Aug. 17, 1954

H. SCHNEIDER

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HIGH-VOLTAGE TRANSFORMER

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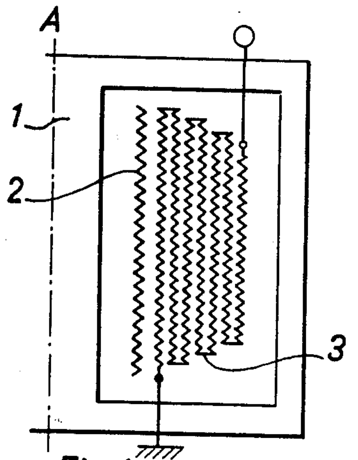

Fig.1

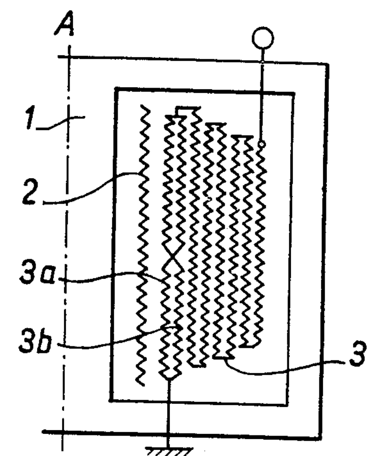

Fig.2

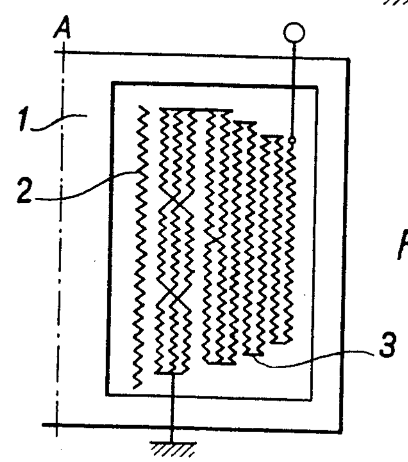

Fig.3

A= Centre line of the column = Symmetrical axis of the shell type transformer

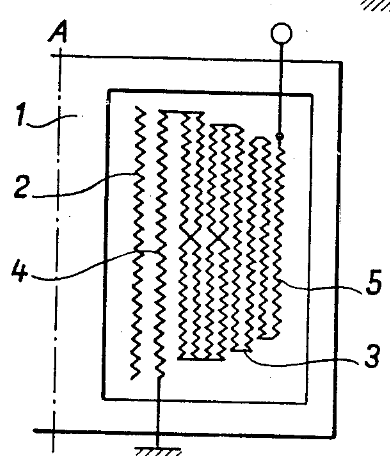

Fig.4

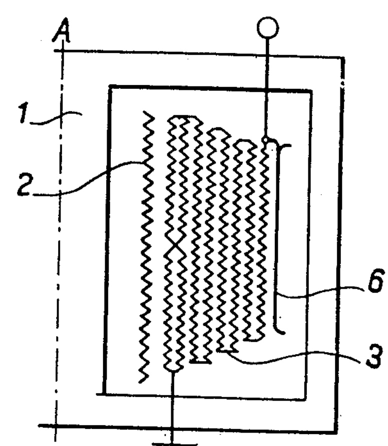

Fig.5

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HIGH-VOLTAGE TRANSFORMER

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4 Claims. (Cl. 336—84)

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In high-voltage testing transformers with one pole grounded the high-voltage winding is frequently arranged in the shape of a so-called layer winding. Such winding consists of a large number of concentric, substantially cylindrical layers of helically wound coils of diminishing length mounted on and surrounding the central leg of a shell type iron core, a similarly shaped low-voltage helical winding being disposed between such leg and the inside of such high-voltage winding. The layer of the high-voltage winding nearest to the low-voltage winding leads to the grounded pole of the transformer, the outermost layer to the high-voltage pole. As the voltage increases the layers are shortened more and more in the axial direction and the insulation spacings are thus increased toward the iron core. The practice has also been adopted to design output transformers with layer windings so as to avoid vibrations in the event of voltage surges.

In the drawing:

Figure 1 is a diagrammatic view of one-half of a transformer having a layer type winding; and

Figs. 2, 3, 4 and 5 are similar views of different modifications illustrating the invention.

As shown in Fig. 1 a transformer is provided comprising an iron core **1** of the shell type having a central leg on which is mounted a low-voltage winding **2**. Such low-voltage winding is surrounded by a high-voltage winding **3** which is composed of several layers: seven in the case of Fig. 1. The intermost layer is grounded, the outermost is connected to the high-voltage line. The greater the number of layers that are introduced the smaller becomes the potential difference between the individual layers. This however makes the windings considerably more expensive and complicated. It is therefore advantageous not to increase the number of layers too much. However, this endeavor is counteracted by the following fact.

As the transformer output increases the additional losses in the winding must be taken into consideration more and more, especially at a network frequency of 60 cycles. If in the case of large transformers one wishes to keep these additional losses within moderate bounds, the winding wire (generally copper wire) must have only a comparatively small dimension in the direction perpendicular to the stray flux, mostly less than 4–5 mm. The dimension of the copper in the direction of the stray flux increases correspondingly. The number of turns per layer becomes small and the number of the layers undesirably

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large. In order to correct this evil it would be conceivable to give different dimensions to the conductor in the various layers. The layers near the stray channel would receive few windings with smaller dimension of the conductor perpendicular to the stray flux. On the contrary in the layers more remote from the stray channel the dimension of the conductor perpendicular to the stray flux might be made considerably larger, thus permitting one to accommodate considerably more turns in said layers. It is actually possible to avoid in this manner an undesirable increase of the number of layers. However, in doing this we must put up with another drawback in that center of gravity of the turns of such a winding is removed considerably from the low voltage winding and the stray flux is correspondingly increased, producing the well-known unfavorable effects in the operation of the transformer.

According to the present invention such drawback is eliminated and the number of layers reduced to a desired degree without the additional losses exceeding a predetermined value and without increasing the stray flux. The invention consists in subdividing the layer nearest to the stray flux path or channel into at least two parallel strands and in crossing the latter by each other in such a way that their position as regards the stray field is equivalent.

As shown in Fig. 1, the innermost layer of the high-voltage winding **3** nearest to the stray channel gives rise to inadmissibly high additional winding losses. To overcome this difficulty such layer is subdivided, as shown in Fig. 2, into two parallel strands *3a* and *3b*. The latter are crossed at the center, so that with respect to their position in the stray field they are equivalent. In this manner it is possible to reduce largely the additional losses in the innermost layer. Moreover even the windings of this layer may be increased in number, which leads to a reduction of the leakage. If necessary, additional layers, e. g. the second layer or the second and the third layer, may be subdivided in the same manner into two parallel strands.

In certain cases it may be advisable to subdivide one layer into more than two parallel strands. An example of this is shown in Fig. 3. In such case the innermost layer is subdivided into three parallel spiral strands and the adjacent layer into two.

In order to reduce in the event of surges the inner oscillations as much as possible, the two extreme layers **4** and **5** which have few windings and conductors of small dimension may be arranged perpendicular to the stray flux. As shown in the example of Fig. 4, the subdivision into parallel spiral strands would then be effected on the side of the stray channel, starting from the second layer only.

The oscillating capacity may be also reduced, as shown in Fig. 5, by arranging outside the outermost layer an electrostatic shield and by connecting the latter to the beginning of the winding.

The manner and process of constructing the device of the invention are accomplished by isolating the helically wound strands of the selected layers to be transposed at the zone or zones of transposition, and by cross-connecting such strands so that, for example, an inner strand and an outer strand form one conductor coil, while the adjacent outer strand and inner strand form another conductor coil, such strands being connected in parallel at opposite ends of the coils (helically wound layers). As a result a reduction in the total number of layers and a reduction of additional losses are accomplished.

Having thus described my invention I claim:

1. A high-voltage transformer comprising a shell type core having a central leg, a low-voltage helical winding surrounding such leg, a single-pole grounded high-voltage winding composed of a plurality of annular individual layers of helically wound coils surrounding said low-voltage helical winding in concentric relation therewith and with one another, means connecting one terminal of said high-voltage winding to ground at one end of the layer next adjacent said low-voltage winding, means connecting said layers in series circuit relation with one another, a selected inner layer of said high-voltage winding, which is otherwise subject to an objectionably high stray flux path consisting of at least two inner and outer helically wound strands, means electrically connecting said strands together in parallel only at opposite ends of the strands, and means cross-connecting the inner and outer strands in series with one another between opposite ends of such strands whereby their positions with respect to such stray flux path thereof are equivalent, the remaining layers consisting of single solid conductors.

2. A high-voltage transformer as defined by claim 1, in which said selected inner layer is the innermost layer of the high-voltage winding and consists of three helically wound concentric strands cross-connected at three uniformly spaced points lengthwise of such layer, said three strands being electrically connected in parallel only at the ends of said strands and the next adjacent layer of said high-voltage winding around said selected layer consists of two helically wound concentric strands cross-connected midway of the length thereof and electrically connected in parallel at their opposite ends.

3. A high-voltage transformer as defined by claim 1, in which the axial lengths of the layers of the high-voltage winding disposed between the innermost and the outermost layers thereof decrease in length one from the other.

4. A high-voltage transformer as defined by claim 1, in which means comprising an electrostatic shield is disposed outside the outermost layer of the high-voltage winding, and means connecting said shield to the other terminal of said high-voltage winding.

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