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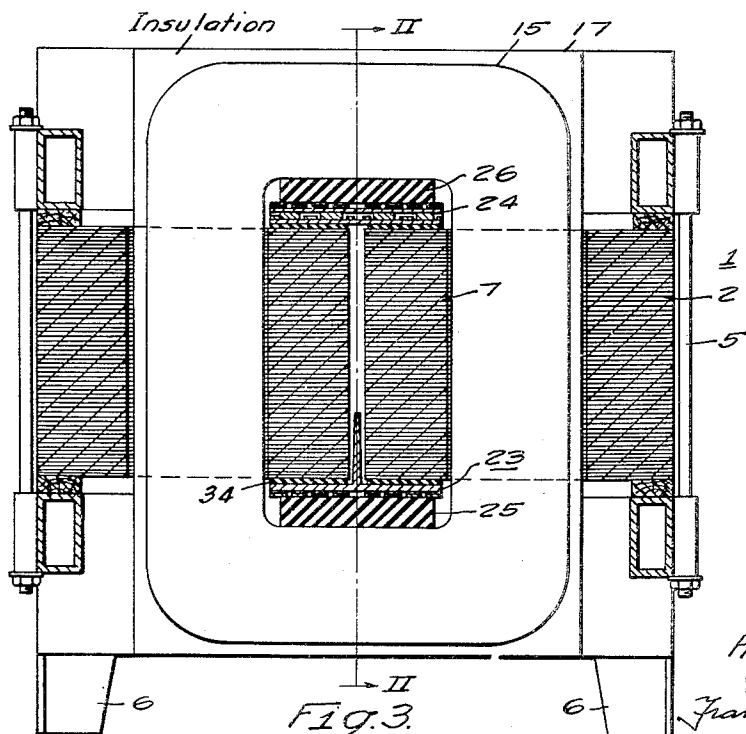
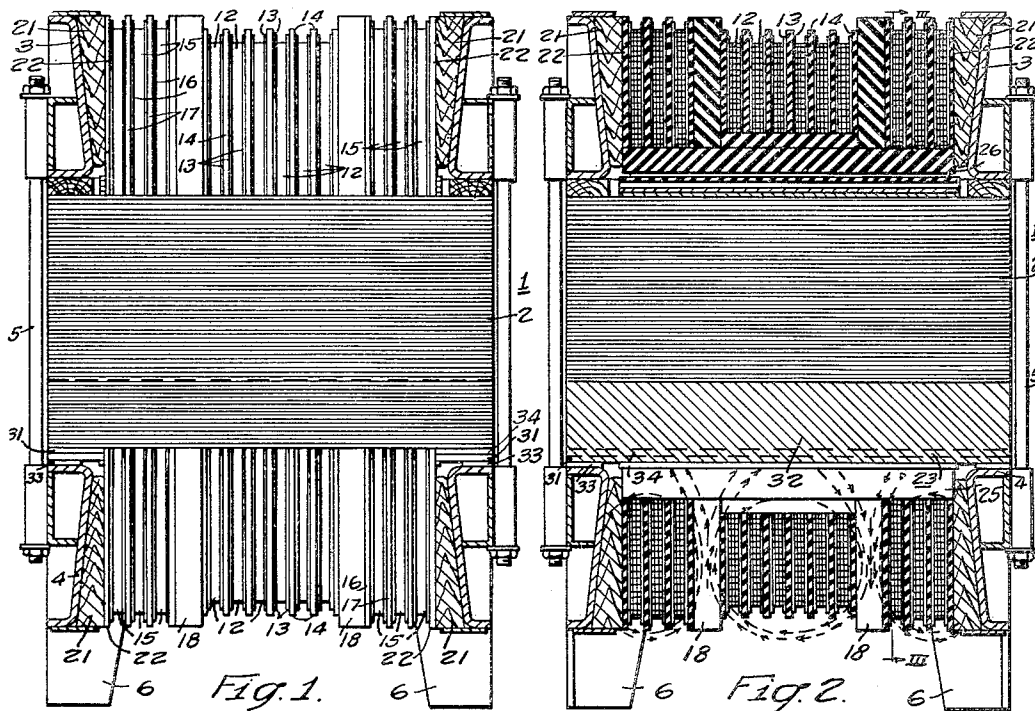
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2,370,045

SHIELDING TRANSFORMER STRUCTURE

Filed Oct. 22, 1942

2 Sheets-Sheet 1



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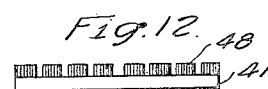
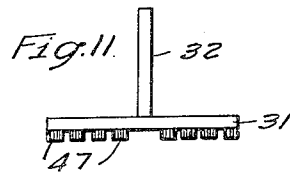
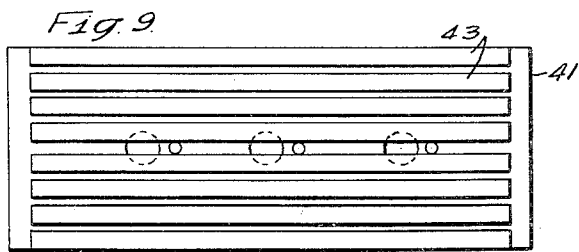
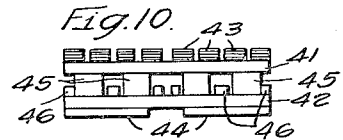
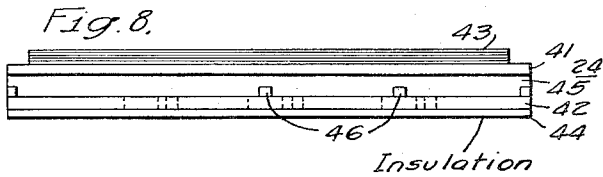
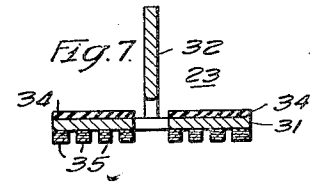
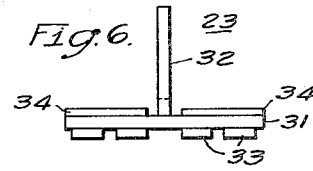
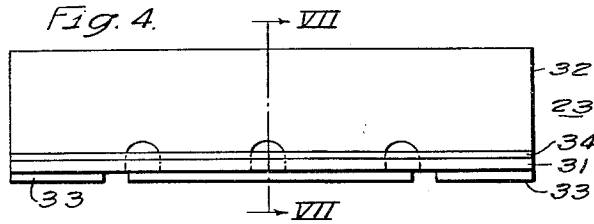
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SHIELDING TRANSFORMER STRUCTURE

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2 Sheets-Sheet 2



WITNESSES:

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## UNITED STATES PATENT OFFICE

2,370,045

## SHIELDING TRANSFORMER STRUCTURES

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Application October 22, 1942, Serial No. 462,975

6 Claims. (Cl. 175—356)

This invention relates to transformers and particularly to core and coil structures therefor.

In building transformer cores, it is desirable to assemble the core iron laminations tightly enough to prevent vibration of the laminations and to so assemble the coils and insulation on the core that they are properly supported against movement resulting from stresses caused by short circuits. In transformers of the shell type, the coils or windings are oblong or oval in shape and extend beyond the iron core at each end, thus leaving a space between the end portions of the coils and iron. When the windings of a transformer are short-circuited or subjected to heavy overload currents, severe mechanical stresses are set up within the transformer which tends to separate the coils in a direction normal to their faces and also if the electrical centers of the coils are not in line these forces tend to move the coils in a direction parallel to their faces. To prevent the movement of the coils in a direction normal to the faces, supporting plates are spaced against the flat faces of the end coils which are supported from the end frames of the structure thus tightly clamping all coils together.

To support the coils against movement in a direction parallel to their faces, to clamp the tongue portion of the core extending through the opening in the coils tightly together, and to support the coils and insulation assembly, it has been customary to insert coil wedges or coil supports through the openings of the coils at the top and bottom of the stack of core laminations between the iron core and the end portions of the coils.

With the advent of more efficient magnetic steels such as the steel sold under the trade-mark name "Hipersil" which permit the core structure to be operated at much higher magnetic inductions than was formerly the practice, the amount of iron required to form a core structure of a transformer having a given power rating has been greatly reduced. The coil wedges or coil supports, if made of electrically conducting material and if not properly shielded are subject to heating due to the stray magnetic fields existing in any transformer. With a decrease in the size of the core structure, the amount of heating resulting from stray flux is greatly increased. The stray flux is greatest in the high-low space between the high voltage and low voltage windings in the winding stack, and with the decrease in the size of transformer structures, it is often desirable to decrease the number of these high-low spaces. In such cases the stray flux in a given area is still further increased. The core structure itself provides a

good path for the leakage flux on the vertical sides of the coils. Where the coils extend beyond the iron core, above and below it, the leakage flux completes its circuit through the air or through whatever material is in its path. The leakage flux density is particularly high at the coil wedge locations. Ordinary wedges of magnetic material attract the flux and develop high losses because the surface is flat and the flux lines develop high eddy currents in these flat members. Metallic wedges of non-magnetic material also develops high losses in high density magnetic fields because of eddy currents produced by the fields.

It is an object of the invention to provide means for decreasing the heating in coil supports and tongue wedges of transformer structures by providing magnetic shields between the body portions of these coil supporting members and the inner edges of the coils for conducting the lines of stray flux and preventing them from developing high eddy current losses resulting in heating in the body members of the coil support or wedge.

Other objects of the invention will be apparent from the following description of a preferred embodiment thereof, reference being had to the accompanying drawings in which:

Figure 1 is a side elevational view, partly in section of a transformer organized in accordance with the invention.

Fig. 2 is a vertical longitudinal sectional view taken along line II—II of Fig. 3.

Fig. 3 is a vertical transverse sectional view taken along line III—III of Fig. 2.

Figs. 4, 5 and 6 are, respectively, a side elevational view, a bottom view, and an end view of the bottom coil support positioned below the tongue iron of the core structure.

Fig. 7 is a sectional view taken along line VII—VII of Fig. 4.

Figs. 8, 9 and 10, are, respectively, a top view, a bottom view, and an end view of a tongue wedge positioned above the tongue iron of the transformer, and

Figs. 11 and 12 are sectional views of a bottom coil support and a top coil wedge, respectively, in which the position of the iron laminations comprising the magnetic shield are modified.

Referring to the drawings, and particularly to Figs. 1, 2 and 3 thereof, an iron core 1 is provided comprising a plurality of laminations 2 arranged to form windows through which the opposite sides of the coils extend vertically. End frame structures 3 and 4, respectively, are provided above and below the stacks of core laminations and are clamped by bolts 5 to bring pres-

sure about the edges of the stack to hold them tightly in place. The entire structure is supported on a lower end frame by the legs 6. The tongue portion 7 of the core provides a winding leg extending through the openings in the coils comprising the transformer windings. The high voltage winding, as shown, comprises a plurality of coils 12 centrally positioned along the winding leg and on opposite sides of which spacing members 13 are provided adjacent insulating barriers 14. On opposite ends of the stack of high voltage coils 12 a group of low voltage coils 15 are provided adjacent to which spacer member 16 and insulating barriers 17 are provided. A high-low space 18 is provided between the group of high voltage coils and the two groups of low voltage coils. The end insulating barriers 22 are braced between the end frames by wedge members 21 so as to clamp the entire stack of coils against movement at right angles normal to their faces.

In order to brace the coils against vertical movement, a T-shaped coil support 23 is provided below the tongue iron 7 and a coil wedge 24 is provided at the top of the laminations comprising the tongue iron. The bottom coil support 23 is positioned between the bottom of the stack of core laminations and an insulating member 25 which is engaged by the coil support 23 and the inner edges of the lower portion of the coils. The top coil wedge 24 is positioned above the tongue portion 7 of the core and an insulating member 26 which engages the lower edges of the upper portion of the vertically positioned coils. The structure of the coil support 23 will be more clearly understood by reference to Figs. 4, 5, 6 and 7, and comprises a flat steel plate 31 welded to a vertical member 32 forming a T-shaped beam, the ends of which are supported on the lower end frame members 4 as shown in Figs. 1 and 2. Supporting plates 33 are provided on the under side of the ends of the plate 31 which rest against the end frames 4. Strips of insulating material 34 are provided extending along the upper side of the plate 31 between the plate 31 and the core laminations. A magnetic shield is provided in the form of bundles 35 of iron laminations welded to and extending along the under side of the plate 31. The laminations comprising these bundles or units of the magnetic shield are formed of high permeability material, such as Hipersil, and provide a direct path for the leakage flux between the body portion or plate 31 of the bottom support and the coil structures. These shielding members provide a path for the leakage flux so that this flux passes along the shield rather than into the tongue support.

The tongue wedge 24 positioned above the tongue portion 7 of the core is shown in detail in Figs. 8, 9 and 10 and comprises two plates 41 and 42 of magnetic or non-magnetic steel. To the upper plate is welded shields comprising bundles of magnetic laminations 43 of high permeability steel extending lengthwise of the plate to perform the same function as the bundles 35 in the lower coil support shown in Figs. 4 to 7. To the under side of the lower plate 42 insulating members or strips 44 are provided, and between the two plates 41 and 42 wedges 45 are driven after the plates 41 and 42 have been positioned within the openings in the stack of coils 12 and 15. The wedges 45, when driven between the plates 41 and 42, separate them and the insulating structures 26 and 25 to cause a tight fit between the insulating structures 26 and 25 and

the inner edges of the coils 12 and 15. Guide members 46 are shown for spacing the wedge members 45 across the surface of the plates 41 and 42.

Figs. 11 and 12 show a bottom coil support and a top coil wedge similar to those illustrated in Figs. 4 to 7 and 8 to 9, respectively, except that the bundles 47 and 48 of laminated material forming the units of the magnetic shield are shown with the laminations extending in a vertical instead of a horizontal direction. When the laminations are arranged in the vertical direction, as in Figs. 11 and 12, there may be a continuous series of laminations across the surface of the metal plate 31 or 41 instead of the laminations being arranged in individual bundles spaced from one another.

It will be appreciated that the magnetic shields formed by bundles of high permeability magnetic steel between the tongue portion of the core and the upper and lower portions of the coils which extend beyond the magnetic circuit of the core will cause the stray flux in these areas to pass through the laminated magnetic shield and prevent this flux from entering the bottom coil support or the top coil wedge thus preventing heating in these members which might otherwise become excessive.

Modifications may be made in the apparatus illustrated and described without departing from the spirit of my invention, and I do not wish to be limited otherwise than by the scope of the appended claims.

I claim as my invention:

1. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils between the coils and the core, and a magnetic shield between the body portion and the coils comprising a plurality of strips of magnetic material attached to the body portion of the supporting member.

2. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils between the coils and the core, and a magnetic shield comprising a plurality of strips of magnetic material attached to the body portion and extending along the body portion on the side thereof adjacent the coils.

3. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils between the coils and the core, and magnetic shields between the body portion and the coils comprising a plurality of bundles of laminations of magnetic material extending lengthwise of the body portion for its entire length, the bundles being spaced apart and attached to the body portion of the supporting member.

4. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils

between the coils and the core, and a magnetic shield comprising a plurality of bundles of strips of magnetic material spaced apart and attached to the body portion and extending along substantially the entire length of the body portion on the side thereof adjacent the coils, the several laminations of a bundle being placed flatwise parallel to the surface of the body portion.

5. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils between the coils and the core, and a magnetic shield comprising a plurality of bundles of strips of magnetic material spaced apart and attached to the body portion and extending along substan-

tially the entire length of the body portion on the side thereof adjacent the coils, the several laminations of a bundle extending at right angles from the body portion.

6. A transformer structure comprising a core formed of a plurality of laminations of magnetic material, a plurality of coils positioned about a portion of said core structure, a supporting member having a body portion of electrically conducting material extending within the coils between the coils and the core, and a magnetic shield comprising a plurality of strips of magnetic material attached to the body portion and extending along substantially the entire length of the body portion on the side thereof adjacent the coils, the several laminations extending at right angles from the body portion.

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