Sept. 20, 1949. F. R. D'ENTREMONT 2,482,403

ELECTRIC INDUCTION APPARATUS

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Fig. 1.

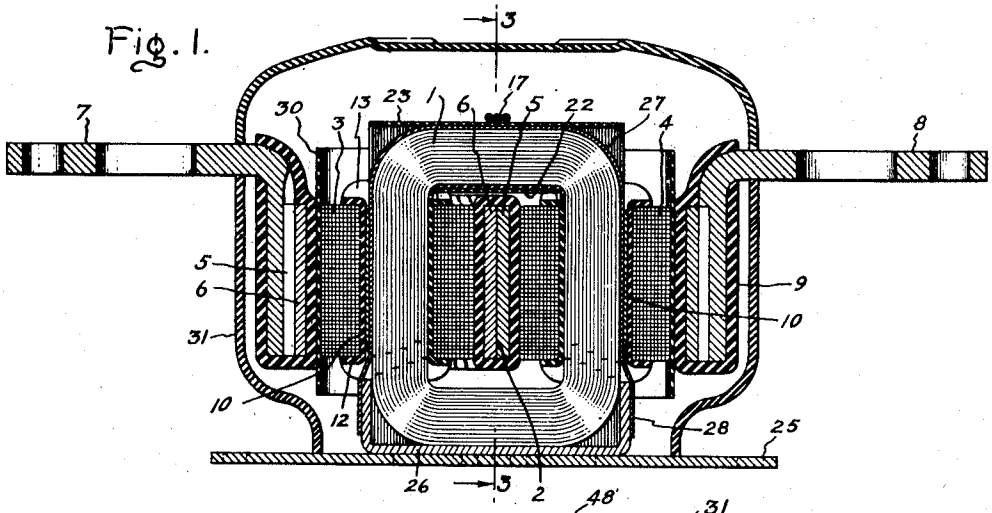


Fig. 2.

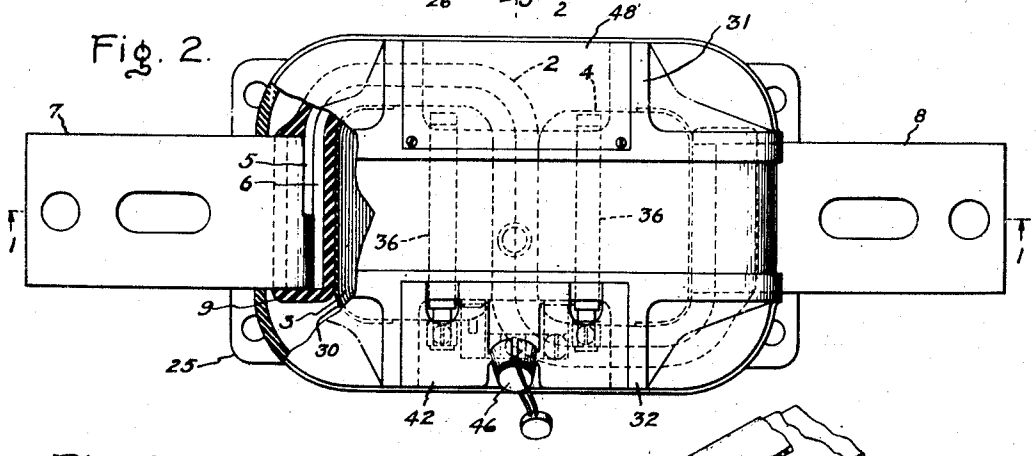
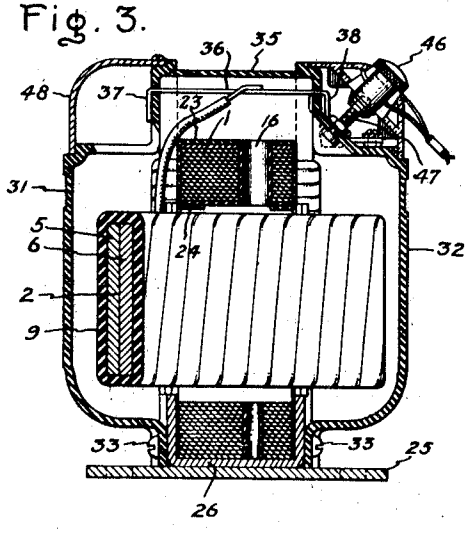


Fig. 3.



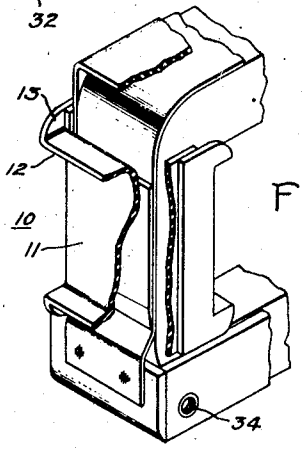


Fig. 4.

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Fig. 5.

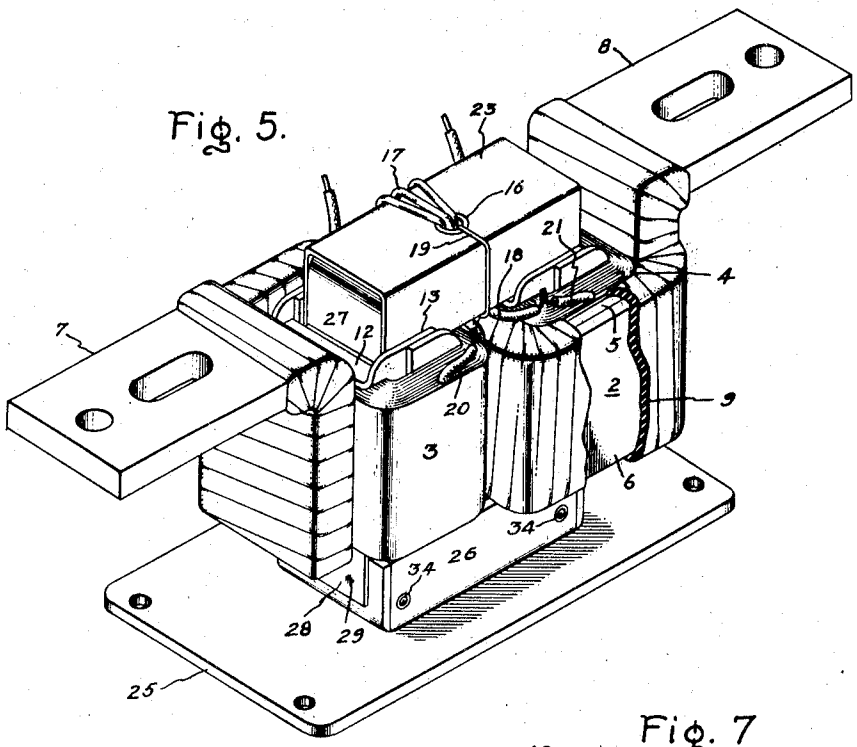


Fig. 6.

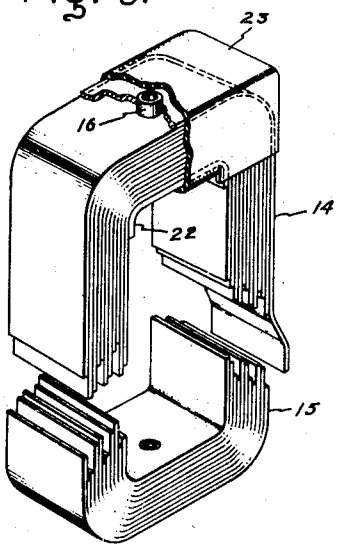


Fig. 7

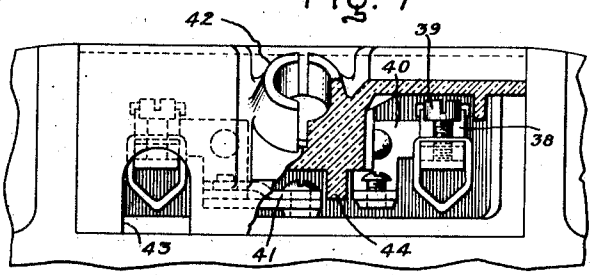
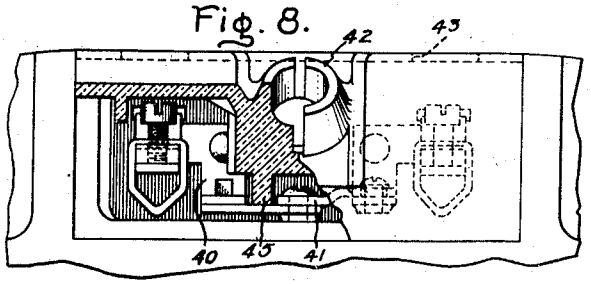


Fig. 8.



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UNITED STATES PATENT OFFICE

2,482,403

ELECTRIC INDUCTION APPARATUS

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Application April 27, 1946, Serial No. 665,423

3 Claims. (Cl. 175—358)

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This invention relates to electric induction apparatus and more particularly to improvements in current transformers.

An object of the invention is to provide a new and improved electrical induction apparatus of simple, compact, and inexpensive construction which permits of obtaining a pleasing appearance. Another object of the invention is to provide an economical and accurate current transformer of improved and simplified construction.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a sectional view of a current transformer embodying the invention taken on line 1—1 of Fig. 2; Fig. 2 is a plan view of the current transformer partly in section; Fig. 3 is a transverse mid-sectional view of the transformer shown in Figs. 1 and 2 taken on line 3—3 of Fig. 1; Fig. 4 is a detailed, partly broken away, perspective view of certain internal structural features of the transformer; Fig. 5 is a perspective view of the completed core and coil assembly of the transformer mounted on its base; Fig. 6 is a partly broken away perspective view showing details of the core and its insulation; Fig. 7 is a view, partly in section, of the secondary terminal board and cover construction with the cover in the operating position; and Fig. 8 is similar to Fig. 7 but shows the cover in its reversed or shipping position.

Referring now to the drawing, more particularly to Figs. 1, 2, 3, and 5, the transformer consists essentially of a magnetic core 1, a primary winding 2, and a secondary winding comprising a pair of coils 3 and 4.

The primary winding is of large current carrying cross section and is shown as comprising two strip conductors 5 and 6. As shown most clearly in Figs. 2 and 5, the primary winding 2 has a generally S-shaped configuration. As it only passes through the window of the core 1 once, it is a one-turn winding. It is provided with heavy terminals 7 and 8 which are preferably of duplicate construction and may consist generally of heavy copper pieces which are bent at right angles to an L-shape.

In order to reduce the overall length of the primary winding so as to be able to put as high a current carrying capacity primary winding as possible into a given size casing, a novel construction is employed. This consists in making the strands or strips 5 and 6 with unequal length ends. For example, as shown in Fig. 2, the left-

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hand end of strand 5, which is on the outside, is shorter than the end of strand 6, which is on the inside. The strands themselves are preferably of duplicate construction so that at the right-hand end the strand 6, which will be on the outside, will be shorter at the end than the strand 5, which at that end is on the inside. This can be seen from Fig. 1 which shows that in the center plane defined by the line 1—1 in Fig. 2, the strand 6 ends, while the strand 5 continues on away from the observer. Conversely, at the left-hand end of the primary winding as shown in Fig. 1, the end of the strand 5 is shown while the strand 6 continues on toward the observer. In order that the duplicate strands will fit closely together, it is necessary that the reverse bend of each strand at its shorter end be wider than at its longer end because the bend having the longer end of each strand fits inside the bend having the shorter end. The normally vertical portions of the two terminals are milled out on one side of their vertical center line to a depth equal substantially to the thickness of one of the strands. In other words, the contacting surfaces of the terminals have a stepped configuration which is complementary to the stepped configuration of the ends of the primary winding. The complementary surfaces are fitted together and are preferably permanently attached to each other such as by brazing, and it will be seen from Figs. 1 and 2 that due to the fitting together of these stepped surfaces, the overall length between the ends of the terminals 7 and 8 is reduced by the overall thickness of the primary conductor in comparison with a conventional terminal connection in which the two strands would be of equal length and a flat terminal surface would be brazed to the outer surface of the outer strand.

The primary winding and the connections to its terminals are insulated in any well known manner such as by means of insulating tape 9 which is wrapped around them.

The secondary coils 3 and 4 are preferably duplicates and they are wound on insulating spools 10 which also are preferably duplicates. These and the following described novel features of the apparatus constitute the subject matter of my divisional application Serial Number 780,129, filed October 16, 1947. As shown most clearly in Fig. 4, each winding spool 10 consists of duplicate channel-shaped pieces 11 of solid insulation such as pressboard. These pieces may be molded from rectangular sheets of pressboard

and they are characterized by having outwardly extending flanged ends 12 on their center portion and straight projections 13 at the ends of their sides. The spools are formed by placing the channel-shaped members face to face with their sides in overlapping relation. In this way the same size parts 11 can together form spools of a wide variety of different sizes by varying the amount of overlap so that the spool can be adapted to fit on different size cores.

The spools are placed on the core in such a way that two of the flanges or opposite ends extend along the inside of the yoke portions of the core for the purpose of insulating the secondary coils from the yoke portions of the core. At the same time, the straight extensions 13 on the spools which are at the sides of the core serve to insulate the secondary leads from the core.

The core 1, the details of which are shown most clearly in Fig. 6, consists of two U-shaped members 14 and 15, each of which consists of a like number of flatwise bent strips of magnetic material. The details of how this core is formed are not part of the present invention and one suitable way of making the core forms the subject matter of Patent Number 2,456,457, granted December 14, 1948, on an application filed May 22, 1944, in the name of G. G. Somerville, and assigned to the assignee of this application. Briefly, this method is characterized by cutting the lamination pieces to the desired length on an index shearing machine which, at the same time, provides at least one perforation in each piece. These perforations, which are known as locating holes, serve to align the pieces, and by reason of the off center position of this locating hole relative to the ends of the pieces, combined with alternate end for end reversal of adjacent pieces, a staggered or overlapping butt joint construction, such as is shown in Fig. 6, may be obtained. As shown in Fig. 6, the locating holes are in the yoke portions of the core and I make further use of one of these locating holes for the purpose of mounting a set of compensating windings on the core. To that end, an insulating tube 16 is inserted in one of the aligned sets of locating holes in the core.

The compensating windings are most clearly shown in Fig. 5, one being a multi-turn winding 17 having leads 18, and the other being a short circuiting-turn winding 19. The leads 18 of the compensating winding 17 are connected respectively to a lead 20 on secondary coil 3 and a lead 21 on the secondary coil 4. This type of compensation is described and claimed in Patent 1,722,167, granted July 23, 1929, in the name of Myron S. Wilson, and assigned to the assignee of this application.

The leads 18, 20, and 21 and their interconnections are relatively uninsulated and the primary insulation between them and the core is obtained by solid insulation which is applied to the core and which cooperates with the ends of the spools 10 for the secondary winding coils. This additional solid insulation consists primarily of a rectangular piece of insulating material 22, such as pressboard, which is placed under the upper yoke portion of the core and which is bent around so as to follow part way down the upper portions of the inside of the core legs. Holding this in place is another piece of solid insulation 23 which is placed on top of the core and has an opening registering with the tube 16. The sides of the piece 23 are folded down along the sides of the upper yoke part of the core and these sides have tabs 24 which are then folded under and into

the core window for holding the piece 22 in place. The lower outside ends of the sides of the piece 23 overlap the straight projections 13 of the winding spools 10 and as shown most clearly in Fig. 5, they are fitted between the core and these straight projections 13. In this manner the core 13 is fully insulated from the secondary coils and their leads, and also from the compensating windings 17 and 19 and from the leads 18 of the compensating winding 17.

The transformer is mounted on a base 25 by means of a bracket 26 which is shown as a receptacle-like member, the bottom of which rests on the base 25 and is preferably permanently attached thereto, such as by welding. The bottom yoke of the core 1 is seated in the bracket 26 and is held firmly in place by means of a binding strip 27 which is placed against the top and sides of the core underneath the insulating piece 23. This binding strip has ends 28 which are securely attached to the upturned ends of the bracket 26, preferably by projection welding, as shown by the two spots 29 at each end. Before the transformer is encased, insulating barriers 30 in the form of curved solid insulating pieces are inserted between the secondary coils and the primary winding, as shown in Fig. 1.

The transformer case consists of two main parts 31 and 32 which are preferably of duplicate concave construction. They may be molded from solid organic insulating material which has been impregnated with a hardened synthetic resin. They are attached at the bottom to the sides of the bracket 26 by means of screws 33 which are threaded into openings 34 provided for that purpose in the sides of the bracket 26. The space between the duplicate concave casing parts 31 and 32 is occupied by a center band 35 which is shown most clearly in Fig. 3 and which is seated in grooves provided for that purpose in the facing edges of the parts 31 and 32. The upper ends of the casing parts 31 and 32 are held together firmly by means of metal strips 36 whose ends are bent over at 37 and 38 for that purpose. These strips 36 serve an additional purpose and that is to complete the connections for the secondary winding. Thus, the bent-over portions 37 are connected to the remaining terminals of the coils 3 and 4 which come out of the coils 3 and 4 on the opposite side from the side where their leads 20 and 21 come out.

The bent-over portions 38 end in binding posts 39 by which external connections to the secondary winding are made. As will be seen most clearly from Fig. 3, these bent-over ends 38 and the binding posts are in a recess in the top edge of the casing part 32. Strip conductors 40, as shown in Fig. 7, are connected to each binding post and attached to one of these strip conductors is a pivoted strip or link 41 which is for the purpose of short-circuiting the secondary winding so as to permit connection of the primary winding in a current carrying circuit at such times as there is no external circuit connected to the secondary winding. The bent-over ends 38 of the conducting strips 36, the binding posts 39, the conducting strips 40 and the pivoted link 41, together constitute a terminal board for the secondary winding of the transformer and this terminal board is enclosed by a cover 42 which is reversible and which has openings 43 in one edge thereof for allowing external conductors to make connection with the binding posts 39. The cover has an integral projection 44 which, when the cover is put on in such a way that the openings 43

are in alignment with the binding post openings, will occupy the space which the pivoted link **41** would occupy if it were in its bridging or interconnecting position for completing a connection between the two binding posts. In other words, the projection **44** prevents the cover being put in place when the secondary winding is short-circuited for the pivoted link. As shown most clearly in Fig. 8, the cover **41** also has another inner projection **45** which when the cover is put on in its reversed position, will occupy the space which would be occupied by the pivoted link **41** if it were in its open position. In other words, the projection **45** prevents the cover being put on in its closed or shipping position except when the pivoted link is in its short-circuiting position.

The cover **40** is held in place in either position by any suitable means, such as a knurled nut **46** threaded into a screw **47**, which is attached to the casing part **33**.

The recess in the duplicate casing part **31** corresponding to that in which the terminal board is located in part **32** is preferably closed by a suitable cover member **48** which may carry a name plate if desired. The free spaces in the casing are filled with suitable insulating compound (not shown).

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and therefore it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A winding comprising, in combination, a multiple strand conductor, said conductor having an end in which its strands are radially superposed and their ends are progressively longer from the outside to the inside so as to present a stepped surface, and a terminal member having a stepped surface fitted into electrical contact with the stepped surface of said end.

2. A winding comprising, in combination, a multiple strand conductor, said winding having two oppositely disposed ends in which the strands of said conductor are radially superposed and their ends are progressively longer from the outside to the inside so as to present a stepped surface, and a pair of terminal members having complementarily stepped surfaces fitted respectively into electrical contact with the stepped surfaces of said ends.

3. A one-turn conductive winding for electric induction apparatus comprising, in combination, duplicate strap conductors bent flatwise into a generally S-shaped configuration characterized by having one end longer than the other and one reverse bend wider than the other, the wider bend being adjacent the shorter end, said conductors being nested together with the narrower bend of each inside the wider bend of the other whereby the long ends of each are adjacent to and radially inside the short ends of the other to form stepped end surfaces, and duplicate terminal members for said winding, said terminal members having complementarily stepped surfaces which are respectively fitted against and attached to the stepped end surfaces of said winding whereby the overall length of said winding and terminals is reduced by twice the thickness of said conductors and said winding has structural and electrical symmetry.

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