C. H. THORDARSON.

TRANSFORMER.

APPLICATION FILED DEC. 8, 1913.

1,338,884. **Patented May 4, 1920.**

Fig. 1

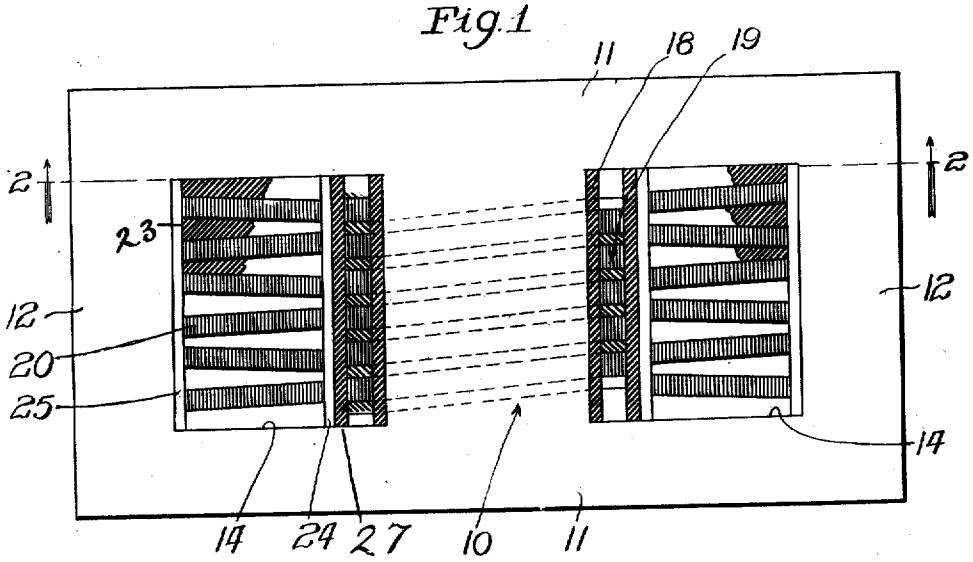


Fig. 2.

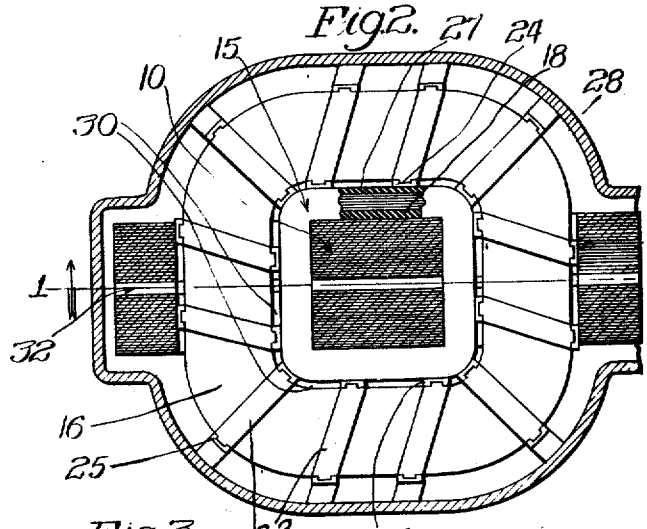


Fig. 4

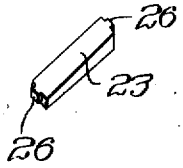


Fig. 5.

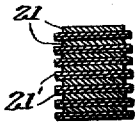
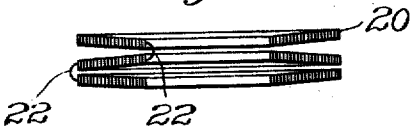


Fig. 3.



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UNITED STATES PATENT OFFICE.

CHESTER H. THORDARSON, OF CHICAGO, ILLINOIS.

TRANSFORMER.

1,338,884. Specification of Letters Patent. Patented May 4, 1920.

Application filed December 8, 1913. Serial No. 805,253.

To all whom it may concern:

Be it known that I, CHESTER H. THORDARSON, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Transformers; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in electrical transformers and relates more specifically to the windings or coil structures of the transformers.

Among the objects of the invention is to provide an improved arrangement of the coil structure for transformers and like devices wherein the winding is composed of a plurality of separately wound winding sections or units suitably connected and spaced in such a way as to suitably insulate the winding sections one from the other, and to also provide between the winding sections ventilating passages for the flow of a cooling medium, so arranged that all the turns of each section are exposed on opposite sides of the section to the action of the cooling medium.

Other objects of the invention are to improve and simplify coil structures of this general character, and the invention consists in the matters hereinafter set forth and more particularly pointed out in the appended claims.

In the drawings:—

Figure 1 is a sectional view of a shell type transformer, to which my invention may be applied, taken on the line 1—1 of Fig. 2.

Fig. 2 is a sectional view of the coil and magnetic circuit, taken on the line 2—2 of Fig. 1, and showing also a portion of the inclosing casing in section.

Fig. 3 is a detail sectional view of a group of coil sections.

Fig. 4 is a perspective view of one of the spacing strips for spacing the coil sections.

Fig. 5 is an enlarged sectional detail of the high tension or sectional winding.

As shown in the drawings, 10 designates the core member 11, 11 the side pieces and 12, 12 the end pieces of the magnetic circuit of a shell type transformer. The circuit structure is composed of thin laminæ clamped together in any suitable manner, and the circuit is provided with the usual windows 14 through which the sides or legs of the primary and secondary windings, designated as a whole by 15 and 16, respectively, and wound upon the core member 10, extend. The said primary winding may be of any suitable type, and is insulated from the core member by the insulating sleeve 18, and the several turns of the said winding are insulated from each other by the insulating members 19.

The secondary winding is herein shown as composed of a plurality of substantially flat winding sections 20, each made up of a continuous flat copper strip or wire wound spirally to produce a generally rectangular open ring, such, for instance, as is shown in my co-pending application for U. S. Letters Patent, Serial No. 776,521, filed on the 30th day of June, 1913, Patent 1,215,429, of date Feb. 13, 1917. The present invention is particularly applicable to this type of coil winding but is not necessarily in all its aspects limited thereto. The turns 21 of said windings are bare and are shown as insulated from each other by insulating strips 21', two strips being shown as employed between adjacent turns, and arranged in such manner that the bare edges of the turns are exposed at the sides of the coil to the direct influence of a cooling medium flowing past the same; said bare edges being insulated from each other by the overhanging edges of the insulating strips.

The said sections are herein shown as connected in series. They are of general dish shape, being depressed from their outer to their inner edges, as most clearly shown in Figs. 1 and 3. This arrangement, in a group of coil winding sections disposes the relatively flat members or legs of the winding sections in transverse oblique relation to each other, and the arrangement is such that at both the inner and the outer edges of the winding the winding sections are arranged alternately close together and wider apart so as to thereby provide between said winding sections spaces of tapered cross section, with the wider ends of the tapered spaces disposed alternately inwardly and outwardly.

Said winding sections thus arranged are electrically connected at the edges thereof which most closely approach each other, as by the conductors 22, 22 of any preferred form. This arrangement is advantageous

for the reason that the potential difference between the edges of the winding sections which are connected is so small as to permit said edges to be placed close together, whereas the potential difference between the unconnected edges is greater and requires a wider insulating space. By this arrangement a given set of winding units or sections may be disposed in a more compact space than if the sections were arranged in parallel planes.

The said sections are spaced from each other by tapered, relatively narrow spacing and insulating strips 23, which extend through the interspaces of the secondary winding and from the inner to the outer edges of the coil sections. These strips are made of wood or other suitable insulating material. They are held in their relative fixed positions by means of strips 24, 25 arranged across the inner and outer edges, respectively, of the winding sections, and are interlocked or otherwise suitably engaged with the ends of the spacing strips. As herein shown, the interlocking connection is a tongue and groove connection, the strips being provided with tongues 26 which engage grooves in the strips 24 and 25. The inner strips 24 or those arranged across the inner edges of the winding sections bear against the insulation 27 between the primary and secondary windings and are thus held fixedly in place. Certain of the outer strips 25 bear against the outer edges of the windows 14 of the magnetic circuit, while others of the strips 25 may be braced in any suitable manner against the casing 28 in which the transformer elements are contained.

The said strips 23, 24 and 25 arranged as shown provide definite passages for directing the flow of a cooling medium around and between the units or sections of the coil. The presence of the strip 24 between the inner edges of the winding sections and the insulation 27 provides between the said insulation and the winding sections spaces or passages 30 for the flow of a cooling medium and these centrally arranged spaces communicate with all of the lateral or radial spaces or passages between the coil sections and defined by the strips 23. It will thus be seen that the cooling medium is brought into contact with each edge of each turn of the winding sections or units so that a uniform and efficient cooling of the coil is effected and maintained.

The flow of the cooling medium will be upward around the core member 10 and laterally outwardly through the passages between the coil sections and defined by the strips 23 and downwardly against the relatively cool walls of the casing 28. The said strips 23 also serve to brace the coil sections, across which they extend. The core may also be provided with one or more ventilating spaces 32.

The terminals of the transformer herein shown have not been illustrated, inasmuch as the arrangement of said terminals will be varied to conform to transformers of different types.

It will be understood that the invention is not limited to the structural details herein shown, but that it is the intent to claim all of invention that is inherent in the structure shown and described and which is novel in view of the prior art.

I claim as my invention:—

1. A transformer comprising a magnetic circuit, winding elements surrounding same comprising bare conductors, with insulation between the turns thereof and arranged to provide means for avoiding short circuiting of adjacent turns upon each other and to maintain the bare turns exposed to free access to a cooling medium, and means for spacing the winding elements, permitting a cooling medium to be directed past all the bare turns to bring it uniformly to sources of heat set up in the winding elements under electrical stress.

2. A transformer comprising a magnetic circuit, winding elements surrounding the same comprising a flat bare wire, with an insulating medium separating the turns of the wire and extending at the edge thereof laterally beyond the line of contact of the medium with the wire to provide means for avoiding short circuiting of adjacent turns upon each other and arranged to maintain the edges of the turns exposed to free access of a cooling medium, and means for spacing the winding elements, permitting a cooling medium to be directed past the bare edges of all of said turns to bring it uniformly to sources of heat set up in the winding elements.

3. A transformer comprising a magnetic circuit, a winding surrounding the same composed of slab-like units, each consisting of spirally wound flat, bare wire, with the turns of each unit insulated from each other against current leakage between their edges, the bare edges of all of the turns of each unit being exposed at the side of the unit, and means for spacing the units, permitting a cooling medium to be directed uniformly to the bare edges of all of the turns of the winding.

4. A transformer comprising a magnetic circuit, a winding surrounding the same composed of slab-like units, each consisting of a spirally wound flat, bare wire, with the turns of each unit insulated from each other against current leakage between their edges, the bare edges of all of the turns of each unit being exposed at the side of the unit, and insulating spacers between the units to brace the winding structure and to provide

passages to permit a cooling medium to be directed to the bare edges of all of the turns of the winding.

5. A transformer comprising a magnetic circuit, a winding thereon composed of slab-like units, each composed of a plurality of turns of narrow, thin flat wire, with two or more insulating strips between each turn, each strip being so thin as not to afford in itself a reliable insulation between the turns and each turn of each coil having a naked edge exposed at the side of the coil for direct contact with a cooling medium, and insulating spacers between said units to brace said windings and to permit a cooling medium to be directed to the bare edges of all the turns of the winding.

6. A transformer comprising a magnetic circuit, a plurality of spaced disk-like windings surrounding the same, each composed of a spirally wound flat bare wire, with the turns thereof insulated from each other, the bare edges of all the turns of each wire being exposed at each side of each winding, and spacing means between the windings permitting a cooling medium to be directed to the bare edges of all the turns of the windings.

7. A transformer comprising a magnetic circuit, a plurality of spaced disk-like windings surrounding the same, each composed of a spirally wound flat bare wire, with the turns thereof insulated from each other, the bare edges of all the turns of each wire being exposed at each side of each winding, and narrow insulating spacers between the windings adapted to brace the winding structure and to afford conduits to direct a cooling medium to the bare edges of all of the turns of the windings.

8. A coil structure for transformers and like uses composed of a plurality of spaced disk-like winding units composed of flat bare wires in which the bare edges of each turn are exposed at the sides of the units and spacing, reinforcing and insulating means between them to provide between the units passages which extend from the inner to the outer sides of the units, whereby the bare edge of each turn of each winding unit is directly exposed to the action of a cooling medium circulated through said passages.

9. A coil structure for transformers and the like uses comprising a plurality of winding units, each composed of a spirally wound flat bare wire and an insulating medium between the turns thereof, whereby the bare edges of each turn are exposed at the opposite sides of the unit, and insulating and spacing means between said units arranged to provide a plurality of passages which extend from the inner to the outer edges of the units, whereby each edge of each turn of the unit is exposed to the direct cooling effect of a cooling medium circulated through said passages.

10. A transformer comprising a core, a low tension winding surrounding and insulated from said core, a plurality of disk-like high tension winding units surrounding the low tension winding, narrow insulating spacers between the inner edges of the high tension windings and the low tension winding adapted to provide oil passages between the high and low tension windings, and narrow insulating spacers between the high tension winding units to provide between said units oil passages which communicate with the first mentioned oil passages.

11. A transformer comprising a core, a low tension winding surrounding and insulated from said core, a plurality of disk-like high tension winding units surrounding the low tension winding, narrow insulating spacers between the inner edges of the high tension winding units and low tension winding adapted to provide oil passages between the high and low tension windings, and narrow insulating spacers between the high tension winding units to provide between said units oil passages which communicate with the first mentioned oil passages, said high tension winding units each comprising a spirally wound flat bare wire, the turns of which are insulated from each other and with the edges of the turns bare and exposed to the oil passages between said units.

12. In a transformer, a core, a primary winding thereon, a secondary winding in inductive relation to the primary winding and said core, said secondary winding being composed of a plurality of separately wound coil sections having substantially flat faces, and each made of a spirally wound flat bare conducting strip with the edges of its turns exposed at the flat sides of the coil section, said coil sections being spaced from each other by means providing transverse passages through the winding which communicate with cooling medium circulating passages at the inner and outer edges of the coil sections, whereby each turn of each coil section is subject to the direct action of the cooling medium, and means for electrically connecting said coil sections.

In testimony that I claim the foregoing as my invention I affix my signature, in the presence of two witnesses, this 3rd day of December, A. D. 1913.

CHESTER H. THORDARSON.

Witnesses:
W. L. HALL,
G. E. DOWLE.