No. 850,863. PATENTED APR. 16, 1907.

W. J. WOOLDRIDGE.

TRANSFORMER.

APPLICATION FILED JUNE 8, 1906.

Fig. 1.

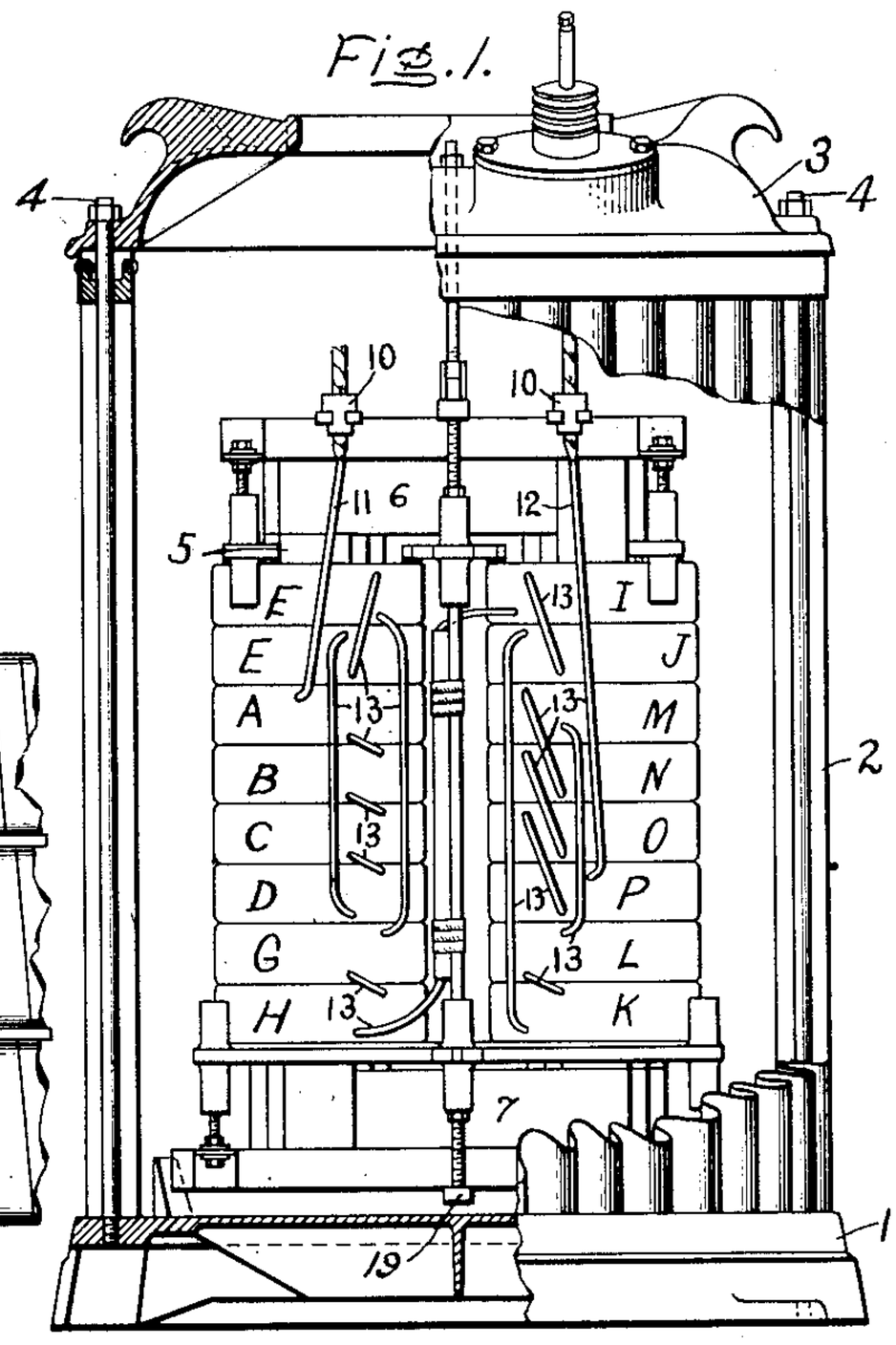


Fig. 2.

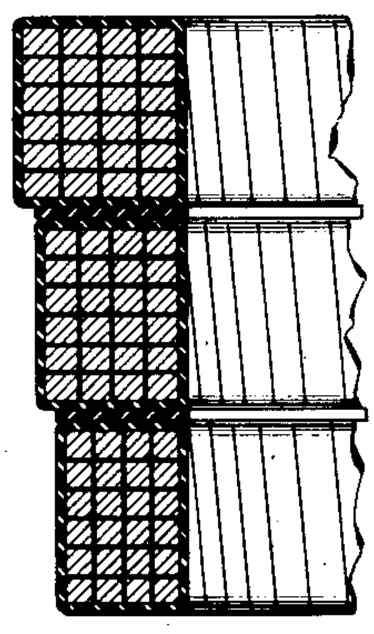


Fig. 3.

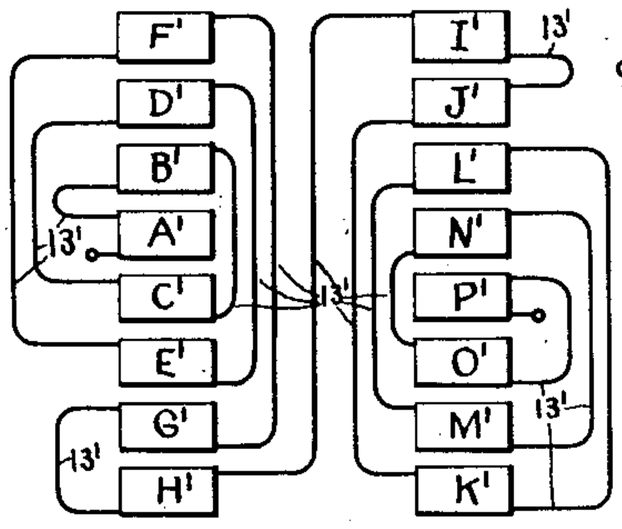


Fig. 4.

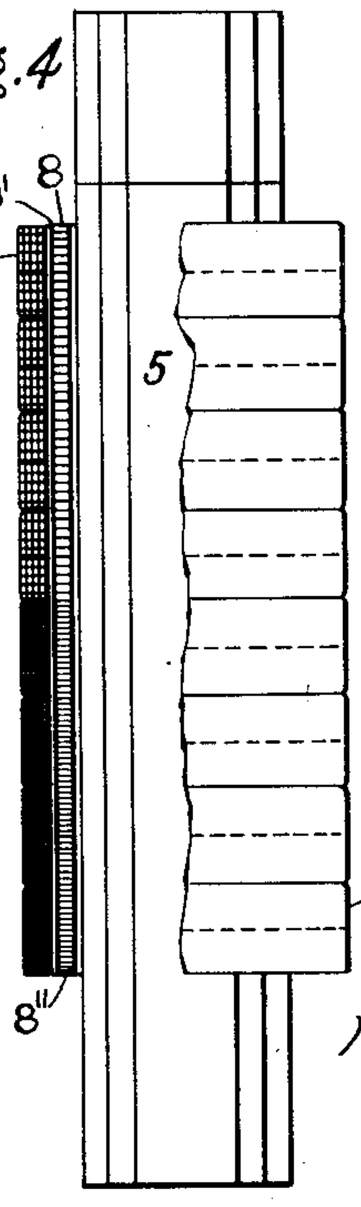
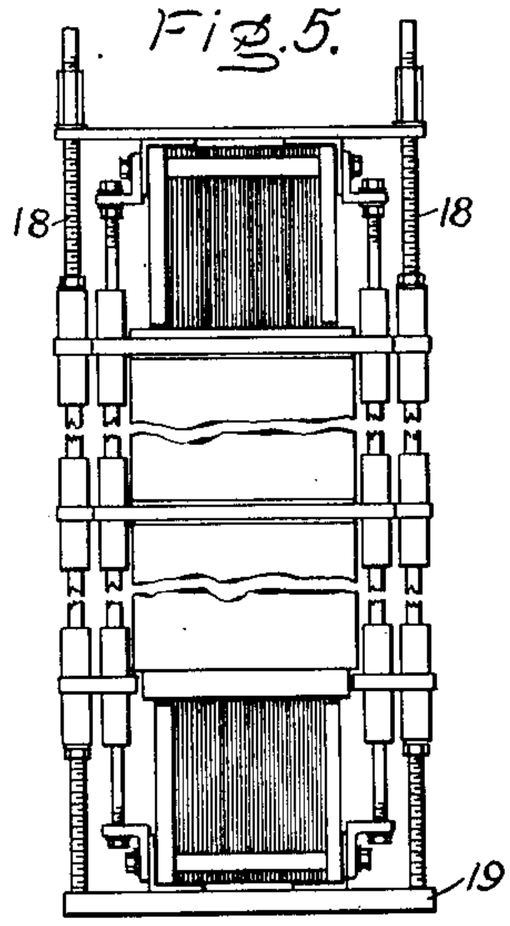


Fig. 5.



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UNITED STATES PATENT OFFICE.

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TRANSFORMER.

No. 850,863. Specification of Letters Patent. Patented April 16, 1907.

Application filed June 8, 1906. Serial No. 320,751.

To all whom it may concern:

Be it known that I, WILLIAM J. WOOLDRIDGE, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

My present invention relates to inductive apparatus, and more particularly to that class of apparatus known as "stationary" transformers.

One of the objects of my present invention is to obtain a more effective use of the conductive material of transformers by so arranging it that portions from which the heat is more readily dissipated carry more current per unit of cross-sectional area than do the portions from which the heat is less readily dissipated. In carrying out this feature of my invention in connection with an ordinary transformer of the core type, in which parallel vertical legs of magnetic material are surrounded by windings and the whole immersed in a receptacle containing a cooling fluid, such as oil, I arrange the windings so that the portions of the windings at the lower ends of the core carry more current per unit of cross-sectional area than do the upper portions.

A second object of my invention is the arrangement of the winding of a transformer so that the liability of breaking down the insulation of the transformer is diminished. In carrying out this feature of my invention in connection with a core-type transformer of the character described in the preceding paragraphs I arrange so that the portions of the winding of the transformer adjacent the yokes or horizontal portions of the core are electrically separated from the transformer-terminals by other portions of the winding. As a result the difference in potential between the yoke portions of the core and the adjacent winding portion is less than the terminal voltage of the winding, a feature of importance in case one terminal of the winding and the core become electrically connected together, accidentally or otherwise. In carrying out this feature of my invention I also prefer to arrange the windings so that the coils connected to the different terminals of the transformer are not in close proximity to each other.

The various features of novelty which characterize my invention are set forth in the claims annexed to and forming a part of this specification.

For a better understanding of my invention and the manner in which it may be carried out and the advantages possessed by it reference may be had to the accompanying drawings and descriptive matter, in which I have illustrated and described forms in which my invention may be embodied.

Of the drawings, Figure 1 is an elevation of a core-type oil-cooled transformer with parts broken away and in section. Fig. 2 is an elevation, partly broken away and in section, on a large scale, showing one arrangement of windings which may be employed. Fig. 3 is a diagrammatic representation of connections differing from those shown in Fig. 1. Fig. 4 is an elevation at right angles to Fig. 1 on a slightly-larger scale, parts of the winding being shown broken away and in section; and Fig. 5 is also an elevation at right angles to Fig. 1, showing the means employed for supporting the core and the winding.

Referring to the drawings, 1 represents the base of the tank or receptacle containing a bath of oil, in which the transformer is immersed. The base 1 supports the tank member 2, which may be formed of corrugated sheet metal. The top member 3 is secured in place at the upper end of the body member 2 by means of bolts 4. In the form of my invention disclosed the laminated transformer-core, which comprises two parallel vertical legs 5 and horizontal top and bottom members 6 and 7, respectively, is supported from the top member 3 by a cradle or frame comprising bolts 18 and frame member 19.

On each leg 5 of the core are placed windings which in the form shown comprises an inner low-potential coil 8, shown as consisting of a single layer of series-connected turns of strip material bent edgewise to form helices. The winding 8 in the form shown in Figs. 1 and 4 comprises an upper portion 8′ and a lower portion 8″. The portions 8′ and 8″ are in series; but the strip forming the portion 8″ at the bottom of the core-leg is smaller in cross-section than the strip forming the portion 8′, which surrounds the upper half of the core-leg. Surrounding the

primary winding 8 and insulated therefrom in a suitable manner is the high-potential winding of the transformer, which comprises a plurality of relatively short coils 9. The coils 9, which are in this form of my invention intended to be connected in series with each other, may be formed of conductors of any suitable shape. The coils 9 surrounding the portion 8″ of the low-potential winding are formed of conductors of less cross-section than that of the conductors forming the coils 9 surrounding the portion 8′ of the low-potential winding. The transformer-terminals 10 are connected to the coils 9 marked A and P, respectively, by conductors 11 and 12. The coils A and P thus form the terminals of the high-potential winding, and the remaining coils B, C, D, E, F, G, H, I, J, K, L, M, N, and O are connected in series in the order named between the coils A and P by suitable conductors 13, as shown. With this arrangement the terminal coils A and P are not directly opposed to each other, as has heretofore been usually the case where the upper coils of the two legs were the terminal coils.

In operation the coils at the ends of each leg differ considerably in potential from the terminal conductors. This is an important feature of my invention, since it is somewhat more difficult to effectively insulate the end coils from the core than it is to insulate any other portion of the winding from the core. This is partly due to the proximity of the end coils to the yoke or end connections of the core and partly to the fact that the core-yokes ordinarily are engaged by the winding-supporting means, as in the construction shown or in some similar manner. With my arrangement should either terminal lead or the line to which it is connected become electrically connected to the core, either directly or by reason of the fact that it becomes grounded while the core is also grounded, none of the coils at the ends of the core-leg has the full-line potential between it and the core.

In the arrangement diagrammatically shown in Fig. 3 the coils A′ to P′, inclusive, are connected by suitable conductors 13′ to obtain the advantages possessed by the arrangement shown in Fig. 1, while at the same time the maximum difference in potential between adjacent coils on the same core-leg is less than with the arrangement shown in Fig. 1.

Instead of forming all corresponding coils of the same external dimensions, as shown in Figs. 1 and 4, where the lower coils each actually contain more turns than the corresponding upper coils, I may make each coil consist of an equal number of turns and of the same axial length, but with the conductors in successive coils from bottom to top of increased radial width, and thereby of greater cross-section. This arrangement is shown in Fig. 2. In either case the use of this feature of my invention permits the capacity of a transformer to be increased without a corresponding increase of material employed.

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

1. In an oil-cooled transformer, a vertical core portion, a winding surrounding said core portion comprising turns of conducting material connected in series, the cross-sectional area of the conducting material forming the turns at the lower end of the core being less than the cross-sectional area of the conducting material forming the turns at the upper end of the core portion.

2. In a core-type transformer, a core comprising wound portions, and unwound portions connecting the wound portions, and a winding on each wound portion comprising turns of conducting material connected in series, the turns adjacent the unwound portions of the core being connected in series with and between other turns more remote from said unwound portion.

3. In a core-type transformer, a core-leg, a plurality of series-connected coils surrounding said core-leg, the coils adjacent the ends of the core-leg being connected in series with and between others of said coils.

4. In a core-type transformer,.a core-leg, a transverse core portion engaging the ends of said leg, a winding surrounding said core-leg comprising a plurality of conductor turns connected in series the terminal turns of said winding being more remote from the ends of said core-leg than other turns of said winding.

5. In an oil-cooled transformer, a winding comprising turns in series, the cross-sectional area of each of the turns in contact with the hottest oil being greater than that of other turns in contact with cooler oil.

6. In an electrical device, a winding comprising parts through which current passes in series, the parts of said winding from which heat is more readily dissipated having a cross-sectional area less than parts from which heat is less readily dissipated.

In witness whereof I have hereunto set my hand this 7th day of June, 1906.

WILLIAM J. WOOLDRIDGE.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.