Sept. 13, 1927. 1,642,470

C. M. WELCH

ELECTRICAL TRANSFORMER CORE OR MAGNETIC CIRCUIT

Filed Oct. 24, 1921

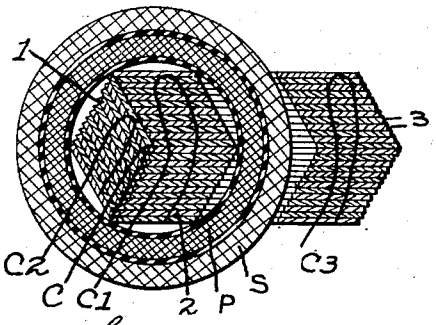


Fig. 1

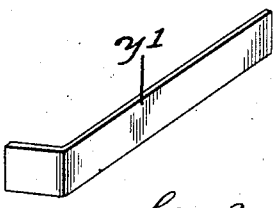


Fig. 3

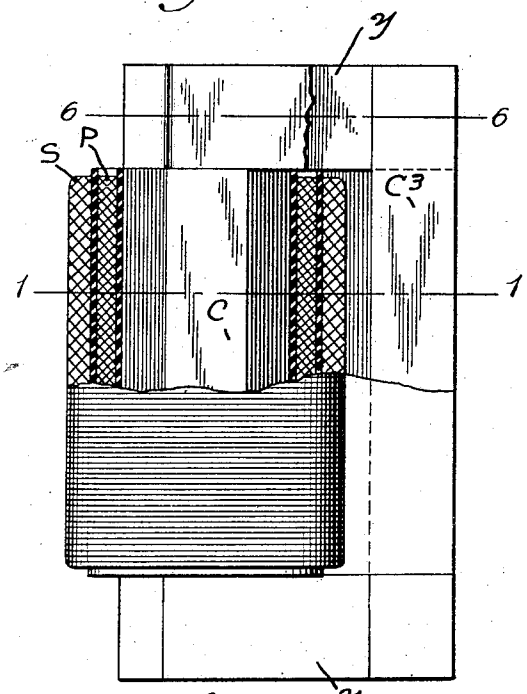


Fig. 2

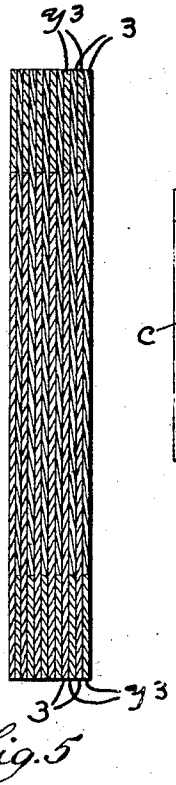


Fig. 5

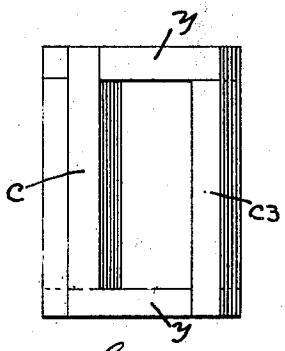


Fig. 4

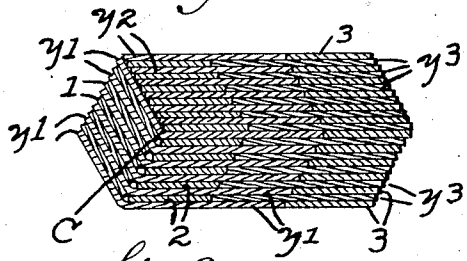


Fig. 6

Inventor

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UNITED STATES PATENT OFFICE.

CHARLES M. WELCH, OF OGDEN, ARKANSAS.

ELECTRICAL TRANSFORMER CORE OR MAGNETIC CIRCUIT.

Application filed October 24, 1921. Serial No. 510,168.

The object of my invention is to secure a form of transformer core which will render the magnetic circuit easy to build and the coils easy to wind, and utilize the maximum available core area with a circular cylindrical coil and a magnetic circuit built of laminated sheet material.

The invention will hereinafter be more particularly described as embodied in a two coil, single magnetic closed circuit transformer. This general type is commonly employed in wireless radio, instrument transformers, high voltage sets, bell ringers and toy transformers and the like. Apparatus of this general type have not heretofore been built extensively for commercial light and power distribution. I believe my improvement is further novel and useful in the design of small capacity high or low voltage transformers for general work.

The specifications, drawings and claims set forth herein what I believe to be the points of novelty in my present invention, and whereas other arrangements and modifications may be made, I intend to cover all such arrangements and modifications which do not depart from the spirit and scope of my invention.

Those skilled in the art will readily understand that my invention may be embodied as a means of constructing a set of series of magnetic circuits to operate as integral part units extending over a wide range of applications, and I do not restrict my improvement in whole, or, in part, to any specific usage which does not depart from the spirit and scope of my invention.

Referring to the drawings, similar letters refer to similar parts throughout the several views, in which:

Fig. 1, is a cross sectional elevation taken on line 1—1 in Fig. 2, and shows the arrangement of the core part members through the coil portions: Fig. 2, represents a side elevation of the assembled core with coils in which the upper portion is shown broken away along the broken lines illustrating the part members: Fig. 3, is a perspective view of my bent end yoke laminæ: Fig. 4, is a side elevation of the assembled core without the coils and illustrates in part the method of interleaving the laminæ and also further identifies the part members: Fig. 5, is a vertical cross sectional elevation through a portion of the depending core leg shown outside the coils in Fig. 2, and further illustrates the method of interleaving the laminæ: Fig. 6, is a cross sectional elevation taken on line 6—6 in Fig. 2, illustrating in detail the laminæ and completes the illustration of the method of forming and joining their parts together.

I provide my coil bearing core leg C with laminated members each departing from the plane of the other in which laminæ of the same size may be employed to produce the polygonal core cross section through the coils P and S shown. The section member C^1 is composed of parallel laminæ offset relative to each adjacent laminæ to produce surfaces substantially V-shaped in cross section. The section member C^2 is composed of other parallel laminæ offset relative to each adjacent laminæ to produce surfaces substantially rhomb-shaped in cross section. The rhomb-shaped member fits along side in the V-shaped member, whereby the core leg C assumes substantially hexagonal section.

I place a depending core leg C^3 outside the coils. This leg C^3 is composed of parallel laminæ offset relative to each adjacent laminæ to produce surfaces substantially V-shaped in cross section. I place this leg C^3 parallel with the section member C^1 thereby forming two depending members with a space between them for the coil thickness. The passage for the coil thickness is not straight through but assumes a shape corresponding to the sides of the adjacent members, whereby the coil fits snug in the opening.

The laminæ composing the members C^1, C^2, and C^3, may be of the same size and same length. In order to provide for joining these members together across their opposite ends with yoke laminæ, hereinafter described, I stack the core leg laminæ through the coils so that each alternate laminæ or multiples thereof is extended from the coil end face and on both ends forming slots of equal depth into which the interleaving end yoke laminæ may lie. And, of course, I prepare the depending core leg C^3 laminæ in similar fashion corresponding to the other core leg laminæ. The C^1 section member laminæ are represented by 2: the C^2 section member laminæ by 1: and the C^3 depending leg member laminæ by 3.

The top and bottom end yokes Y are com-

posed of yoke laminæ of the same width and two lengths. The short yoke laminæ Y^2 and Y^3 are of the same size. The long yoke laminæ Y^1 is longer by approximately the width of one of the core laminæ than the other yoke laminæ. This long yoke laminæ Y^1 has a bent end as illustrated in Fig. 3, which is secured by bending the laminæ flatwise at an angle corresponding to the plane of the laminæ in section member C^2. In the assembly of the yoke laminæ I may use single laminæ or multiples thereof corresponding to the number of laminæ placed in a cluster in the core members as stated above, it being conventional practice to use relatively thin laminæ and stack them in clusters of two or three in conventional transformers, which is an obvious expedient and I point it out to show the conventional application. The bent end yoke laminæ Y^1 is interleaved with the leg laminæ in the section member parts C^1 and C^2 thereby joining these parts together, whereby the plane of the laminæ in C^2 relative to the plane of the laminæ in C^1 determines the degree of angle of the bent angle laminæ. Yoke laminæ Y^2 are interleaved with the core laminæ remaining in C^1 and the core is joined up complete by interleaving the yoke laminæ Y^3 with core laminæ C^3 and with the projecting yoke laminæ Y^1 and Y^2 thereby completing the magnetic circuit through common end yokes assuming substantially rectangular section through their middle portions. The core may be clamped in any conventional way by compression means.

Because the trough of my V-shaped section member C^1 fits with two sides of my rhomb-shaped section member C^2 a complete core section C is produced composed of laminations of the same size assembled within a circular coil, whereby an effective core area approximately equal to a circumscribed hexagon is secured.

As will be readily understood from the drawings, the core C is substantially hexagon section, the depending leg C^3 a V-shape section, and the yokes Y adjacent the coils have substantially rectangular section, which renders a novel and practical shaped core to fit circular cylindrical coils.

The development of the transformer art, especially in the higher voltages, has lately turned towards circular coils. Heretofore, the cores for circular coils have usually been made up of laminations of different sizes which complicates the work and wastes time and material and increases the expense.

I believe it is a fact that from the standpoint of economical design the designer prefers to use shell type transformer construction in which the copper expense is only about 30 per cent of the total cost against about 40 per cent for the core type. But for structural reasons the shop stays by the core type. In this connection, my improved core when employed with small transformers below 25 Kv. a. equals or betters shell type copper saving and has obvious structural advantages comparable to the core type. Moreover, I effect a further saving and better the transformer in other ways which are apparent from consideration of the geometrical form of coil bearing core leg section employed in which:

With a given perimeter 3.1416 inches, the areas of figures are as follows:

Figure.	Area.	Per cent.
	Sq. in.	
Circle	.7854	100.00
Hexagon	.7131	90.00 approx.
Square	.6168	78.00 approx.
Rectangle	.5483	69.00 approx.

With a given area .7854 square inches, the perimeters of figures are as follows:

Figure.	Perimeter.	Per cent.
	Inches.	
Circle	3.1416	100.00
Hexagon	3.2378	103.00 approx.
Square	3.5481	114.00 approx.
Rectangle	3.7613	118.00 approx.

By following conventional design methods it is possible with my improved core to save 20 per cent under conventional core type cost and about 12 percent under conventional shell type cost. And with the same cost and efficiency I am able to further improve the construction by compromise in use of material, whereby I secure greater space factors for the insulation and I employ this advantage to better the insulating medium and secure more uniform cooling.

A patent was granted Hassler in 1894 for a hexagon core section so that I do not claim a hexagon core section broadly. Moreover the Hassler patent has been public property for a matter of ten years or more during which time certain advantages of the idea have been developed into other patents forming the basis of successfully built commercial transformers in which the makers by reason of the large number of their transformers in use and continuation of manufacture thereof bear testimony of the utility of such core section form with its advantages.

And because I have produced a simple construction in a novel way of arrangement built around the idea of employing the maximum amount of core material within a circular coil area, I wish to set forth that what I claim as new and wish to secure by Letters Patent of the United States, is,—

1. In combination with a transformer, a laminated magnetic circuit therefor, a coil bearing core leg polygonal in cross section having a V-shaped section member com-

posed of parallel plane laminæ and a rhomb-shaped section member composed of other parallel laminæ departing from the plane of the said parallel plane laminæ, a non-coil bearing core leg V-shaped in cross section composed of parallel plane laminæ, common yoke laminæ interleaved across opposite coil ends joining the said coil bearing and non-coil bearing V-shaped section member parallel plane laminæ, and yoke laminæ having a bent end portion joining the said other parallel laminæ having said departing plane composing the said rhomb-shaped section member to portions of said common yoke laminæ and to portions of said coil bearing and non-coil bearing parallel plane V-shaped section member laminæ and interleaved therewith across opposite coil ends.

2. In a coil bearing transformer core leg polygonal in cross section, a section member composed of parallel plane laminæ offset relative to each adjacent laminæ producing surfaces forming substantially a V-shape, and also a section member composed of other parallel laminæ offset relative to each adjacent laminæ and having planes departing from the plane of the said parallel plane laminæ and producing surfaces forming substantially a rhomb-shape.

3. The combination with a transformer, a laminated magnetic circuit therefor, a coil bearing core leg section composed of laminæ of the same size, offset relative to each adjacent laminæ in two part members to produce surfaces on the said part members each departing from the plane of the other, a non-coil bearing core section composed of laminæ offset relative to each adjacent laminæ to produce surfaces corresponding to the surfaces of its adjacent said coil bearing core leg section part member and set parallel with same forming two adjacent depending core sections, end yoke laminæ of a common width and two lengths, long bent angle end yoke laminæ interleaved with the said two part member laminæ along their like plane portions, and short yoke laminæ interleaved with the said long bent angle end yoke laminæ and also interleaved with the said two adjacent depending core leg laminæ.

4. In combination, a set of coil windings substantially cylindrical, a magnetic core leg polygonal in cross section through said coil windings and having a plurality of laminated members each departing from the plane of the other, a depending laminated core leg set parallel with said polygonal coil bearing core leg and outside the said coil windings, the said coil bearing core leg and the said depending core leg being connected by yoke laminæ across the opposite ends of the said coil windings and forming a core body composed of laminations providing an opening through which the said coil windings are disposed around the said polygonal core leg, the said yoke laminæ having portions adapted to interleave with and join together the said polygonal laminated members each departing from the plane of the other, and the laminæ composing the respective said members and said depending core leg being so arranged that the coil space opening through the said core body is not straight through but assumes a shape corresponding to surfaces of said members and said depending core leg whereby the said coil windings fit snug in said opening.

5. The combination in an electrical transformer core or magnetic circuit, a coil bearing polygonal core leg section arranged forming a plurality of parts composed of parallel laminæ arranged in the respective parts forming an equal plurality of planes in which the respective laminæ lie, a non-coil bearing depending core leg section composed of parallel laminæ and arranged in V-shaped fashion, end yoke members composed of laminæ having portions adapted to connect the laminæ planes of the said coil bearing polygonal core leg section parts together, and with the said end yoke members assuming substantially a rectangular shape through their middle portions whereby the magnetic circuit is completed through the said polygonal core leg and the said depending core leg by common end yokes.

6. In a transformer core or magnetic circuit, a set or series of bent end laminæ interleaved adjacent the bend with core laminæ composing section members each departing from the plane of the other, and with said end laminæ joining the complete magnetic circuit through laminated members common to the said section members each departing from the plane of the other.

7. The combination of bent end laminæ in a transformer core, the said bent end laminæ consisting of plates bent flatwise at an angle forming angle portions, and which said angle portions join a plurality of core sections connected through a magnetic circuit.

8. The combination in a transformer core or magnetic circuit, of laminæ bent flatwise in obtuse angle formation, and with the said bent laminæ interleaved along its respective angles with a plurality of laminated members in which the plane of the respective laminæ composing the said members determines the degree of angle of the said bent angle laminæ.

9. In a coil bearing transformer core leg polygonal in cross section and composed of laminæ of the same size, a section member composed of parallel plane laminæ offset relative to each adjacent laminæ producing surfaces forming substantially a trough-shape on one side thereof, and a section member composed of other parallel plane

laminæ offset relative to each adjacent laminæ to produce a surface having portions adapted to fit against and abut said trough-shaped surface.

10. In a transformer core or magnetic circuit of the character described, a coil bearing laminated core leg composed of two members each departing from the plane of the other and arranged to form a polygonal cross section, a depending core leg set outside the coil and composed of parallel plane laminæ forming substantially a V-shaped cross section, and common laminated yoke members joining said legs together on opposite ends thereof and having middle portions substantially rectangular in cross section.

In testimony I affix my signature.

Ogden, Arkansas, September 5, 1921.

CHARLES M. WELCH.