

[54] **POWER TRANSFORMER HAVING FLUX SHIELDS SURROUNDING METALLIC STRUCTURAL MEMBERS**

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[58] Field of Search 336/84

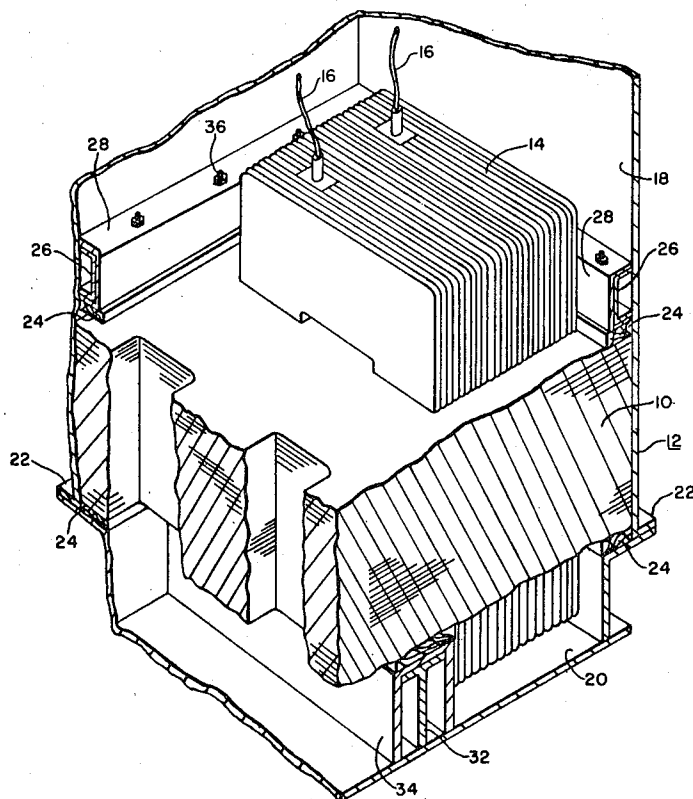
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[57] **ABSTRACT**

Structural members projecting from the transformer tank are surrounded by flux shields to prevent leakage flux from entering and heating the structural members. The flux shields are constructed of a non-magnetic material which has relatively good electrical conductivity. Current induced into the flux shield by the leakage flux produces flux which counteracts the leakage flux and reduces heating of the structural members.

6 Claims, 3 Drawing Figures



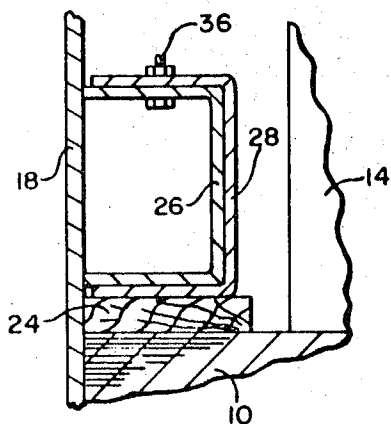
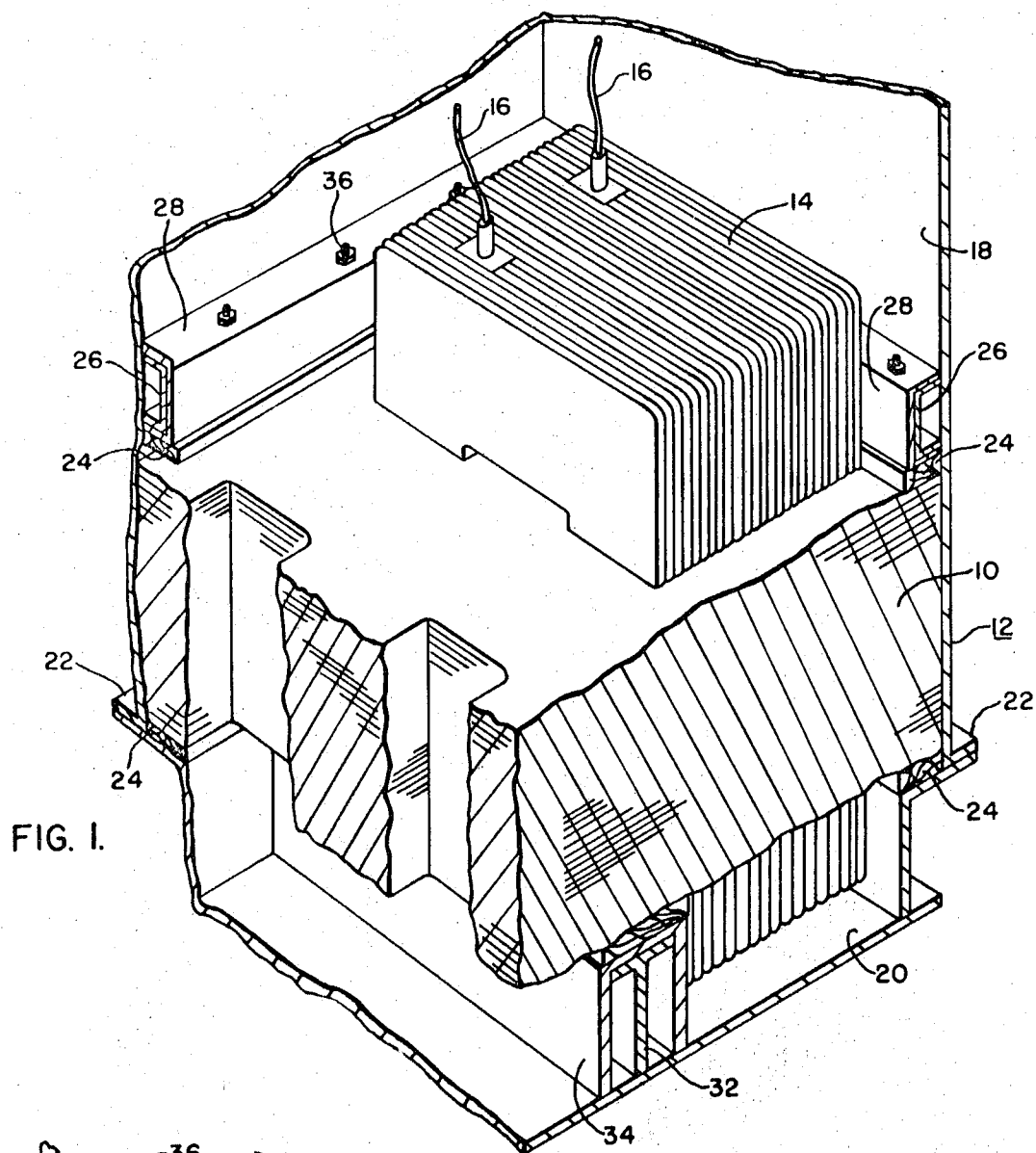


FIG. 2.

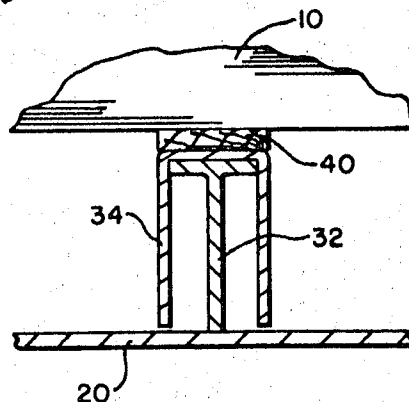


FIG. 3.

POWER TRANSFORMER HAVING FLUX SHIELDS SURROUNDING METALLIC STRUCTURAL MEMBERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates, in general, to electrical inductive apparatus and, more specifically, to power transformers having flux shields.

2. Description of the Prior Art

Large power transformers have structural braces attached to the tank walls for reinforcement and for holding the core laminations together. Such braces project from the tank walls and extend into the leakage flux field of the transformer winding structure. The braces are usually constructed of steel for maximum strength and often provide a relatively low reluctance path for the leakage flux. The leakage flux produces circulating currents in the braces which cause heating and a reduction in the efficiency of the transformer.

A common arrangement for reducing these losses involves the placing of magnetic lamination bundles on the steel braces, thus effectively diverting the leakage flux from the steel braces to the magnetic laminations which are not as susceptible to circulating currents. Such an arrangement is very effective; however, the magnetic bundles occupy a considerable amount of space in the transformer assembly, are costly to construct, and require many man-hours to assemble and install. Therefore, it is desirable, and it is an object of this invention, to provide a flux shield which economically and effectively reduces the amount of leakage flux entering the braces around the tank walls of large power transformers.

The magnetic core of three-phase, shell-form power transformers is extremely large and requires additional supports between the phase winding structures of the transformer. Supporting beams, usually steel "I" or "T" beams, are used for this purpose and are attached to the bottom of the transformer enclosure and project upward therefrom to support the magnetic core. Since the supporting beams extend into the leakage flux of the winding structures, flux shields must be provided therearound to prevent losses due to heating of the supporting beams. According to the prior art, a useful arrangement for shielding the supporting beams from the leakage flux consisted of placing magnetic lamination bundles over the beams. Such magnetic lamination bundles around the supporting beams produce the same disadvantages described in connection with their use around the supporting braces. Therefore, it is also desirable, and it is another object of this invention, to provide a flux shield which economically and effectively reduces the amount of leakage flux entering the supporting beams which project from the bottom of the transformer enclosure.

SUMMARY OF THE INVENTION

There is disclosed herein new and useful arrangements for shielding metallic structural members of a power transformer from the effects of leakage flux from the winding structures of the transformer. A plate of non-magnetic, highly conductive material is placed around the structural members which project from the transformer enclosure. Leakage flux which normally would enter the structural members first enters the flux

shield which is constructed of the non-magnetic material. Circulating currents induced therein produce flux which is directed in the opposite direction from the flux which produced the current. Thus, the net flux traveling through the non-magnetic shield is substantially equal to zero. Therefore, the structural members are not heated by the leakage flux. The flux shields constructed of the non-magnetic, highly conductive material are easily fabricated from a metallic plate and bolted or welded around the structural members. The thickness of the metallic plate is considerably smaller than the thickness of the magnetic bundles used according to the prior art, thus a reduction in the space required to locate the magnetic flux shield may be realized.

BRIEF DESCRIPTION OF THE DRAWING

Further advantages and uses of this invention will become more apparent when considered in view of the following detailed description and drawing, in which:

FIG. 1 is a cut-away view, partly in section, of a three-phase, shell-form power transformer constructed according to this invention;

FIG. 2 is a partial sectional view of a structural brace of the transformer shown in FIG. 1; and

FIG. 3 is a partial sectional view of a supporting beam of the transformer shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the following description, similar reference characters refer to similar elements or members in all the figures of the drawing.

Referring now to the drawing, and to FIG. 1 in particular, there is illustrated a partial view of a three-phase, shell-form power transformer. The transformer includes the magnetic core 10 which is disposed within the transformer tank 12. The phase winding assembly 14 is inductively coupled to the magnetic core 10 and includes the leads 16 which may be connected to the appropriate bushings or terminals on the transformer. The complete transformer would include two additional phase windings which are similar to the phase winding assembly 14. The transformer tank 12 includes an upper tank portion 18 and a lower tank portion 20 which are connected together at the flange region 22. The magnetic core 10 is secured within the tank 12 between the spacer blocks 24 which are located adjacent to the top and bottom surfaces of the magnetic core 10. The structural support braces 26 provide a stop against which the support blocks 24 may rest to tightly hold the magnetic core 10. The structural support brace 26 also increases the strength of the tank wall. The support braces generally extend around the entire circumference of the transformer tank, thus providing reinforcement of the entire tank wall and support for the magnetic core along all of its edges.

The flux shield 28 is disposed around the support brace 26 in the regions where leakage flux may cause heating in the support brace. As shown in FIG. 1, the flux shield 28 is continuous around the corner of the transformer tank 12. However, it is within the contemplation of this invention that the flux shield 28 may consist of two or more portions suitably disposed around the supporting braces 26.

Supporting beams, such as the supporting beam 32, extend between the phase winding assemblies of the

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transformer to help support the magnetic core 10. Flux shields such as the flux shield 34, are suitably disposed around the supporting beams to shield the beams from the leakage flux. Normally, in three-phase, shell-form transformers, two supporting beams, of the "T" or "I" beam construction, would be used.

FIG. 2 is a view of the transformer shown in FIG. 1 illustrating a support brace and flux shield. The flux shield 28 is formed from a metallic plate which is shaped to conform to the shape of the supporting brace 26. The bolt assembly 36 secures the flux shield 28 to the support brace 26, although other arrangements for securing the members together may be used. Since the flux shield 28 substantially covers the entire projecting surface of the support brace 26, the support brace 26 is not heated due to leakage flux from the winding assembly 14. Although some heat will be generated within the flux shield 28 due to the circulating currents therein, the overall cooling capacity of the transformer components will not be substantially reduced. The flux shield 28 is exposed to the transformer oil and is effectively cooled thereby. Additional heating of transformer components is much more critical when the components are located in a region which is not as accessible to the transformer coolant oil, such as within the winding assembly 14.

FIG. 3 is a view of the transformer shown in FIG. 1 illustrating the supporting beam 32 and the flux shield 34 disposed therearound. The lower tank portion 20 supports the "T" beam 32 which is enclosed by the magnetic flux shield 34. The spacer block 40 rests on top of the flux shield 34 and supports the magnetic core 10. It is within the contemplation of this invention that the flux shield 34 may conform to the shape of the supporting beam 32, rather than exhibit a generally U-shaped cross-section.

The type of material used for the flux shield and the frequency at which the transformer operates determine the thickness of the plate which is required to provide substantially complete flux shielding. In general, the plate of material must have a thickness which is greater than the skin depth of the material at the frequency of the magnetic flux. If the plate is not as thick as the skin depth, the shielding effect would not be as great. It has been found that a flux shield thickness approximately equal to $1\frac{1}{2}$ times the skin depth of the material used provides the maximum shielding with the minimum amount of heating. For 60-cycle transformers using aluminum plate as the shield material, the desired thickness would be approximately one-half of an inch.

By using the flux shield disclosed herein, projecting structural members may be enlarged for greater

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strength due to the smaller space required by their shielding members. Since numerous changes may be made in the above-described apparatus, and since different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all of the matter contained in the foregoing description, or shown in the accompanying drawing, shall be interpreted as illustrative rather than limiting.

We claim:

1. A power transformer comprising:

a tank assembly;

a magnetic core disposed within said tank assembly;

a winding assembly inductively coupled to said magnetic core;

structural members projecting from the surface of said tank assembly and bracing said core; and

flux shields which surround disposed adjacent to said structural members and which effectively reduce the leakage flux entering said structural members, said flux shields being constructed of a relatively good electrical conducting, non-magnetic material.

2. The power transformer of claim 1 wherein the flux shields are constructed of a metallic plate having a thickness which is greater than the skin depth of the plate at the frequency of the flux in the core.

3. The power transformer of claim 1 wherein the flux shields surround substantially the entire projecting surface of the structural members.

4. The power transformer of claim 1 wherein the flux shield is constructed of a U-shaped channel member.

5. The power transformer of claim 1 wherein the flux shield is constructed of aluminum.

6. A power transformer comprising:

a tank assembly;

a magnetic core disposed within said tank assembly;

a winding assembly inductively coupled to said magnetic core;

structural supporting members which project from the surface of said tank assembly and brace said core; and

flux shields surrounding substantially the entire projecting surface of said supporting members;

said flux shields being constructed of a metallic plate having a thickness which is greater than the skin depth of the plate at the frequency of the magnetic flux in said core, and said metallic plate being constructed of a relatively good electrical conducting, non-magnetic material.

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