

A. R. EVEREST.

TRANSFORMER.

(Application filed Mar. 5, 1901.)

(No Model.)

3 Sheets—Sheet 1.

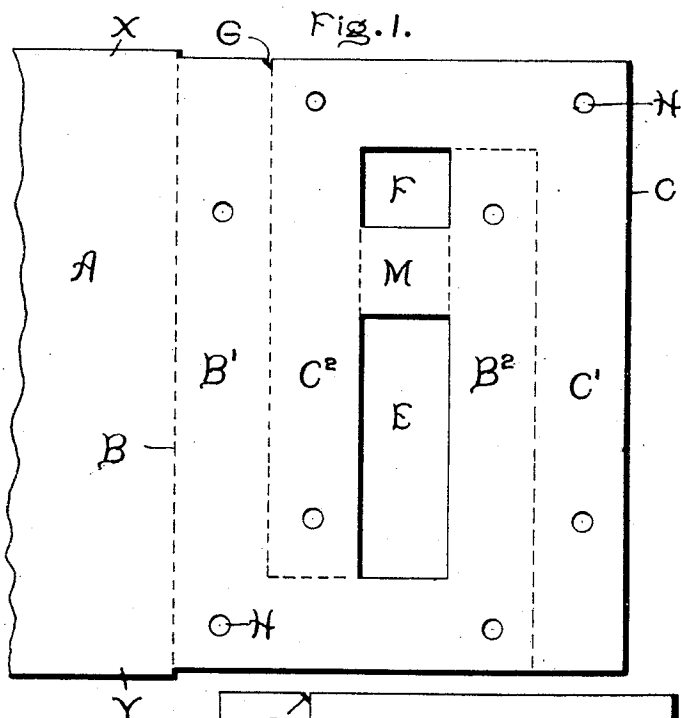


Fig. 2.

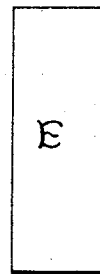
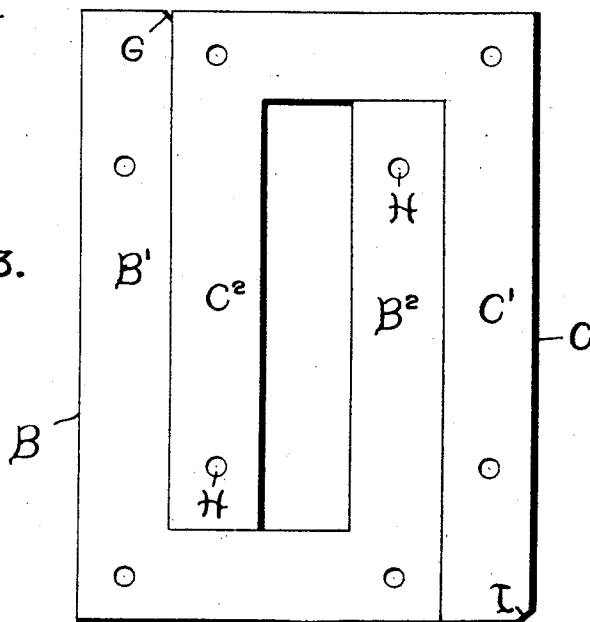


Fig. 3.



Witnesses.

Marcus S. Byng.
Benjamin B. Hume.

Inventor:

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by *Albert B. Davis*
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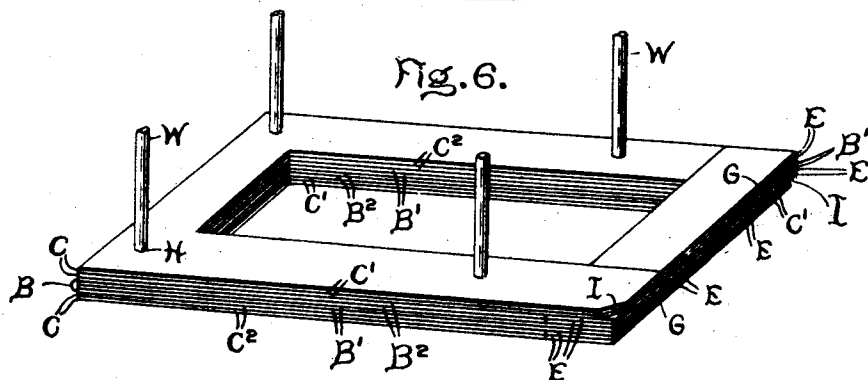
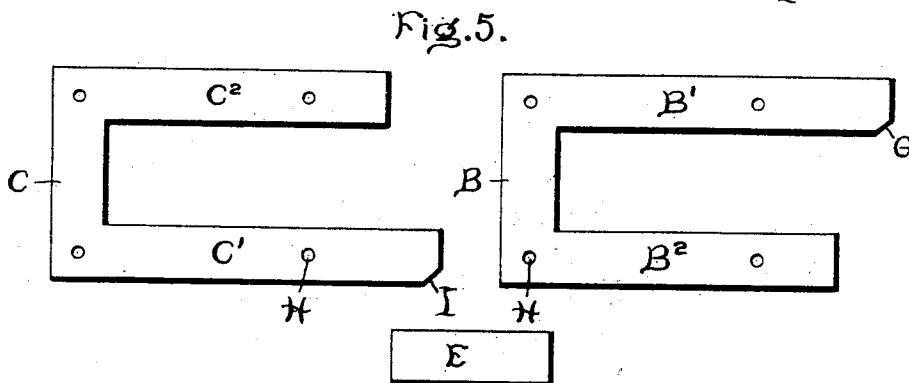
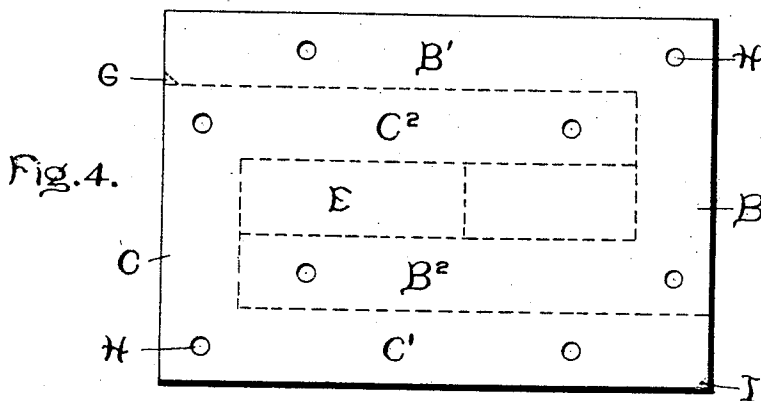
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(Application filed Mar. 5, 1901.)

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3 Sheets—Sheet 2.



Witnesses.

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3 Sheets—Sheet 3.

Fig. 7.

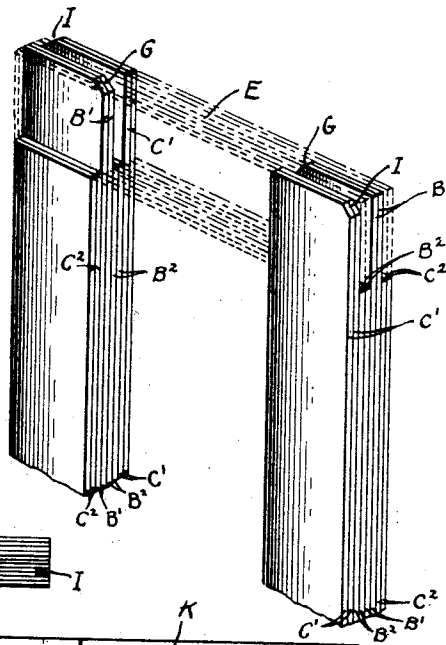


Fig. 8.

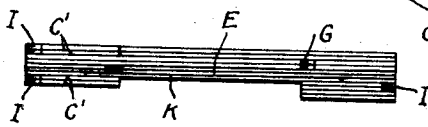
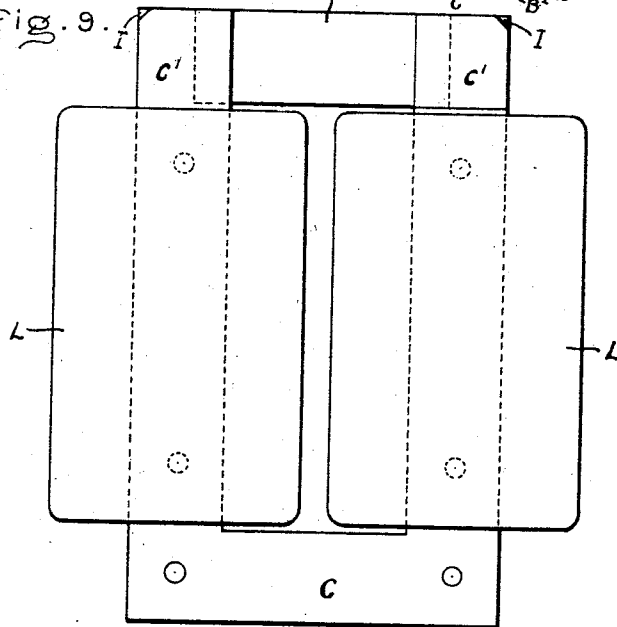


Fig. 9.



Witnesses:

Frank G. Rattie,
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Inventor
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By *Wm B. Davis*
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UNITED STATES PATENT OFFICE.

AUGUSTINE R. EVEREST, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 696,953, dated April 8, 1902.

Application filed March 5, 1901. Serial No. 49,693. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTINE R. EVEREST, a subject of the King of Great Britain, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Transformers, (Case No. 1,723,) of which the following is a specification.

This invention relates to new and useful improvements in the construction of laminated transformer-cores of the general type disclosed in the patent to Moody, No. 567,250. As described in that patent the coils were first wound on two bundles of straight laminae having tongue-and-groove ends, which bundles, with the coils wound thereon, were then placed a suitable distance apart and their ends joined by short bundles of laminae to complete the magnetic circuit. One end of each short bundle interlocked with the tongue-and-groove end of the long bundle, which constituted one leg of the core. The other end of each short bundle abutted against the side of the long bundle, which constituted the other leg of the core. This proved a very cheap and convenient mode of constructing a durable and efficient transformer. However, there was a not inconsiderable core loss in transformers constructed in the above manner, which was due to the fact that there were necessarily four joints between the laminae. With the aid of and in accordance with the present invention transformers have been made which show a reduction in core loss of over five per cent. with respect to transformers constructed as described above. This is a very conservative estimate. As the core loss of a transformer continues independently of translating devices in the secondary circuit, it is clear that such a reduction is material and important.

This result has been obtained by reducing the number of joints between the laminae, so that a better magnetic circuit is obtained. The core made in accordance with this invention is built up of substantially U-shaped laminae, each of which has a long and short leg. The coils are wound independently and are afterward slipped over the legs of the U-shaped core, which is left open at one end for this purpose. The number of joints between the laminae can be decreased by this construction, so that the fixed core loss will be considerably

reduced, and transformers having cores made in this manner have been uniformly efficient in operation and economical in manufacture. It may be noted at this point that, as described in an application of Walter A. Hall, Serial No. 49,694, filed of even date herewith, it has recently been discovered that the U-shaped laminae used in executing my invention are susceptible of being produced in a very economical manner. This of course is an additional advantageous feature of my invention.

Figure 1 is a plan of a sheet-metal blank upon which is performed the first or punching operation as constructed in accordance with the method invented by Hall. Fig. 2 shows a short end lamina which is the result of this operation. Fig. 3 is a plan which shows the result of a second or shearing and final operation, also as constructed in accordance with the method invented by Hall. Fig. 4 is a reversed plan of the blank shown in Fig. 1 before the punching operation has taken place. Fig. 5 includes views of the three parts which are punched or sheared from the blank shown in Fig. 4. Fig. 6 is a perspective view showing the core in process of construction from the parts shown in Fig. 5. Fig. 7 is a perspective view showing the free ends of the assemblage of the sheared U-shaped laminae and the location of the punched end sheets of laminae which complete the magnetic circuit. Fig. 8 is an end view showing the method of locking the end sheets in place; and Fig. 9 is an elevation of the core complete, the coils having been slipped over the core-legs and the end sheets having been inserted in position.

With reference to Fig. 1, the first or punching operation, which is accomplished by a suitable die, trims away the edges X Y of the sheet-metal blank A, punches the pin-holes H, and punches the holes E and F, leaving the strip M between them. The sheet of laminae E (shown in Fig. 2) occupied the space E and is cut out in this operation in order to save a separate operation of cutting it to proper length later, the length shown in Fig. 2 being its final length for adapting it to be used as an end sheet for the core. During the first operation also the guide G is cut in

the upper portion of the blank A. The part M is left to hold the parts rigid until the second or shearing operation, when, as is clear, it can also be sheared off. The part F, which is wasted, is punched out in order to permit the second operation to be merely a shearing operation without the punching which would be necessary if the corners were not removed before the second operation. The removal of the part E by punching permits the shearing to be accomplished along the dotted line at the lower portion of Fig. 1. In any case there must be a free space at the beginning of the part to be sheared in order to permit the operation of the shear. The second or shearing operation results in the separation of the metal along the dotted lines in Fig. 1, the result of which is seen in Fig. 3, wherein the guide I of the lower right-hand corner is also formed. In the case shown the part M is wasted; but this is not always the case. In Fig. 3 it will be seen that two substantially U-shaped laminæ are formed, each having a long and a short leg, the length of the latter of which is equal to the difference between the length of the long leg and the width of the base of the U-shaped laminæ, so that when the parts are arranged, as in Fig. 3, just as they come from the blank A they form a rectangular figure. In addition it will be observed in Fig. 3 that the space between the short inner legs B² and C² is of the same width as the legs or bases of the U-shaped laminæ, or, in other words, the distance between the long leg and the short leg of one laminæ is twice the width of either leg, and therefore equal to the added widths of both legs. From the metal in the space between the short legs B² and C² in Fig. 3 the end sheets of the core are always formed, and according to the dimensions of any given transformer there will be a greater or less waste. In the case illustrated the amount of metal wasted in the construction of this transformer is represented by M and F. If the transformer which is being built is of sufficient size, the material M (the part F being as small as possible) may serve for cores of smaller transformers. On the other hand, the core may be so proportioned that the metal taken from the entire space E M may be used as the end sheet for that particular transformer.

I do not claim the above-described method of punching, as it is the invention of Walter A. Hall, and is more particularly described and claimed in his application for patent, Serial No. 49,694.

In Fig. 5 the three pieces formed from the blank are shown separately, and it should be particularly noted that the lamina C has the outside corner of its longer leg C' cut away at I, while the lamina B has the inner corner of the end of its long leg B' cut away at G. In Fig. 6 is shown a partial assemblage of these parts held together by wooden pins W,

which fit tightly in the holes H. The ends E are not inserted until the coils have been slipped over the core-legs. In assembling the laminæ are slipped loosely over pointed steel pins. The steel pins are then removed and the wooden pins are driven into the holes. The coils L of Fig. 9, which have been wound by another operation, are then (Fig. 9) slipped over the legs of the core and the end sheets E are inserted, as shown in Fig. 7. In the latter figure the lower portion of the core, which is integral with the legs, is cut away. It will be observed that each end sheet E is inserted between the projecting ends of the longer legs, according to the indication afforded by the guides G and I. The guide I on the right-hand corner of the end of the right-hand long leg and the guide G on the left-hand corner of the end of the long leg behind the first serve to indicate to the operator that the end sheet E is to be placed in the space between them. The other end of the end sheet abuts against the side of the end of the long leg, which is contained in the left-hand leg of the core. The end of the next end sheet is inserted between the projecting ends of the long legs of the left-hand core-leg, as indicated to the operator by the guides I and G, and this end sheet abuts against the inner side of the end of the opposite long leg of the right-hand core-leg. The remaining end sheets alternate in the same way until the core is completely assembled.

In practice, as shown in the drawings, the units of assemblage comprise two or more single laminæ.

Reference to Fig. 6 is again necessary in order to explain how from the two different kinds of U-shaped laminæ shown in Fig. 5 the result shown in Fig. 5 is accomplished by means of the alternating guides I and G.

Beginning at the bottom of Fig. 6, a group of two laminæ C is laid with its short leg C² in the foreground and its long leg C', with the outer cut-away corner I, in the background. Upon this group is laid a group of two laminæ B, with their long legs B' and inner cut-away corner G in the foreground and their shorter legs B² in the background. The third layer is a group of two of the same laminæ B which constitute the second layer, but turned upside down, so that their short legs B² are in the foreground and their long legs B' and inner cut-away corner G are in the background. The fourth layer consists of a group of two of the laminæ C, which form the first layer, but turned upside down, so that their long legs C' and outer cut-away corner I are in the foreground and their short legs C² are in the background. This series of four layers is continued until the core is completely assembled. From this description it follows, as shown in Fig. 7, that the successive projecting long legs have their cut-away portions located alternately on the inside and outside of the core-leg, so that the

operator can quickly and accurately insert the ends E in the proper position after the coils have been slipped over the core-legs.

Fig. 8, which is an end view of that portion of the core in which the end laminæ E are inserted, shows the method of locking the end laminæ in position. The strip K has its ends interlapped with the legs of the U-shaped laminæ, so that the adjacent end sheets, which would otherwise be free, are not permitted to flare out beyond the core-legs.

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

1. A laminated transformer-core which has two legs, each having the same number of laminæ; which comprises a plurality of substantially U-shaped laminæ, each of which has a long and a short leg; and also a plurality of end laminæ for completing the magnetic circuit; said core being built up so that the long and short legs of the U-shaped laminæ alternate in the respective core-legs; and the end laminæ, the two coils being in position on the core-legs, being also alternated so that one end of one lamina fills the space at the end of a short leg of a U-lamina of the first core-leg, the other end of said end lamina abuts against the long leg of the same U-lamina in the second core-leg, one end of the next end lamina fills the space at the end of the short leg of the next U-lamina in the second core-leg, and so that the other end of the latter end lamina abuts against the long leg of the latter U-lamina in the first core-leg.

2. A transformer-core, which comprises a plurality of substantially U-shaped laminæ, each of which has a long and a short leg; said laminæ being assembled alternately to form two core-legs of the same thickness and the same number of laminæ; and end laminæ which complete the magnetic circuit.

3. A laminated transformer-core, which has two legs each having the same number of laminæ and which comprises a plurality of substantially U-shaped laminæ, each of which has a long and a short leg, said laminæ being alternately reversed, so that each short leg is included between two long legs; and end laminæ which complete the magnetic circuit.

4. A laminated transformer-core, which has two legs each having the same number of laminæ, and which comprises a plurality of U-shaped laminæ, each of which has a long and a short leg, said laminæ being alternately reversed so that a short leg lies between two long legs and a long leg lies between two short legs, and laminæ having a width substantially equal to the difference between the lengths of the long and short legs, one set of ends of which laminæ fill the spaces in one core-leg between the long legs which lie on opposite sides of the short leg, and the other set of ends of which laminæ abut against the sides of the long legs of the other core-leg.

5. A transformer-core, which comprises a plurality of substantially U-shaped laminæ,

each of which has a long leg and a short leg, said laminæ being alternately reversed, so that each short leg is included between two long legs; and end laminæ which alternate to fill the spaces between the long legs at the ends of the short legs and serve to complete the magnetic circuit.

6. A transformer-core, which comprises a plurality of substantially U-shaped laminæ, each of which has a long and a short leg, certain of the laminæ having the inner corners of the long legs cut away, certain others of the laminæ having the outer corner of the long legs cut away, and a core being built up first, with one or more laminæ of one kind, next, laminæ of the other kind, then laminæ of the latter kind turned upside down, fourth, laminæ of the first kind turned upside down and so on until the core is complete; and end laminæ for completing the magnetic circuit, which laminæ are inserted between the long legs of the U-shaped laminæ as indicated by the cut-away corners.

7. A transformer-core, which is built of a plurality of substantially U-shaped laminæ, each of which has a long and a short leg, each built-up core-leg being composed of long and short legs alternately arranged, all the long legs in both core-legs having guides at their ends which serve to indicate the proper spaces for the insertion of end laminæ.

8. A transformer-core, which is built up of a plurality of substantially U-shaped laminæ, of two kinds, both kinds of which have long and short legs, one of which kinds has the inner corners of the ends of the long legs cut away, the other of which kinds has the outer corner of the ends of the long legs cut away; and each leg of the core being composed of long and short legs alternately arranged, the two long legs which include a short leg belonging respectively to the said two kinds of laminæ.

9. A transformer-core, which is built up of a plurality of substantially U-shaped laminæ of two kinds, both of which kinds have long and short legs, one of which kinds has characteristic guides at the ends of the long legs, and the other of which kinds has different characteristic guides at the ends of its long legs; each leg of the core being composed of long and short legs alternately arranged, and the two long legs which include a short leg being longing respectively to the two kinds of laminæ.

10. A transformer-core, which comprises a plurality of substantially U-shaped laminæ, each of which has a long and short leg, certain of the laminæ having the outer corner of the long leg cut away, certain other of the laminæ having the inner corner of the long leg cut away, and the core being built up, first, with one or more laminæ having an outer corner of the long leg cut away, second, with laminæ having the inner corner of the long leg cut away, said long leg lying in the other leg of the core with respect to the first long

leg; third, with laminæ having the inner corner of the long leg cut away, but turned upside down so that the long leg lies in the same core-leg as the long leg of the first laminæ; 5 and fourth, with laminæ having the outer corner of the long legs cut away, but turned upside down so that the long leg lies in the same core-leg as the long legs of the second laminæ; fifth, with laminæ like the first, and 10 so on, until the core is complete, and end laminæ for completing the magnetic circuit, which laminæ are inserted between the ends of the long legs of the laminæ of one core-leg and abut against the edges of the ends of the 15 long legs on the other core-legs, and vice versa, according as indicated by the cut-away corners of the long legs.

11. A plurality of substantially U-shaped laminæ each having a distance between its 20 legs equal to twice the width of a leg, said laminæ being assembled in reverse order so that a short leg is included between two long legs, and vice versa, in combination with separate end laminæ for completing the magnetic circuit and filling the spaces at the end 25 of the short legs between the long legs.

12. A substantially U-shaped lamina having a long and a short leg, the difference between the lengths of the legs being substantially one-half the distance between them. 30

13. A transformer-core, which comprises a

plurality of laminæ, each of which has a long and a short leg, the distance between which is twice the width of each leg, said laminæ 35 being alternately reversed; and end laminæ for completing the magnetic circuit, the widths of which laminæ are equal to the difference between the lengths of the long and short legs of the U-shaped laminæ.

14. A substantially U-shaped lamina, having a long leg and a short leg, the difference between the lengths of said legs being substantially equal to the width of the base of the lamina, and substantially equal to one-half the distance between the legs. 40

15. A transformer-core, which comprises a plurality of substantially U-shaped laminæ, each having a long and a short leg, the difference between the lengths of the legs being equal to the width of the base of the laminæ, 50 and to one-half the distance between the legs, and end laminæ for completing the magnetic circuit, the widths of which end laminæ are equal to the difference between the lengths of the long and the short legs of the U-shaped 55 laminæ.

In witness whereof I have hereunto set my hand this 1st day of March, 1901.

AUGUSTINE R. EVEREST.

Witnesses:

DUGALD MCK. MCKILLOP,
JOHN J. WALKER.