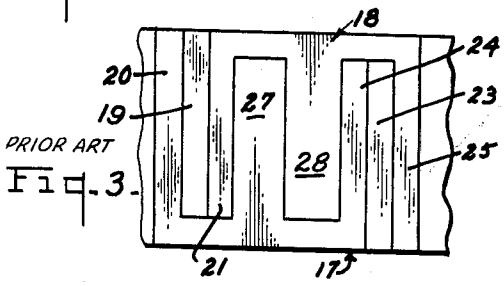


Fig. 2.

PRIOR ART



PRIOR ART

Fig. 3.

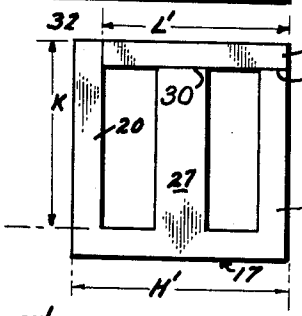


Fig. 4.

PRIOR ART

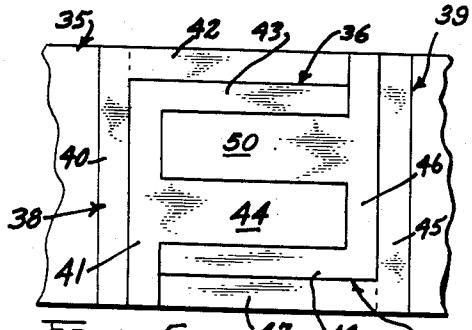


Fig. 5.

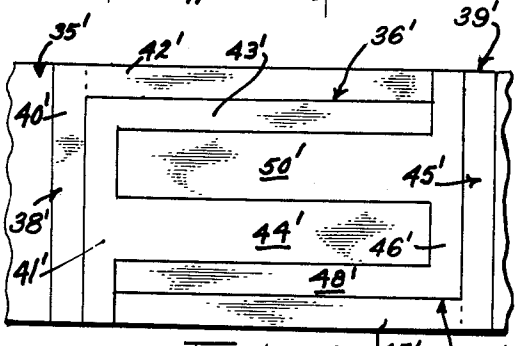


Fig. 7.

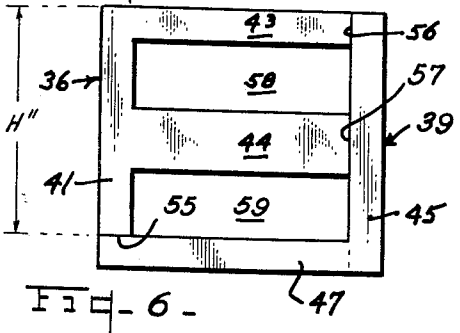


Fig. 6.

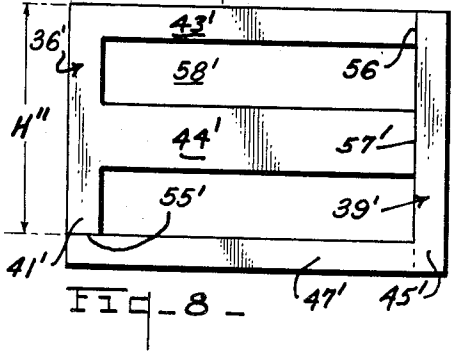


Fig. 8.

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METHOD OF FORMING F-SHAPED AND L-SHAPED LAMINATIONS FOR SHELL-TYPE CORE

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3 Claims. (Cl. 83—32)

This invention relates to an electrical apparatus and particularly to a lamination for a shell-type core, and more especially to such a lamination which may be manufactured from an elongated sheet of material without scrap.

Transformer manufacture has been guided in the past and probably will continue to be guided principally by consideration of cost. It appears that cost of material has made the conventional shell-type core using scrapless punchings predominant in the small power transformer business; the cost of material being greater than one half the total cost of manufacture of the shell-type core. However, use of scrapless-type laminations of conventional construction has in the past, allowed variation in proportions only by changing the stack height.

The ratio of stack height to center leg width is normally in the range of 1:1 to 3:1 with the lower ratios in the range being most commonly used for design and manufacturing reasons in all present day production. Thus, the core proportions available to a designer are relatively fixed, and the designer cannot apply in a general manner the criteria leading to an optimum design of laminations.

It is particularly desirable that a scrapless-type lamination be provided a 2 to 1 ratio of window width to outer leg width, of rectangular shape in horizontal plan and of any length desired.

This relatively increased window width in laminations with F-shaped and L-shaped members, makes possible a greater volume of winding for a given size core and is particularly desirable, for example, with high voltage and multi-secondary units in which the space factor tends to be low. A greater proportion of insulation in the total winding space tends to reduce the costs, losses and weight per volume of the windings giving a pronounced advantage over the conventional scrapless-type lamination. The prior art produces patents such as: 1,718,176; 2,302,571 and 2,811,203; all limited in their own field of endeavor, or having scrap material left over at a loss to the manufacturer.

It is therefore, an object of the present invention to provide a method of forming shell-type laminations from strips of sheet material, cutting said strip to define a pair of facing and overlapping F-shaped members and also cutting L-shaped members therefrom in a scrapless manner.

It is a further object of the present invention to provide a method of forming lamination of F and L shape for a shell-type core for an electrical apparatus.

It is another object of the present invention to provide a method of forming laminations for a shell-type core having improved magnetic characteristics.

It is a further important object of the present invention to provide a method of forming laminations which can be formed with F and L shaped members such that the top leg and center leg of the F member and the upright

leg of the L member can be arbitrarily long; this provides arbitrarily large window areas in the assembled lamination.

Other novel features of the invention are set forth in the following specification. The invention itself, relating to the method of construction and advantages thereof may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a plan view of a pair of conventional, substantially scrapless-type laminations for shell-type cores as cut from magnetic steel, similar to the prior art Patent 2,302,571;

FIGURE 2 is a plan view of an assembled conventional lamination as shown by FIGURE 1;

FIGURE 3 is a plan view of a pair of conventional, substantially scrapless-type laminations for shell-type cores with increased window areas and cut from magnetic steel, similar to prior art Patent 2,811,293;

FIGURE 4 is a plan view of an assembled conventional lamination as shown by FIGURE 3;

FIGURE 5 is a plan view of a pair of laminations as formed from sheet magnetic steel in accordance with the teachings and principles of the present invention without scrap, wherein the laminations are of different configuration than the type laminations of FIGURES 1 and 3;

FIGURE 6 is a plan view of an assembled scrapless lamination in accordance with the teachings and principles of the present invention, the legs of the L-shaped members being substantially of the same length;

FIGURE 7 is a plan view of a pair of laminations as formed from sheet magnetic steel, similar to that shown by FIGURE 5, but having the upright leg of the L-shaped members of greater length than the base legs; and

FIGURE 8 is a plan view of an assembled scrapless lamination in accordance with the teachings and principles of the present invention, as shown by FIGURE 7.

As illustrated in FIGURES 1 and 2, in one form of conventional substantially scrapless-type lamination, the laminations are formed from a strip with E-members **10** and **11** opposing each other in abutting relation with the bridging members **12** and **13** being cut from between the legs of the E-members. It is observed from FIGURES 1 and 2 that the height "H" of the E-members **10** and **11** and the length "L" of the bridging members **12** and **13** cannot be chosen independently without violating the scrap free design desired.

As illustrated in FIGURES 3 and 4, the laminations are cut from a sheet of magnetic material. As indicated in FIG. 3, the E-members **17** and **18** are facing and overlapping with the bridging member **19** being cut from between the long outer leg **20** of the E-member **17** and the short outer leg **21** of the E-member **18**, while the bridging member **23** is cut from between the short outer leg **24** of the E-member **17** and the long outer leg **25** of the E-member **18**. The bridging members **19** and **23** are of the same length "K" as the long legs **20** and **25** and of equal width, while the center legs **27** and **28** are twice the width of the outer legs and are of the same length as the shorter legs **21** and **24**. As illustrated in FIGURE 4, the bridging member **19** in assembled relation with E-member **17** has an end abutting the side edge of the long leg **20** along a

juncture indicated at 32, while the ends of the shorter legs 24 and 27 abut the bridging member 19 along junctures 33 and 34. It is observed from FIGURES 3 and 4 that the height H', of the E-members 17 and 18 and the length L', of the bridging members 19 and 23 cannot be chosen independently without violating the scrap free design desired.

The laminations according to the present invention may be cut from a sheet of magnetic material 35. As indicated in FIGURE 5, the F-shaped members 36 and 37 are facing and over-lapping with the L-shaped bridging members 38 and 39 being cut from the strip material 35 adjacent the outer edge portions of said F-shaped members. The base leg 40 extends adjacent to the body 41 of the F-shaped member 36 and the upright leg 42 extends adjacent to the top leg 43 of the F-shaped member 36. The said member 36 having a center leg 44 and said member 37 having a center leg 50. The base leg 45 extends adjacent to the body 46 of F-shaped member 37 and the upright leg 47 extends adjacent to the top leg 48. The upright legs 42 and 47 are of the same length as the top legs 43 and 48 and of equal width, while the center legs 44 and 50 are twice the width of the top legs 42 and 47 and are of the same length as said top legs. It will be observed that the length of the base legs 40 and 45 of each L-shaped member 38 and 39 is four times the width of the center leg thereof, and also equal to the length of the body of each F-shaped member plus the width of an upright leg of an L-shaped member; the body length of each F-shaped member being three and one-half times the width of the center leg thereof. As illustrated in FIGURE 6, the F-shaped member 36 in assembled relation with the L-shaped member 39 has the bottom end of its body 41 abutting the side edge of the free end of upright 47 along a juncture indicated at 55, while the free ends of the top leg 43 and center leg 44 abut the base 45 of the L-shaped member 39 along junctures 56 and 57 respectively.

The window 58 between the top leg 43 and the center leg 44 of the assembled lamination in FIGURE 6 will be observed to be identical to the window, or as sometimes referred to as the space area 59 between the center leg 44 and upright leg 47, said windows being wider than those shown in FIGURE 2, the windows being as wide as the center leg 44 rather than being the width of the outer legs as in FIGURE 2.

It will be observed that by virtue of the size and shape of the F-shaped member 36, the laminations in a stack may be interleaved so that the junctures 55 and 56, for example, will be disposed successively at the four corners of the stack whereby the flux losses in the overlapping laminations are reduced, and a distinct improvement in magnetic characteristics is obtained.

In FIGURES 7 and 8 is illustrated a manner of increasing the window area by increasing the length of the upright leg of the L-shaped member and the lengths of the top leg and center leg of the F-shaped member and doing this without the introduction of scrap material.

It will be observed that the main difference between the assembled lamination shown in FIGURE 8 and the assembled lamination shown in FIGURE 6 is that in FIGURE 8 the overall length of the top leg 43' and the center leg 44' of the F-shaped member 36' is greater than the height, H'', of the F-shaped member 36'; whereas in FIGURE 6, the top leg 43 and the center leg 44 of the F-shaped member 36 are the same length as the height, H'', of the F-shaped member 36. Generally speaking it will be observed that the reason for the elimination of scrap by the applicants' design is that the length of the upright leg of the L-shaped member changes the same amount as the lengths of the top and center legs of the F-shaped member as the window length changes.

Furthermore it is observed that the length change is independent of changes in the height of the lamination, H''. It will also be observed that the base legs of the F-shaped members are always equal to the height of the body of the F-shaped member, H'', plus the width of the upright leg of the L-shaped member.

The method of manufacturing the construction described above regarding this invention shown in FIGURES 5, 6, 7, and 8, over the prior art references is highly advantageous and novel. With high voltage multi-secondary units, it is desirable to have large window spaces in relation to the other core dimensions to allow a greater proportion of insulation in the total winding space of the transformer core and thus to reduce cost, losses and weight per unit volume of the winding. Further, the magnetizing current and core loss depend greatly on the joint construction, and the core can be greatly improved by lowering the ratio of gaps to bridging laminations, as is possible with F-shaped and L-shaped laminations.

It will thus be observed that the pattern shown in FIGURE 5 or 7 can be modified without scrap to alter its dimensions and proportions in a number of ways. Namely, assuming that the center leg thickness and window width are always twice the outer leg thickness, there are two design parameters; window width and window length. With the applicants' design, both of these design parameters can be chosen independently, whereas in the prior art of FIGURE 3, only one of these parameters could be chosen independently. That is in FIGURE 4 when the body height H' is chosen, then the length is automatically determined for a scrapless design, and vice versa; while with the applicants' design, when body height, H'', of FIGURE 8 is fixed, the leg length can still be arbitrarily chosen, and vice versa. There is thus provided in accordance with the present invention a novel highly adaptable lamination pattern which can be adapted to a number of designs not possible with the conventional substantially scrapless-type laminations.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention, and it is, therefore, not the purpose of this specification to limit the patent granted hereon otherwise than nessitated by the scope of the appended claims.

We claim:

1. The method of forming shell-type laminations which comprises selecting a generally rectangular strip of sheet magnetic material, cutting said strip to define a pair of facing and overlapping F-shaped members, and cutting said strip to define generally L-shaped members outside and adjacent to the outer edges of the body and top leg of each of the respective F-shaped members to form a pair of shell-type laminations.

2. The method of forming F-shaped and L-shaped laminations which comprises selecting a strip of sheet magnetic material, making cuts in said strip to define a pair of facing and overlapping F-shaped members with one window of each F-shaped member having the center leg of the other F-shaped member therein and with the other window of each F-shaped member having the top leg of the other F-shaped member and one upright leg of an L-shaped member therein, whereby the width of said windows may be equal to the width of said top leg of the said F-shaped member plus the width of the said upright leg of said L-shaped member.

3. The method of forming scrapless F-shaped and L-shaped laminations which comprises selecting a strip of sheet magnetic material, making cuts in said strip to define an F-shaped member having a center leg twice the width of the top leg thereof, and with an upper window between the center leg and the top leg thereof and a lower window below the center leg thereof, said windows being equal in width to each other and also equal in width to the width of the top leg thereof plus the width of an upright leg of an L-shaped member, said windows also equal in width to the width of said center leg and to define the upright leg of the L-shaped member of a length greater

than the length of the center leg of said F-shaped member by the width of its upright leg, making cuts to define an identical second F-shaped member having a center leg in the upper window of said first F-shaped member and having its top leg in the lower window of said first F-shaped member, and making cuts to define two L-shaped members, one L-shaped member having its upright leg in said lower window of said first F-shaped member and its base leg adjacent and along the body of said second F-shaped member and the second L-shaped member having its upright leg in the lower window of said second F-shaped member and its base leg adjacent and along the body of said first F-shaped member.

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