June 13, 1939. E. C. WENTZ 2,162,496

TRANSFORMER

Filed Dec. 30, 1937 2 Sheets-Sheet 1

Fig. 1.

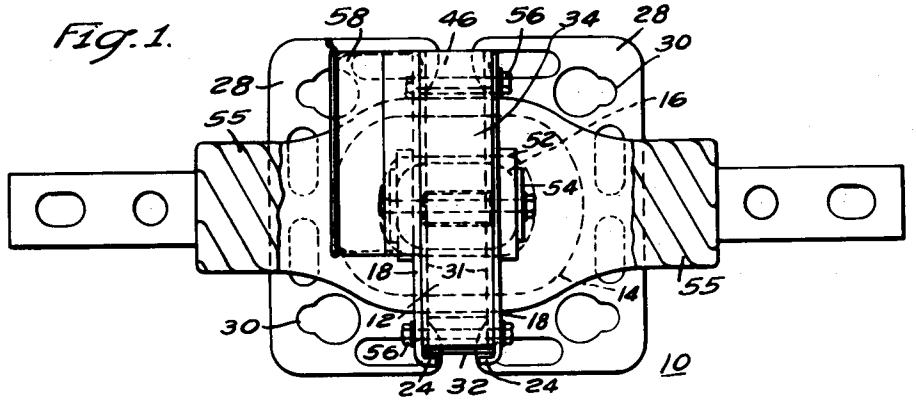


Fig. 2.

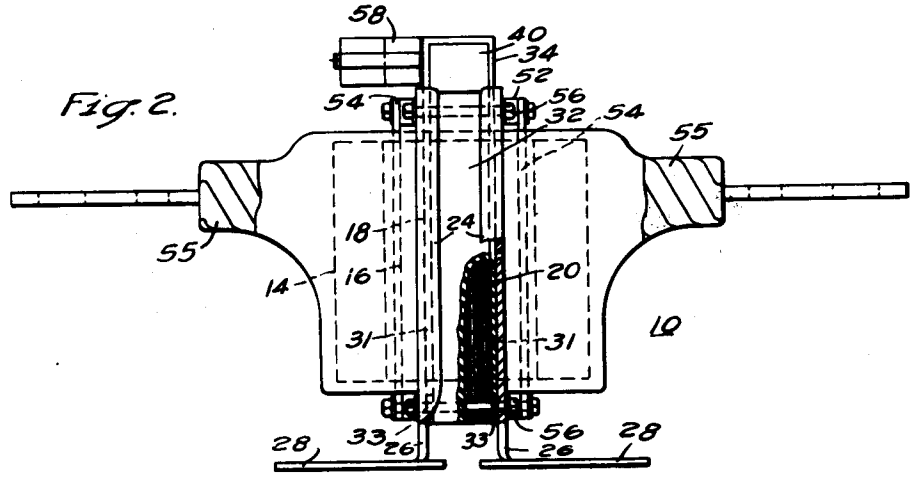
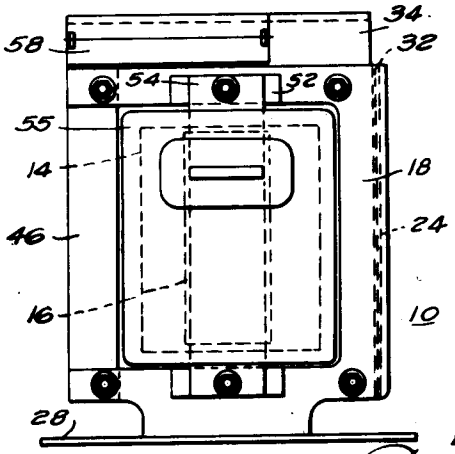


Fig. 3.



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TRANSFORMER

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Fig. 4.

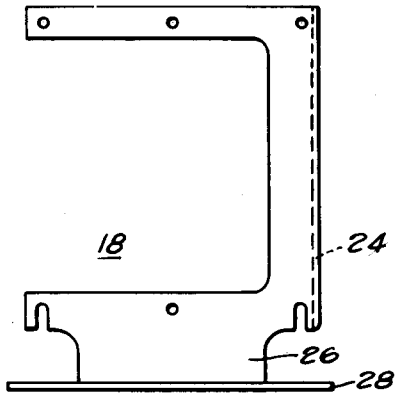


Fig. 5.

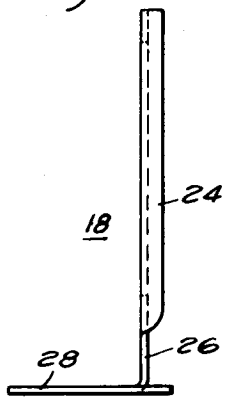


Fig. 6.

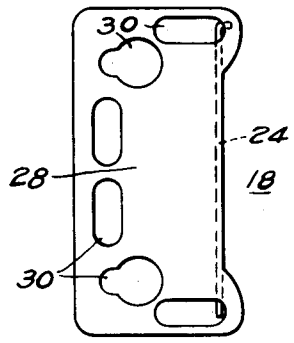


Fig. 7.

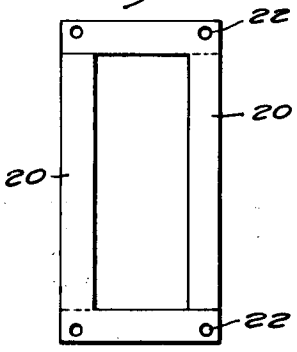


Fig. 8.



Fig. 9.

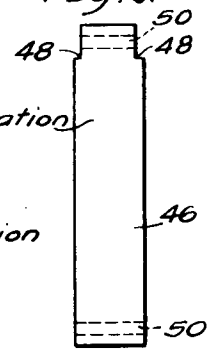


Fig. 10.

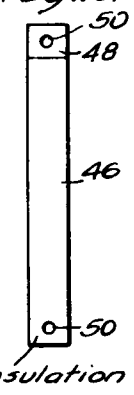


Fig. 11.

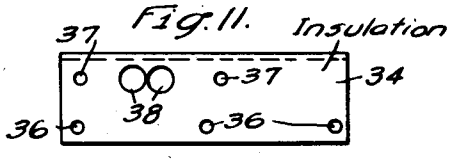


Fig. 13.

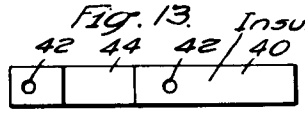


Fig. 15.

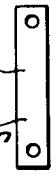


Fig. 12.

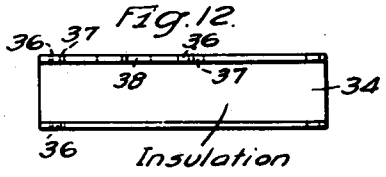
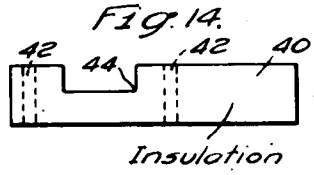


Fig. 14.



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2,162,496

TRANSFORMER

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Application December 30, 1937, Serial No. 182,483

5 Claims. (Cl. 175—358)

This invention relates to transformers.

An object of this invention is the provision of the transformer having a core of high magnetic permeability.

Another object of this invention is the provision of a transformer in which the core member is free from mechanical stresses and has a high magnetic permeability.

A further object of this invention is to provide a transformer in which the coils are rigidly supported by the end frames and the core is carried loosely by and between the end frames.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a top plan view of a transformer constructed in accordance with this invention;

Fig. 2 is a side elevational view, partly in section, of the transformer shown in Fig. 1;

Fig. 3 is an end elevational view of the transformer shown in Fig. 1;

Fig. 4 is a side elevational view of an end frame employed in accordance with this invention;

Fig. 5 is an end elevational view of the end frame shown in Fig. 4;

Fig. 6 is a bottom plan view of the end frame shown in Figs. 4 and 5;

Fig. 7 is a plan view of the core member employed in the transformer shown in Fig. 1;

Fig. 8 is a plan view in elevation of a spacer employed in accordance with this invention;

Fig. 9 is a side elevational view of another spacer employed in accordance with this invention;

Fig. 10 is an end elevational view of the spacer shown in Fig. 9;

Fig. 11 is a side elevational view of a channel shaped spacer employed in this invention;

Fig. 12 is a bottom plan view of the channel shaped spacer shown in Fig. 11;

Fig. 13 is a side elevational view of an insert employed in conjunction with the channel shaped spacer shown in Fig. 11;

Fig. 14 is a bottom plan view of the insert shown in Fig. 13; and

Fig. 15 is a plan view of a strip of insulating material employed in this invention.

Referring to the drawings and Figs. 1, 2 and 3 in particular, this invention is illustrated with reference to a current transformer 10. The transformer consists of a core member 12 and a plurality of coils such as a primary coil 14 and a secondary coil 16 suitably disposed thereabout. The core and coil assembly is disposed in and suitably supported in a plurality of end frames 18 disposed in spaced relation to each other and maintained spaced as will be explained hereinafter. The core 12 is constructed from a plurality of alternately stacked L-shaped laminations 20 as illustrated in Fig. 7 which have openings 22 drilled therein and so spaced as to receive supporting bolts for maintaining the laminations in their assembled relation supported between the end frames.

Referring to Figs. 4, 5 and 6, one of the end frames is illustrated in detail. The end frame 18 is fabricated from a single steel sheet member so cut in one piece as by means of suitable dies or with a burning torch into a substantially rectangular frame having an open end therein for slipping the end frame over the coil assembly and for interrupting the magnetic circuit in the end frame about the coils. In cutting the end frame to shape, an excess of material is left along one edge thereof suitable for forming a flange 24 when bent inwardly from the plane of the frame. In order that the end frame may be seated on a support, sufficient material, formed to shape, is left so attached to the rectangular frame, as by means of the strip of metal 26, that when bent outwardly it will form a mounting foot 28. Suitable openings 30 of different shapes and sizes may be formed in the mounting foot for receiving bolts, etc., to facilitate the mounting of the end frames on any desired support.

The end frames 18 are employed in pairs, each of the frames being of similar shape and size and having similarly spaced bolt holes therein, but having flanges 24 and mounting feet 28 extending in opposite directions when assembled with the core and coil assemblies as illustrated in Figs. 1, 2 and 3.

In assembling a transformer, the end frames 18 are spaced apart a distance slightly larger than the width of any given core assembly and electrically insulated therefrom by means of strips 31 of suitable material inserted between the legs of the core member and the end frames. Thin strips 33 of fibre having a width and length equal to the yoke of the core and bolt holes spaced similarly to the bolt holes in the core are disposed on both sides of the bottom yoke between the core and the end frames to insulate them from the core. The spacing of the end frames is desired in order to prevent any compressive force from being exerted on the core by reason of the end frames. In order to maintain the end frames spaced, a plurality of spacers 32, 34 and 46 are employed between the end frames about the core. The

spacers 32, 34, and 46 are illustrated in Figs. 8, 11 and 9, respectively, and are of insulating material such as fibreboard or sheets of fibrous material impregnated with condensation resin or wood formed to a predetermined size to maintain the end frames spaced and the core free from compressive forces.

As illustrated in Figs. 1, 2 and 3, spacer 32 is disposed between the end frames along the outer leg of the core member and is retained in position adjacent the leg of the core by the inwardly turned flanges 24 of the end frames 18. The spacer 32 is of a length equal to that of the leg of the core and sufficiently wide to maintain the end frames spaced apart a distance equal to at least the width of the leg or built-up height of the core member plus the thickness of the insulating strips 31 of fibre disposed between the leg of the core and the end frame on each side of the core.

The spacer 34 is a channel member formed from fibrous material impregnated with condensation resin having a width equal to the width of spacer member 32 and a length as illustrated in Fig. 3 substantially equal to the length of the end frame. As illustrated, spacer 34 substantially covers the top of the secondary winding, the top of the core member, spaces the tops of the end frames and provides a suitable outlet for the leads (not shown) to the secondary coil. When inserted between the end frames on top of the core, the side walls of the molded spacer extend downwardly adjacent the sides of the core for a distance equal to the yoke of the core thereby serving to insulate the end frames from the yoke of the core member. Suitable bolt holes 36 and 37 and openings 38 for the leads to the secondary coil are drilled into the side walls of the channel shaped spacer 34 as illustrated in Figs. 11 and 12 for receiving assembly bolts and the leads from the coil when in position with respect to the core and end frames.

In order to strengthen the channel shaped spacer 34, and to further cover the top of the core, a block 40 of suitable material such as wood, is formed to shape to fit within the channel member 34 when it is positioned as explained hereinbefore. The insert 40 of wood has a plurality of bolt holes 42 and a grooved out portion 44 as illustrated in Figs. 13 and 14, so formed therein that when inserted in the channel member 34 the grooved out portion 44 cooperates with the openings 38 in the spacer to permit the bringing out of the leads from the secondary coil while the bolt holes 42 are in alinement with the bolt holes 37 in the spacer.

The core member employed in the illustration is a two-legged core member disposed between one end of the end frames while the other end of the end frames opposite the core end is an open end for permitting the end frame to be slipped over the coils as described hereinbefore. In order to aid in supporting and bracing the coils, a spacer 46 of some suitable material such as wood and illustrated in Figs. 9 and 10, is employed between the end frames to fill the open end thereof. As illustrated, the spacer 46 is of a size comparable to that of a leg of the core and when positioned between the end frames gives a symmetrical appearance to the assembled transformer. The top edge of the spacer 46 is recessed on each side as at 48 to a depth equal to the thickness of the walls of spacer 34 to provide for receiving the downwardly extending walls of the channel member 34. As recessed, the spacer 46 extends upwardly within the channel member 34 to a height equal to the top edge of the core member and aids in supporting the wood block insert 40 within the channel member 34. Bolt holes 50 are also provided in each end of the spacer 46 for cooperating with the bolt holes formed in the end frame 18 for receiving bolts to maintain it in position.

The primary coil 14 and secondary coil 16 are mounted concentrically about the inner leg of the core 20 and, in order to support the coils without placing the core under supporting stresses, it is necessary to support the coils from the end frames 18. As illustrated in Fig. 1, the secondary coil 16 extends beyond or projects through the side of end frames 18 a slight distance. Blocks 52 which project outwardly a distance substantially equal to the exposed portion of the secondary coil 16 are disposed on and carried by each of the end frames 18 above and below the coil to substantially cover the coil 16. In order to rigidly attach the coils 14 and 16 to the end frames, a supporting bar 54 of fibre is disposed between and projects beyond the primary and secondary coils to the blocks 52 carried by the end frames and is secured thereto as will be explained hereinafter. The space between the primary and secondary coils is filled with a suitable cement such as an asphaltic cement having a high melting point for bonding the coils to the supporting bar 54 and when the cement is set, it is found that the coils are rigidly attached to the end frames. In practice the coils are alined in a suitable fixture with the supporting bars 54 in position therebetween and hot cement is then poured in between the coils and permitted to cool and set to rigidly hold the respective elements in position. A suitable finish coating 55 of tape, a portion of which is shown on the right-hand terminal of Figs. 1 and 2, is applied to the primary coil before cementing them to give a symmetrical, smooth appearance to the coil assembly extending outwardly to the leads of the primary coil.

With the core and coil assembly mounted in the end frames disposed in spaced relation by the spacers 32, 34 and 46 as hereinbefore described, the respective elements of the transformer are retained in position by mounting bolts 56 which project through the aligned bolt holes in the assembled end frames 18, in the core assembly, the spacers 34 and 46, the insert 40, the blocks 52 and the fibre strips 54, as will be evident from an examination of Figs. 1, 2 and 3 of the drawings. When tightened, the bolts 56 retain the end frames tightly against the edges of the spacers disposed about the core, but, since the spacers are slightly wider than the core member, the end frames will not exert a compressive force on the core member. Where the core member and consequently its laminations are thus loosely carried by the end frames and do not support the coils, it is found that there is an increase in the magnetic permeability of the core member. Such an increase in the magnetic permeability is highly desirable in current transformers.

As a safety feature in conjunction with the transformer described hereinbefore, a secondary terminal block 58 is illustrated as being carried by one of the end frames 18. Details of the terminal block 58 will not be described since any of the well known safety type terminal blocks, such as those illustrated in Patent No. 1,786,746, issued December 30, 1930, to J. B. Gibbs, may be employed in conjunction with the particular transformer described. This type of terminal block

provides fixed binding posts for connecting the secondary leads, automatically short circuits the secondary terminals when the cover of the block is removed, opens the short circuit when the cover is replaced in correct position and provides a sealed cover to enclose and protect the secondary connections.

As is evident from the foregoing description, the transformer of this invention comprises a core member carried loosely by the end frames with the coil members rigidly attached to, and supported by, the end frames. By this construction the core member is free from all compressive forces resulting from clamping the end frames and is free from stresses encountered in supporting the coil assembly, with the result that an increase of from 20 to 100% in the magnetic permeability of the core is obtained as compared to that of similar transformers having clamped cores. The spacers employed to maintain the end frames in their spaced relation with respect to each other for carrying the core member loosely therebetween not only protect the core by relieving pressure therefrom, but, in addition, give a structure having a symmetrical design and a finished appearance.

Although this invention is described with reference to a particular embodiment thereof, it is, of course, not to be limited thereto except insofar as is necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. A transformer comprising, in combination, a core member formed from a plurality of laminations and having a plurality of legs and upper and lower yoke members, a plurality of coil members disposed about one of the legs of the core member, a plurality of end frames disposed in spaced relation to each other on opposite sides of the core member, each of said end frames being a substantially rectangular frame having an open end therein for slipping the frame over the coil members, means for maintaining the end frames spaced, said means comprising spacer members between the end frames and bolts projecting through the end frames to retain them tightly against the spacer members, certain of the bolts also functioning to loosely carry the laminations of the core member between the end frames free from compressive forces, the spacer members being of a size sufficient to cooperate with the end frames to substantially enclose the upper yoke member and the other leg member of the core, and means for rigidly attaching the coil members to the end frames to prevent relative movement therebetween.

2. A transformer comprising, in combination, a core member formed from a plurality of laminations and having a plurality of legs and yoke members, a plurality of coil members disposed about one of the legs of the core member, a plurality of end frames disposed on opposite sides of the core member, each of said end frames being substantially rectangular and having an open end therein for slipping the frame over the coil members, the end of each of the end frames opposite the open end being turned inwardly toward the other end frame when disposed on opposite sides of the core member, a plurality of spacer members disposed between the end frames for maintaining the oppositely disposed end frames in spaced relation to each other, said plurality of spacer members comprising a spacer disposed between the inwardly turned ends of the end frames and another of the legs of the core member, a second spacer disposed between the end frames above the upper yoke member of the core member, and a third spacer disposed between the end frames at the open end thereof, a plurality of bolts projecting through the end frames to retain them tightly against the spacers, certain of the bolts also functioning to loosely carry the laminations of the core between the end frames free from compressive forces, the spacers being of a size sufficient to cooperate with the end frames to substantially enclose said yoke and leg members of the core to protect them, and means for rigidly attaching the coil members to the end frames to prevent relative movement therebetween.

3. A transformer comprising, in combination, a plurality of end frames disposed in spaced relation to each other, means for maintaining the end frames spaced, said means comprising spacer members disposed between the end frames and being of a size sufficient to substantially close the space formed between the spaced end frames at their upper and side edges, a core member formed from a plurality of laminations and having an upper and lower yoke and a plurality of legs disposed between and carried by the end frames, the laminations of the core member being carried loosely between the end frames, the spacer members and the frame members cooperating to substantially enclose the upper yoke and at least one of the legs of the core member, and a plurality of coils concentrically disposed about at least another of the legs of the core member, supporting bars disposed to extend between the concentrically disposed coils and secured to the end frames, and means for securing the coils to the supporting bars to prevent relative movement between the coils and the end frames.

4. A transformer comprising, in combination, a core member formed from a plurality of laminations and having an upper and lower yoke and a plurality of legs, a plurality of coil members disposed about at least one of the legs of the core member, a plurality of end frames disposed in spaced relation to each other on opposite sides of the core member, each of said end frames being a substantially rectangular frame having an open end therein for slipping the frame over the coil members, means for maintaining the end frames spaced, said means comprising spacer members between the end frames and bolts projecting through the end frames to retain them tightly against the spacer members, certain of the bolts also functioning to loosely carry the laminations of the core member between the end frames free from compressive forces, the spacer members being of a size sufficient to cooperate with the end frames to substantially enclose the upper yoke and the legs of the core member which are free of the coils, supporting bars disposed to extend between the coil members and secured to the end frames, and means for securing the coil members to the supporting bars to prevent relative movement between the coils and the end frames.

5. A transformer comprising, in combination, a core member formed from a plurality of laminations and having upper and lower yokes and a plurality of legs, a plurality of coils concentrically disposed about at least one of the legs of the core member, a plurality of end frames disposed in spaced relation to each other on opposite sides of the core member, each of said end frames being substantially rectangular and having an open end for slipping it over the coils, means

disposed between the core member and the end frames to insulate the end frames, means for maintaining the end frames spaced, said means comprising a plurality of spacer members disposed about the core member between the end frames, bolts projecting through the end frames to retain them tightly against the spacer member and in position with respect to the core member, certain of the bolts also functioning to carry the core member between the end frames, the spacer members being of a size sufficient to cooperate with the end frames to substantially enclose the upper yoke and the legs of the core member which are free of the coils while maintaining the end frames so spaced that the core member therebetween is free of compressive forces, supporting bars disposed to extend between the concentrically disposed coils and secured to the end frames, and means for securing the coils to the supporting bars to prevent relative movement between the coils and the end frames.

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