SHELL FORM TRANSFORMERS

INSTRUCTIONS

WINDINGS

The windings are made up of groups of high and low voltage coils. These are wound with a paper insulated conductor usually sub-divided, with paper insulation on each sub-division, to keep the eddy current loss to a minimum. To secure equal current distribution in each sub-division, transpositions are made at frequent points in the winding. The coils are wound with one turn per layer, thus obtaining the minimum voltage stress between layers. The thickness of the coil is thus the width of the conductor and each conductor is exposed to the cooling medium. Insulation between layers is in general supplied by the conductor covering. The paper insulation used provides the greatest insulation strength in a minimum of space.

Taps for additional voltage are placed in that part of the winding where they will be least exposed to line surges and where the changing of taps will have the least effect on the magnetic balance. Where a high-voltage tap passes across the face of a coil, the lead insulation is reinforced by placing a fullerboard head sheet between the tap and coil.

TREATMENT OF COILS

After the coils are wound, they are pressed and clamped to size, thoroughly oven dried, dipped in varnish and baked, thus giving the coil the mechanical strength to insure that there will be no displacement of turns during the assembly of the coils.

As no tape is used on the completed coil, each conductor is exposed directly to the cooling medium, permitting transfer of heat from the conductor to the cooling medium with a minimum temperature difference. This effectively keeps hot spots to a minimum.

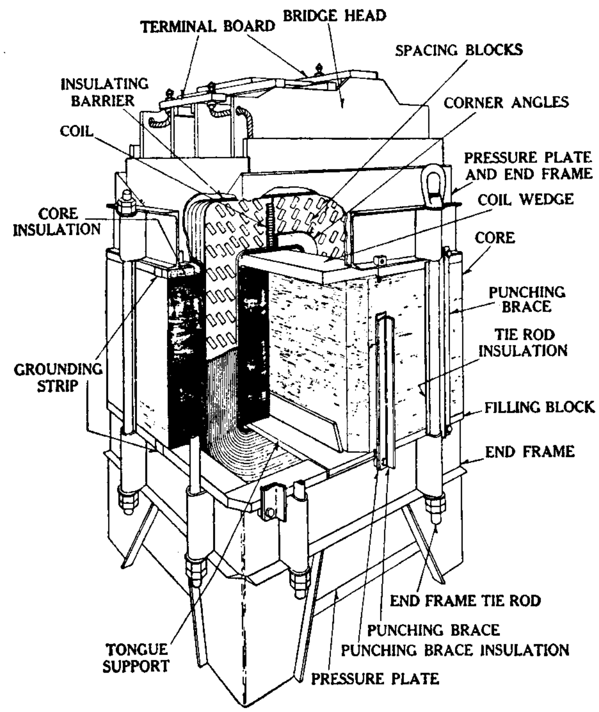

FIG. 1—SECTIONAL VIEW OF A LARGE SINGLE-PHASE SHELL FORM TRANSFORMER

ASSEMBLY OF COILS

Groups of high and low-voltage coils are assembled with barriers of high grade insulating sheets, and with angles and channels of the same material. As each group of high-voltage coils is made up of a relatively small number of wide coils, the initial distribution of the impulse voltage within the group is practically uniform. The arrangement of the coils and the insulating barriers surrounding each coil and the group of coils is made so that as near as it is practicable to do so, the surface of the insulating barriers are coincident with the equi-potential surfaces of the electrostatic field. Thus, creepage surfaces are practically eliminated and the high impulse strength is secured.

Ample ducts, formed by inserting spacers of insulating material between coils, are provided to allow the flow of the cooling medium along at least one face of each coil and leaving more than 50 per cent of each conductor exposed. These spacers are cemented firmly to the insulating barriers between coils.

Terminal boards are mounted on extensions of the insulating barriers. This results in a terminal board of rugged construction free from grounded supports.

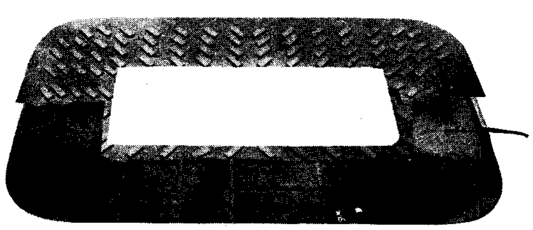

FIG. 2—SHELL FORM TRANSFORMER COIL WITH PORTION CUT AWAY TO SHOW SPACER ARRANGEMENT

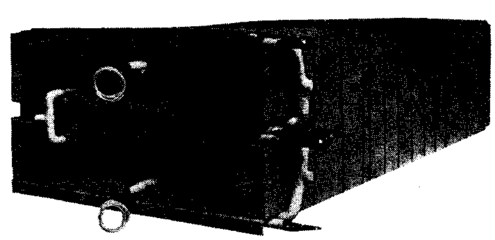

FIG. 3—ASSEMBLED GROUP OF COILS AND INSULATION FOR A SHELL FORM TRANSFORMER

SHELL FORM TRANSFORMERS—Continued

INSTRUCTIONS—Continued

CORE

The core is made up of high grade laminated sheet steel, carefully annealed and practically non-aging. Alternate layers of laminations have the joints staggered, thereby reducing the exciting current to a minimum. The shell form of construction does not require the use of heavily insulated core bolts, since there are no bolts passing through the magnetic circuit The core laminations are sheared; this eliminates burrs which result from a punching operation.

END FRAMES AND COIL BRACING

Welded structural steel end frames support and make a substantial unit of the core and windings. The core laminations are held securely in place, being interlaced on the corners and clamped between top and bottom end frames. This clamping action is obtained by heavy tie bolts. The upper end frame is provided with eye bolts or loops so that the core and coils can be lifted and handled as a unit. The lower end frame is provided with feet so that the core and coils can be set down without the use of external supports.

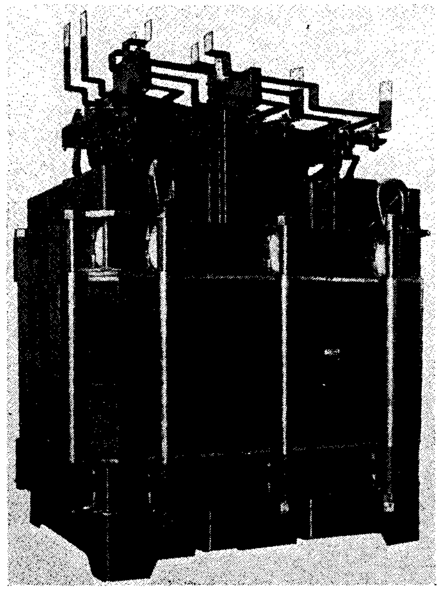

FIG. 4—SHELL FORM THREE-PHASE 36,000 KV-A., 60 CYCLE AUTOTRANSFORMER

The end frames are provided with wide structural steel surfaces so as to support the flat faces of the coils, that extend beyond the iron core, against mechanical stresses which tend to separate the coils under short circuit conditions. Wedges are inserted between these surfaces and the coils and insulation assembly to insure a completely rigid structure after the assembly has been clamped together. The short circuit stresses, which may be accurately calculated, are in this way transmitted to the end frames which are designed to withstand the maximum stress that can be developed. The area of contact between the surfaces and the coils is large, resulting in a low pressure per unit area, well within the value which the insulating material will stand.

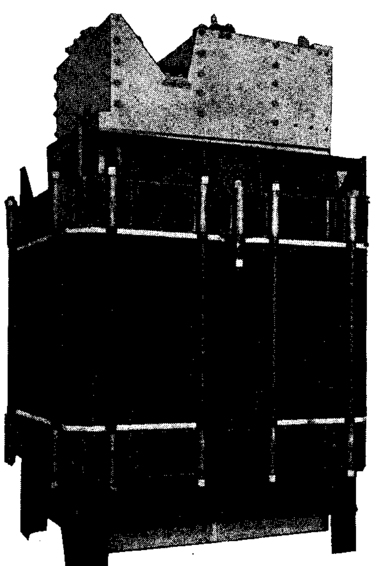

FIG. 5—SHELL FORM SINGLE-PHASE 20,000 KV-A., 60 CYCLE TRANSFORMER

To brace the coils against stresses acting in a plane parallel to the face of the coils and tending to separate the primary and secondary coils in that direction, a "T" beam is mounted through the opening at the bottom of the coils, which forms a rigid support for the coils and insulation, and the tongue iron. A tongue wedge is placed above the tongue iron under the coils so that a pressure is brought to bear against the tongue, compressing the punchings, and bracing the windings firmly against vertical movement.

The assembled coils, insulation, core, end frames and coil bracing are dried out by the application of heat while in a vacuum and are then thoroughly impregnated with oil.

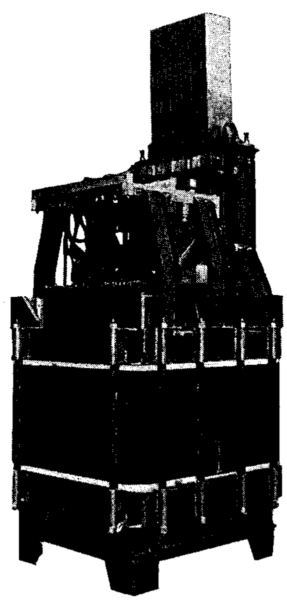

FIG. 6—SHELL FORM SINGLE-PHASE 3500 KV-A., 60 CYCLE FURNACE TRANSFORMER

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