Nov. 18, 1947. E. A. LINK 2,431,128

THREE PHASE TRANSFORMER

Filed June 4, 1943 2 Sheets-Sheet 1

Fig. 1

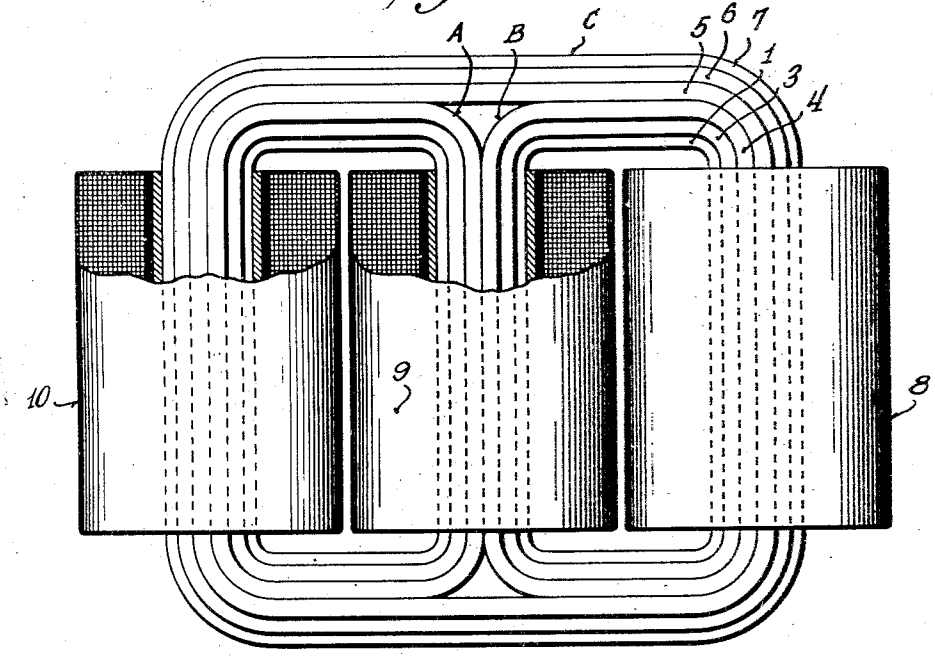
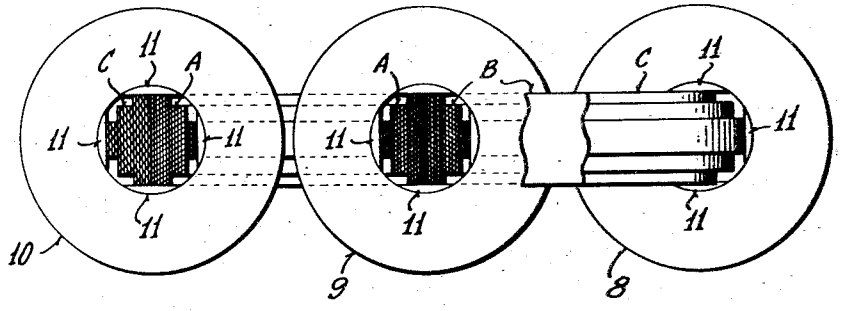


Fig. 2



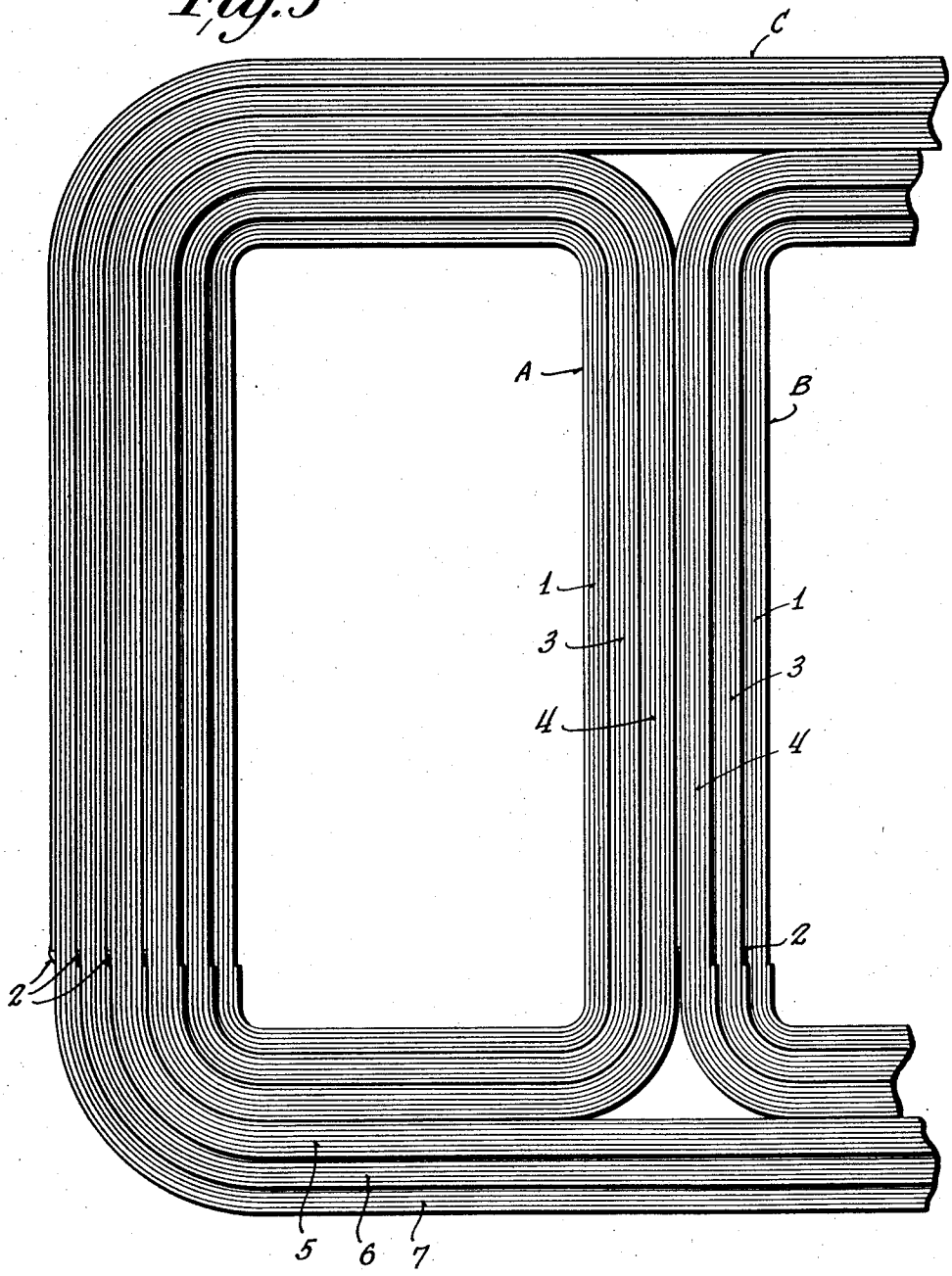
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Filed June 4, 1943 2 Sheets-Sheet 2

Fig. 3



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THREE-PHASE TRANSFORMER

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Application June 4, 1943, Serial No. 489,600

2 Claims. (Cl. 175—356)

1

This invention relates to three phase transformers and is particularly directed to the core construction.

Three phase transformers have heretofore been made of the stacked core construction in which a multitude of pieces of flat core steel were joined together by stacking to form the necessary shape of core for the three groups of conducting winding assemblies of the three phase transformer. This stacking operation entailed a high labor cost due to the long process of interleaving all of the small pieces of steel. Even in the initial stacking operation some mechanical stress was always imparted to the core pieces in the practical manufacture of the transformer and this reduced the efficiency of the transformer. Also in the stacked core construction it is necessary for the magnetic flux to traverse a multitude of air gaps and to travel cross grain at the corners of the core and this entailed a certain amount of loss in the core of the transformer.

This invention is designed to overcome the above noted defects, and objects of this invention are to provide a novel form of three phase transformer which has its core structure formed of wound magnetic ribbon, which is wound into closed cores, in which no unusual care is required in the assembly of the parts of the device, in which no bending, machining or other working of the core structure is required after annealing and which therefore provides a finished core free from stresses, and in which short-circuiting of the laminations is avoided as the oxide film formed on the laminations is preserved and is not scraped off as there is no working subsequent to annealing.

Further objects are to provide a core construction for a three phase transformer in which two inner closed cores wound from magnetic ribbon are provided and are surrounded by an outer closed core wound from magnetic ribbon, the construction providing great rigidity and providing a unitary core construction for a three phase transformer which is substantially free from air gaps which therefore requires a low exciting current for the transformer, thus allowing a more economical design of the three phase transformer by increasing the flux density and yet not exceeding the allowable limits of exciting current, and to provide a construction in which the path of the magnetic flux follows the grain in the magnetic ribbon due to rolling, thus furthering economy by reducing core losses and exciting current and allowing the material to be worked economically.

2

Further objects are to provide a three phase transformer having a core construction of cruciform shape, thus providing a good space factor and allowing the winding of the conducting coil assemblies as circular coils with all of the inherent advantages resulting therefrom such as the ability of the conducting winding to resist distorting forces due to short-circuit or similar conditions as the circular coil is considerably stronger than rectangular coils, and in addition to the mechanical strength entails less danger of damaging the insulation during winding than where a rectangular conducting coil assembly is employed as it requires less tension on the wire and no pounding of the coil to make a firm coil.

Further objects are to provide a three phase transformer construction which has less hum than the stacked core type of three phase transformer as there are substantially no gaps in the magnetic circuit and as the wound core construction is inherently a firmer construction and much more rigid than the stacked core construction.

Further objects are to provide a novel form of three phase transformer which is simple to manufacture and in which the number of operations required in its production is materially reduced.

An embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is an elevation of the three phase transformer, with parts broken away and in section.

Figure 2 is a plan view of the structure shown in Figure 1, with parts broken away and in section.

Figure 3 is an enlarged fragmentary elevation of the core.

Referring to the drawings, it will be seen that the transformer core structure comprises two inner core sections indicated generally by the reference characters A and B, and an outer core section indicated generally by the reference character C. Each of these core sections is formed by winding a closed core of magnetic ribbon. The material used in making the cores is any suitable type of magnetic ribbon though it is preferable to use silicon steel, which may be either hot rolled or cold rolled, as this material has been found highly efficient in the manufacture of transformers.

The inner cores A and B are duplicates and a description of one will, therefore, be sufficient. In making an inner core, a magnetic ribbon of suitable width indicated by the reference character I is first wound to provide the necessary thickness

and when the winding is completed, the outer end is brazed, tack welded, or otherwise secured as indicated by the reference character 2, see Figure 3. Thereafter a magnetic ribbon of greater width is wound directly on the section 1 to form a closed core section 3 and its end is similarly tack welded as shown in Figure 3. Thereafter a magnetic ribbon of still greater width is wound directly on the section 3 to form a closed core 4 and its end is tack welded or otherwise secured. Obviously the ends of the successive sections may be tied with wire or otherwise secured if desired, tack welding or brazing having been found satisfactory however.

Two inner cores, as stated, are produced and are either wound on a circular mandrel and thereafter shaped to their rectangular shape, as shown in Figure 1, or else are wound on a rectangular mandrel to the desired shape.

Thereafter the outer core section C is either wound on a circular mandrel and thereafter given a rectangular shape or is wound on a rectangular mandrel and, after completion, positioned so as to encircle the two inner core sections A and B, or the outer core section C may be wound directly on the shaped inner core sections A and B.

This outer core section C is formed by first winding the inner closed portion 5 of the outer core section C of magnetic ribbon of the same width as that of the core sections 4 of the inner core sections A and B. After this winding is completed, the end of the strip is tack welded or brazed as previously described.

The next step is to wind a narrower magnetic ribbon to form a closed portion 6 whose end is brazed, tack welded or otherwise secured. Thereafter the narrowest magnetic ribbon is wound to form a closed portion 7 and its end brazed, tack welded or otherwise secured.

After the winding and assembly of the core sections is completed and after all of the sections are either wound in final shape or are separately wound and thereafter shaped and assembled as described hereinabove, the entire core of the three phase transformer is clamped together and annealed so as to remove all stresses due to the working of the magnetic ribbon during winding or during winding and subsequent shaping, depending on which process hereinabove described is followed. After annealing there is no further working, machining or bending of any of the core sections whatsoever and consequently there is no stress imparted to any portion of the core section which would otherwise adversely affect the characteristics of the transformer.

The conducting winding assemblies including the primaries and secondaries are indicated by the reference characters 8, 9 and 10. These winding assemblies are wound on the finished annealed cores in any suitable manner. For example, the winding machine disclosed in the patent to Steinmayer et al. 2,305,999 of December 22, 1942, for Method and machine for winding coils, could be used.

After the conducting windings have been finished, suitable wedges 11 may be driven into place as shown in Figure 2 to suitably hold the conducting winding assemblies firmly positioned with reference to their cores.

It is to be noted from an examination of Figure 1 that the three phase transformer has a central leg formed by the abutting or back to back straight portions of the core sections A and B and has two outer legs formed by the abutting outer straight portions of the inner core sections A and B and the spaced straight portions of the outer core section C.

It will be seen that the cross-section of each leg of the transformer is cruciform, and thus a good space factor is obtained.

Further it will be seen that circular conducting winding assemblies are provided which have all of the inherent advantages hereinbefore set forth and that the entire core structure is a rigid structure and is handled as a unit during the winding of the conducting coil assemblies.

Further it is to be noted that there are substantially no air gaps in the magnetic path and that the magnetic flux travels in the direction of the grain of the magnetic ribbon which is the path of minimum reluctance.

The core construction for the three phase transformer provides a structure having great inherent rigidity as the outer wound core section serves to bind and hold the inner wound core sections in place.

It will be seen that a three phase transformer construction has been provided by this invention which has very small magnetic reluctance for the flux travel and which is extremely simple to make and requires a minimum number of operations in its production and allows the winding of circular conducting winding assemblies directly on the legs of the core without any working whatsoever of any portion of the core after annealing, and in which the flux path follows the grain of the magnetic ribbon.

This invention, therefore, provides a novel type of three phase transformer construction which utilizes the wound core principle and also utilizes circular conducting coil assemblies with all of the advantages resulting from such constructions.

The expression conducting winding assembly or assemblies is intended to include both the primaries and secondaries.

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.

I claim:

1. A unitary core construction for three phase transformers, said unitary core construction comprising two inner substantially rectangular contacting core sections and an outer substantially rectangular core section contacting the major portion of the peripheries of the inner core sections, the arrangement being such that the inner core sections jointly provide a central core leg and with the outer core section provide a pair of outer legs, said core sections each consisting of closely and tightly wound, stress-free magnetic ribbon, annealed and free from working after annealing, said outer core section being wound tightly and closely in embracing relation around the inner core sections and serving as the unifying and binding element of the core construction to provide a rigid unitary structure, the core legs of the construction thus unified constituting the cores which are adapted to have conducting winding assemblies wound thereon.

2. A unitary core construction for three phase transformers, said unitary core construction comprising two inner substantially rectangular contacting core sections and an outer substantially rectangular core section contacting the major portion of the peripheries of the inner core sections, the arrangement being such that the inner core sections jointly provide a central core leg

and with the outer core section provide a pair of outer legs, said core sections each consisting of closely and tightly wound, stress-free magnetic ribbon, annealed and free from working after annealing, said outer core section being wound tightly and closely in embracing relation around the inner core sections and serving as the unifying and binding element of the core construction to provide a rigid unitary structure, the core legs of the construction thus unified constituting the cores which are adapted to have conducting winding assemblies wound thereon, the adjacent portions of the inner and outer core sections and the adjacent portions of the inner core sections constituting pressure contact areas whereby the core construction provides inherent rigidity in itself irrespective of any other elements of the transformer.

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