BEST AVAILABLE COPY

Apr. 17, 1923.

S. HORELICK

1,452,158

TRANSFORMER

Filed July 21, 1921

2 Sheets-Sheet 1

Fig:1.

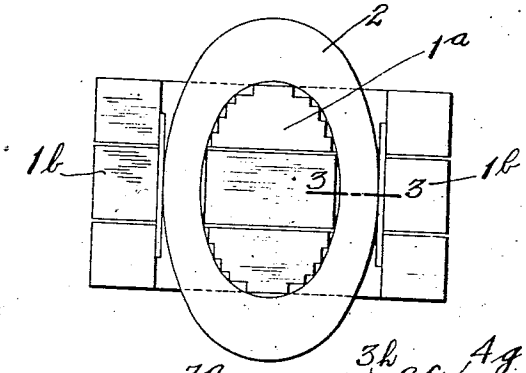


Fig:2.

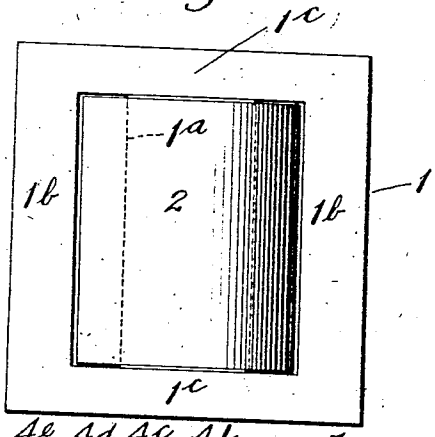


Fig:3.

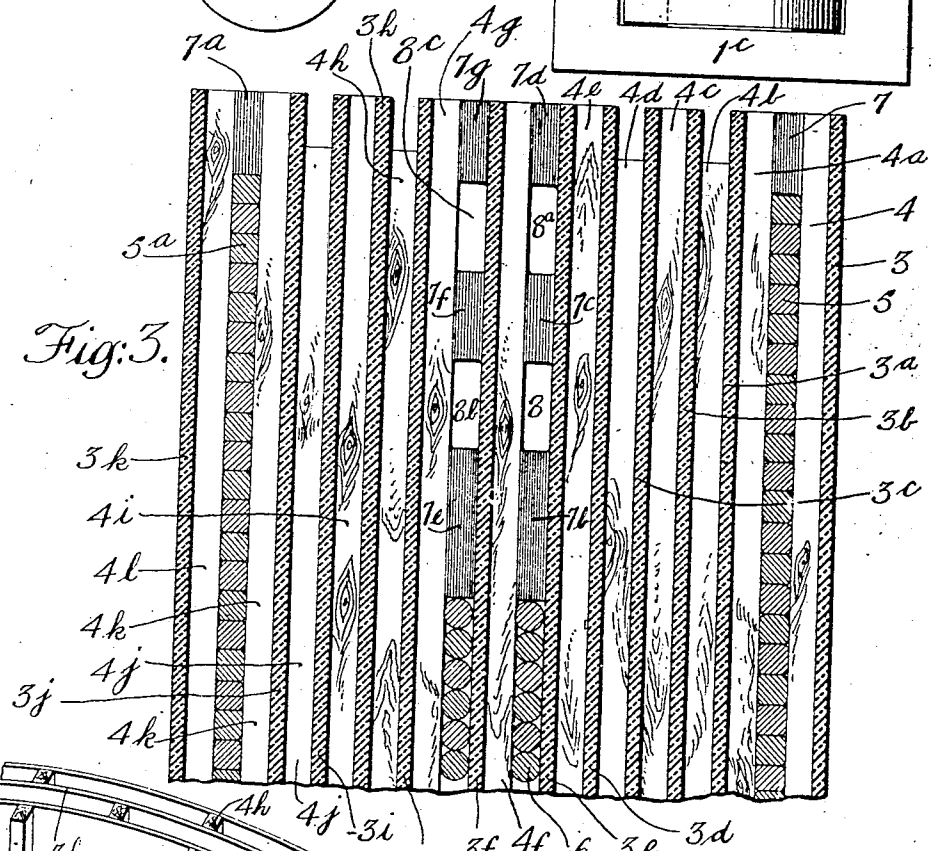
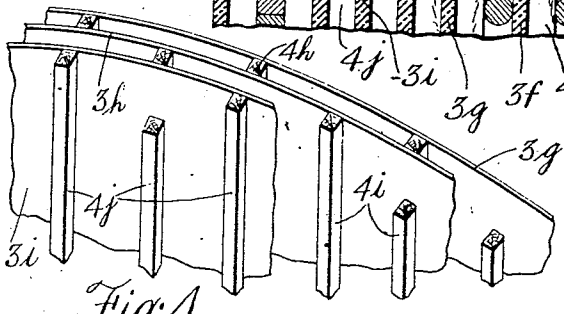


Fig:4.



Inventor
Samuel Horelick
Attorneys
Edwards, Sager & Bowen

BEST AVAILABLE COPY

Apr. 17, 1923.

1,452,158

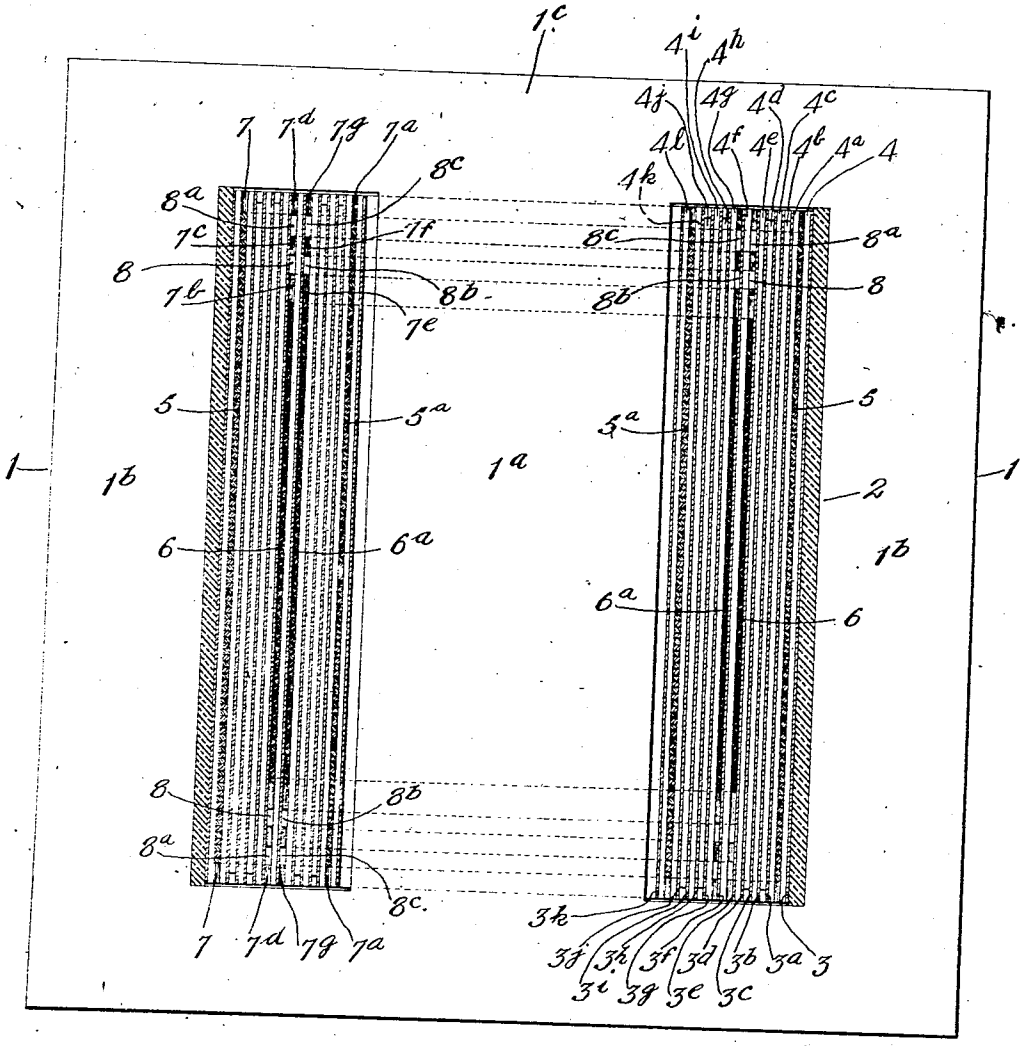
S. HORELICK

TRANSFORMER

Filed July 21, 1921

2 Sheets-Sheet 2

Fig. 5.



Samuel Horelick
Inventor

Edwards, Sager & Bower
his Attorneys.

BEST AVAILABLE COPY

Patented Apr. 17, 1923. 1,452,158

UNITED STATES PATENT OFFICE.

SAMUEL HORELICK, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO PITTSBURGH TRANSFORMER COMPANY, A CORPORATION OF PENNSYLVANIA.

TRANSFORMER.

Application filed July 21, 1921. Serial No. 486,636.

To all whom it may concern:

Be it known that I, SAMUEL HORELICK, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

This invention relates to electric transformers and particularly to the construction of the coils and their relation to the core.

In general, the object of my invention is to provide an improved construction of transformer which will be adapted to withstand high voltages without breakdown or loss in insulating properties with continued use, reduce leakage of current or flashing over between primary and secondary windings, or to the core, to a minimum, and be well ventilated and cooled with continuous operation at full capacity.

My invention will be understood from the following description and accompanying drawings, in which Fig. 1 is a horizontal section of a core and coils of a transformer embodying my invention, Fig. 2 is a front view of the same, Fig. 3 is an enlarged vertical section on the line 3—3 of Fig. 1, with the lower part of the coils broken away, Fig. 4 is an enlarged perspective view of a top portion of the insulating and ventilating means between the windings; and Fig. 5 is an enlarged central vertical cross section through the core and coils in a plane parallel with the laminæ.

Referring to Figs. 1 and 2, the laminated core 1 has a vertical central leg 1^a and outside legs 1^b and upper and lower connecting portions 1^c, forming a core of the double magnetic circuit type. The coil is elliptically shaped and surrounds the middle leg 1^a, the latter preferably being so shaped as to conform in general outline to the interior surface of the coil 2, as shown in Fig. 1. The transformer is of the type adapted to be immersed in oil in a tank, and the coil is provided with vertical passages between its parts so as to facilitate cooling of the coils and core by continuous circulation of the oil upwardly through the passages and downwardly at the outside of the transformer and adjacent to the interior walls of the enclosing tank.

Referring to Fig. 3, and beginning at the left-hand portion of the figure, there is shown a protective and insulating sheet of insulating material 3^k, such as insulating fiber board or press board, extending around the central leg of the core and forming an elliptical inner cylinder. Adjacent thereto is a series of insulating strips 4^l extending vertically the height of the coil and spaced from each other so as to provide a series of spaces for the upward passage of the circulating and cooling medium. Around these spaced strips is a winding 5^a forming a portion of the low tension winding. The conductors of this winding are preferably of square or rectangular cross section and each turn is suitably insulated from the adjacent turn by an insulating coating or by being wound by a cord of rope so that a large portion of the conductor is directly exposed to the cooling medium. Each turn may be made of a single conductor or several bound and wound together. Outside the winding 5^a is another series of vertical insulating strips 4^k spaced from each other, similar to the strips 4^l. Outside these strips is another enveloping elliptical shaped cylinder 3^l, similar to the sheet 3^k and this is followed in turn by a series of spaced insulating strips 4^l, 4^i, 4^h and 4^g, having interposed between them the insulating sheets 3^i, 3^h, and 3^g.

Around the strips 4^g is wound a section 6^a of the high tension winding of the coil, the turns of which are of course insulated from each other and may be formed of a single conductor or grouped conductors to suit the particular requirements. Outside this section of the high tension winding is another enveloping sheet 3^f, then another series of insulating strips 4^f, and then another section 6 of the high tension winding. Outside this section is an enveloping sheet 3^e and then a series of spaced strips 4^e, 4^d, 4^c, 4^b and 4^a with intervening sheets 3^d, 3^c, 3^b and 3^a. Around the strips 4^a is another section 5 of the low tension winding, outside of which are spaced insulating strips 4 and an enveloping sheet 3.

At the upper ends of the sections of the low tension windings, and between the upper ends of the insulating strips 4 and 4^a and between strips 4^k and 4^l, are located solid insulating packing strips, or strips of insulating press-board 7, 7^a. These strips extend continuously around at the upper end of the coil and protect and insulate the upper ends of the low tension windings. The upper ends of the high tension sections of the

BEST AVAILABLE COPY

windings are located a much greater distance inwardly from the ends of the coil structure, and the insulating packing strips 7^b, 7^c, 7^d, 7^e, 7^f and 7^g are located beyond the end of the high tension windings and extend circumferentially around and are held in place and located between the vertical insulating spacing strips and the insulating sheets already described. As shown in Fig. 3, the strips 7^b, 7^c and 7^d are spaced axially from each other, leaving circumferentially extending passages 8, 8^a, and likewise between the strips 7^e, 7^f and 7^g are similar passages 8^b and 8^c.

As regards the vertically extending spacing strips 4 to 4^l, it will be seen that the series of these strips between the high tension windings and the low tension windings do not all extend to the end of the coil structure, and leave a space beyond their ends, so as to form a long creepage or discharge path between the ends of the high tension windings and the low tension windings. But instead of all of the vertical strips between two insulating sheets being all shortened at one end, or extending completely to the end of the coil structure, they are alternately arranged short and long. This will be better understood from Fig. 4, which shows the upper end portions of the sheets 3^g, 3^h, and 3^i having the intervening strips 4^h, 4^i and 4^j. It will be seen that every other strip 4^j for example, extends to the top of the coil structure and the ends of the intervening strips are considerably below the top of the coil structure. Similarly the other strips are thus arranged so that the leakage path in any direction between the high tension and low tension windings is greatly increased over what it would be if all of the vertical insulating strips extended to the end of the coil structure. Moreover the alternate arrangement of any one set of strips, being arranged so that they oppose the reversely arranged strips in the next group, result in the insulating sheets being held firmly in position and prevent their curling or bending over in the continued use of the transformer and thus the cooling and ventilating passages are maintained open and clear at all times, while at the same time obtaining a much greater protection from leakage or discharge between the ends of the high tension and low tension windings.

It will be understood of course that the lower end of the coil structure is similarly constructed. The vertical insulating strips may be all made of the same length if desired, and displaced as above described, so that a strip which extends the full distance to the top of the coil structure will be inwardly displaced at the lower end and vice versa. The core structure is built up by first placing the sheet 3^k on a mandril and then successively applying the strips, windings, insulating sheets and packing strips until the whole structure is finally built up as above described.

The complete coil is then heated and may be placed in a vacuum thoroughly drying the unit throughout all its parts and is then treated with liquid varnish or other suitable material while still subjected to the vacuum and the structure thus becomes thoroughly impregnated with the insulating liquid, pressure being added to increase the penetration. The coil structure is then drained and heated in the presence of air and thoroughly dried until the liquid insulating material is hardened, giving a final structure which is thoroughly bound together, strong and durable and highly insulated throughout all its parts. Moreover, all the surfaces are coated with the hardened insulating liquid giving very smooth surfaces and forming fillets in all the corners. This results not only in giving smooth surfaces for the easy and free passage of the oil through all the ventilating surfaces and permanence of structure, but also greatly decreases the leakage or tendency to discharge between the ends of the windings. Also when the transformer is immersed in oil in its containing tank, it will be seen that there are located at the ends of the high tension windings between the series of packing strips 7^b to 7^g the oil pockets 8 to 8^c.

It is apparent that by the means of my invention there is not only provided a long creepage distance between the ends of the high tension and low tension windings, but also a number of solid insulating sections and oil filled spaces in successive sequence therewith.

The above description and drawings illustrate one embodiment of my invention, but the structure may be varied without departing from the scope thereof; also the windings may be grouped differently or differently located with reference to each other and the number and relationship of the insulating sheets and spacing strips may be varied and differently proportioned to suit the requirements of any particular case.

I claim:—

1. A transformer coil comprising windings, circumferentially extending sheets of insulating material between portions of said windings, and axially extending insulating strips spaced from each other between said sheets and windings, certain of said strips extending nearer the end of the coil structure than other intermediate strips.

2. A transformer coil comprising windings, circumferentially extending sheets of insulating material between portions of said windings, and axially extending insulating strips spaced from each other between said sheets and windings, certain of said strips extending nearer the end of the coil structure than other intermediate strips as re-

BEST AVAILABLE COPY

gards the path between portions of the windings.

3. A transformer coil comprising windings, circumferentially extending sheets of insulating material between portions of said windings, and axially extending insulating strips spaced from each other between said sheets and windings, certain of said strips extending nearer the end of the coil structure than other intermediate strips as regards the circumferential direction between windings.

4. A transformer coil comprising windings, circumferentially extending sheets of insulating material between portions of said windings, and axially extending insulating strips spaced from each other between said sheets and windings, certain of said strips extending nearer the end of the coil structure than other intermediate strips as regards the path between portions of the windings and also as regards the circumferential direction between windings.

5. A transformer coil comprising windings, axially extending insulating strips between portions of said windings, circumferentially extending strips spaced from each other and located at the end of a portion of said windings and having spaces between said circumferentially extending strips communicating with spaces between the axially extending strips.

6. A transformer coil comprising windings, axially extending insulating strips between portions of said windings, circumferentially extending strips spaced from each other and located at the end of a portion of said windings and having spaces between said circumferentially extending strips communicating with spaces between the axially extending strips and a hardened insulating coating covering the walls of the spaces.

7. A transformer coil comprising windings, sheets of insulating material between portions of said windings, axially extending insulating strips spaced from each other and between said sheets and windings, and circumferentially extending insulating strips spaced from each other at the end of at least a portion of said windings.

8. A transformer coil comprising windings, insulating sheets between portions of said windings, axially extending insulating strips spaced from each other and between said portions of said windings and said sheets, and circumferentially extending insulating strips spaced from each other at the end of at least a portion of said windings, certain of said axially extending strips extending to the end of the structure and intervening strips terminating at a distance within the end of the structure.

SAMUEL HORELICK.