Nov. 12, 1946. R. D. NELSON 2,411,104

THREE PHASE TRANSFORMER

Original Filed May 17, 1943

Fig. 1

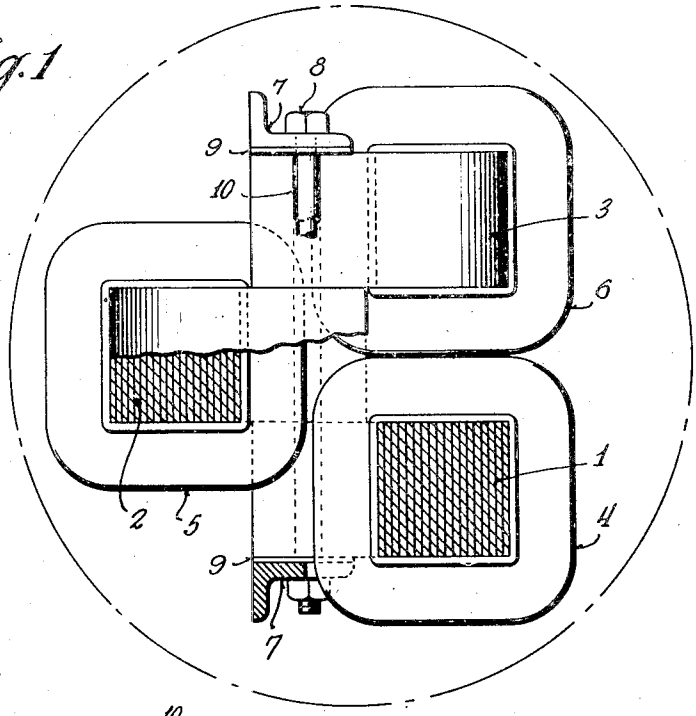


Fig. 2

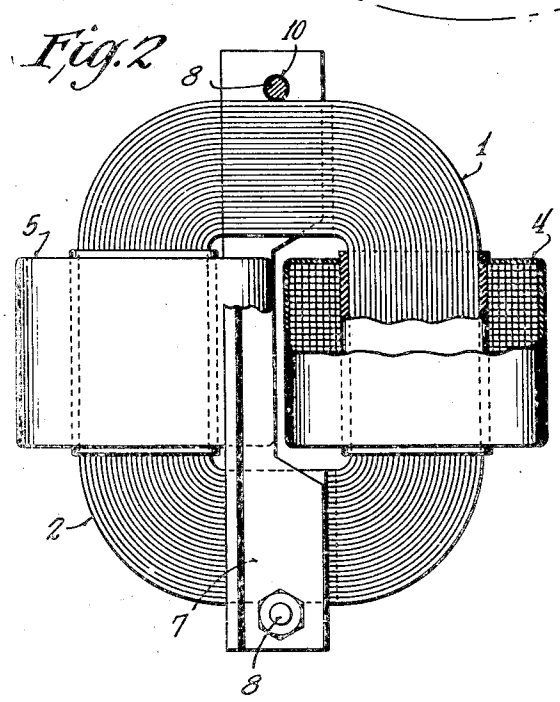
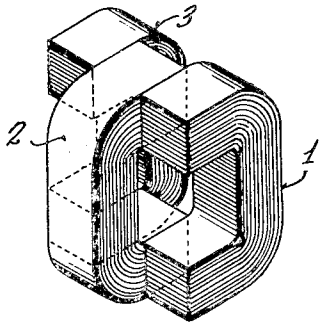


Fig. 3



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THREE-PHASE TRANSFORMER

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Original application May 17, 1943, Serial No. 487,202. Divided and this application April 1, 1944, Serial No. 529,101

4 Claims. (Cl. 175—356)

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This invention relates to three phase transformers and is a division of my application filed May 17, 1943, Serial No. 487,202, now Patent No. 2,398,109, for Three phase transformers.

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. It also required a relatively long and narrow shape of tank, the round tank being impractical to use with the customary type of core for the three phase transformer. These stacked types of three phase transformers were hard to repair in case of failure of one of the coils since it was necessary to remove the entire stacked end portion in order to remove the defective coil. 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 travel cross grain at the corners of the core and this, in addition to the defect hereinabove noted, 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, which are thereafter cut into sections and such sections used in the completed device, 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 in which short-circuiting of the laminations is avoided.

Further objects of this invention are to provide a three phase transformer which in its preferred form is composed of cores which are formed of wound magnetic ribbon subsequently cut into sections and so arranged that an efficient three phase transformer core structure results, and in which the conducting windings may be very readily wound in a simple and ordinary manner upon the core sections without requiring any special machine other than the usual type of winding machines for winding the conducting windings.

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This invention in its broadest aspect permits the use of stacked magnetic laminations or of wound cores formed of magnetic ribbon which are subsequently cut into parts after winding, the resulting magnetic core structure whether formed of stacked laminations or wound cores subsequently cut into sections being laminated throughout its entire extent.

Further objects are to provide a three phase transformer in which there are relatively few joints in the core structure, in which the joints in the core structure are so formed that a substantially edge to edge contact of the adjacent laminations is obtained, thereby materially reducing the reluctance of the magnetic path, and in which these results are obtained in a very simple manner and with a very small amount of work required in the manufacture of the device.

Further objects are to provide a novel construction of three phase transformer in which the losses are relatively small, and in which a very good space factor is obtained for the conducting winding.

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 drawing, in which:

Figure 1 is a plan view of the transformer with parts broken away and parts in section and showing in dotted outline the transformer casing.

Figure 2 is an elevation of the transformer with parts broken away.

Figure 3 is a perspective view of the core structure.

Referring to the drawing, it will be seen that the transformer core structure comprises three identical core sections indicated by the reference characters 1, 2 and 3. Each of these core sections is formed by winding a closed core of magnetic ribbon and cutting it across, preferably cutting it in half. The material used in making the cores is any suitable magnetic ribbon. 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.

As stated, the magnetic ribbon is wound to form a closed, continuous core and thereafter is cut across to form a pair of sections. These sections are arranged with their side faces in substantial contact. They may be in actual physical contact or they may be spaced apart by the

oxide formed on the marginal edges of the laminations or by a layer of insulating paint or other insulating material that may be applied to the juxtaposed faces of the core section, or the insulation may be in the form of thin sheets between the end portions of adjacent core sections. It is preferable to grind the juxtaposed faces of these sections to get true, flat faces.

In the manufacture of the core sections, after the sections have been tightly wound as closed cores and cut, preferably in half, as described hereinabove, and after the appropriate faces have been ground, they are annealed while they are held in shape. After annealing no further working of the cores takes place in any manner whatsoever. Any wire edges that may be left are usually burned off during annealing, but if any should be found to remain, they may be removed by a wire brush or in any other suitable manner. After the core sections have been annealed, they are then separately wound to provide their primaries and secondaries, which will hereinafter be referred to as conducting winding assemblies, indicated respectively by the reference characters 4, 5 and 6. The winding is readily done in the ordinary manner on ordinary and common types of winding machines.

The core sections are then assembled as shown in Figures 1 and 2 and clamping means is provided for holding the sections clamped securely together. This clamping means may comprise a pair of upright angle irons 7 which are held in clamping relation by means of the upper and lower tie bolts 8. Insulating sheets 9 are positioned between the clamping means and the adjacent core sections to prevent short-circuiting across the ends of the core sections and it is preferable to provide an insulating sleeve indicated at 10 on the tie bolts. It is to be noted that the tie bolt structure, that is to say, the bolt with the insulating sleeve 10, engages the upper and lower faces of the outermost layers of the core sections and thus prevent these layers from being distorted outwardly out of position.

It is to be noted particularly that the side edges of the adjacent laminations of the end portions of successive core sections are arranged in parallelism so that they have either an edge to edge contact or an edge to edge juxtaposition. By having the edge to edge contact or edge to edge juxtaposition between the laminations of the central and outer cores, a material reduction in the reluctance of the magnetic path results.

It is to be noted that the magnetic flux travels lengthwise of the magnetic ribbon in substantially all portions of the core structure and this is the path having minimum magnetic reluctance. However, there is a small portion of the magnetic flux path where the flux travels crosswise of the magnetic ribbon where it passes from the end portions of one core section to the end portions of the adjacent core section. This path of cross travel of the flux is very short and is confined to a very limited portion of the entire flux path.

It will be seen, therefore, that a transformer has been provided by this invention which has a very small magnetic reluctance for the flux travel and which is extremely simple to make and which utilizes the advantages of wound magnetic cores formed from magnetic ribbon though allowing the conducting winding assemblies to be wound in the ordinary simple manner without requiring any special processes or special machines. In winding the conducting winding assemblies, it is

obvious that a core section can be placed in a lathe or other suitable machine and the conducting winding wound directly thereon in a very simple manner.

This invention, therefore, provides a novel type of three phase transformer construction which utilizes the wound core principle but which nevertheless provides a very simple way of directly winding the conducting winding assemblies on each of the core sections.

It is to be noted further that the symmetrical arrangement of the core sections makes the transformer fit readily within an ordinary cylindrical transformer casing.

While it is much preferred to form the core sections in the manner hereinabove outlined, nevertheless it is to be understood that the core sections may be built up from laminations of succeedingly greater lengths and shaped as shown in the drawing, and therefore it is to be understood that whenever the expressions "laminations" or "magnetic laminations" are employed, it is intended that these expressions shall not be limited to stacked laminations but shall include any laminated structure whether it is formed by winding magnetic ribbon or by stacking magnetic laminations.

It will be seen that by forming the core sections in either of the ways hereinbefore described, three identical core sections are provided, each formed of a plurality of laminations arranged in nesting relation with successive laminations enclosing preceding laminations.

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 core construction for a three phase transformer comprising three separate and identical core sections each having a main portion adapted to receive a conducting winding assembly and having outwardly projecting end portions at opposite ends of the main portion, the side faces of the end portions of the core sections being in close juxtaposition, said core sections being formed of laminations with the side edges of the laminations of the end portions of a core section arranged in substantial parallelism with the side edges of the laminations of the end portions of the next adjacent core section and with the side edges of the laminations in the said one core section in substantial edge-to-edge contact with the side edges of the laminations of the end portions of adjacent core sections.

2. A core construction for a three phase transformer comprising three separate core sections each having a main portion adapted to receive a conducting winding assembly and having outwardly projecting end portions at opposite ends of the main portion, the side faces of the end portions of the core sections being arranged in close juxtaposition, each of said core sections being formed of a plurality of laminations arranged in nesting relation with successive laminations enclosing preceding laminations, the core sections being arranged with the end portions of one core section located between the end portions of the other two core sections.

3. A core construction for a three phase transformer comprising three separate core sections each having a main portion adapted to receive a conducting winding assembly and having outwardly projecting end portions at opposite ends

of the main portion, the side faces of the end portions of the core sections being arranged in close juxtaposition, each of said core sections being formed of a plurality of laminations arranged in nesting relation with successive laminations enclosing preceding laminations, the core sections being arranged with the end portions of one core section located between the end portions of the other two core sections and with the side edges of the laminations in the said one core section in substantial edge-to-edge contact with the side edges of the laminations of the end portions of adjacent core sections.

4. A core construction for a three phase transformer comprising three core sections each having a main portion adapted to receive a conducting winding assembly and having outwardly projecting end portions at opposite ends of the main portion, the core sections being arranged with the end portions of one core section located between the end portions of the other two core sections and with the side faces of the end portions of successive sections in close juxtaposition and with the side edges of the laminations in the said one core section in substantial edge-to-edge contact with the side edges of the laminations of the end portions of adjacent core sections, the said one section being reversed with respect to the other two sections.

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