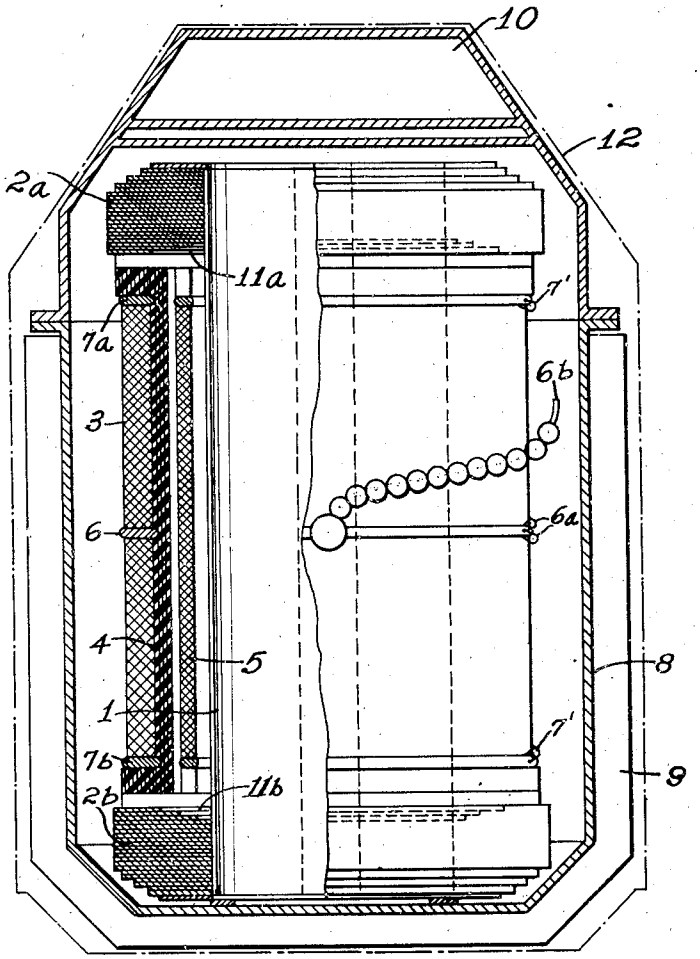
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ELECTRICAL TRANSFORMER

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ELECTRICAL TRANSFORMER

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In travelling transformers of the construction hitherto usual there have been added to the iron core, for the purpose of diminishing the height of the yoke, two unwound return columns of about $1/\sqrt{3}$ times the cross-sectional area of the wound columns in the case of three-phase units and of about half the cross-sectional area of the wound columns in the case of single-phase units. The distribution of flux in the yokes is then such that the necessary height of yoke also corresponds to $1/\sqrt{3}$ or to ½ of the diameter of the column. Since the leading-in insulators for the highest voltages have to be mounted upon the end of the transformer in the direction of the longitudinal axis of the yoke, the unwound return columns form a hindrance to the connecting of the winding. The connections have to be passed laterally between the return columns and the wall of the casing. With a line voltage of 400 kilovolts, for instance, and with the large column diameters such as are necessary for the large power units required nowadays, the spacing of the insulation, which is obtained from the internal breadth of the casing, minus the column diameter, divided by four, is altogether insufficient. If unwound return columns are not provided, the design requirements for the magnetic circuit indicate that the heights of the yokes should be increased and made equal to the diameter of the columns, but this change in design would result in an inadmissible reduction of the active length of the columns, and therefore of the winding space.

According to the invention a way out of this difficulty is found by adopting the radially laminated core, known in itself with transversely laminated yokes.

Thus the invention relates to a travelling transformer, more particularly one for very large power outputs and very high voltages, in which, according to the invention, for the purpose of obtaining a large winding space, the iron core consists of columns laminated radially or in evolute form and of transversely laminated yokes, the breadth of which is selected with the fullest utilisation of the railway profile, while the height thereof amounts to less than half the diameter of the columns.

One embodiment of a travelling transformer according to the invention is diagrammatically illustrated in cross section through the casing in the accompanying drawing, the right-hand half of the figure showing a front view of the active portion, and the left-hand showing a longitudinal section through one column.

By 1 is denoted the column, which consists of radial or evolute laminations, and which penetrates through the transversely laminated yokes 2*a* and 2*b*. The high-tension winding is denoted by 3, and the low-tension winding by 5. Between the high-tension and low-tension windings is located the insulation 4, of solid, laminated insulating material. A metal guard ring 6 is located between the two sections of the high tension winding 3 and electrically connected to the adjacent ends thereof, as indicated diagrammatically by the jumpers 6*a*. Guard rings 7*a*, 7*b* at the top and bottom respectively of the high tension winding 3 are electrically connected to the adjacent ends of the winding, as indicated diagrammatically by the jumpers 7', and the several end guard rings 7*a*, 7*b* of a three phase transformer with Y-connected primary windings are electrically connected to the neutral point of the system. From the guard ring 6*a* a conducting connection 6*b* may extend to the high-tension leading-in terminal, freely and without hindrance, this terminal extending along the front of the travelling transformer in the direction of the longitudinal axis of the yoke. The transformer is lodged in a casing 8, with stiffening ribs 9, an expansion vessel 10 also being provided in the upper portion of this casing. The casing, with its stiffening ribs, which are at the same time constructed as longitudinal girders between the car-tracks, is adapted to the track profile, indicated by a dot-and-dash line 12, with the fullest possible utilization of the space available. The breadth of the yokes 2*a* and 2*b* is also dimensioned so as to utilize as fully as possible the space available within the profile of the track, the height of the yokes being made lower than half the diameter of the columns, in order in this way to provide a large winding space. In the limiting case the cylindrical surface of penetration in the yokes that serves for the passage of the flux between column and yoke must correspond at least to the active cross-sectional area of the column. The action cross-sectional area of column, with a filling factor equal to 0.75, amounts to

$$D^2 \cdot \frac{\pi}{4} \cdot 0.75$$

As an effective cross-sectional area of passage for the flux in the case of a yoke height H and a filling factor in the yoke equal to 0.9 we obtain

$$D \cdot \pi \cdot H \cdot 0.9$$

Now if the column cross-sectional area and the passage cross-sectional area are assumed to be equal, this gives a height of yoke H equal to

$$\frac{D^2 \cdot \pi / 4 \cdot 0.75}{D \cdot \pi \cdot 0.9} = 0.21 D$$

With a height of yoke amounting to 0.21 of the diameter of the column, however, a breadth of yoke is obtained which in many cases is too great, having regard to the breadth of the profile. Favourable proportions for a satisfactory utilisation of the profile breadth are obtained with a yoke height amounting to 0.3 to 0.35 of the

diameter of the column. Under these circumstances it is advantageous for the yokes 2*a* and 2*b* to be stepped on the longitudinal edges, in order to adapt them to the inclinations and recesses of the track profile 12, as illustrated in the drawing.

In order that the leakage flux that enters from the column 1 into the sides of the transversely laminated yokes 2*a* and 2*b* facing the windings may not give rise to large eddy-current losses, step-like gradations are provided, as indicated at 11*a* and 11*b*. The gradations may be annular, to correspond to the shape of the column. The stepped gradations may also be progressive, as illustrated from the longitudinal edges of the yokes towards the column.

I claim:

1. A travelling transformer for railroad cars, particularly for very large power outputs and very high voltages comprising an iron core consisting of radially laminated columns and transversely laminated yokes, and primary and secondary windings on the columns, wherein the primary winding surrounds the secondary winding and comprises two axially arranged sections, a central guard ring located between said primary winding sections and two end guard rings contacting the opposite ends of said primary winding sections, the central guard ring serving as the high voltage connection to the primary winding and the end guard rings serving as neutral point connections for the primary winding.

2. A travelling transformer as defined in claim 1 wherein the yokes are stepped on the sides facing the windings.

3. A travelling transformer as defined in claim 1 wherein the yokes are stepped on the sides facing the windings, the steps being annular and progressive away from the longitudinal edges of the yokes toward the column.

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