A. B. HENDRICKS, JR.

TRANSFORMER.

APPLICATION FILED MAY 20, 1914.

1,297,161. Patented Mar. 11, 1919.

Fig. 1.

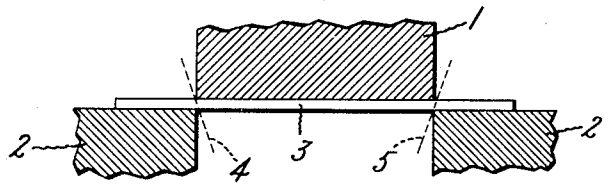


Fig. 2.

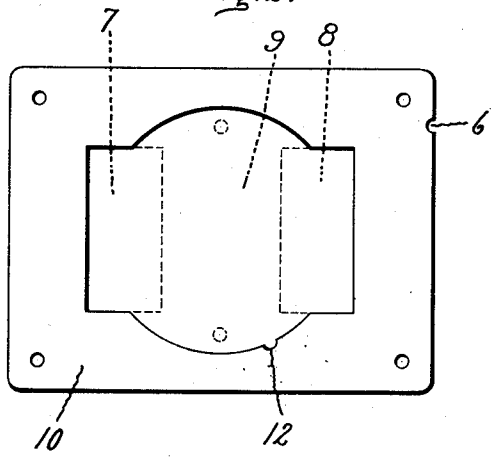


Fig. 3.

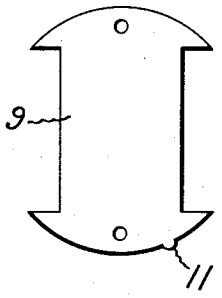
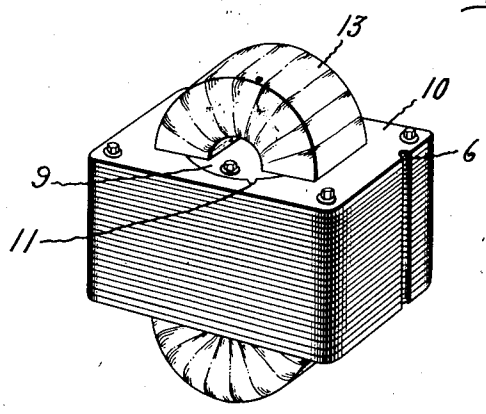


Fig. 4.



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UNITED STATES PATENT OFFICE.

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TRANSFORMER.

1,297,161. Specification of Letters Patent. Patented Mar. 11, 1919.

Application filed May 20, 1914. Serial No. 839,890.

To all whom it may concern:

Be it known that I, ALLAN B. HENDRICKS, Jr., a citizen of the United States, residing at Pittsfield, county of Berkshire, State of Massachusetts, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

My invention relates to transformers and the objects of my invention are to reduce the operating losses in transformer cores generally, and to provide particularly for the manufacture, at as low cost as may be, of a line of small butt joint shell type transformers of variable sizes and good electrical and mechanical characteristics, having no case about the core and hence better heat radiation therefrom. The cores of these transformers preferably comprise a single laminated, but otherwise integral, outer portion, and the inner sections of the laminations, that is, the sections of the laminations comprising the inner legs, are punched from the outer sections of the laminations. A number of difficulties are encountered in such a construction and it is these difficulties I intend primarily to overcome though it will be obvious that certain features of my invention are not limited to this single application but are of much wider application.

I have found that the inner and outer dies of an ordinary punch press are always unsymmetrically related, not by design but because it is impossible practically to locate them otherwise; thus when a portion of sheet metal is struck or punched out, the piece is not exactly symmetrical. I have found, in other words, that if such a piece or portion is to be replaced, it must be replaced so that the inner and outer sections bear the original relations to each other again, if the best butt joint or joints, magnetically and mechanically, are to be secured. If two pieces punched from each other by the same dies are thus unsymmetrical, it is apparent that any two complemental pieces punched by different sets of dies must be still more unsymmetrical and anticomplemental, however nearly alike the two sets of dies may seem to be, and that any butt joint between them must be imperfect. Furthermore, when a piece of metal is punched from a sheet thereof in any ordinary punch press, the break between the two pieces is not exactly at right angles to the plane of the sheet, but is more or less at an angle to that plane. The extent of this angle is dependent upon the relation and spacing between the inner and outer dies, and therefore is not the same for any two sets of dies, and in a single set tends to change as the dies are used, worn and reground. Prior to my invention these irregularities were not taken into consideration in the construction of butt joint transformer cores and the laminæ were assembled as they might run, resulting in unnecessarily imperfect joints and unnecessary core losses and in general in unnecessarily imperfect constructions. I propose to give these facts due consideration.

In carrying out the objects of my invention I employ a novel method of construction and a novel design of lamination sections and construction of core. The core construction comprises such sections of laminæ and their location in such a manner that the irregularities or angles of the abutting surfaces or edges fit into and complement each other as fully as may be, thereby securing the maximum areas of engagement throughout joints between the sections. To this end I design the laminated sections so widely unsymmetrical, preferably by a notch on one section and a projection to fit therein on the abutting section, that they will be naturally assembled in the proper, complementing way. Now the very best results would be secured by composing each lamination of the completed core of the very sections originally cut from each other, but this construction obviously introduces difficulties of assembly which I do not now believe warranted. I find it satisfactory to assemble each core from sections cut by the same dies within a short time of each other, or to say it in a better way perhaps, from sections which are members of a small lot of successive punchings from a single set of dies,—just how large the lot may be depends upon the case in hand, the idea being to minimize the effect of the wear of the dies. The method of constructing the core which I employ consists in striking one section of each lamination from another lamination section at, and to form, (what are to be later) the edges or surfaces which abut other sections; preferably then assembling the inner and outer portions of the core separately from sections of a small lot as pointed out

above, in such a way that the complemental sections may have their original relative positions after the core portions are put together to form the completed core (except that each section does not necessarily abut another from which it was struck); and finally putting the portions together, preferably fitting the portions together in the direction in which the various sections were struck out. The windings are placed on one or more of the core portions before the portions are finally put together. When the outer core portion is an integral member in the direction of the planes of the laminations (which is the form I have illustrated), considerable pressure will be found necessary to seat an inner portion.

The preceding paragraphs related to the proper arrangements of the lamination sections to secure the best joints between the sections; there is also a proper arrangement of each whole lamination to secure the smoothest exterior surface for the core and hence the best appearance. The exterior surface of each whole lamination is formed by one set of dies and the sections of each lamination are generally separated later by another set. Not only then may the sections be related to each other in different orders as I have indicated in the paragraphs above, but also the laminations as a whole may be related in different orders. The preferred order for the whole laminations will be understood from what I have said above regarding the irregular and unsymmetrical surfaces produced by punch presses: The laminations should be so assembled in the core that they bear the same relations to each other as they bore to each other successively in the press which produced their exterior surfaces, but they need not necessarily be arranged in the order in which they were punched. Such a relation of the laminæ produces a reasonably smooth outer surface for the core; this sort of surface is obviously desirable when the core itself supplies an exterior surface of the transformer. This relation may be easily obtained by such an unsymmetrical outline of the laminæ, as by indexes, as to require the proper assembly, in a manner quite similar to that heretofore described.

The accompanying drawings and the following description disclose more specifically my invention as I have found it advantageous to apply it to a line of small transformers. Figure 1 illustrates in section two dies in position to punch a section from a sheet of metal. Figs. 2 and 3 illustrate the two sections of a core lamination. Fig. 4 illustrates the completed shell type transformer involving my invention.

As illustrated in Fig. 1, the upper die 1 of an ordinary punch press is designed to fit closely within the lower die 2. Between these two dies is placed the material 3 from which a section is to be punched by the dies. As the upper die 1 is brought downward into the lower die 2, a section of the material 3 having an area approximately equal to the cross area of the upper die, is punched out. Now it will be found almost invariably that the upper die 1 is irregularly placed with respect to the lower die 2 and that the surfaces or edges along which the parts of the sheet 3 separate, are not perpendicular to the plane of this sheet, but are at an angle thereto, as I have indicated by the dashed lines 4 and 5.

It will be apparent from this that, in putting the inner and outer sections together again, the two sections must be put back in their original relative positions if the greatest and most uniform engagement throughout the contacting surfaces is to be secured, for if, for example, the inner section is reversed so that what was the bottom surface in the original position is the top surface in the replaced position, then the contacting surfaces or edges do not naturally complement each other and the area of contact between them is problematical. Likewise, if the inner section is reversed end for end so that its contacting surface at 4 contacts with the outer section at 5, the contacting surfaces may not fit into and complement each other for the upper die 1 may have been displaced farther from the right hand wall of the lower die 2 than from the left hand wall of the lower die. Further the inner section should be replaced in the outer section in the same direction as it was stamped out in order that there may be the least disturbance of irregularities.

My invention in its complete form wherein I take these facts into consideration will be better understood by a description of the method I employ in constructing a transformer similar to that shown in Fig. 4. I may start by punching a lot of laminations of the exact size required for the transformer and having the general outlines of Fig. 2, providing each with the notch 6 to make the same unsymmetrical to direct the proper assembly to secure the smooth outer surface. Taking care to place the pieces in the press in the same way, being directed by the notches 6, I strike out from each of these pieces of metal the rectangular sections 7 and 8 indicated by the solid and dotted lines of Fig. 2, to provide the winding spaces, and also the section 9, thus leaving the outer lamination section 10 shown in solid lines in Fig. 2. It will be noted that the section 9 is provided with a projection 11 unsymmetrically placed with respect to the section, and by striking out this projection on the section 9, I provide a complementary notch 12 in the section 10. As a whole, it will be observed that the sections

9 and 10 are so unsymmetrical, due to this notch and projection, that the section 9 can be replaced in the section 10 only in its original position relative to the section 10; it is impossible to reverse section 9 end for end without reversing the section 10 and it is likewise impossible to reverse the section 9 by making that surface which was originally the bottom, the top surface when it is replaced in the section 10, for in none but the original position can the projection 10 fit in the notch 12. I then construct the inner and outer core portions separately from as many of the sections 9 and 10 respectively as may be necessary for the particular size of transformer I may wish to construct at that time, taking them as they run from a single set of dies, the laminæ of each portion being bolted together as shown in Fig. 4; the projections and notches on the sections direct the proper relations of the sections. On the complete inner core portion I then place the transformer windings 13 and force this portion into an outer core portion, preferably in the same direction as the inner sections were punched from their respective outer sections. I find that very considerable force is necessary to force the inner section into the outer, and that the work can be most conveniently done by means of a hydraulic press. Since the core portions have been made up from the various sections taken as they ran, it is not to be expected that any particular lamination section 9 is so located that it abuts the section 10 from which it was originally struck, but since the sections 9 and 10 of any particular transformer core are taken from the same small lot of punchings by the same dies, there is little objection to this. Such dissymmetry of outline and differences of inclination of the abutting edges as there may be, must be due principally to differences in the material of the plates and the wear of the dies. Ordinary care in the selection of material will obviate any appreciable differences due to this factor, and the wear of the dies in punching the small lot of sections is so little that the resultant differences between the abutting edges or surfaces of the sections is too small to warrant, generally, any greater refinement in assembling. I believe it will generally be found that such care as I have taken in this particular case is sufficient for most constructions.

While I have described the principle of my invention and the best mode I have contemplated for applying this principle, other modifications will occur to those skilled in this art and I aim in the appended claims to cover all modifications which do not involve a departure from the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. Two transformer core lamination sections adapted to be assembled together with abutting edges, an abutting edge of one section having a projection offset from its center and the complemental abutting edge of the other section being provided with a notch to receive the projection, the notch and projection being so located as to require the assembly of the sections in such a manner that the irregularities of the edges caused by the punching fit into each other.

2. The method of constructing a laminated core transformer of the butt joint shell type which consists in striking each section of each core lamination from a complemental lamination section for the same or a similar transformer core, assembling the outer portion and the inner portion of the core separately and from sections struck at about the same time by the same set of dies, and so that except that each lamination section does not necessarily abut another from which it was struck, when the inner and outer portions are placed together the complemental sections will have the same relative positions as before their separations, placing a winding on the inner core portion, and placing the inner portion in the outer portion.

In witness whereof, I have hereunto set my hand this 18th day of May, 1914.

ALLAN B. HENDRICKS, Jr.

Witnesses:

A. K. Nugent,

Geo. F. Wright.