No. 861,029.

PATENTED JULY 23, 1907.

W. A. HALL.

TRANSFORMER CORE.

APPLICATION FILED SEPT. 24, 1904.

Fig. 1.

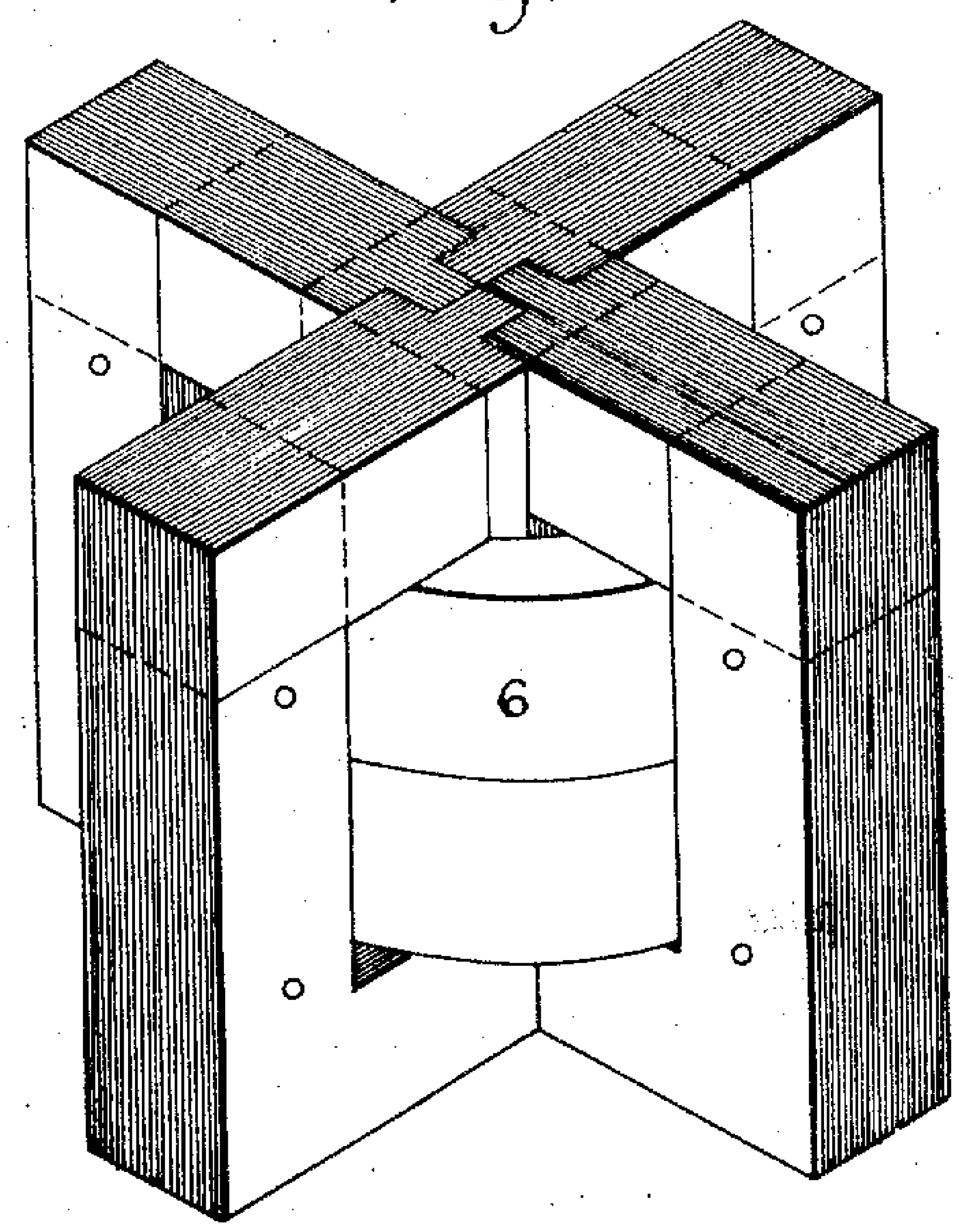



Fig. 2.

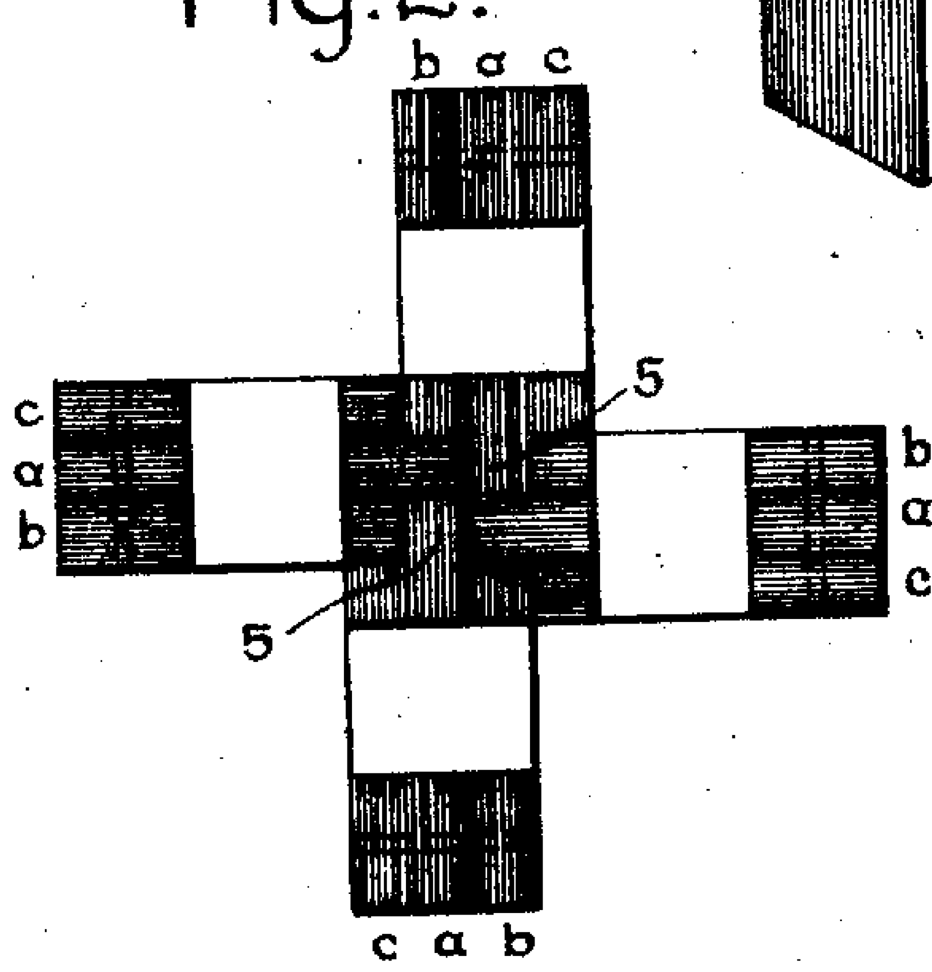



Fig. 3.

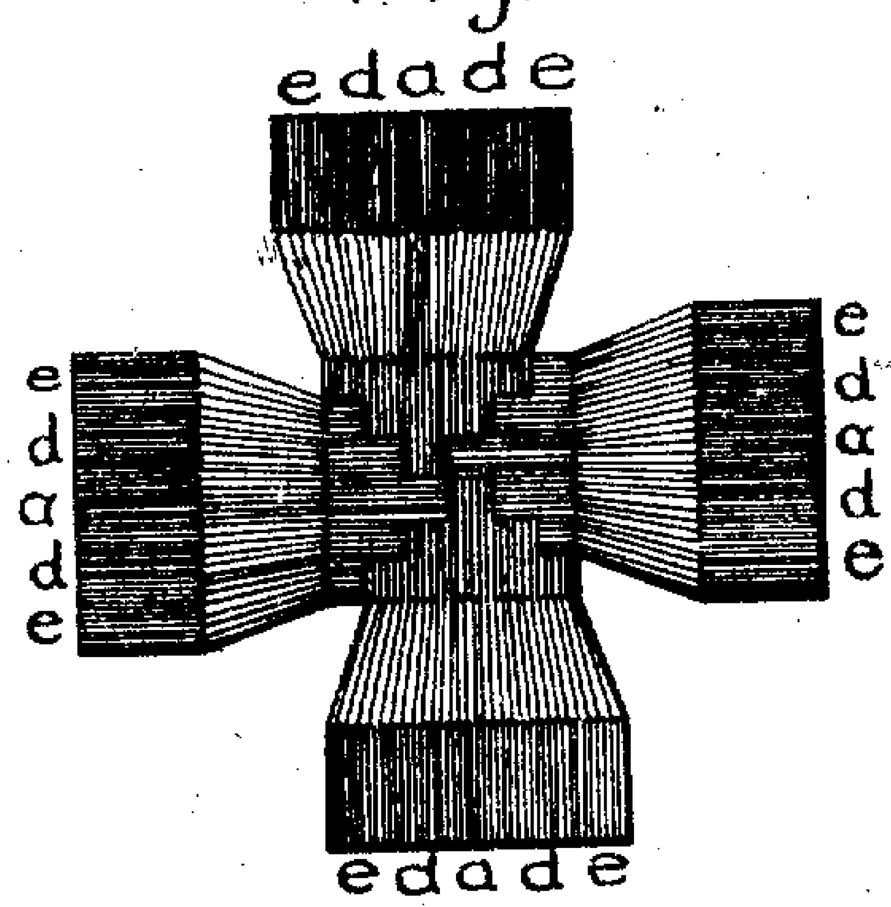



Fig. 4.

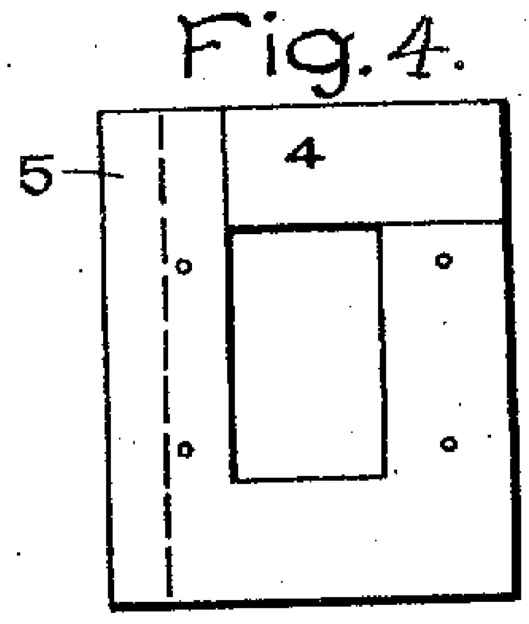



Fig. 5.

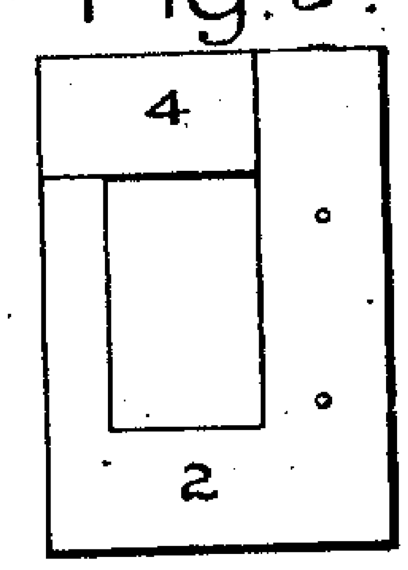
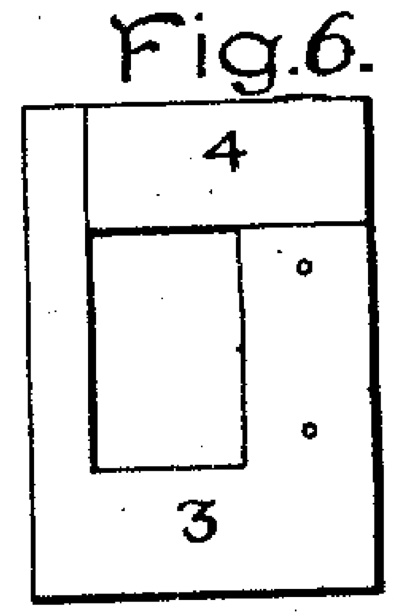



Fig. 6.




Witnesses:
Irving E. Steers.
Arleen Oxford

Inventor,
Walter A. Hall.
by Albert G. Davis
Att'y.

# UNITED STATES PATENT OFFICE.

WALTER A. HALL, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## TRANSFORMER-CORE.

No. 861,029. **Specification of Letters Patent.** **Patented July 23, 1907.**

Application filed September 24, 1904. Serial No. 225,736.

*To all whom it may concern:*

Be it known that I, WALTER A. HALL, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Transformer-Cores, of which the following is a specification.

This invention relates to electric transformers and its object is to improve the construction of the core, so that the transformer may have a large cross-section of iron with a small length of magnetic circuit for the minimum mean length turn of copper.

The present invention is a development of that shown and described in my patent No. 755,766, dated March 29, 1904. In that patent, the central leg of the core is cruciform in section, and two of the outside legs are wider than the other two.

In my present invention, the central leg is square in cross-section, and all the outside legs are of the same size as each other though each is smaller than the central leg. I provide, however, for a greater total cross-section in the outside legs than in the central leg, in order to lessen the reluctance of the magnetic circuit outside the coil and thus compensate for the necessarily greater flux density in the central leg.

In the accompanying drawing, Figure 1 is a perspective view of one form of my improved transformer removed from the casing; Fig. 2 is a transverse section of the core; Fig. 3 is a similar section of a modification; Figs. 4, 5 and 6 are side elevations of the iron laminæ from which the core shown in Figs. 1 and 2 is made.

The core is composed of branches preferably four in number meeting at a central point. Each branch is composed of sections, and each section is built up of similar U-shaped laminations. In Figs. 1 and 2 three sections are used for each branch. One of said sections *a* is composed of stampings 1 having both legs of equal width but of different lengths: the laminations being laid up with long and short legs alternating, in the usual manner. The other sections *b*, *c*, are alike, each being built up of stampings 2 3 having one leg of the same width as the legs of the stamping 1, but the other leg only half as wide. The stamping 2 has the wide leg the longer, while in the stamping 3, the narrow leg is the longer, so that when laid up alternately with the narrow legs coinciding, there will be the usual spaces for interleaving the end pieces 4. Each section is composed of the same number of laminations, and its thickness is equal to the width of the narrow leg of the stampings 2 3. In forming the section, the proper number of laminations are laid together, pressed in a powerful hydraulic or other press, and secured in their compressed condition by transverse fiber rivets.

When the sections *a*, *b*, *c* are assembled to form a branch, they are laid with their wide legs coinciding. The section *a* therefore projects beyond the other two along one edge by an amount equal to the difference in width between its leg and the narrow legs of the other sections; that is, equal to the width of said narrow leg. This forms a longitudinal rib or tongue 5 along one edge of each branch that is square in cross-section. Adjacent to the rib is a shoulder or shoulders formed by the edges of the sections *b*, *c*. In this form of my invention the section *a* is between the sections *b*, *c* so that there is a shoulder on each side of the rib, of the same thickness as said rib.

When the ribbed edges of the several branches are brought together and intermeshed, each rib 5 abuts against one side of another rib, and is received between the shoulder of section *b* on one branch and the end of the rib 5 on the opposite branch. The shoulder of section *c* abuts against the side of the section *b* in the next branch. In this case there is formed a substantially solid square central core leg, on which the coils 6 are placed. The central leg portion of the core is thus formed of four similar parts each composed of a central layer of laminæ placed between a pair of outer layers of laminæ. The laminæ in the central layer, being wider than those in the outer layer, project by the outer layers to form a rib 5. One corner of each rib lies at the center of this square leg. The central planes of the branches are therefore all offset from the center of the leg by an amount equal to one half the thickness of said rib.

The cross-sectional area of the portion of the section *a* forming a part of the center leg of the core is twice that of the cross-sectional area of the corresponding portions of the other sections in each branch, while the cross-sectional areas of the sections in the remainder of the branch are equal or substantially so. In consequence, the portion of the section *a* in the central leg of the core carries more flux than either of the corresponding portions of the other sections. This causes a certain amount of flux to pass from the sections *b* and *c* into the section *a* at one end of the central leg and from the section *a* into the sections *b* and *c* at the other end of the central leg. By making the portion of each branch entering the central leg symmetrical, with the section *a* between the sections *b* and *c*, the reluctance in the path of this cross-flux becomes quite small.

In Figs. 1 and 2, the thickness of the branch is three fourths the width of the central core-leg. It is therefore necessary to make the outer legs of the core of considerable width, in what may be called a radial direction, in order that the combined cross-section of said legs may be decidedly greater than that of the central leg. I prefer to make them at least fifty per cent greater. The object of this is to enable the outer and longer portions of the core to operate at a flux density much below that portion inside the coils.

Now it is evident that by increasing the number of sections in each branch of the core, the thickness of said branch will more nearly approach that of the central leg, and consequently the width of the outer leg of the branch may be lessened, and thus shorten the magnetic circuit.

In Fig. 3 is shown a construction in which each branch is composed of five sections, all having one wide outer leg, one section *a* having a wide inner leg, two sections *d* having inner legs of two thirds the width of the section *a*, and two sections *e* having inner legs one third of said width. The thickness of each section equals the width of the narrowest legs. The sections are assembled preferably with the wide section *a* in the middle, and the others on each side, forming a double shouldered or stepped edge. The thickness of these branches is five sixths that of the central leg formed by intermeshing them as shown in Fig. 3.

The increase in the cross section of the external magnetic circuit by using wider legs is limited by the fact that there is a critical point beyond which any increase in width causes an actual loss in cost efficiency. In order, therefore, to increase the cross section without increasing the length of the magnetic circuit, the laminations may be spread apart in the outer legs, and additional sheets slipped in between them outside the winding space, as shown in Fig. 3. This makes the outer legs thicker than the inner ones and materially reduces the flux density in the external circuit.

These improvements have been found in practice to effect a large saving in cost and give a better electrical efficiency.

I do not claim broadly as my invention a transformer core composed of units or parts whose meeting edges have longitudinal ribs which intermesh to form a substantially solid leg surrounded by a transformer winding, which construction I believe to be the invention of Claxton E. Allen.

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

1. A transformer core composed of separate branches whose meeting edges have longitudinal ribs which intermesh to form a substantially solid leg, the rib on each branch being symmetrically disposed with respect to the central plane of said branch.

2. A transformer core composed of separate branches whose meeting edges have longitudinal ribs which are square in cross-section, the rib on each branch being symmetrically disposed with reference to the central plane of said branch.

3. A transformer core composed of separate branches, each of which consists in part of sections each having one narrow and one wide leg, and in part of another section placed between the first mentioned sections and having two legs of the same width.

4. A transformer core composed of separate branches, each of which consists in part of sections each having narrow and wide legs, and in part of one section having legs of the same width, said one section being placed between the first mentioned sections, and the thickness of each section being equal to the width of the narrowest legs.

5. A magnetic core portion formed of separate parts intermeshed together, each of said parts comprising a layer of laminæ placed between a pair of other layers of laminæ, the laminæ in said other layers being narrower than the laminæ in the first mentioned layer.

6. A magnetic core portion formed of separate parts intermeshed together, each of said parts comprising a layer of wide laminæ between a pair of layers of narrow laminæ.

7. A transformer core composed of separate branches having intermeshed ribbed edges meeting at a common center, the central plan of each branch being off-set from said center, and each rib being symmetrically placed with reference to the central plane of the branch of which it forms a part.

8. A transformer-core composed of branches having inner and outer legs, the former intermeshed to form a central leg, and the thickness of the outer legs being greater than that of the intermeshed inner legs.

9. The combination with a transformer-core having a central leg and a plurality of outer legs, of additional iron in the outer legs to make them thicker.

10. The combination with a transformer-core composed of laminations and having a central leg and a plurality of outer legs, of additional laminations interleaved in the outer legs to make them thicker.

11. A transformer-core composed of branches having inner and outer legs, the former being shouldered and intermeshed to form a central core-leg, and the latter having additional iron added to them to increase the cross-section of the external magnetic circuit.

12. In a transformer, a core composed of branches having inner and outer legs, the former being intermeshed together to form a central core leg, and each comprising a layer of wider laminæ placed between a pair of other layers of narrower laminæ, and a winding surrounding said central core leg and being surrounded by said outer legs.

13. In a transformer, a core composed of branches having inner and outer legs, each inner leg comprising a layer of wide laminæ between a pair of layers of narrow laminæ, said inner legs being interlocked together to form a central core leg, and the outer leg having additional laminæ interleaved in them to make them thicker than the inner legs, and a winding within said outer leg and surrounding said central core leg.

In witness whereof I have hereunto set my hand this twenty second day of September, 1904.

WALTER A. HALL.

Witnesses:
JOHN A. MCMANUS, Jr.,
ROBERT SHAND.