Nov. 23, 1965 J. B. McKEE 3,219,958

ELECTRICAL INDUCTION APPARATUS

Filed April 23, 1962

FIG. 1

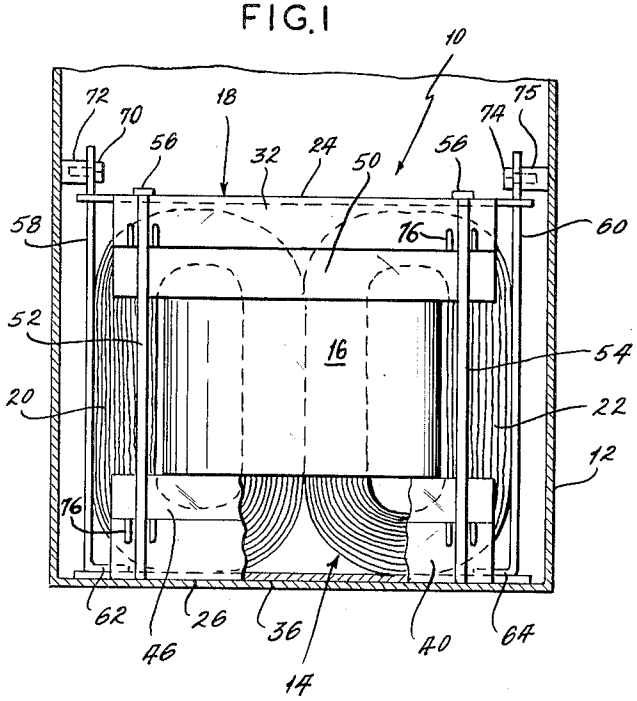


FIG. 2

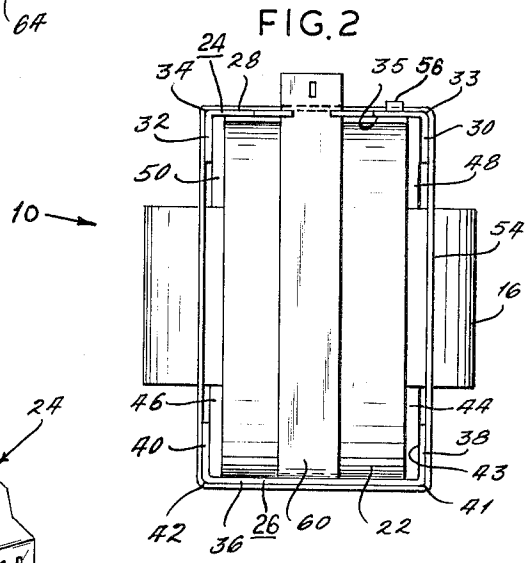
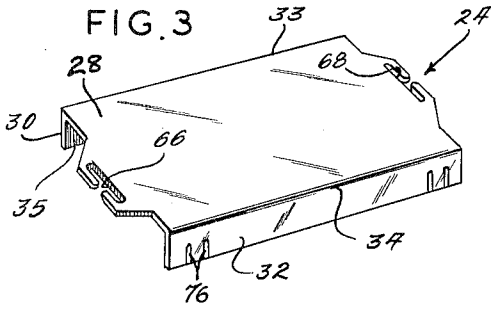


FIG. 3



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ELECTRICAL INDUCTION APPARATUS

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This invention relates to electrical induction apparatus and more particularly to improved retaining means for the coil and core assembly of such an apparatus.

In the past, the high cost invloved in the manufacture of electrical induction apparatus, such as distribution transformers, has been due, to no small extent, to the large number of structural parts that went into the apparatus. In ordered to provide the desired mechanical strength, properly support and locate the coil assembly relative to the magnetic core, and properly mount the coil and core assembly in the usual enclosing casing, a relatively large number of separate parts were used. For example, a considerable number of nuts, bolts, lockwashers, different types of spacers, coil supporting elements, coil and core bracing and clamping parts, and so forth, were required. The manufacture of such apparatus was not only expensive because of the cost of the parts and the handling and storage thereof, but also because of the high amount of labor time required in assembling the many parts to form the finished product.

It is therefore a general object of the present invention to provide an improved electrical induction apparatus which is especially economical to manufacture.

Another object is to provide an improved coil and core assembly for an electrical induction apparatus which is relatively simple and inexpensive in construction and which provides the desired mechanical strength.

Another object is to provide retaining means for a coil and core assembly having improved means for resisting electromechanical forces and avoiding damage to parts thereof.

Another object is to provide an improved coil and core assembly for an electrical induction apparatus which requires relatively few separate and different parts while providing the desired mechanical strength.

Still another object is to provide improved retaining means for assembling and securing together the coil and core of an induction apparatus and for mounting the coil and core in an enclosing casing.

These and other objects and advantages of the present invention will become apparent from the following description and accompanying drawing in which:

FIG. 1 is a cross-section of a casing containing a transformer coil and core assembly shown partly in section,

FIG. 2 is a right-hand end view of the coil and core assembly shown in FIG. 1, and

FIG. 3 is a perspective view of an end plate employed in the assembly shown in FIGS. 1 and 2.

Referring now to the drawings and particularly to FIGS. 1 and 2, there is shown a coil and core assembly 10 mounted within a casing 12 which may be filled with a suitable dielectric such as transformer oil. The assembly 10 includes a three-legged magnetic core 14 with a current conductive coil or coil assembly 16 encircling the middle leg of the core, and a retaining frame indicated generally at 18.

The magnetic core 14 is shown as a conventional curved or wound shell-type core which includes two closed-loop core sections 20 and 22 in side-by-side relation. The coil 16 may consist of one or more windings, and in the case of a transformer, includes insulated primary and secondary windings which may be of the preformed type.

The retaining frame 18 of the assembly includes upper and lower end pieces shown in the form of channel-shaped

clamping plates 24 and 26. The upper plate 24, as also shown in FIG. 3, has a web 28 and two parallel side pieces or depending flanges 30 and 32 perpendicular to and integral with the web to form longitudinally extending rounded corners or edges 33 and 34 where the side pieces join the web. The side pieces and web form a channel 35. The lower plate 26 is shown similar to plate 24 in the illustrated embodiment and it has a web 36 and integral side pieces or flanges 38 and 40 forming corners or edges 41 and 42, and a channel 43. The end plates are preferably made from suitable sheet metal.

The bottom portion or yoke of the core 14 extends into the chanel 43 and rests on the web 36 of plate 26. A pair of coil spacers or supporting blocks 44 and 46 are disposed between the plate 26 and the bottom side of coil 16, respectively, on opposite sides of the core. The spacers 44 and 46 are shown as fast rectangular members preferably made of suitable insulating material such as pressed woodboard. The plane of each spacer is perpendicular to the plane of the web 36 and each spacer extends lengthwise along the channel between one side piece of the plate 26 and the adjacent side of the core. The upper side edges of the spacers engage the lower side of the coil and the lower side edges engage the web 36 along the corners 41 and 42 of plate 26. The height of the spacers is such that coil 16 rests on the spacers in spaced relation with the core yoke so that core does not bear the weight of the coil. In this way, the coil 16 is supported substantially independently of the core to thereby avoid strains in the magnetic material of the core and adverse electrical magnetic characteristics.

Another pair of spacers 48 and 50 are positioned at the top of the assembly in similar fashion to the lower spacers 44 and 46 at the bottom of the assembly. Upper spacers 48 and 50, which are also shown as flat rectangular members which may be made of pressed wood, are disposed in planes perpendicular to the plane of the web 28 of upper plate 24. The upper spacers extend lengthwise along channel 35 between side pieces 30 and 32 and the opposite sides of the core, respectively. The upper side edges of the spacers 48 and 50 engage web 28 along the corners 33 and 34 of plate 24 and the lower side edges thereof engage the upper side of coil 16.

All four spacers 44, 46, 48 and 50 are shown similar to each other in the construction shown for illustration in the drawing.

The frame 18 is provided with clamping means shown as including a pair of laterally spaced tension straps or bands 52 and 54 firmly clamping the upper and lower plates 24 and 26 in assembled relation. The upper spacers 48 and 50 are dimensioned so that web 28 of plate 24 essentially does not engage the top of the core in order that the pressure of the tension straps urge the spacers 48 and 50 against the upper side of coil 16. In this way, coil 16 is rigidly located relative to the core.

The tension straps 52 and 54 are shown as conventional banding straps of suitable metal which encircle the upper and lower end plates laterally on opposite sides of the coil at each end of the assembly. These straps may be readily affixed under tension by a conventional banding machine with the opposite ends of each strap being attached together by any suitable coupling means, such as crimping sleeves 56. Each of the straps extends vertically along the opposite sides of the core and transversely of the channel-shaped plates 24 and 26, with the straps being bent over the corners 33, 34, 41, and 42 of the plates.

The retaining frame is also provided with means for retaining the core against any lateral or endwise movement relative to the other elements of the frame. As shown in the drawing, a pair of similar vertical end supports or end strap members 58 and 60 each extend between

adjacent ends of the upper and lower end plates 24 and 26 at the opposite ends of the assembly and serve to retain the core against any endwise movement. The end supports 58 and 60 are provided with inwardly extending horizontal flanges 62 and 64, respectively, which may be secured, such as by welding, to the lower end plate 26. The end supports engage the opposite ends of the core and are respectively received in openings or slots 66 and 68 formed in the ends of the upper end plate 24.

The end supports 58 and 60 also provide convenient means for securing the core and coil assembly in the casing 12. As shown, the assembly 10 rests on the bottom wall of the casing and is secured in the casing by attaching the upper ends of the end supports to the walls of the casing. As seen in FIG. 1, the end support 58 extends above the upper end plate 24 and is secured to the casing by a bolt 70, which passes through an opening in the upper end of the support and is threadedly received in a boss or pad 72 which may be welded to the casing. End support 60 is secured in similar manner by a bolt 74 which is threadedly received in a pad 75.

Means for preventing any lateral movement of the straps 52 and 54 may be provided by forming a pair of spaced embossments 76 in each of the end plate side pieces 30, 32, 38 and 40 at each end thereof. By attaching the straps 52 and 54 so that each lies between adjacent embossments 76, the straps are prevented from moving laterally relative to the end plates.

The assembly shown in the drawing may be readily assembled by securing the end supports 58 and 60 to the lower end plate 26, inserting the lower coil spacers 44 and 46, and the core with its assembled coil, into the channel of the lower end plate. The upper end plate 24 may then be slipped over the upper ends of the supports 58 and 60 which pass through their respective end plate openings 66 and 68, and the spacers 48 and 50 positioned in place. Then the clamping straps 52 and 54 may be tensioned around the assembly and the end supports bolted to the casing.

As is well known, the electromechanical forces, when the apparatus is in operation, increase as the current flowing in the windings increases. For example, in the event of a short circuit in the winding circuit of the transformer, the primary and secondary windings tend to move in opposite directions and exert considerable forces on parts of the assembly. In the assembly shown in the drawing, such forces will urge the upper spacers 48 and 50 upwardly exerting forces at the corners 33 and 34 tending to bend the upper end plate 24. However, with the tension straps 52 and 54 surrounding the assembly and being bent under tension around the corners of the end plates, these straps react against the corners and provide reaction forces in direct opposition to the electromechanical forces. In other words, the tensioned straps 52 and 54 will provide substantially the greatest reaction force at the corners of the end plates where it is most desired.

It will be apparent that the apparatus shown and described herein requires relatively few parts which can be quickly and easily assembled together to provide an assembly of high mechanical strength. In many cases, duplicate parts of the frame may be used in the same assembly, such as in the construction shown in the drawing, to reduce the number of different types of parts required.

It is to be understood that the foregoing description and accompanying drawings have been given only by way of illustration and example and that the present invention is limited only by the claims which follow.

What I claim is:

1. An electrical induction apparatus comprising a core and coil assembly including a magnetic core, a coil on said core, and retaining means for maintaining said coil in position relative to said core comprising a pair of end plates adjacent opposite ends of said core, a first pair of spacer means respectively on opposite sides of said core in engagement between one side of said coil and one of

said end plates to space said one side of said coil from said core, a second pair of spacer means respectively on opposite sides of said core between the other side of said coil and the other of said plates, and clamping means having opposite ends connected together encircling said end plates and said spacer means under tension to apply a force on said other plate to urge said other plate and said second pair of spacer means toward said one plate and clamp said coil assembly between said first and second pairs of spacer means.

2. In an electrical induction apparatus having a magnetic core and a current conductive coil on the core, a frame for maintaining said coil in position relative to said core comprising first and second channel members at opposite ends of said core, said core engaging said first channel member, a first pair of spacer means extending into the channel of said first channel member respectively on opposite sides of said core, said first pair of spacer means engaging one side of said coil and bearing on said first channel member to space said one side of said coil from said core, a second pair of spacer means extending into the channel of said second channel member respectively on opposite sides of said core, said second pair of spacer means engaging the opposite side of said coil and bearing against said second channel member, and clamping means encircling said channel members under tension and normally urging said second channel member and said second pair of spacer means toward said first channel member.

3. In an electrical induction apparatus having a magnetic core and a current conductive coil on the core, retaining means for maintaining said coil in position relative said core comprising a pair of end plates each having a web portion and two parallel side portions perpendicular to the web portion forming longitudinally extending corners where the side portions join the web portion, one end of said core bearing on the web portion between said side portions of one of said end plates, a first pair of spacer means engaged between one side of said coil and the web portion of said one end plate respectively at opposite sides of said core to space said one side of said coil from said core and support the weight of said coil, a second pair of spacer means engaged between the other side of said coil and the web of the other of said end plates respectively at said opposite sides of said core, and clamping means under tension extending along said sides of said core between said plates and bearing on said corners of said plates to normally urge said other plate and said second pair of spacer means toward said one end plate.

4. In an electrical induction apparatus having a magnetic core and a current conductive coil on the core, retaining means for maintaining said coil in position relative said core comprising a pair of end plates each having a longitudinally extending web portion and two parallel side portions perpendicular to the web portion forming a channel, one end of said core bearing on the web portion between the side portions of one of said end plates, a first pair of spacer means engaging one side of said coil and the web portion of said one end plate respectively at opposite sides of said core to support the weight of said coil substantially independently of said core, the opposite end of said core extending into the channel of the other of said end plates, a second pair of spacer means engaging the other side of said coil and the web portion of said other end plate respectively at said opposite sides of said core, and clamping means under tension encircling said end plates with a portion thereof extending transversely of said web portions to normally urge said end plates toward each other to clamp and maintain said pairs of spacer means against said coil.

5. In an electrical induction apparatus having a curved type magnetic core and a current conductive coil assembly on the core, retaining means for maintaining said coil assembly in position relative said core comprising a pair

of end plates each having a web portion and two parallel side portions perpendicular to and integral with the web portion forming a channel and corners where the side portions join the web portion, one end of said core extending into the channel and bearing on the web portion of one of said end plates, a first pair of spacer means between one side of said coil assembly and the web portion of said one end plate respectively at opposite sides of said core to support the weight of said coil assembly, each of said spacer means having a portion thereof disposed between one of said side portions of said one end plate and one side of said core, the opposite end of said core extending into the channel of the other of said end plates, a second pair of spacer means between the other side of said coil assembly and the web portion of said other end plate respectively at said opposite sides of said core, each of said second pair of spacer means having a portion thereof disposed between one of said side portions of said other end plate and one side of said core, and spaced straps under tension encircling said end plates and bearing on said corners urging said other end plate and said second pair of spacer means toward said one end plate to maintain said second pair of spacer means clamped between said other end plate and said other side of said coil.

6. In an electrical induction apparatus including a magnetic core and a current conductive coil on said core, a retaining frame for maintaining said coil in position relative to said core comprising first and second end plates respectively adjacent the upper and lower ends of said core, each of said plates having a web and opposed side pieces, said lower end of said bore bearing on the web of said first plate between said side pieces of said first plate, a first pair of spacer means disposed between the opposed sides of said core and said first plate side pieces, respectively, said first pair of spacer means engaging one side of said coil and bearing against the web of said first plate to support the weight of said coil, a second pair of spacer means disposed between the opposed sides of said core and said second plate side pieces, respectively, said second pair of spacer means engaging the other side of said coil and bearing against the web of said second plate, and tensioned strap means encircling and engaging said end plates transversely of said first and second plate side pieces to maintain the engagement between said first and second plate webs and said first and second spacer means.

7. An electrical induction apparatus comprising a magnetic core having a plurality of legs and upper and lower yoke portions, a current conductive coil assembly encircling one of said legs, and a frame for supporting and locating said coil assembly relative to said core comprising upper and lower end plates respectively adjacent said upper and lower yoke portions, each of said end plates having a web portion and two parallel side portions perpendicular to the plane of the web portion to form a channel, said lower yoke portion bearing on the web portion of said lower end plate between said side portions of said lower end plate, a first pair of spacers extending into the channel of said lower end plate respectively between opposite sides of said core and the side portions of said lower end plate, each of said first pair of spacers having a side edge in engagement with one side of said coil assembly and another side edge bearing on the web portion of said lower end plate for bearing the weight of said coil assembly, a second pair of spacers extending into the channel of said upper end plate respectively between opposite sides of said core and the side portions of said upper end plate, each of said second pair of spacers having a side edge in engagement with the opposite side of said coil assembly and another side edge bearing on the web portion of said upper end plate, and clamping means including laterally spaced tensioned bands encircling said end plates with portions of said bands extending transversely of said channels.

8. An electrical induction apparatus comprising a magnetic core having at least three legs and upper and lower yoke portions, a current conductive coil assembly encircling the middle leg of said core, and a frame for supporting and locating said coil assembly relative to said core comprising upper and lower end plates respectively adjacent said upper and lower yoke portions, each of said end plates having a web portion and two parallel side portions perpendicular to the plane of the web portion to form a channel, said lower yoke portion bearing on the web portion of said lower end plate between said side portions of said lower end plate, a first pair of spacers extending into the channel of said lower end plate respectively between opposite sides of said core and the side portions of said lower end plate, each of said first pair of spacers having a side edge in engagement with one side of said coil assembly and another side edge bearing on the web portion of said lower end plate for bearing the weight of said coil assembly, a second pair of spacers extending into the channel of said upper end plate respectively between opposite sides of said core and the side portions of said upper end plate, each of said second pair of spacers having a side edge in engagement with the opposite side of said coil assembly and another side edge bearing on the web portion of said upper end plate, clamping means including laterally spaced tensioned bands encircling said end plates with portions of said bands extending transversely of said channels, and end supporting means connecting adjacent ends of said end plates at opposite ends of the frame and extending along the outer side of the outer legs of said core.

9. An electrical induction apparatus comprising a casing, a curved type magnetic core having three legs and upper and lower yoke portions, a current conductive coil assembly encircling one of said legs, said core and coil assembly being disposed in said casing, a frame for supporting and locating said coil assembly relative to said core comprising upper and lower end plates respectively adjacent said upper and lower yoke portions, each of said end plates having a web portion and two parallel side portions perpendicular to the plane of the web portion to form a channel, said web portion of said upper plate having an opening therein adjacent each end thereof, said lower yoke portion bearing on said web portion of said lower end plate between said side portions of said lower end plate, a first pair of spacers extending into said channel of said lower end plate respectively between opposite sides of said core and said side portions of said lower end plate, each of said first pair of spacers having a side edge in engagement with one side of said coil assembly and another side edge bearing on said web portion of said lower plate for bearing the weight of said coil, a second pair of spacers extending into said channel for said upper end plate respectively between opposite sides of said core and said side portions of said upper end plate, each of said second pair of spacers having a side edge in engagement with the opposite side of said coil assembly and another side edge bearing on said web portion of said upper end plate, a pair of tensioned banding straps encircling said end plates with portions of said straps extending transversely of said channels, a pair of end supports at opposite ends of said frame, the lower ends of said supports being connected to said lower plate adjacent the opposite ends thereof, said supports extending along the outside of the outer legs of said core, respectively, and passing through said openings in said upper plate respectively, and means for securing the upper ends of said supports to said casing.

10. An electrical induction apparatus comprising a magnetic core, a coil on said core, and means for predeterminately positioning said coil relative to said core including a pair of frame members disposed adjacent to the opposite ends of said core, a first pair of spacer means respectively disposed on opposite sides of said core and engaged between one of said frame members and one side of said coil to space said coil from said core and support the weight thereof, a second pair of spacer means respec-

tively disposed on said opposite sides of said core and engaged between the other of said frame members and the opposite side of said coil, and banding means encircling and engaging said frame members and normally urging said other frame member toward said one frame member to prevent displacement of said second pair of spacer members from engagement between said other frame member and said coil.

11. An electrical induction apparatus comprising a magnetic core, a coil on said core, and frame means for maintaining said coil and core in assembled relation comprising a first frame member engaging one end of said core and having opposed side flange portions on opposite sides of said core extending toward the other end of said core, a first pair of spacer means disposed respectively on said opposite side of said core with portions thereof disposed between said opposed flange portions, one side of each of said spacer means engaging one side of said coil and the opposite side thereof engaging said frame member to space said one side of said coil from said core, a second frame member adjacent the opposite end of said core, a second pair of spacer means each disposed respectively on said opposite sides of said core in engagement between said second frame member and the opposite side of said coil, and banding means under tension encircling and engaging said frame members with opposite end portions thereof connected together to apply clamping pressure on said frame members and said spacer means for restraining said coil against movement relative to said frame members.

12. An electrical apparatus comprising a magnetic core having opposed yoke portions and a plurality of leg portions, a coil on said core surrounding one of said leg portions, a pair of end plates, one of said end plates being disposed in abutting engagement with one of the opposed yoke portions of said core, spaced support members connected with said one end plate and in supporting engagement with opposed leg portions of said core, a pair of spacer means respectively disposed adjacent to the sides of said one yoke portion and engaged between said one end plate and said coil to space said coil from said core, the other of said end plates being slidably engaged between said support members and disposed adjacent to the other of said yoke portions of said core, another pair of spacer means disposed adjacent to the sides of said other yoke portion and engaged between said other end plate and coil to space said other end plate from said other yoke portion, and banding means spaced from said support members and normally urging said other end plate toward said one end plate to maintain the engagement of said one and other pairs of spacer means between said coil and end plates.

13. An electrical apparatus comprising a magnetic core having opposed yoke portions and a plurality of leg portions, a coil on said core surrounding one of said leg portions, a pair of end plates, one of said plates having a web and opposed side flange portions, one of the opposed yoke portions being in abutting engagement with the web portion of said one plate, spaced support members connected with said one plate and in engagement with opposed leg portions of said core, a pair of spacer means disposed between the opposed sides of said one yoke portion and said one plate flange portions, respectively, said pair of spacer means engaging one side of said coil and the web portion of said one plate to space said coil from said one yoke portion, the other of said end plates being slidably engaged between said support members and disposed adjacent to the other of said yoke portions of said core, another pair of spacer means disposed adjacent to the opposed sides of said other yoke portion and engaged between said other end plate and the opposite side of said coil to space said other plate from said other yoke portion, and banding means spaced from said support members encircling and engaging said plates under tension to normally urge said other end plate and said other pair of spacer means toward said one end plate.

14. An electrical induction apparatus comprising a casing having base and side walls, a magnetic core disposed in said casing and having opposed yoke portions and leg portions, a coil on said core surrounding one of said leg portions, a pair of end plates, one of said plates being disposed on said base wall of said casing, a pair of spaced support members connected with said one plate and extending therefrom, said core being disposed in engagement between said support members with one of said yoke portions engaging said one plate, a first pair of spacer means disposed respectively on opposite sides of said core and engaged between said one plate and one side of said coil to space said coil from said one yoke portion, the other of said plates being disposed adjacent to the other yoke portion of said core between said support members, a second pair of spacer means disposed respectively on said opposite sides of said core and engaged between said other plate and the opposite side of said coil to space said other plate from said other yoke portion, means at the opposite ends of said other plate respectively engaging said support members to prevent displacement of said support members from said core for restraining said core from movement relative to said plates, clamping means under tension encircling and engaging said plates to apply a force on said other plate urging said other plate toward said one plate to clamp said second pair of spacer means between said other plate and said opposite side of said coil, and fastening means connecting said support means to said side wall of said casing.

15. In an electrical induction apparatus including a core and a coil assembly on said core, retaining means for maintaining said coil assembly positioned relative to said core comprising a pair of end plates respectively adjacent the upper and lower ends of said core, each of said end plates including a web portion having opposed parallel side portions respectively extending outwardly beyond the opposite sides of said core, said lower end of said core being in engagement with the web portion of one of said end plates between said web side portions thereof, a first pair of spacer means respectively on said opposite sides of said core each having one side in engagement with one side of said coil assembly and the opposite side thereof in engagement with one of said web side portions of said one end plate so that the web portion of said one end plate bears the weight of said coil assembly independently of said core, a second pair of spacer means respectively on said opposite sides of said core each having one side in engagement with the other side of said coil assembly and the opposite side thereof in engagement with one of said web side portions of the other of said end plates, and clamping means engaged with said end plates and applying a force thereon urging said end plates toward each other whereby said end plates respectively urge said first and second pairs of spacer means against said one and other sides of said coil assembly.

16. A transformer comprising a magnetic core, a coil assembly including primary and secondary windings positioned on said core, and retaining means for maintaining said coil assembly positioned relative to said core comprising a pair of end plates respectively adjacent the upper and lower ends of said core, each of said plates including a web portion having parallel side portions respectively extending outwardly beyond the opposite sides of said core, said lower end of said core resting on the web portion of one of said plates between said web side portions thereof, a first pair of spacer means respectively on said opposite sides of said core each having one side in engagement with one side of said coil assembly and with the opposite sides thereof in engagement with said web side portions of said one plate, respectively, whereby the web portion of said one plate bears the weight of said

coil assembly independently of said core, a second pair of spacer means respectively on said opposite sides of said core each having one side in engagement with the other side of said coil assembly and with the opposite sides thereof in engagement with said web side portions of the other of said plates, respectively, and banding means under tension encircling said plates and being bent over said web side portions of said plates to apply a constant clamping pressure on said plates whereby said plates respectively urge said first and second pairs of spacer means against said one and other sides of said coil assembly.

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