No. 755,766.

PATENTED MAR. 29, 1904.

W. A. HALL.

TRANSFORMER.

APPLICATION FILED SEPT. 29, 1902.

NO MODEL.

Fig.1.

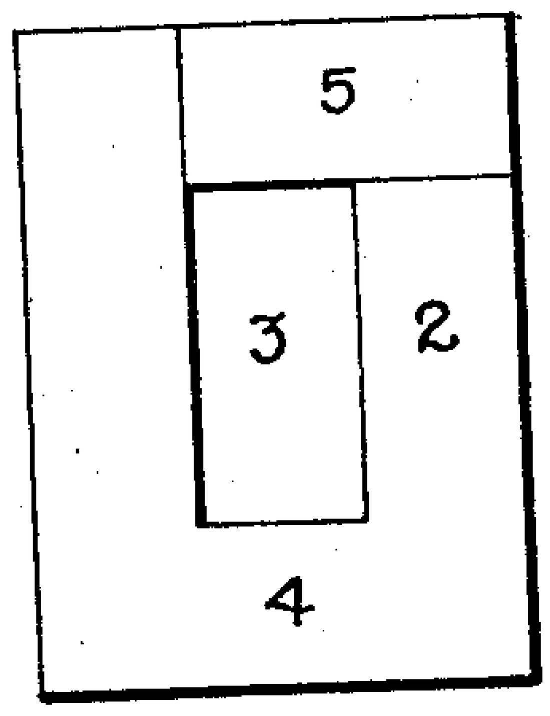


Fig.2.

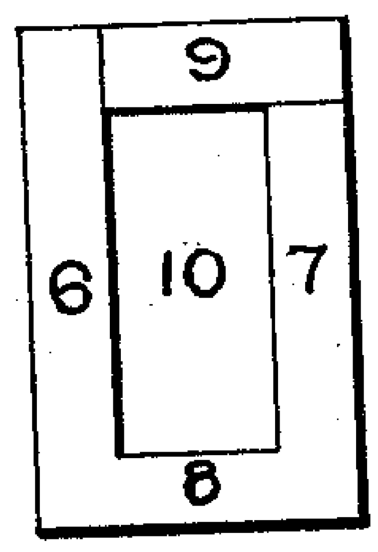


Fig. 3.

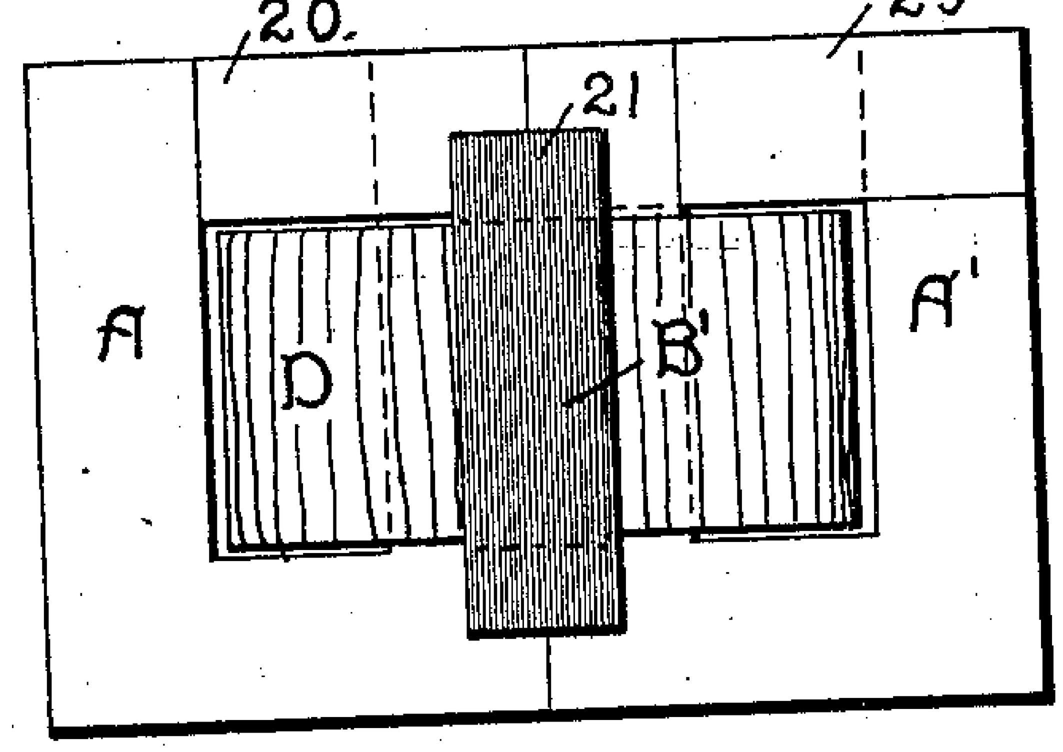


Fig. 5.

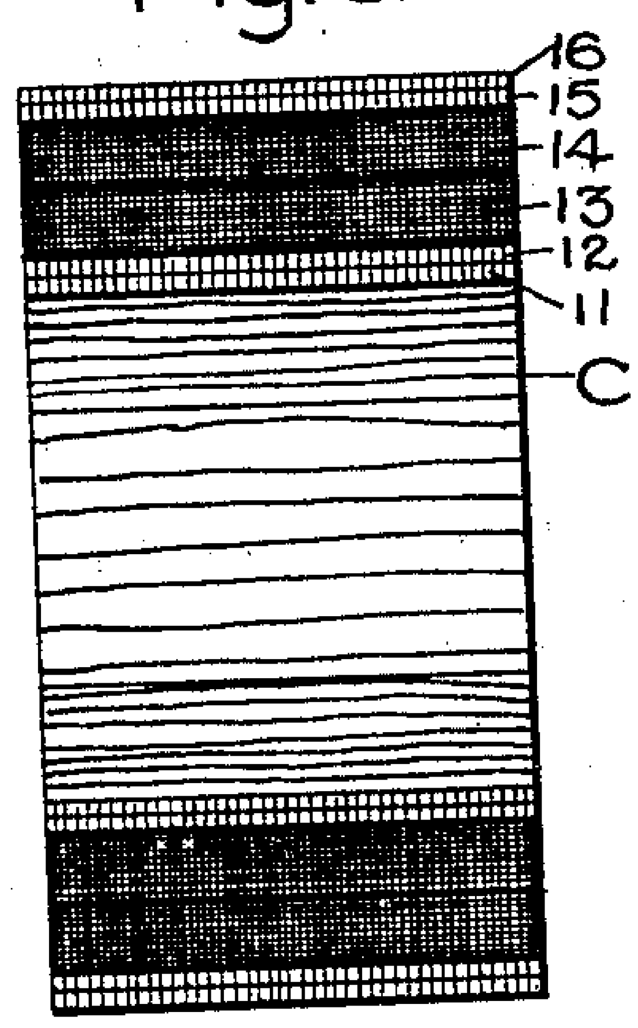


Fig.4.

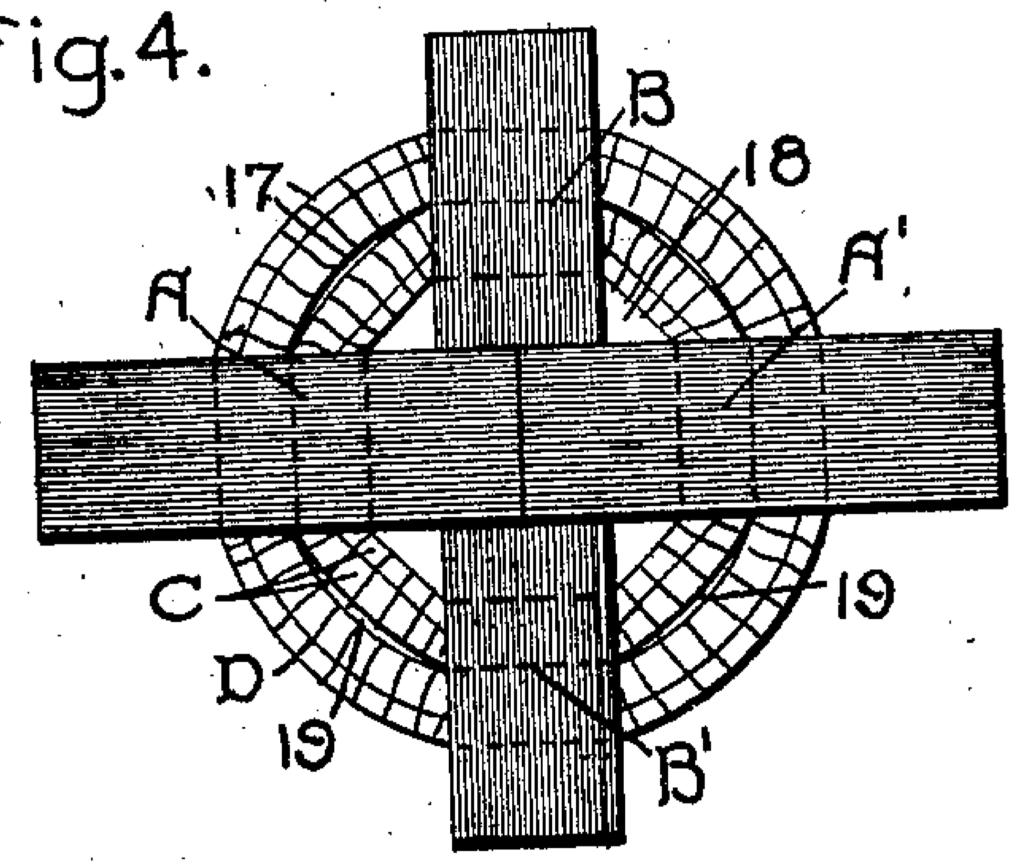


Fig.6.

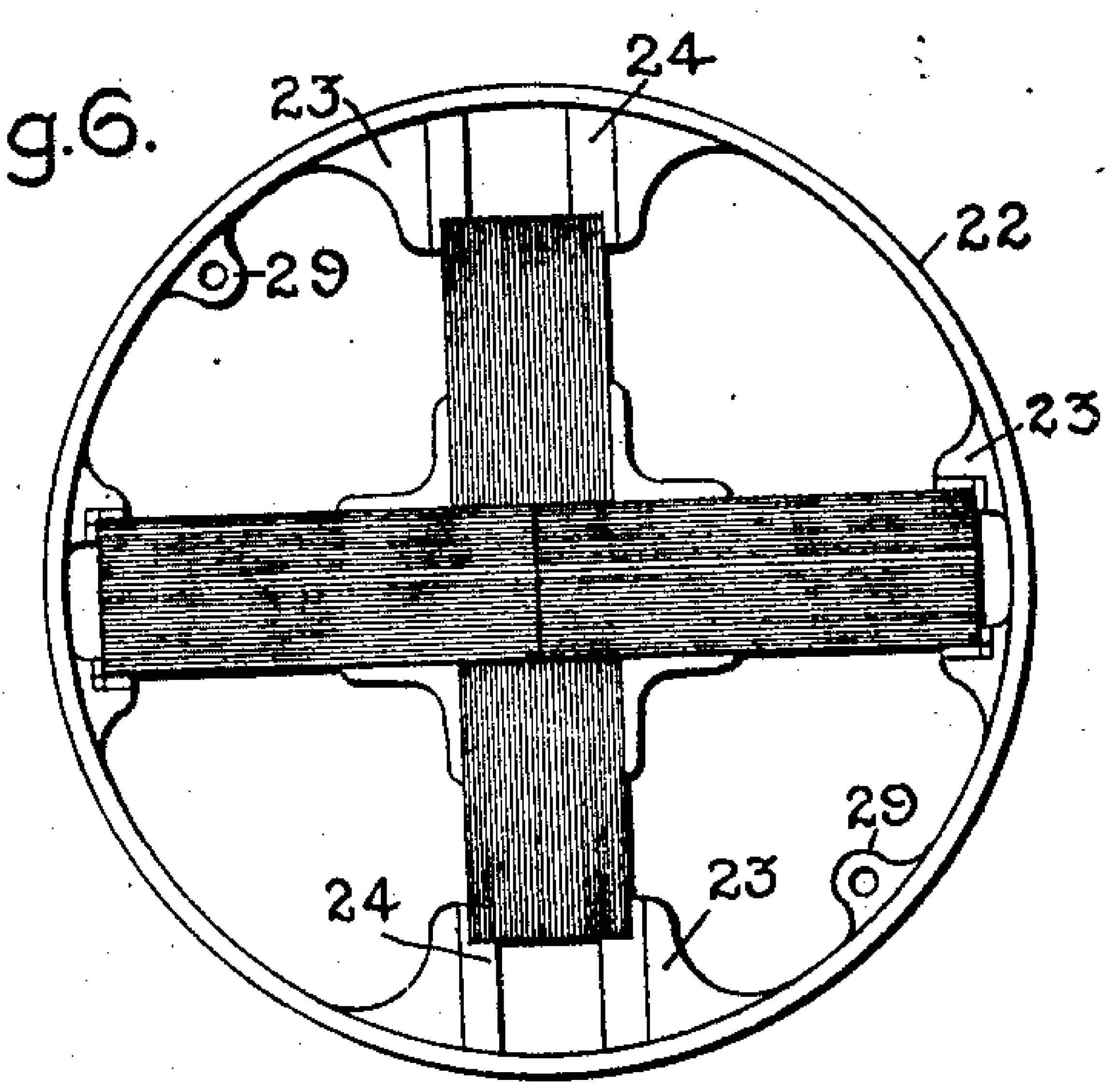
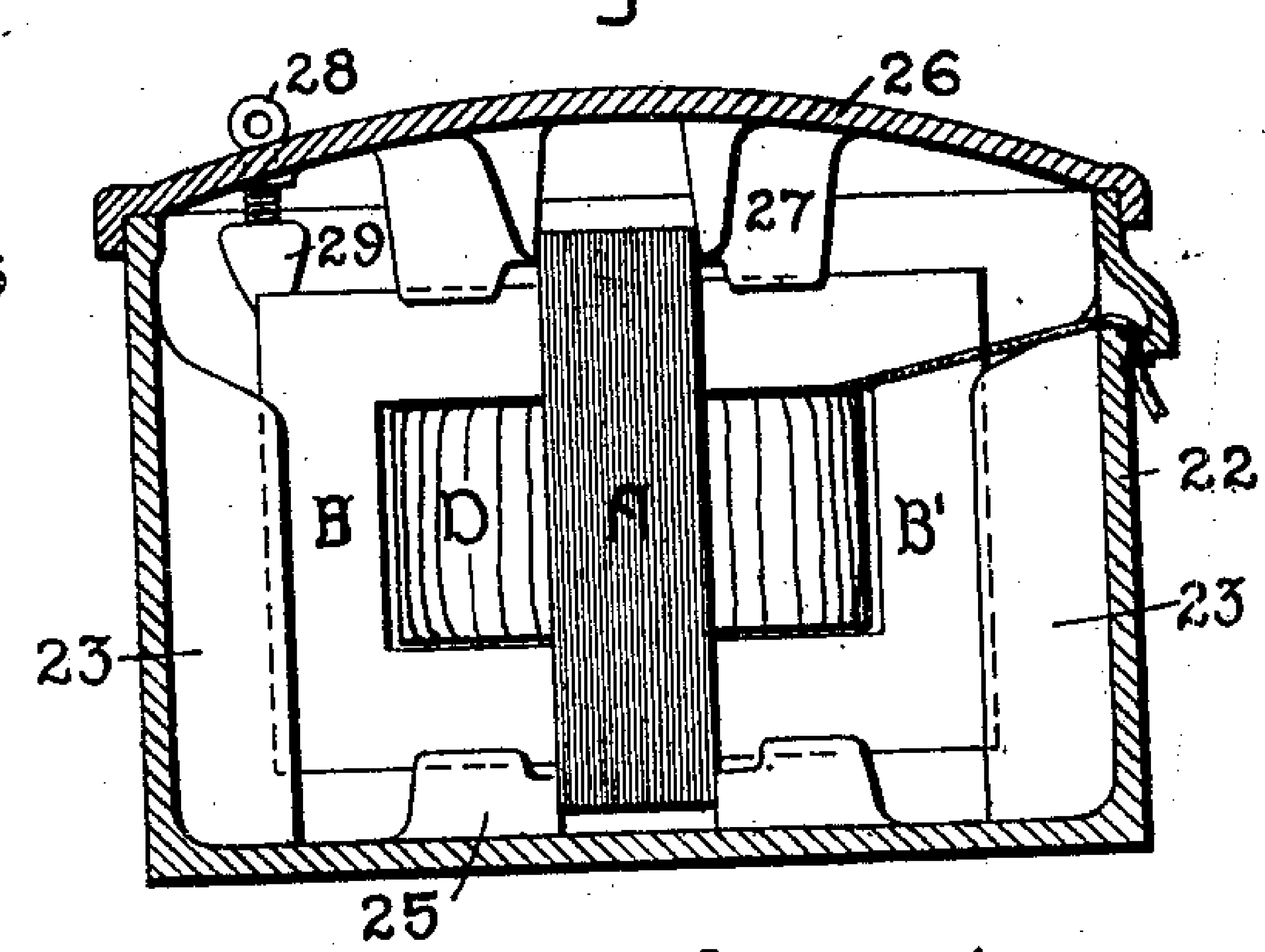


Fig 7.



Witnesses.

Helen Oxford

Inventor.

Walter A. Hall,

by Allen G. Davis

Atty.

No. 755,766. Patented March 29, 1904.

UNITED STATES PATENT OFFICE.

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

TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 755,766, dated March 29, 1904.

Application filed September 29, 1902. Serial No. 125,214. (No model.)

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 Transformers, of which the following is a specification.

This invention relates to improvements in electrical transformers; and its object is to enable transformers of large size to be economically constructed having a minimum mean-length turn of copper, a magnetic circuit of minimum length and maximum cross-section, and an abundance of ventilating or oil-circulating spaces.

To this end the invention consists in the construction and arrangement of parts hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings, Figures 1 and 2 are side elevations of the iron laminæ of which the core of the transformer is composed. Fig. 3 is a side elevation of the core and the coil. Fig. 4 is a top plan view of the same. Fig. 5 is a cross-section of the coil. Fig. 6 is a top plan view of the core and the casing or box with the cover removed; and Fig. 7 is a diametrical cross-section of the casing, showing the core and coil in elevation.

In building up the core of my transformer two different sizes of sheet-iron laminæ are used. Each complete lamina is composed of two pieces, a main U-shaped piece and a rectangular end piece. The width of each leg 1 2 of the large U-shaped piece is the same as that of the winding-space 3 between them, and the length of said space is preferably twice its width. One leg, as 1, is full length, while the other leg, 2, is only as long as the winding-space. The width of the lower integral end 4 and of the upper separate end piece 5 is equal to the width of one leg. The length of the end piece 5 is equal to the width of one leg plus the width of the winding-space. The smaller U-shaped pieces have legs 6 7, whose width is one-half that of the legs 1 2 of the large pieces. The integral end 8 and the end piece 9 are both of the same width as the legs 6 7. The total length of this smaller lamina is less than that of the larger one by an amount equal to the width of the end 4. The winding-space 10 is of the same dimensions as the winding-space 3. The larger laminæ after suitable treatment are laid together coincidently until the cross-section of each leg is square. The mass is then pressed in a powerful hydraulic or other press and is then clamped in any suitable manner to retain it in shape. The smaller laminæ are laid up until the thickness of the legs 6 7 is the same as that of the legs 1 2 of the larger laminæ.

To form the core of the transformer, two bundles A A′ of the larger laminæ are placed edge to edge in the same plane, and two bundles B B′ of the smaller laminæ are placed at right angles to the bundles A A′, one edge of each bundle B B′ abutting against the meeting edges of the bundles A A′ and the bottoms of the winding-spaces 3 10 being all in the same plane. The core thus formed has a central leg cruciform in cross-section, two opposite legs square in cross-section, and two opposite legs rectangular in cross-section.

The coil for this transformer is preferably composed of two portions, an inner octagonal portion C, composed of one or more secondary windings 11 12, and an inclosing primary winding 13, and an outer portion D, consisting of a primary winding 14, surrounded by one or more secondary windings 15 16, all wound in substantially square form with rounded corners 17 of large radius. The inner portion C fits closely upon the cruciform central leg of the core, leaving triangular ventilating or oil-circulating spaces 18 at the corners, and the combined thickness of the two portions just fills the winding-spaces 3 10, leaving crescent-shaped ventilating or oil-circulating spaces 19 between the rounded corners 17 and the flat sides of the inner portion C. The several windings are of course fully insulated from each other and from the core. The secondary windings 11 12 15 16 are all connected, so as to form one winding, and the two primary windings 13 14 are also connected. After the coil has been slipped over the central leg of the core and seated on the bottom of the winding-space in each branch of said core the end irons 20 21 are placed in position, and the core and coil are assembled in a box or casing 22, which is filled with oil. In order to secure them in place, the box has internal lugs 23 on its sides, between which the edge of the core branches are received. Wooden wedges 24 are driven in between the lugs and the core to fasten the latter securely. On the bottom of the box are lugs 25, preferably tapered, to compress the laminæ as the bottom edges of the core enter between said lugs. The cover 26 has lugs 27, similar to those on the bottom of the box, and when the cover is drawn down by suitable fastening devices, such as the eyebolts 28, screwed into lugs 29 on the box, the lugs 27 clamp the core at the top.

It will be seen that by means of this construction I obtain several advantages:

First. A maximum cross-section of magnetic circuit for a minimum length of same, thereby reducing to a minimum the weight of iron and the consequent turns of copper required for a given core loss. It will be noted that in the smaller branches of the core the mean length of the magnetic circuit is less than that in the larger branches in the ratio of ten to eight, the resultant of the entire magnetic circuit being nine and one-third instead of ten, which would be the case were all of the laminations laid in one direction, as in the case of a common shell-type transformer.

Second. A core which in effect corresponds to what is commonly known as the "shell type" design, but having an advantage over that design in that it permits pressing of the iron before assembly and obtains thereby a maximum effective cross-section of iron in a given space.

Third. It presents for the central leg, upon which are assembled the windings, an octagonal perimeter, a figure which as closely approximates a circle as is commercially practicable, thereby allowing the magnetic circuit to be linked by a minimum mean-length turn of copper for a given cross-section of core so inclosed. This octagonal center presents a further advantage in that large conductors may readily be made to conform closely to its contour in winding, permitting a maximum amount of copper to be wound in a given thickness of coil without the necessity of applying excessive tension injurious to insulation, which would be required on a form having sharper angles.

Fourth. A number of oil-channels of considerable cross-section and short length between core and windings and between parts of the winding, promoting a rapid circulation of oil and dissipation of heat. The introduction of oil-channels between windings is effected without loss of winding-space between the leg-irons, while those between the core and coils are obtained with a similar saving in winding-space and at the same time without increasing the length of copper required.

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

1. A transformer-core consisting of four bundles of iron laminæ arranged radially to abut each other at the center of the core, each bundle constituting a magnetic circuit, two of the bundles of laminæ directly abutting each other, the second two bundles abutting the opposite sides of the joint between the directly-abutting laminæ, the legs of the second two bundles of laminæ being of less width than the legs of the directly-abutting bundles of laminæ, in order to make the center of the core cruciform in cross-section.

2. A transformer-core consisting of oppositely-disposed bundles of iron laminæ constructed and arranged radially to fill the center of the core with a mass of laminated iron polygonal in cross-section to form cooling-spaces in the periphery of the center of the core.

3. A transformer-core consisting of a plurality of bundles of iron laminæ arranged radially and closely abutting each other at the center to make the center of the core a solid mass of laminated iron, the construction and arrangement of the bundles contributing to form a core having a periphery with reëntrant angles, whereby cooling-spaces are provided between the core and the coils thereon.

4. A transformer-core consisting of a plurality of bundles of iron laminæ arranged radially to abut each other at the center, the width of the legs of some bundles being less than that of the legs of the other bundles, whereby cooling-spaces of large cross-section and short length are formed between the center of the core and the coils thereon.

5. A transformer-core consisting of a plurality of U-shaped bundles of iron laminæ assembled in radial planes, the legs of certain bundles being smaller in cross-section than the legs of other bundles in order to provide the center of the core with an irregular periphery.

6. A transformer-core consisting of two bundles of iron laminæ abutting each other in the same plane and having the space between the legs equal to the width of a leg, and two bundles of iron laminæ in the same plane with each other abutting the first two bundles of laminæ on opposite sides of their joint and having the same space between the legs as the first two bundles, but the width of the legs one-half that of the first two bundles.

7. A transformer-core consisting of two bundles of iron laminæ abutting each other, and two bundles of laminæ abutting the opposite sides of the joint between the first two bundles, the second two bundles being of such thickness that they do not extend the full combined width of the first two abutting bundles.

8. A transformer-core consisting of two

bundles of iron laminæ abutting each other, and two bundles of iron laminæ abutting the opposite side of the joint between the first two bundles, the second two bundles being of such thickness that they do not extend the full combined width of the first two abutting bundles, and the width of the second two bundles being less than that of either of the first two bundles, whereby the four bundles form a substantially symmetrical figure in cross-section.

9. A transformer-core consisting of a plurality of compressed bundles of U-shaped laminæ retained in compression and arranged radially to abut each other to form a polygonal figure in cross-section through the center of the core.

10. A transformer-core consisting of a plurality of bundles of iron laminæ arranged radially to abut each other at the center of the core, all the laminæ in each bundle being substantially duplicated or coextensive and pressed together, whereby the center of the core consists of a maximum amount of laminated iron.

11. A transformer-core of substantially the shell-type design, consisting of a plurality of bundles of iron laminæ abutting each other at the center of the core, the laminæ in each bundle being pressed closely together in order to obtain a maximum effective cross-section of iron in a given space.

12. A transformer having a coil made in two concentric portions, the inner one polygonal, and the outer one square with rounded corners, whereby ventilating-spaces are left between said portions.

13. A transformer-core composed of two U-shaped branches lying in the same plane, and presenting a given length of magnetic circuit, and two U-shaped branches lying in a plane at right angles thereto, and presenting a shorter magnetic circuit.

In witness whereof I have hereunto set my hand this 26th day of September, 1902.

WALTER A. HALL.

Witnesses:
DUGALD McK. McKILLOP,
JOHN A. McMANUS.