Oct. 16, 1956 A. G. STEINMAYER 2,767,382

WOUND CORE TRANSFORMER

Filed May 27, 1952 2 Sheets-Sheet 1

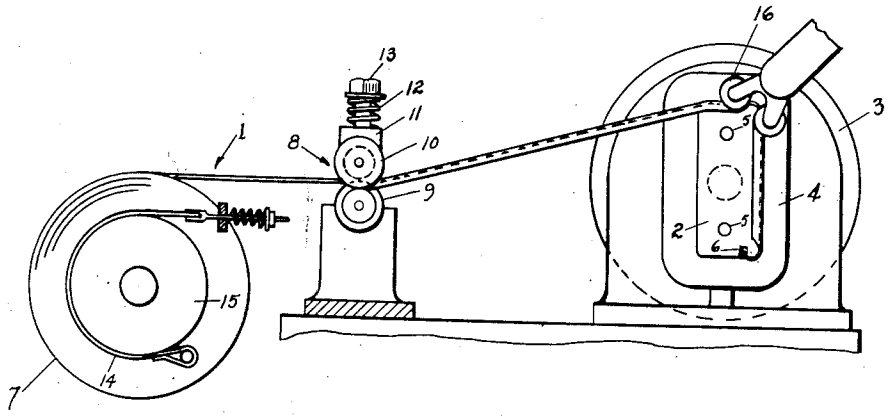


Fig. 1



Fig. 2

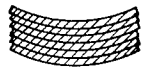


Fig. 3

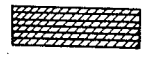


Fig. 4

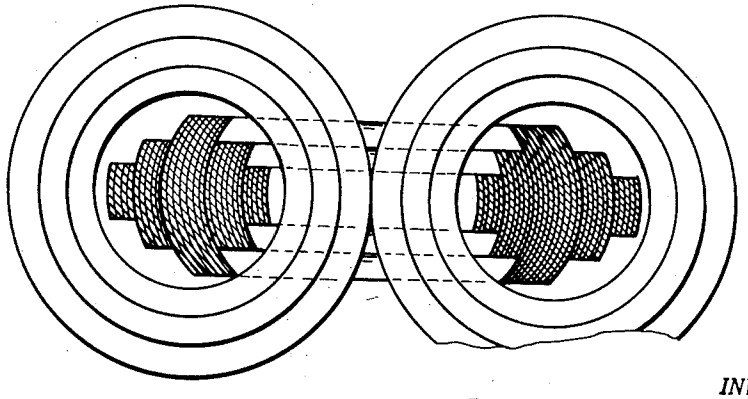


Fig. 5

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WOUND CORE TRANSFORMER

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2 Sheets-Sheet 2

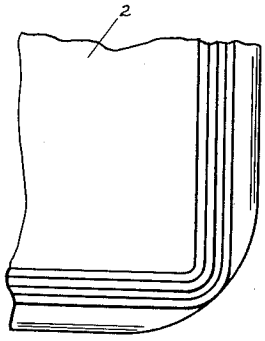


Fig. 6

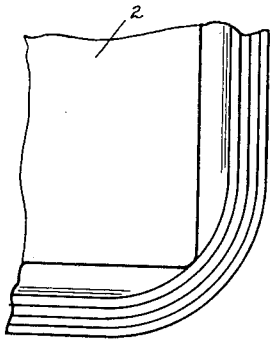


Fig. 7

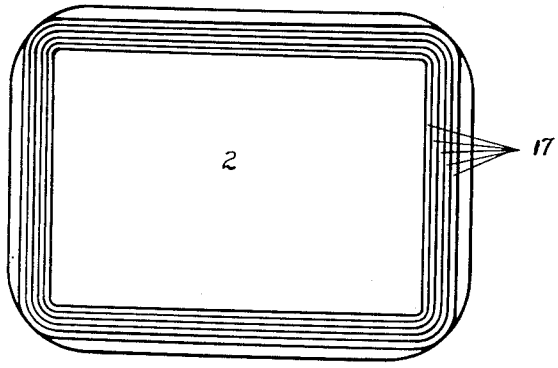


Fig. 8

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WOUND CORE TRANSFORMER

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3 Claims. (Cl. 336—213)

This invention relates to a wound magnetic core structure for transformers or the like.

The demands upon transformers is constantly growing greater and to meet the multiplicity of varied demands every effort is being made to provide a transformer to fill each need.

A great percentage of cores for inductive apparatus are made from flat oriented steel strips wound into a rectangular core shape. One of the problems in the manufacture of these cores is to make them sufficiently rigid so that the legs and yokes will retain their shape prior to annealing. After the annealing process rigidity can be a great strength factor.

The usual method of adding strength requires more materials or heavier material resulting in a core of greater weight. This, of course, adds to the processing and handling cost as well as to the initial material cost.

It is real progress to add strength without additional weight. When this can be done, it has a two fold advantage. It provides a stronger core of a predetermined weight and also a lighter core of a predetermined strength.

Another ever present desire in every manufacturing field is to reduce the amount of material and number of processes necessary to achieve the same or better results. When this can be accomplished, cost saving can be passed on to the consumer which broadens the use and develops the industry. Not to be able to pass advantages on to the consumer is generally recognized as the turning point downward in an industry.

The inventive idea herein described, I consider a contribution of real progress to the electrical induction field.

The object of this invention is to provide a core composed of curvilinear strip steel.

Another object of this invention is to provide a core composed of oriented strip steel that is arcuately shaped in cross section along the leg portions of the core and flat in cross section at the corners of the core.

Another object of this invention is to provide a core composed of oriented strip steel that has a linear mid-section arcuately shaped and on a plane above or below edges of the strip steel along the leg portions of the core, but which at the corners has a mid-section on the same plane as the edges.

Still another object of this invention is to provide a core composed of oriented strip steel in which the layers nest together forming a holding action on adjacent layers.

Another object of this invention is to utilize the additional strength provided by a curved form, to make magnetic cores.

And another object of this invention is to provide a means of shaping strips of magnetic material into a curvilinear shape and to wind them into a core in such a manner so that successive layers nest together without straining the grain.

Other objects will appear from time to time in the course of the specification and claims.

The terms "concave" and "convex" are used hereinafter

in the specification to connect the arcuate curvature of wound strips when viewed from the exterior of the core, i. e., a strip which has the middle portion of its arcuate cross-section at a greater distance from the winding window of the core than the edges of the strip is termed "convex."

I illustrate several embodiments of this invention in the accompanying drawings in which:

Fig. 1 is a fragmentary sectional view showing a form of machine suitable to carrying out this process.

Fig. 2 is a section of convex nested strips as they look along the straight leg portion of the core.

Fig. 3 is a section of concave nested strips as they look along the straight leg portion of the core.

Fig. 4 is a section of adjacent strips showing the flat shape that curvilinear strip steel takes at a corner.

Fig. 5 is a view of a transformer showing the conductive windings in elevation and the magnetic core of cruciform shape wound from convex strips shown in section.

Fig. 6 is a fragmentary side elevation of a corner illustrating convex strips moving to a flat shape.

Fig. 7 is a fragmentary side elevation of a corner illustrating concave strips moving to a flat shape.

Fig. 8 is a side elevation of a wound curvilinear core.

Like reference figures illustrate like parts throughout.

This invention operates similarly to that disclosed in my Patent No. 2,288,855 issued July 7, 1942, to Alwin G. Steinmayer and William E. Krueger and assigned to the same assignee as this application.

The details for winding cores of either the cruciform shape or otherwise are described in detail in the above mentioned patent and so will not be described in detail in this application. However, an external clamping arrangement in the above patent is eliminated in this invention. Generally, it consists, with reference to Fig. 1, of an elongated strip of magnetic material such as a magnetic ribbon 1, hereinafter described, which is wound on a revolubly mounted suitably shaped form 2. This form 2 is power driven from any source, such as a driving wheel 3. It is preferably composed of a central portion and end flanges 4 which are removably bolted together by means of bolts or other fastening means 5. Preferably, the core form or mandrel 2 has a notch formed therein indicated by the reference character 6 within which the end of the ribbon 1 is positioned to secure the first convolution of the core to the form.

The ribbon of magnetic material is usually furnished in a coil as indicated by the reference character 7 and is fed from this coil between a shaping tensioning means 8. This shaping tensioning means 8 consists of a lower convex roller 9 and an upper concave roller 10 which fit together in such a manner than when the magnetic ribbon slides between them it is bent into a convex shape.

The upper concave roller 10 is clamped against the lower convex roller 9 by means of a spring pressed clamping device 11. This clamping device 11 is urged downwardly by means of a spring 12 whose pressure is adjusted by means of a bolt 13 or in any other suitable manner.

This ribbon may be additionally tensioned if desired by providing a brake like member 14 which is adjusted to yieldingly bear against a drum 15 on which the roll of ribbon 1 is wound.

After the ribbon 1 has been shaped between the rollers 9 and 10 into a convex shape, it is wound on the form 2. A concave shaped roller 16 presses against the convex strips as they are being wound to hold them close together. This roller 16 can be held under tension by some appropriate spring tension means which is not shown. Successive convolutions of convex strips nest together on the straight leg sections in a manner similar to that shown in Fig. 2. As the strip curves around a corner however, it

tends to change to a flat strip as shown in Fig. 4. The core shape thus formed with the strip convex shaped for the leg portion and flat shaped for the corners looks similar at the corner to the enlarged version shown in Fig. 6. The edges of the strip move to the same plane as the center line of the strip as shown in Figs. 6 and 7.

In Fig. 1, I illustrate a mandrel **2** with the convex strip curving somewhat around the edge of the mandrel. This would require a collapsible mandrel. However, the winding can be done equally well on a flat edged mandrel with the outer edges only of the strip resting on the mandrel. With this method the mandrel can easily be pushed out after annealing.

It is also possible to reverse the convex shaped strips and use concave shaped strips as shown in Fig. 3. The rollers **9** and **10** of Fig. 1 would in that case be reversed and the roller **16** having a convex shape instead of a concave. The resulting core made from concave strips would have a corner similar to that shown in Fig. 7 with the outer edges of the strip on the same plane as the center line of the strip.

The same concave or convex shaped strip can be used on a cruciform core and a cross-section of the core will look similar to that shown in Fig. 5. The construction and method of making a core of cruciform cross-section is disclosed in my aforementioned Patent No. 2,288,855 and my Patent No. 2,344,006 to which reference is made for details of construction. Such a core is made up of a plurality of core sections of different widths with each section comprising a plurality of convolutions wound one upon another from a single, continuous, constant width, magnetic steel strip having a preferred orientation lengthwise of the strip. The sections are wound one upon another to provide a substantially rectangular core member having a pair of leg portions and a pair of connecting yoke portions defining a winding window. The widest section is at the middle of the core and the narrowest core sections are disposed at the inner and outer peripheries to thus provide a setpped core section. The magnetic steel strips maintain the arcuate in transverse cross-section deformation on the legs and yokes of the core, but at the corners of the core the edges of the strips move to the same plane as the center line of the strip. The arcuate portions on the legs and yokes of each turn nest in the arcuate portions of adjacent turns to prevent lateral relative movement of the turns after they are wound and to strengthen the turns against collapse.

In Fig. 8 it can be seen how the layers **17** of a core wound from curvilinear strip, nest together, each layer forming a clamping action on the adjacent layer. Because of this clamping action of the strips themselves, additional clamps are not necessary to hold the core together during annealing. This is a great saving because the clamps absorb a great many B. t. u.'s during the annealing and also occupy quite a bit of space in the annealing ovens.

Therefore, it can be seen that by using this inventive idea, I simplify the process of annealing by eliminating clamps and the subsequent B. t. u.'s that they would absorb. I also save the space that the clamps would occupy thus making it possible to place a greater number of cores in the annealing furnace at one time.

It is well-known that a curved surface has greater strength than a flat surface and so by utilizing this attribute in the forming of magnetic cores, it is possible to make a core of greater strength with a similar amount of material and weight.

Curvilinear strips nested together form legs and yokes of great rigidity that will not collapse or bend askew. They will retain their rectangular or cruciform shape before annealing and possess great strength after annealing.

By allowing the strips to move to a flat shape at the corners, means that new longitudinal stresses are not set

up within the steel strips as would occur if the strips were forced to retain their arcuate shape at the corners. The grain structure is not disturbed but remains in the same well oriented condition as it had in the original flat state.

Thus, it can be seen that by constructing a core of oriented strip steel that has a nested curvilinear shape on the leg portions and a flat shape at the corners, I benefit by the strength and rigidity of a curved material without losing any of the magnetic properties that would be lost if additional longitudinal stress existed.

I claim:

1. A magnetic core member for electrical induction apparatus comprising, a plurality of nested convolutions wound one upon another from magnetic steel strip having a predetermined deformation applied thereto longitudinally throughout the length of the strip and having a preferred orientation lengthwise of the strip to provide a substantially rectangular member of predetermined size having a pair of leg portions and a pair of connecting yoke portions, said deformation being arcuate in transverse cross-section from edge to edge of the strip and convex when viewed from the exterior of the core, said strip maintaining said arcuate cross-section along said legs and yokes with the arcuate portions of each convolution nesting in the arcuate portions of adjacent convolutions to prevent lateral movement of the convolutions after they are wound, said strip being from edge to edge in transverse cross-section at the corners of said rectangular member.

2. A cruciform in cross-section magnetic core member for electrical induction apparatus comprising, in combination, a plurality of superposed core sections each comprising a plurality of turns wound one upon another from constant width magnetic steel strip having a preferred orientation lengthwise of the strip, said core sections being of different widths and wound one upon another to provide a substantially rectangular core member of cruciform cross-section having a pair of leg portions and a pair of connecting yoke portions defining a winding window, the steel strips along the leg and yoke portions of the core being arcuate in transverse cross-section from edge to edge of the strip, the arcuate cross-section being concave with reference to said winding window, said steel strips being flat from edge to edge in transverse cross section at the corners of said core, the arcuate portions of each turn nesting in the arcuate portions of adjacent turns to prevent lateral relative movement of the turns.

3. A magnetic core for stationary electrical induction apparatus comprising a plurality of turns wound flatwise one upon another from magnetic steel strip having a predetermined deformation longitudinally throughout the length of the strip and having a preferred orientation lengthwise of the strip to provide a closed, spirally wound, substantially rectangular member having a pair of leg portions and a pair of connecting yoke portions, the apex of the deformed portion of said strip being toward the outside of said core, said strip maintaining said deformation along said legs and yokes with the deformation in one turn nesting in the deformation of adjacent turns to prevent lateral relative movement of the turns after they are wound, said strip being flat from edge to edge in transverse cross-section at the corners of said rectangular member.

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