Sept. 1, 1959 W. LE ROY HENDERSON 2,902,661

COIL INSULATING AND LEAD ANCHORING MEANS FOR TRANSFORMERS

Filed May 11, 1954

Fig. 1.

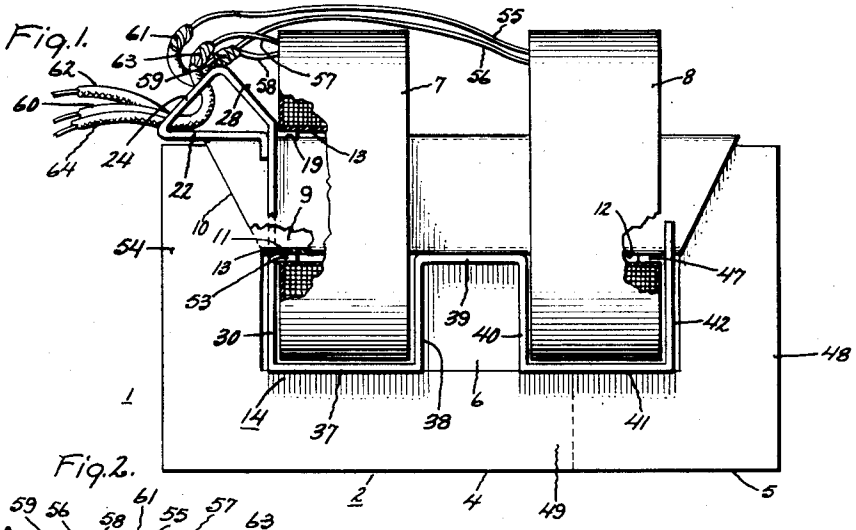


Fig. 2.

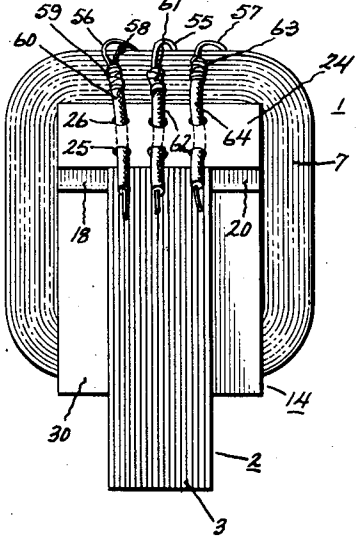


Fig. 3.

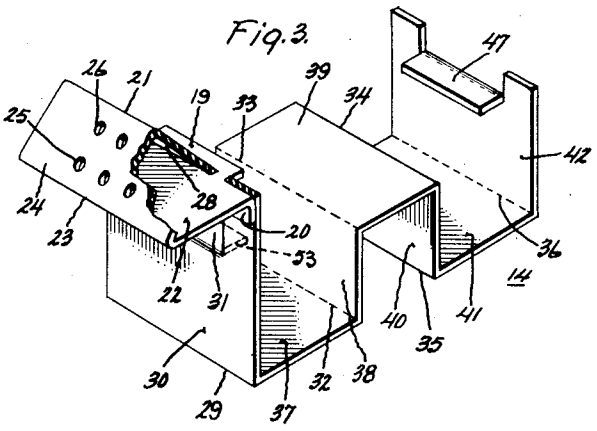
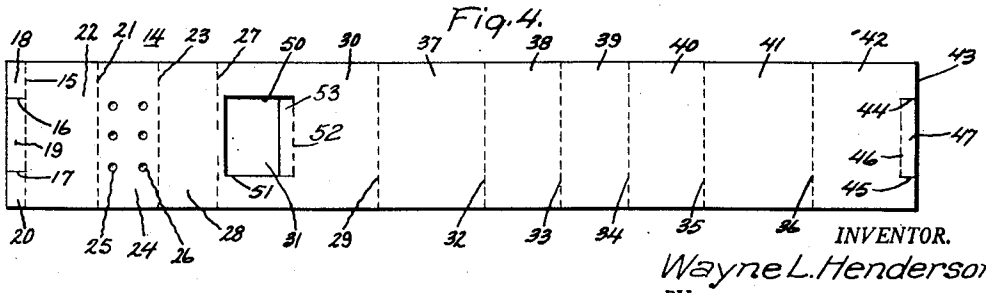


Fig. 4.



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COIL INSULATING AND LEAD ANCHORING MEANS FOR TRANSFORMERS

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Application May 11, 1954, Serial No. 428,926

9 Claims. (Cl. 336—196)

This invention relates to transformers and more particularly to improved coil insulating and lead anchoring means for use therein.

It has been found, with respect to coils for use in small transformers, that by precision winding the coils less material is necessary to achieve the same effect as where the coils are not so wound. Precision wound coils are generally formed on an arbor without any insulation between the coils except for the actual insulating coating on the wire forming the coils. Each individual turn of wire fits into the groove formed by the two adjoining turns of wire of the layer directly below the one being formed. Because of their advantages, such coils have been used extensively; however, the problem of adequate insulation of the coil from the transformer core has been difficult to solve economically. A common practice heretofore, has been to provide insulation around the core portion on which the coil is positioned, and on the sides of the coil. No insulation is generally provided around the outer surface of the coil nor between the core and the inner edges of the coil, the air space being depended upon in these locations for proper insulation. However, this construction may permit arcing to occur between the inner edge of the coil and the inner edge of the core, and between the outer surface of the coil and the inner surface of the core. The first of these results generally because the insulation at the side of the coil and the insulation around the portion of the core on which the coil is positioned may not meet completely. Likewise, arcing may occur between the outer surface of the coil and the adjacent core, since again, only an air space separates them.

Another difficulty encountered in the manufacture of small transformers has been the presence of tension on the transformer coil leads. Such pulling may well result in the leads being completely pulled away from the transformer coil. In addition, it may result in a lessening in the diameter of the lead wire which while small, can decrease to a noticeable degree the conductivity of the wire. Also, the lead may be pulled tight around the corner of the coil, thus creating the danger of short circuits. In view of the above, it is desirable to provide positive insulation at all points between the coil and the adjacent core parts and to prevent the application of tension to the coil leads. Insulation providing the above advantages is set forth in co-pending application Serial No. 391,635 of the present applicant and Harry J. Proxmire, filed November 12, 1953, and assigned to the assignee of the subject application; the co-pending application is particularly intended to provide protection for single coils. It is, however, desirable to provide unitary insulation which is readily applicable to a plurality of coils, both insofar as the insulation itself is concerned, and for the location of the means preventing external tension from reaching the coil leads.

An object of this invention is, therefore, to provide an improved transformer construction which incorporates the desirable features described above.

Further objects and advantages of this invention will become apparent and the invention will be better understood by reference to the following description and the accompanying drawing. The features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

This invention, in its broadest aspects, provides a single piece of sheet material, preferably flexible, with good insulating qualities and shearing strength. This sheet is fitted around one or more coils so as to insulate them from the sides of the core. A tab is cut at each end of the sheet and is folded under the coil between the coil and the core leg thereby to insulate completely the coil and the core from each other at that part of the coil which is adjacent the inner end of the core leg. Openings may be provided near an end of the sheet and the external leads to which the coil leads are attached may be threaded through these openings. The openings are preferably placed close enough together so that tension on the outside lead would tend to shear the insulating material before the lead were to slide through the openings and place tension on the coil lead attached thereto.

In the drawing, Figure 1 is a side view of a transformer utilizing the improved insulating means of this invention;

Figure 2 is an end view of the transformer provided with the improved insulating means;

Figure 3 is a view in perspective of the improved unitary insulating means of this invention; and

Figure 4 is a developed view of the insulating means of Figure 3 before they are formed around the coil and the core.

Referring now to the figures of the drawing, there is shown a transformer indicated generally at 1 which may be of the high reactance type having autotransformer connections as shown. It will be understood that this type of transformer is used merely for illustrative purposes and is not a requisite part of the invention. Transformer 1 has a core 2 of any standard type, made up of relatively thin laminations 3 of magnetic material. The core shown is made up, for illustrative purposes, of U-shaped laminations or portions such as 4 which are combined with laminations of a type shown by 5 to make up a closed core. A group of laminations are combined into a shunt 6 which is located, as shown, centrally of the closed core. A pair of transformer coils 7 and 8 are placed over winding leg portion 9 of the transformer core.

It has previously been the practice to fold insulation around leg 9 to depend wholly thereon for insulation between the coils 7 and 8 and the core leg 9. This insulation is generally formed as shown at 10, having a somewhat trapezoidal shape when seen from the side. Insulation 10 fits entirely around core member 9 as shown, for example, at 11 and 12, and 13. It will be observed that the insulation 10, as shown at 12, extends sufficiently far along the core member 9 to prevent any danger of shorting between the coils and the core. However, that part of insulation 10 which covers the inner part of the core leg 9, as shown at 11, is limited in length by the space along the inner side of the core leg 9. It will thus be seen that insulation 10 will cease to afford protection at the location where the edge of the coils will be adjacent to the core. Any error or wear whatsoever will produce arcing between the inner edge of the coil and the core if no insulation other than 10 is provided along the inner surface of core leg 9. This has been discovered from experience since, previously, insulation such as 10 was the only kind provided and such arcing did frequently occur. To prevent such arcing where the edge

of a coil is in proximity with the end of an inner core leg, an improved unitary insulating member 14 has been provided.

Referring now particularly to Figures 3 and 4 of the drawing, it will be seen that insulating piece or member 14 is formed from a relatively long rectangular sheet or strip, thereby avoiding almost all waste. Starting at the left end, it will be seen that insulation piece 14 is folded at 15 and cut at 16 and 17 to provide three areas, a pair of flaps 18 and 20, and a tab 19. Another fold is provided at 21 to define an area 22. A fold 23 in turn defines an area 24 wherein three holes 25 and three holes 26 are provided, with each pair of holes 25 and 26 preferably in alignment with the others. A fold 27 defines yet another area 28, and fold 29 defines an area 30 in which an opening 31 has been cut. A pair of cuts 50 and 51 and a fold 52 define a tab area 53 formed at the right end of opening 31. Still moving to the right in Figure 4, folds 32, 33, 34, 35 and 36 define respectively areas 37, 38, 39, 40, and 41. An area 42 is formed between fold 36 and the end 43 of the sheet of insulation. A pair of cuts 44 and 45 are made into area 42 from end 43, and a fold 46 is provided so that a tab 47 is formed.

Referring now particularly to Figures 1, 2 and 3, the positioning of insulation member 14 with respect to core 2 and coils 7 and 8 will be shown. Starting at the right end of Figure 1, area 42 of the insulation extends upwardly between leg portion 48 of core 2 and the adjacent side of coil 8. Tab 47 is folded in between leg 9 of the core and the inner surface of coil 8. It will be seen that this structure completely isolates the coil 8 from the core at the precise spot where insulation 10 is the most likely to be ineffective. Area 41 of the insulation fits between the leg portion 49 of the core and the adjacent peripheral outer surface of coil 8. Area 40 provides insulation between the coil 8 and the shunt 6. Area 39 of the insulation comes between the end of shunt 6 and leg 9 of the core thereby determining exactly the minimum gap between the two. Area 38 of the insulation is folded down so as to insulate the adjacent side of coil 7 from the shunt 6 and area 37 insulates the adjacent outer surface of coil 7 from leg 49 of the core in the same manner as area 41 of the insulation for coil 8. Area 30 is positioned between the adjacent side of coil 7 and leg portion 54 of the core. Tab 53 is bent out of the plane of the rest of area 30 of insulation 14 so that it fits between the edge of the coil and the surface of the core in the same manner as tab 47. By means of this tab 53, the other spot which is vulnerable to arcing because of the shape of insulation 10 is completely protected. Area 30 continues up to the top of the core, opening 31 being provided to accommodate leg 9 of the core. Insulation piece 14 is then bent along line 27 so that area 28 rises away from both the core and the coil at an angle as shown. Area 24 then descends toward the core again, at an angle, and area 22 is bent back at 21 to lie flat upon the top of the core. Tab 19 may then be inserted through the top of opening 31 underneath the coil 7 and the insulation 10 to provide mechanical strength and anchoring means for the insulation piece 14. Flaps 18 and 20 are then bent down along the outside of area 30. It will, of course, be seen that if it is so desired, flaps 18 and 20 may be eliminated. However, for greater economy in production, it is deemed preferable to leave them as shown.

It will be observed that the folding of areas 24 and 28 will have left a space between them and area 22 which lies flat along the top of the core. It will further be observed that leads 55 and 56 extend from coil 8 and leads 57 and 58 extend from coil 7. In order to effect autotransformer connections, leads 56 and 58 are joined at 59. Leads 56 and 58 are joined, also at 59, to an external connection 60. Lead 55 is joined at 61 to an external connection 62 and lead 57 is joined at 63 to an external connection 64. It will be seen that each of the external conducting leads 60, 62 and 64 is passed consecutively through an outer opening 25 in area 24 and then bent back up through an opening 26 before it is connected to one of the coil leads. By this means, no external tension will be permitted to reach the coil leads since any such tension will act against the edges of the holes 25 and 26; it is very likely that the material of which insulation member 14 is made will shear before the external leads slip through the holes and tension on the coil leads occurs. The fact that tab 19 anchors this portion of insulating piece 14 also means that areas 24 and 22 of the insulating piece will not be pulled out because of tension on one or more of leads 60, 62 and 64.

It will now be seen that this invention provides a unitary piece of insulation which thoroughly insulates the coil from the core at the danger spot and in addition provides a tension relief for the coil leads.

It will be understood that connections other than for an autotransformer may be used and that the number of leads and the number of pairs of openings to relieve tensioning may be varied accordingly. In addition, the invention is applicable to any number of coils, and coils of different sizes may be used. While this invention has been explained by describing a particular embodiment thereof, it will be apparent that improvements and modifications may be made without departing from the scope of the invention as defined in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A transformer having a core with a winding leg and a plurality of coils mounted thereon, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member covering a portion of the peripheral surface of each of said coils and having areas folded over the sides thereof, the area of said member which is folded over that side of one of said coils which is removed from the remainder of said coils being slitted to define a tab portion, said tab being folded under said one coil between the same and said winding leg, the area of said member which is folded over that side of another of said coils which is removed from the remainder of said coils also being slitted to define a second tab portion, said second tab being folded under said other coil and said winding leg, and insulating means surrounding said winding leg whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core.

2. A transformer having a core with a winding leg portion and a plurality of coils mounted thereon, said core having another portion surrounding a part of each of said coils and forming a closed core with said winding leg portion, said coils each having a portion of their respective peripheral surfaces adjacent said other core portion, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member covering that portion of the peripheral surface of each of said coils which is adjacent said other core portion and having areas folded over the sides of said coils, the area folded over the side of one of said coils between the same and said other core portion being slitted to define a tab portion, said tab being folded under said one coil between the same and said winding leg portion, the area folded over the side of another of said coils between the same and said other core portion being slitted to define a second tab portion, said second tab being folded under said other coil and said winding leg portion, and insulating means surrounding said winding leg portion whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core.

3. A transformer having a core with a winding leg portion and a pair of coils mounted thereon, said core having another portion surrounding a part of each of said coils and forming a closed core with said winding leg

portion, said coils each having a portion of their respective peripheral surfaces adjacent said other core portion, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member covering that portion of the peripheral surface of each of said coils which is adjacent said other core portion and having areas folded over the sides of said coils, the area folded over the side of one of said coils between the same and said other core portion being slitted to define a tab portion, said tab being folded under said one coil between the same and said winding leg portion, the area folded over the side of the other of said coils between the same and said other core portion being slitted to define a second tab portion, said second tab being folded under said other coil and said winding leg portion, and insulating means surrounding said winding leg portion whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core, said member being extended beyond said second tab portion around said winding leg portion, said member further comprising a portion spaced from said other coil and from said core, said spaced portion having a pair of openings relatively close together and adapted to have a conductor threaded therethrough whereby tension exerted on an end of the conductor will be transmitted to said member instead of to the other end of the conductor because of the relative closeness of said openings.

4. A transformer having a core with a winding leg portion and a pair of coils mounted thereon, said core having another portion surrounding a part of each of said coils and forming a closed core with said winding leg portion, said coils each having a portion of their respective peripheral surfaces adjacent said other core portion, leads extending from each of said coils, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member covering that portion of the peripheral surface of each of said coils which is adjacent said other core portion and having areas folded over the sides of said coils, the area folded over the side of one of said coils between the same and said other core portion being slitted to define a tab portion, said tab being folded under said one coil between the same and said winding leg portion, the area folded over the side of the other of said coils between the same and said other core portion being slitted to define a second tab portion, said second tab being folded under said other coil and said winding leg portion, and insulating means surrounding said winding leg whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core, said member being extended beyond said second tab portion around said winding leg portion, said member further comprising two adjacent areas, the first of said two areas being folded away from said core, the second of said two areas being folded at an angle to the first of said two areas and toward said core, said second area having a pair of openings in a line substantially parallel to the sides thereof, said openings being formed relatively close together and being adapted to have a conductor threaded therethrough and secured to one of said coil leads whereby tension exerted on an end of the conductor will be transmitted to said member instead of to said one coil lead because of the relative closeness of said openings.

5. A transformer having a core with a winding leg portion and a pair of coils mounted thereon, said core having another portion surrounding a part of each of said coils and forming a closed core with said winding leg portion, said coils each having a portion of their respective peripheral surfaces adjacent said other core portion, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member covering that portion of the peripheral surface of each of said coils which is adjacent said other core portion and having areas folded over the sides of said coils, the area folded over the side of one of said

coils between the same and said other core portion being slitted to define a tab portion, said tab being folded under said one coil between the same and said winding leg portion, the area folded over the side of the other of said coils between the same and said core being slitted to define a second tab portion, said second tab being folded under said other coil and said winding leg portion, and insulating means surrounding said winding leg whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core, said member being extended beyond said second tab portion around said winding leg portion, said member further comprising three additional areas, the first of said three areas being folded away from said core, the second of said three areas being folded at an angle to the first of said areas and toward said core, the third of said three areas being folded back along said core and being anchored thereto, said second area having a pair of openings in a line substantially parallel to the sides thereof, said openings being formed relatively close together and being adapted to have a conductor threaded therethrough whereby tension exerted on an end of the conductor will be transmitted to said member instead of to the other end of the conductor because of the relative closeness of said openings.

6. A transformer having a core with a winding leg portion and a pair of coils mounted thereon, said core having another portion surrounding a part of each of said coils and forming a closed core with said winding leg portion, said coils each having a portion of their respective peripheral surfaces adjacent said other core portion, leads extending from each of said coils, means for insulating said core from said coils comprising a unitary member formed of pliable sheet insulating material, said member having a pair of areas covering respectively those parts of the peripheral surfaces of said coils which are adjacent said core, said member further having a pair of areas folded over the sides of said coils which face each other and having an area joining said folded pair of areas, said member further having an end area folded over the side of one of said coils between said one coil and said other core portion, said end area being slitted to define a tab portion, said tab being folded in between said one coil and said winding leg portion, said member having another area folded over the side of the other of said coils between the same and said other core portion, said last mentioned area being separated from said end area by said two pairs of areas and by said joining area, said last-mentioned area extending beyond the outer side of said winding leg and having an opening provided to accommodate said winding leg portion, said lastmentioned area further being slitted at an edge of said opening to define a second tab portion, said second tab being folded in between said other coil and said winding leg portion, insulating means surrounding said winding leg whereby said two means cooperate to insulate completely said coils from all adjacent parts of said core; and three additional areas extending beyond said lastmentioned area, the first of said additional areas being folded away at an angle from said core and said coils, the second of said additional areas being folded at an angle away from said coils and toward said core, and the third of said additional areas being folded back along said core toward said other coil, said third additional area terminating in a tab member, said tab member extending through said opening and being anchored between said other coil and said winding leg portion, said second additional area having a plurality of pairs of openings formed therein, each of said pairs of openings being formed relatively close together and on a line substantially parallel with the sides of said second additional area, each of said pairs of openings being adapted to have a conductor threaded therethrough and secured to one of said coil leads whereby tension exerted on an end of the conductor will be transmitted to said member intsead of to said one coil lead because of the relative closeness of said openings.

7. A unitary strip insulating member for a plurality of coils having electrically conductive leads comprising an end area cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define a tab portion, a plurality of areas located in consecutive order from said end area, each of said areas being defined by folds and an area joining the last of said plurality of areas on the side thereof remote from said end area, said lastmentioned area being cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define an opening and a second tab portion, and an additional area joined to said lastmentioned area on the side thereof remote from said plurality of areas and having a pair of openings relatively close together therein for consecutively receiving one of said conductive leads.

8. A unitary strip insulating member for a pair of coils having electrically conductive leads comprising an end area cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define a tab portion, a plurality of areas located in consecutive order from said end area, said areas being defined by folds, an area joining the last of said plurality of areas on the side thereof remote from said end area, said lastmentioned area being cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define an opening and a second tab portion, and an additional area joining said lastmentioned area on the side thereof remote from said plurality of areas and having a pair of openings relatively close together therein for consecutively receiving one of said conductive leads, said openings forming a line substantially parallel to the sides of said additional area.

9. A unitary strip insulating member for a pair of coils having electrically conductive leads arranged about a core leg comprising an end area cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define a tab portion, a plurality of areas located in consecutive order from said end area, said areas being defined by folds, an area joining the last of said plurality of areas on the side thereof remote from said end area, said lastmentioned area being cut along a portion of the length thereof and folded across at least a portion of the width thereof thereby to define an opening and a second tab portion, and three areas located in consecutive order from said lastmentioned area on the side thereof remote from said plurality of areas, the center one of said three areas having a pair of openings relatively close together for consecutively receiving one of said conductive leads.

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