July 7, 1942. A. G. STEINMAYER ET AL 2,288,855

METHOD AND MEANS FOR MAKING CORES FOR TRANSFORMERS OR THE LIKE

Filed June 7, 1940 2 Sheets-Sheet 1

Fig. 1

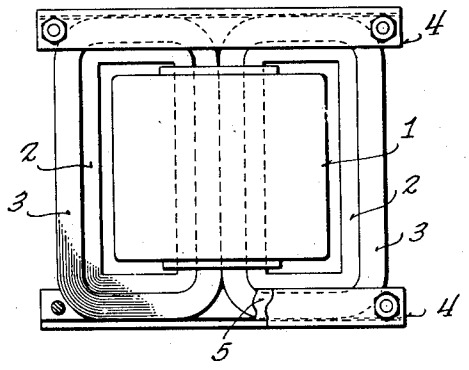


Fig. 2

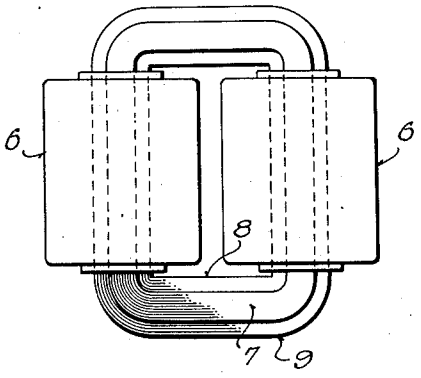
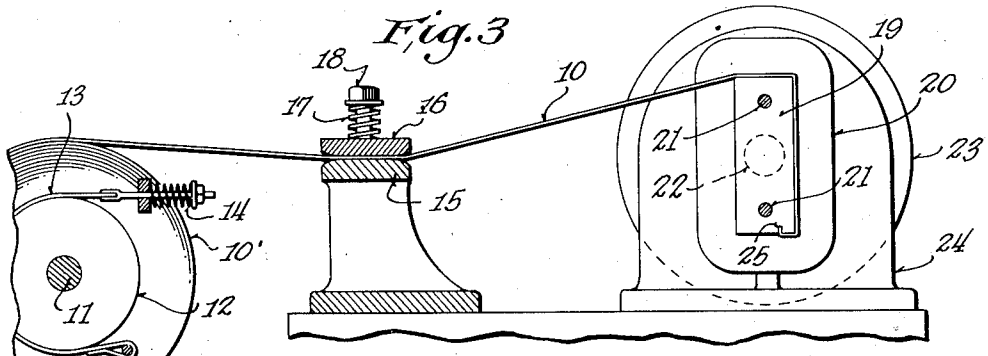


Fig. 3



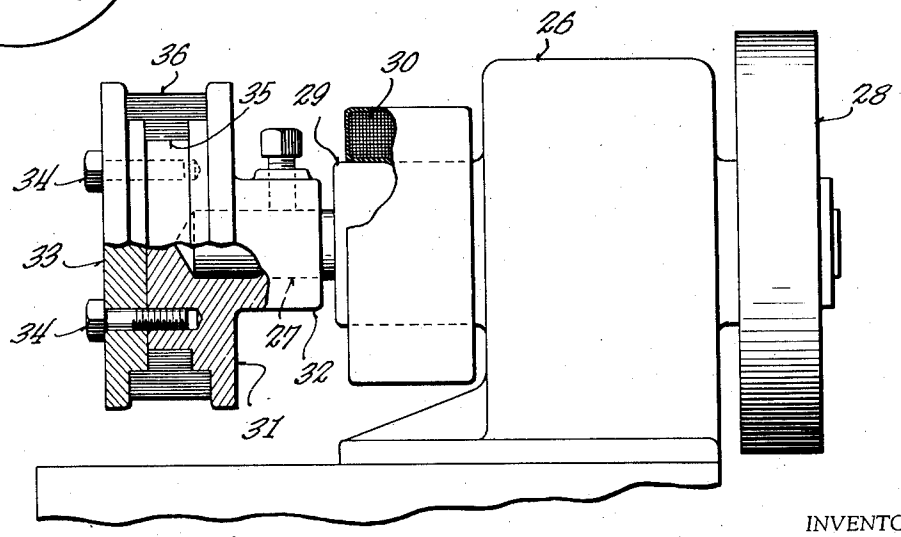


Fig. 4

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Fig. 5

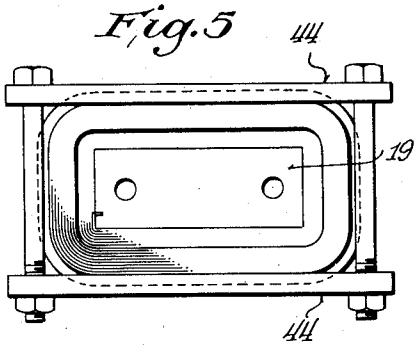


Fig. 6

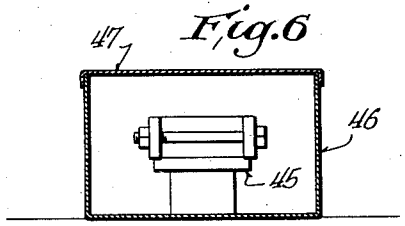


Fig. 8

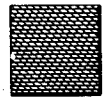


Fig. 7

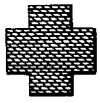
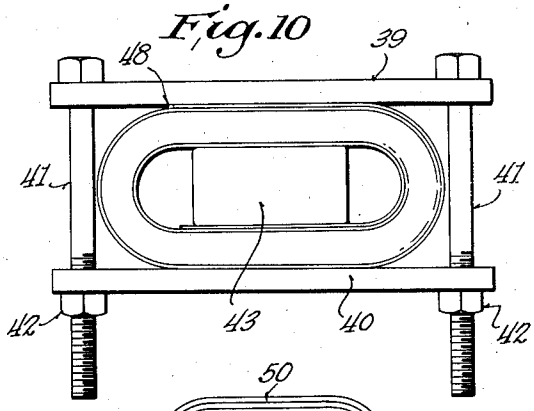


Fig. 10



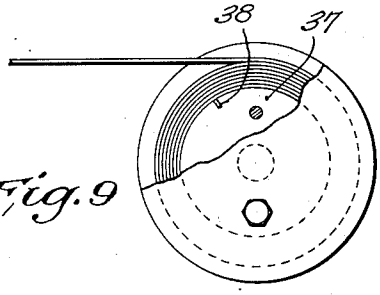


Fig. 9

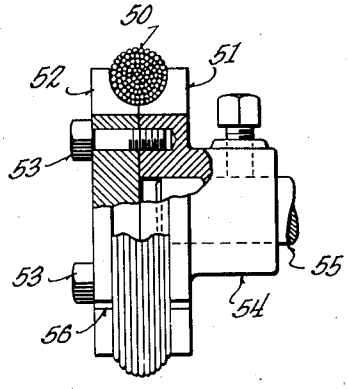


Fig. 11

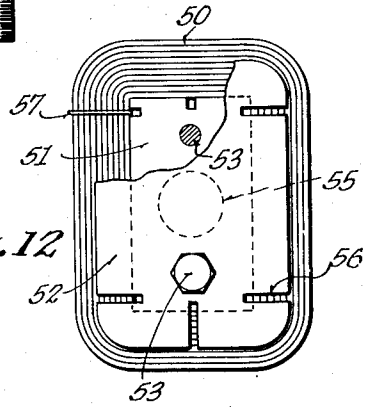


Fig. 12

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UNITED STATES PATENT OFFICE

2,288,855

METHOD AND MEANS FOR MAKING CORES FOR TRANSFORMERS OR THE LIKE

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Application June 7, 1940, Serial No. 339,256

6 Claims. (Cl. 148—12)

This invention relates to a method and means for making cores for transformers or the like.

Objects of this invention are to provide a method of forming cores for transformers or the like in which an elongated strip or elongated strips of magnetic material are employed of any desired cross-section, for instance rectangular as in a ribbon, round as in a wire, or of some other shape, and in which a closed core is wound to shape or is reshaped after winding, but without unwinding, and is held in its desired shape and annealed to remove internal stresses due to the winding or working of the core so that a finished core is provided free from stresses and ready to have a coil structure wound thereon without reworking of the core.

Further objects are to provide a simple, practical method of winding closed cores for transformers or the like from elongated magnetic material which method may be economically and rapidly followed to produce a core for a transformer or the like having good electrical characteristics.

Further objects are to provide means for winding and forming the core from an elongated strip or elongated strips of magnetic material, in which means are provided for preventing slipping of the core on the form on which it is wound, and in which means are provided for insuring the close association of successive convolutions of the core.

Further objects are to provide means for winding and shaping a closed core for a transformer or the like so as to provide a straight portion of the core on which a coil structure can be wound.

Further objects are to provide a machine for winding closed cores for transformers or the like in which any desired cross-sectional contour may be given the core so that the core may be formed either with a rectangular section, cruciform section, round section, or any other desired section.

Further objects are to provide novel means for insuring the holding of the core strip to the form while it is being wound and for insuring the close association of successive convolutions of the core.

In certain forms of the invention, further objects are to provide either mechanical or electromagnetic means for holding the core to the form on which it is being wound, and still further objects are to provide means for preventing the unwinding of the core while it is being annealed, and to provide means for insuring the retention of the correct shape of the core during the annealing step.

Embodiments of the invention are shown in the accompanying drawings, in which:

Figure 1 is a view of one form of completed transformer, with the terminal blocks, casing, etc., omitted.

Figure 2 is a view of a further form of transformer, with the terminal blocks, casing, etc. omitted.

Figure 3 is a diagrammatic view, partly in section, showing the manner in which the closed core is formed in one form of the invention.

Figure 4 is a view of a further form of construction for winding the core.

Figure 5 is a view showing the manner in which the core is held clamped to the form ready for annealing.

Figure 6 is a view partly in section showing the manner in which the core is mounted during annealing.

Figures 7 and 8 are cross-sectional views of different cross-sectional forms that the core may have.

Figure 9 is a view showing a further form in which the core may be wound, the core in this form being subsequently reshaped.

Figure 10 is a view showing the manner in which the core as wound in Figure 9 is reshaped.

Figures 11 and 12 show a different construction of form on which a closed wire core may be wound.

The machine and the process may be employed to form cores for different types of transformers. For example, one type of transformer is shown in Figure 1 in which the coil structure is indicated by the reference character 1 and a pair of wound cores are provided which interloop with the coil structure, the coil structure in the case of the transformer of course including both primary and secondary windings, though in the case of a choke a single coil may be employed.

The core is made up of the two parts as illustrated which may be similar and which may comprise a section 2 formed of relatively narrow ribbon like magnetic material and the section 3 formed of relatively wide ribbon like magnetic material. Jointly these two parts of the core form at the point where they pass through the transformer a cruciform shape as shown, for example, in Figure 7. This shape requires a smaller opening through the coil for the same amount of magnetic material than the rectangular shape as shown in Figure 8, though

any shape desired could be employed. Suitable mounting brackets 4 are employed and these mounting brackets grip the sections 3 of the core, suitable insulating strips 5 being positioned between the mounting brackets 4 and the sections 3.

The transformer may take other shapes—for example that shown in Figure 2 in which two coil structures 6 may be employed and each may include both the primary and secondary in accordance with the usual practice. This transformer may have a cruciform core consisting of the relatively wide central section 7 and the relatively narrow inner and outer sections 8 and 9 and would conform in cross-sectional contour to that shown in Figure 7, or if desired, the cross-sectional contour may be rectangular. As will appear hereinafter, further shapes may be employed. For instance, a core having a circular cross-sectional contour may be employed as illustrated in Figure 11.

In forming the core an elongated strip or elongated strips of magnetic material, either hot rolled or cold rolled, may be employed. A roll of this ribbon like magnetic material is indicated in Figure 3 by the reference character 10' and is carried by a suitably supported mandrel 11. It may be wound on a drum 12 which may cooperate with a brake like tensioning member in the form of a strap 13 encircling a portion of the drum 12 and tensioned by means of an adjustable spring 14. The ribbon like magnetic material 10 is led through any suitable guiding means which is preferably in the form of a tensioning means. For example, it may be led over the guiding support 15 and clamped against this support by means of the spring pressed clamping plate 16. The clamping plate 16 may be urged downwardly by means of springs 17 whose pressure is adjusted by means of bolts 18 or in any other suitable manner. Either or both of the tensioning means can be employed as desired.

In the form of the invention shown in Figure 3, a winding form 19 of rectangular contour is employed and this rectangular form is provided with removable end flanges or plates 20 which may be held to the form 19 by means of the bolts 21. The form is carried on a suitable mandrel or other support 22 which is rotated by power means, for example as indicated at 23, and mounted in a suitable headstock or bearing member 24.

The form 19 is provided with a slot 25 which receives the inturned end of the magnetic ribbon material 10 as shown in Figure 3 so as to start the ribbon without slipping on the form.

When the parts are assembled as shown in Figure 3, power is applied and the form 19 is rotated, thus winding the core in a rectangular shape. The core can be wound in other shapes if desired.

As stated hereinabove, either or both tensioning means can be employed. The tensioning means 13 additionally performs the function of preventing unwanted unrolling of the roll 10'. The guiding means assists in correctly guiding the magnetic strip and also as described may act as a tensioning means. The magnetic ribbon is wound on the rectangular form 19 under considerable tension to cause successive convolutions to lie in close relation to each other.

Other means can be employed for holding the magnetic ribbon to the form. For example, in Figure 4 electromagnetic means are employed. In this form of the invention the headstock is indicated at 26 and revolubly carries the mandrel or shaft 27 which is power driven in any suitable manner, as from the pulley 28 for instance. The headstock is relatively massive and has a projecting boss 29 upon which the magnet winding 30 is placed.

The form upon which the magnetic material is wound as shown in Figure 4 may consist of a body portion 31 which has a hub 32 relatively massive and closely adjacent the boss 29 so as to conduct the magnetic flux not only through the shaft 27 but also from the boss 29 to the hub 32. This hub is removably secured to the shaft 27. An end member 33 completes the form and is bolted as indicated at 34 or otherwise removably secured to the body portion. This form is so shaped that it is adapted to wind a core of cruciform shape. For example, the first portion of the core may be formed of a relatively narrow ribbon of magnetic material as indicated at 35, and thereafter relatively wider magnetic ribbon as indicated at 36 may be wound thereon. If the core as shown in Figure 1 is desired, this would complete the winding of the core. However, if a core as shown in Figure 2 is desired, an outer layer of relatively narrow magnetic ribbon similar to that shown at 35 in Figure 4 would be wound on top of the portion 36.

It is apparent that when the magnet is energized by passing direct current, for instance, through the coil 30, the core is intensely magnetized, such core being preferably formed of mild steel or soft iron. The magnetic ribbon will thus cling to the core and it will not be necessary to mechanically interlock an end tongue of the magnetic ribbon to the core as previously described. Additionally, the highly magnetized form will cause successive convolutions of the magnetic ribbon to lie closely against each other.

The form on which the core is wound, as shown in Figure 4, may be either rectangular as illustrated in Figure 3 or circular as shown in Figure 9. The circular form in Figure 9 is indicated by the reference character 37 and may have a slot 38 formed therein similar to that shown in Figure 3 or may be highly magnetized as described in connection with Figure 4.

When the core is wound on the circular form, it is reshaped by any suitable press means for instance. It may be drawn into shape by means of the structure shown in Figure 10, which may consist of an upper and a lower bar 39 and 40 which are drawn towards each other by means of bolts 41 upon which nuts 42 are threaded. When the core has been somewhat flattened towards the position shown in Figure 10, a rectangular form or block 43 is inserted in the window of the core and the core is clamped tightly to this block. If a cruciform shape of core is employed, it is obvious that the clamping bars 44, see Figure 5, may be recessed to accommodate the narrower ribbon and also to apply pressure to the wider ribbon. For example, in Figure 5 the form of core shown in the transformer of Figure 2 is illustrated as being held in clamped position against the rectangular form 19 on which it was wound. Obviously a power press could be used to reshape the core and any suitable means could be used to temporarily hold the core in its reshaped condition.

It is preferable to either tie or otherwise secure the end convolution in place. This is readily accomplished by means of brazing, welding,

or otherwise securing the end convolution, the brazing or welding being at the point indicated at 48 in Figure 10.

After the core has been reshaped by this or any similar process and while it is held in shape, it is placed in an annealing oven and annealed to remove internal stresses due to the working of the core in the winding process. The clamped core is preferably placed on a suitable support 45 in an enclosing box 46 to keep the flame from directly impinging against the core. A top 47 may be employed or the core may be packed in flaked mica. Preferably a reducing atmosphere is employed in the annealing furnace whether hot rolled or cold rolled magnetic material is used in the production of the core.

After annealing the clamping means are removed and the block or form is removed from the window of the core. It will be found that the core will retain its shape as the internal stresses have been removed by the annealing process and thus a completely finished core is provided free from stresses and ready for the coil to be wound thereon.

If desired a core of round cross-sectional contour or of other cross-sectional contour may be provided and also if desired elongated magnetic material of other shapes than rectangular can be employed.

For example as shown in Figures 11 and 12, the core is shown as being wound from magnetic wire indicated at 50 which may be of any desired cross-sectional shape. In this form of the invention the main body portion of the form 51 and the end member 52 are formed with quarter-circular grooves therein which together form a semicircular groove when the parts are secured together by bolts 53 or other means. As previously described, this form may be provided with a hub 54 which is removably secured to the power driven shaft 55. Obviously the first convolution of the wire may be held in place by entering the end of the wire in a suitable notch in the form or by the magnetic means hereinbefore described. Preferably the form is of rectangular contour as shown in Figure 12.

At suitable intervals the end flanges and body portion are provided with slots 56 through which tie wires 57 may be passed for tying the core together so as to retain the circular cross-sectional shape of the core. This core is also annealed after it has been wound so as to remove internal stresses and improve its electrical characteristics.

It is to be noted that where a rectangular cross-sectional contour of the wound core is desired, that end flanges may be provided either or both of which may be removed from the core proper, but where either a round or cruciform shape is employed, it is to be noted that the form is so made that it is removable from opposite sides of the core.

It will be seen that a very simple method of producing a closed core for transformers or the like has been provided by this invention, and it will be seen further that the devices for winding and producing these cores are relatively simple and are easy to construct and operate.

Further it will be seen that the core may be formed circular and thereafter may be reshaped prior to annealing, or the core may be formed with at least one straight side as, for example, when it is formed on a rectangular form, so as to provide an elongated leg portion of the core adapted to have the coil wound thereon.

It is to be noted particularly that the core is not reworked after it has been annealed but is given its correct and permanent shape prior to annealing so that the stresses are removed from the core by the annealing and no further working of the core is required.

It will also be seen that by following the method disclosed that a core for a transformer or other similar device has been disclosed in which straight side portions are provided in the core structure itself, thus enabling the conductive coil to be wound as a circular coil with all of the inherent advantages of strength and freedom from the likelihood of breaking the insulation due to the sharp bending which does result when a preformed rectangular coil is employed. In addition to these features, the use of the straight-sided core produced by this invention enables a coil to be wound thereon which has a relatively small depth as compared with its length, thus materially reducing the reactance of the resulting transformer.

This invention produces a transformer core in which the air gap is reduced to a minimum as there is in effect only one air gap which has a very small effect as compared with the multiplicity of air gaps in the ordinary transformers where individual sections are assembled. In addition to this, following the method of this invention the successive layers are held very closely compacted and the air gap therefore is reduced to a minimum. Also by having the core clamped during annealing, it is apparent that no chance for the separation of the successive layers is afforded. Also after annealing it is apparent that the successive layers hold their shape and remain in their close compacted relation.

In addition to this, by forming the core in the manner herein disclosed it is possible to efficiently use a high grade steel and have a higher flux density therein as the reluctance of the magnetic path has been greatly reduced by the reduction in air gaps. If, on the other hand, it were attempted to have a high flux density in the magnet core and yet have a number of air gaps, it is obvious that the high flux density would also exist at the air gaps and consequently a very inefficient transformer would result as the exciting current would be very high.

Also by using a high grade steel and substantially eliminating the majority of air gaps, it is possible to effect a real economy in the production of cores for transformers or the like. The forms on which the cores are wound have been shown as provided with end flanges. It is to be understood that the invention is not limited to the use of end flanges as these forms may be made without them.

The coil structure may be wound on the core either by hand or by a suitable winding machine.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

We claim:

1. The method of making cores for transformers or the like comprising winding a closed core of magnetic material on a first form of one shape, removing said first form and substituting a second form of a different shape, reshaping the core to the second form, holding the core clamped to the second form, annealing the core while it is held in shape on said second form, and subsequently removing the annealed closed core from the second form.

2. The method of making finished, closed, magnetic cores comprising winding a closed core of magnetic ribbon on a form, clamping the closed core on the form, annealing the core while it is clamped to the form to remove stresses from the clamped, wound core, and subsequently removing the form from the annealed closed core, whereby a finished, closed, wound, magnetic core is produced in a finished condition and free from stresses.

3. The method of making a finished, closed, shaped, magnetic core having at least one straight side comprising winding the core from magnetic ribbon on a form having at least one straight side, clamping the core on the form with the straight side of the core tightly compacted, and annealing the core while it is clamped on the form to cause the core to take a permanent shape corresponding to the form and to free the core from stresses due to shaping the core to the form, and subsequently removing the form, whereby the shape of the core is retained after annealing and hardening due to winding is avoided in the finished core.

4. The method of making a finished, closed, shaped magnetic core having opposed straight sides comprising winding a core from magnetic ribbon on a form having opposed straight sides, clamping the opposed straight sides of the core to the straight sides of the form to hold the straight sides of the core tightly compacted, annealing the core while it is clamped to the form to cause the core to take a permanent shape with straight, compacted side portions, and subsequently removing the core from the form, whereby a closed wound magnetic core is produced which is free from stresses due to winding and which has opposed straight side portions.

5. The method of making a finished, closed, shaped, magnetic core having at least one straight side and having a cross-section of different widths comprising successively winding a series of lengths of magnetic ribbon of different widths in a regular sequence upon a form which has at least one straight side, clamping the straight side of the core to the straight side of the form to hold the straight side of the core tightly compacted, annealing the core while it is clamped to the form to cause the core to take a permanent set with at least one straight, tightly compacted side and to free the core of stresses due to winding, and subsequently removing the core, whereby a closed, wound magnetic core is produced which has a cross-section of different widths and which has at least one straight side and is free from stresses due to winding.

6. The method of making a finished, closed, shaped, magnetic core having a plurality of laminations lying one upon the other and having at least one straight side comprising winding the core from magnetic ribbon to provide a plurality of convolutions lying one upon the other, clamping the core to a form having at least one straight side with the laminations of the straight side held tightly clamped to the form, annealing the core while it is clamped to the form to cause the core to take a permanent set with one side straight and to free the core from stresses, and subsequently removing the form, whereby a closed, wound magnetic core is produced which has at least one straight side and which is free from stresses.

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