March 7, 1944. J. M. WILSON 2,343,725

TRANSFORMER

Filed April 24, 1941

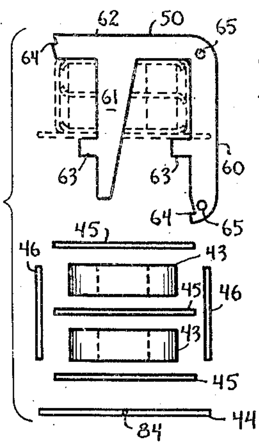

Fig. 4

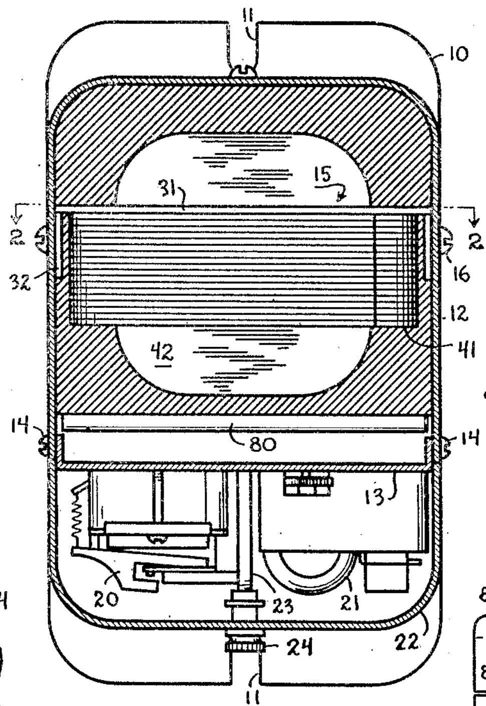

Fig. 1

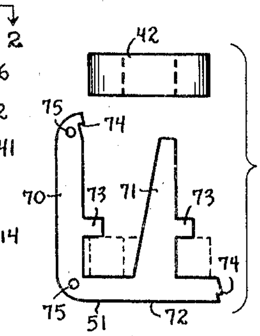

Fig. 5

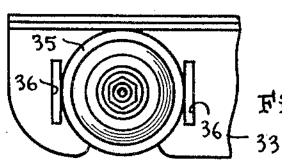

Fig. 7

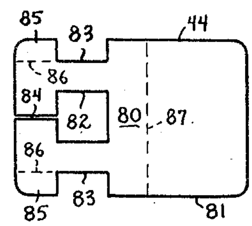

Fig. 6

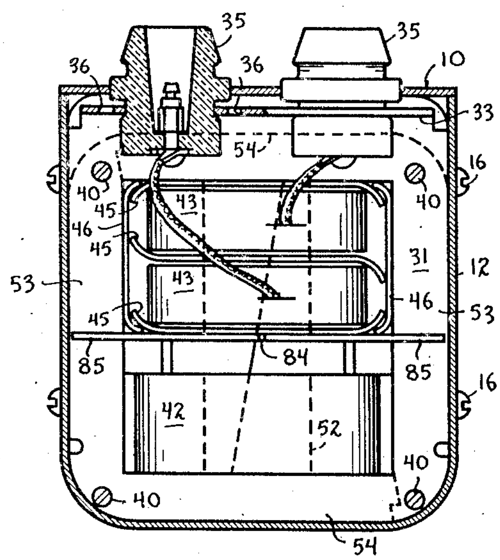

Fig. 2

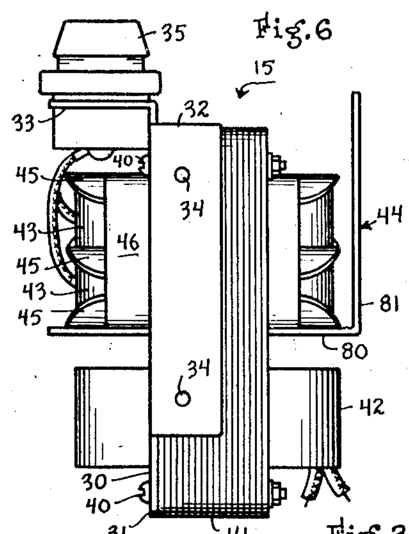

Fig. 3

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TRANSFORMER

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Application April 24, 1941, Serial No. 390,098

12 Claims. (Cl. 175—356)

This invention relates to transformers in general, and one of its objects is to provide a construction which shall be more compact and easier to assemble than those of the prior art.

Another object of the present invention is to construct an improved transformer having a high voltage secondary winding, and insulators for high voltage leads projecting through said housing. A further object is to provide, in such a transformer, improved means for supporting the core, windings, and insulators within the housing.

A further object of the invention is to provide a transformer structure whereby the core, windings and insulators for high voltage leads may be assembled as a unit and then placed within a housing. A still further object is to construct such a core, winding, and insulator unit which will not obstruct the flow of a thermoplastic insulating material into the housing after the unit is placed therein.

A further object of the invention is to provide, in a transformer having a high voltage secondary winding and means for shielding said secondary winding, a structure whereby the shielding means, core and windings may be assembled as a unit.

A further object of the invention is to provide a transformer core structure made up of two stacks of laminations, so constructed that one winding may be assembled with one stack, and the other winding with the other stack, and the two stacks may then be assembled by the cooperation of notches on the laminations. A still further object is to provide a shielding structure for one of said windings which may be assembled simultaneously with the core and windings.

A further object is to provide a mounting bracket for a core, winding and shield assembly of the type described which may be readily attached to the complete assembly. A still further object is to provide such a bracket which is adapted to support insulators for carrying high voltage leads through the transformer housing.

A further object of the invention is to provide a shield structure for a transformer winding which is of flexible material, and so constructed that it may be held out of its effective shielding position while the transformer housing is being filled with sealing material, and thereafter bent so as to take on its shielding position.

Another object of the invention is to construct a transformer casing including means for mounting auxiliary electrical equipment on one side thereof, and to provide therein improved means for shielding one of the windings from the other winding and from said auxiliary electrical equipment.

A further object of the present invention is to provide improved methods of assembling transformer structures and to construct a transformer which is readily adapted to such assembly methods.

Other objects and advantages of my invention will become apparent from a consideration of the attached specification, claims, and drawing, in which

Figure 1 represents a vertical cross section through a transformer embodying my invention,

Figure 2 represents a horizontal section taken on the line 2—2 of Figure 1, looking in the direction of the arrows,

Figure 3 represents an elevation of the internal assembly unit of the device shown in Figures 1 and 2, looking from the right in Figure 2.

Figures 4 and 5 are sketches on a smaller scale, showing details of the core and winding construction used in my invention, and indicating certain assembly methods, and

Figure 6 is a view of the shielding means employed in the device shown in the other figures, on a smaller scale.

Figure 7 is a fragmentary view of the supporting bracket used in my invention and illustrates the manner in which an insulator member is secured thereto.

The drawing discloses a transformer device mounted on a base plate **10**, which is provided with any suitable means, such as the slots **11**, to facilitate mounting of the device on a supporting structure. Attached to the base plate **10** in any desired manner is a housing member **12**, shaped generally like a box with two adjacent sides left open. One of these open sides is closed by the base plate **10**, and the other, which happens to be the lower side as the device appears in Figure 1, is closed by a partition member **13** having upturned edges which are fastened to the housing member **12** by any suitable means, such as the bolts **14**.

Mounted in the space enclosed by base plate **10**, housing member **12**, and partition member **13** is a transformer assembly unit generally indicated at **15** and shown separately in Figure 3. This unit **15** is fastened to the sides of housing member **12** by screws **16**.

Mounted on the under side of the partition member **13**, as it appears in the drawing, is a relay generally indicated at **20** and a switch mechanism generally indicated at **21**. The particular auxiliary electrical apparatus mounted on the plate 13 forms no part of the present invention. This auxiliary electrical apparatus is enclosed by a housing member 22 which is complementary with the housing member 12. The housing member 22 is held in place by the cooperation of a threaded post 23, mounted on the partition member 13 by any suitable means, and an internally threaded coupling member 24. The coupling member 24 extends through the housing member 22. The part of the coupling member outside the housing is provided with a shoulder to engage the housing and a knurled portion to permit the coupling member to be manually threaded on said post.

The internal assembly unit 15 comprises a bracket member generally indicated at 30, having a base portion 31, side flanges 32, and an end flange 33. The base portion 31 extends vertically in Figures 2 and 3, and is best shown in Figure 2, being generally in the shape of a hollow square. The side flanges 32, appearing in Figures 1 and 3, are turned at right angles to the base portion 31, and are provided with internally threaded holes 34 which cooperate with the screws 16 to hold the assembly unit 15 in the casing member 12. The end flange 33, shown in Figures 2 and 3, is also turned at right angles to the base portion 31, but in a direction opposite to the side flanges 32. This end flange is provided with suitable apertures for receiving high voltage insulator members 35. When the bracket 30 is first made, the apertures for receiving the insulator members 35 are wider than they now appear in the drawing, in order that the wide lower portions of the insulator 35 may be passed through the apertures. After the wide portions of the insulators 35 have been passed through these apertures, a suitable tool is inserted through each of two smaller apertures 36 provided at each side of the larger aperture, and by a suitable twisting motion the tool is made to deform the material of the bracket so that it engages the sides of the insulators 35.

Mounted on the base portion 31 of the bracket 30 by any conventional means such as the bolts indicated at 40, is a core structure generally indicated at 41, on which are supported a primary winding 42, secondary windings 43, and a shielding member 44.

The core structure 41 is made up of laminations of suitable magnetic material. Each layer of laminations consists of two complementary generally F-shaped pieces 50 and 51 shown in detail in Figures 4 and 5, respectively. When stacked and assembled these laminations form a central winding leg 52, a pair of side legs 53 and a pair of end yoke members 54 connecting all three of said legs. These leg and yoke members taken together complete the core structure 41 of the transformer.

Each lamination 50 is of a generally F-shaped cross-section and comprises a pair of cross-bars 60 and 61 connected by a portion 62 which may be regarded as the upright member of the F. On the left-hand side of the cross-bars 60 and 61, as they appear in Figure 4, are projections 63. Notches 64 are provided in the ends of the members 60 and 62, and holes 65 are provided in the laminations 50 in order to permit the passage of the bolts 40 therethrough.

The laminations 51 are similar in shape to the laminations 50. Cross-bars 70 and 71 are provided, and the F-shape is completed by an upright member 72. Projections 73 are located on the right-hand side of cross-bars 70 and 71, as they appear in Figure 5. Notches 74 are located at the ends of members 70 and 72, and holes 75 are provided for the passage of bolts 40 through the laminations.

The only difference between the laminations 50 and the laminations 51 lies in the distance between the upright 62 and the projections 63, as contrasted with the distance between upright 72 and projections 73. This difference is necessary because of the different amounts of space taken up by the windings 42 and 43. If both windings filled an equal amount of space, the laminations 50 and 51 might be identical.

When the core structure is assembled, the projections 63 and 73 cooperate to form a magnetic shunt between the primary winding 42 and the secondary windings 43.

The windings 43 are high voltage windings, and suitable insulating members 45 and 46 are provided to insulate these windings from each other and from the core structure 41. The insulating members 45, which extend horizontally in Figures 2 and 4, are provided with apertures to permit the passage of the central winding legs 52 of the core structure therethrough.

The shielding member 44 is composed of some flexible, electrically conductive material, such as sheet copper for example, and comprises a portion 80 extending transversely to the core structure 41 and a portion 81 extending parallel to the core structure 41. The portion 80 is provided with a central opening 82 to accommodate the central winding leg 52 of the core structure. Openings 83 are also provided at the sides of the portion 80 to accommodate the side legs 53 of the core structure. A narrow slit 84 is cut through the portion 80 from the central opening 82 to its outside edge, in order that a circulating curent may not be induced in the shield 44 by the magnetic field in the core structure.

Method of assembly

The first step in assembling a transformer such as that disclosed herein is the building of the core and winding structure. A suitable number of laminations 50 are piled together to form a stack. Then the following parts are slipped over the cross-bars 61 of the laminations in the stack: an insulating member 45, a winding 43, another insulating member 45, another winding 43, and another insulating member 45, and the shielding member 44. These parts are moved to the position shown in dotted lines in Figure 4.

A similar stack of laminations 51 is prepared. A winding 42 is slipped over the cross-bars 51 of the stacked laminations 52, and moved to the position shown in dotted lines in Figure 5.

The two stacks of laminations; with the coils assembled thereon, are then moved together so that the cross-bars 61 and 71 compliment each other to form the central winding leg 52. When the stacks are nearly in complete engagement it is necessary to apply considerable force to cause the projections adjacent the notches 64 and 74 to slip over the opposite projections and engage the notches. After the projections have snapped into engagement with the notches 64 and 74, the entire core and winding unit is permanently assembled and cannot be readily disengaged.

The projecting wing portions 85 of the transverse portion 80 of the shield member 44 are then bent along the line 86 to a position which would be vertical as viewed in Figure 2. After this is done the bracket 30 may be moved into engagement with the core structure 41, without interfering with the shield **44**. After the bracket **30** is moved into engagement with the core structure **41**, it is fastened thereto by means of the bolts **40**. The portions **85** of the shield member **44** are then bent back to their original position, indicated in Figure 2.

The insulating members **46** may be slipped into place at this time.

The insulating members **35** are then inserted in the openings in the end flange **33** of the bracket **30**, in the manner previously described. The leads from the windings **43** are attached in any desirable manner to the connectors which extend through the insulators **35**, and the entire internal transformer assembly unit **15** is then ready for insertion in the casing.

The assembly unit **15** is then placed in the housing member **12**, and fastened therein by means of the screws **16** cooperating with the threaded holes **34** in the bracket member **30**. The base member **10**, in which holes are provided to receive the insulators **35**, is then placed over one open side of the housing member **12** so that the insulators **35** project through the holes as shown in Figure 2. The base plate **10** may be fastened to the casing member **12** by any suitable means (not shown).

The entire structure which has been assembled so far is then placed in a position upside down from that shown in Figure 1, so that it forms a cup-shaped housing with the transformer inside. At this time, the shield **44** has not yet been bent at right angles along the line **87**, so that the portion **81** of the shield member **44** extends transversely to the core structure **41**, or in a vertical direction. The cup-shaped housing containing the transformer is then filled with a suitable thermoplastic insulating material which has been heated to its fluid state. After all the windings have been covered by this material the shield member **44** is bent along the line **87** so that the portion **81** extends parallel to the core structure **41** and its edges substantially engage the edges of the housing. The partition member **13** with the auxiliary equipment mounted thereon is then placed over the open side of the casing member **12** and fastened in place by the bolts **14**.

The casing member **22** may then be fastened over this auxiliary equipment by the mechanism previously described, and the assembly is then complete.

It will be seen that I have provided a transformer structure which is extremely compact and which is capable of rapid assembly. It should be further noted that the device is so constructed that spaces are left between the windings and the side legs to permit free flow of thermoplastic insulating material therebetween, so that the windings may be completely insulated after assembly.

Since other modifications of my invention will readily occur to those skilled in the art, my invention is not to be construed as limited by the present disclosure, but only by the appended claims.

I claim as my invention:

1. A transformer, comprising in combination, a housing for said transformer having apertures therein, a core and winding mounted on said core, leads connected to said windings and extending through said housing, means for insulating the leads associated with at least one of said windings from said housing, a unitary bracket, means for securing said insulating means thereto, means for assembling said core, windings insulating means and bracket as a unit, said unit being insertable in said housing, said bracket serving to support said unit in said housing and means for attaching said bracket to said housing in a position whereby said insulating means extends through said apertures.

2. A transformer, comprising in combination, a housing for said transformer having apertures therein, a core and at least two twindings on said core, shielding means mounted on said core between said windings, conductors extending from said windings through said housing, means for insulating the conductors associated with at least one of said windings from said housing, a bracket, means for securing said insulating means thereto, means for assembling said core, windings, shielding means, insulating means and bracket as a unit, said unit being insertable in said housing, said bracket serving to support said unit in said housing, and means for attaching said bracket to said housing in a position whereby said insulating means extends through said apertures.

3. A transformer, comprising in combination, a housing for said transformer, means for mounting auxiliary electrical equipment on one side of said housing, a core and at least two windings on said core, shielding means mounted on said core between said windings so as to shield one winding from the other, said shielding means having a portion extending between said one winding and said one side of the housing so as to shield said one winding from said auxiliary equipment, conductors extending from said windings through said housing, means for insulating the conductors associated with at least one of said windings from said housing, a bracket for supporting said core, windings, shielding means, and insulating means, means for assembling said core, windings, shielding means, insulating means and bracket as a unit, said unit being insertable in said housing, and means for attaching said bracket to said housing.

4. A transformer core construction, comprising a plurality of stacked laminations, forming a central winding leg, a pair of side legs spaced therefrom and parallel thereto, a pair of yoke portions joining all said legs at their ends, and magnetic shunt portions extending between said winding leg and said side legs, each layer of said laminations comprising two similar, generally F-shaped pieces positioned inversely with respect to each other, the upright portion of each F-shaped piece forming one of said yoke portions, the upper cross-bar of each F-shaped piece forming one of said side legs, and the central cross-bars of said F-shaped pieces cooperating to form said winding leg, said shunt portion comprising a projection depended from each of said cross-bars, said projections on the two pieces extending toward but not engaging each other when the core is assembled.

5. A transformer core construction, comprising in combination, two stacks of generally F-shaped laminations, each lamination having a projection depending from each cross-bar of said F, and notches on at least two of the extremities of said F, said stacks being adapted for assembly with said F-shapes inverted with respect to each other, and their ends in contact, said projections cooperating to form a magnetic shunt for said core, the central cross-bars of said F-shapes engaging each other so that said assembled stacks may not be separated in a lateral direction, and said notches engaging each other so that said

assembled stacks may not be separated in a longitudinal direction.

6. A transformer, comprising in combination, a pair of windings of annular cross-section, a core structure including two stacks of generally F-shaped laminations, each lamination having a projection depending from each cross-bar of said F, and notches on at least two of the extremities of said F, said stacks being adapted for assembly with said F-shapes inverted with respect to each other, and their ends in contact, said projections cooperating to form a magnetic shunt for said core, said notches engaging each other so that said assembled stacks may not be separated, said windings being of sufficiently large internal diameter to be receivable on the central cross-bar of one of said stacks over the projection thereon, said central cross-bars of said two stacks serving when assembled as complementary portions of a winding leg for said core structure, and said projections serving to hold said windings in place on said leg.

7. A transformer, comprising in combination, a housing for said transformer, means for mounting auxiliary electrical equipment on one side of said housing, a core and at least two windings on said core, shielding means mounted on said core between said windings so as to shield one windings from the other, said shielding means having a portion extending between said one winding and said one side of the housing so as to shield said one winding from said auxiliary equipment.

8. A transformer, comprising in combination, a core structure, at least two windings mounted on said core structure, flexible shielding means mounted on said core between said windings and a housing for said transformer comprising a metallic main portion to which said core is fixed, and a removable cover portion, said core structure extending substantially parallel to said cover, said shielding means comprising a portion extending transversely to said core structure and a portion extending substantially parallel to said cover portion between one of said windings and said cover portion, said main portion and said shielding means cooperating to shield said one winding completely, said one winding being accessible upon removal of said cover and bending back of the parallel portion of said flexible shielding means.

9. A transformer, comprising in combination, a pair of windings of annular cross-section, shielding means having an opening therein shaped similarly to the openings in said windings, a core structure including two stacks of generally F-shaped laminations, each lamination having a projection depending from each cross-bar of said F, and notches on at least two of the extremities of said F, said stacks being adapted for assembly with said F-shapes inverted with respect to each other, and their ends in contact, said projections cooperating to form a magnetic shunt for said core, said notches engaging each other so that said assembled stacks may not be separated in a longitudinal direction, said openings being of sufficiently large internal diameter to be receivable on the central cross-bar of one of said stacks over the projection thereon, said central cross-bars of said two stacks serving when assembled as complementary portions of a winding leg for said core structure, and said projections serving to hold said windings and said shielding means in place on said leg.

10. A transformer, comprising in combination, a core and windings mounted on said core, an apertured housing for enclosing said core and windings, a bracket mounted within said housing, means for securing said core to said bracket, leads connected to said windings and supported by said bracket, means for insulating each lead from said bracket comprising a hollow insulator having a terminal therein, said lead being connected to said terminal, and means for securing said insulator to said bracket comprising an aperture in said bracket for receiving said insulator and aligned with a corresponding aperture in said housing adapted to receive said insulator, said insulator having an annular recess adjacent said aperture, a plurality of apertures in said bracket adjacent said first aperture defining small portions of said bracket adjacent said recess, and said small portions being bendable toward said insulator to enter said recess thereby securing said insulator to said bracket.

11. In a transformer, in combination, a core having at least two windings mounted on said core, said core comprising a frame, flexible shielding means mounted on said core between said windings and extending transversely to said core, and a bracket for supporting said windings and core, said bracket having an opening corresponding to the opening of said core frame, and said flexible shielding means having ear means projecting outwardly beyond the boundary of said frame opening so as to extend completely between said windings, said ear means being bendable so as to permit said shield to extend through the opening in said bracket to permit attachment of the bracket to the core, and bendable back to the original position thereof after attachment of said bracket to said core.

12. A transformer core construction, comprising in combination, two stacks of generally F-shaped laminations, each lamination having a projection depending from each cross-bar of said F, and notches on at least two of the extremities of said F, said stacks being adapted for assembly with said F-shapes inverted with respect to each other, and their ends in contact, said projections cooperating to form a magnetic shunt for said core, the central cross-bars of said F-shapes engaging each other so that said assembled stacks may not be separated in one direction, and said notches engaging each other so that said assembled stacks may not be separated in a second direction.

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