INSTRUCTIONS

TYPE ASL TRANSFORMER CONSTRUCTION

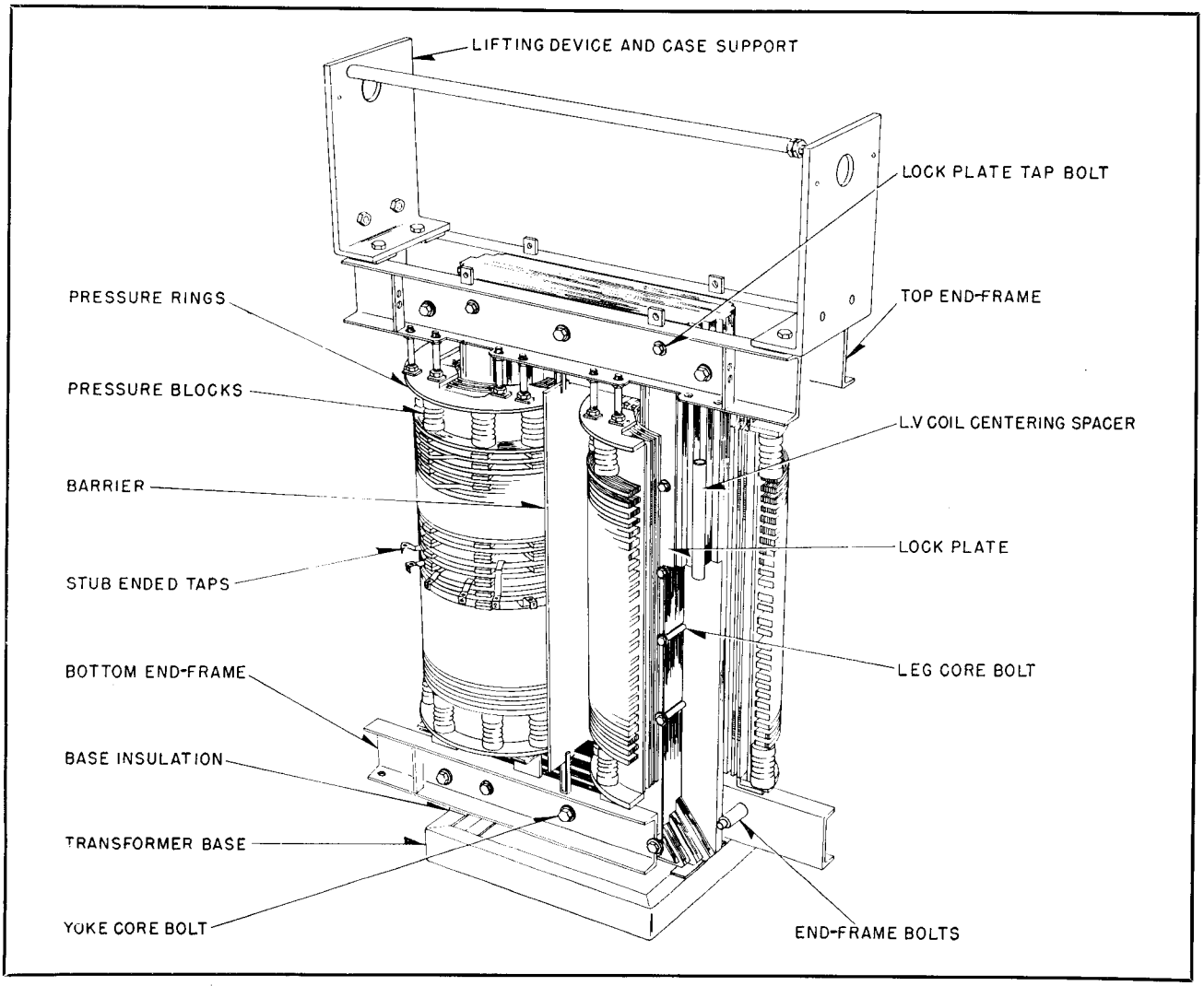

FIG. 1. Sectional View of a Single-Phase ASL Core Form Transformer.

WINDINGS

TYPE ASL TRANSFORMERS are equipped with windings made from special electrolytic oxygen-free copper conductor. This copper conductor is manufactured without melting by a special process giving high ductility and eliminating the possibility of scale or slivers. The use of this special copper conductor prevents insulation failures resulting from surface imperfections in the conductor.

The insulation applied to each conductor consists of two layers of machine-wound glass fibers bonded to the conductor with a high temperature, moisture-resistant varnish.

Taps are brought out from the center of the coil stack. With this arrangement the tapped portion of the winding is not exposed to line surges, and the electrical centers are more nearly balanced on all connections.

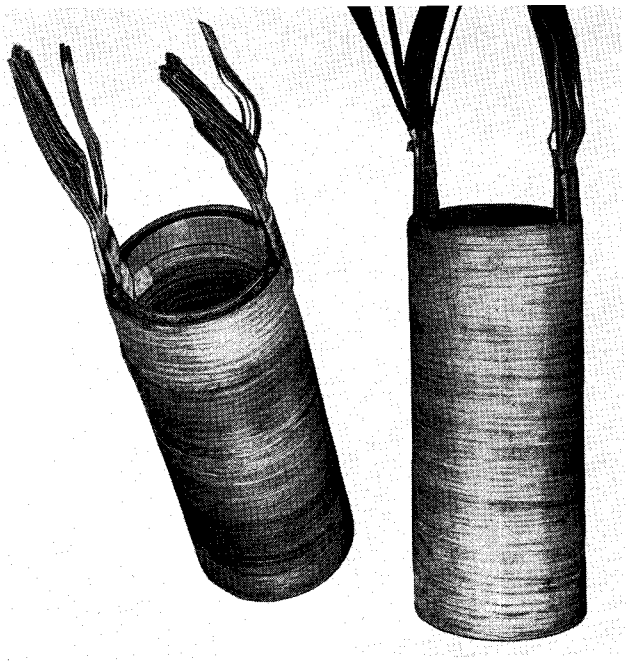

FIG. 2. Two Views of Type ASL Cylindrical Coil.

All coils are circular in form and, in general, may be classified as follows:

Cylindrical Coils. The cylindrical coil (Fig. 2) consists of one or more layers of insulated conductors wound on an insulating cylinder. Each conductor consists of a number of copper ribbons, of suitable cross-section in parallel, which are properly transposed to minimize eddy losses. Collars of suitable form are placed at the ends of the layers to give the necessary electrical and mechanical strength. Ducts, formed by glass spacers, are placed between the layers and between the conductor and the insulating cylinder so that the air can circulate freely through the coils to keep temperature gradients uniformly low.

Continuous-Wound Pancake Coils. The continuous-wound pancake coil (Fig. 3) consists of a number of circular disc coil sections of rectangular strap conductor, with one turn per layer, wound by a continuous process with no joints at section connections. The conductor may consist of one or more copper ribbons of suitable cross-section and where multiconductors are used in parallel, they are properly transposed throughout the coil to minimize eddy losses. Porcelain radial spacers and mica washers separate the various sections from each other. Insulating porcelains are placed at the ends of the coil for electrical and mechanical strength. The thickness of the coil section is the width of the conductor and the sides of the coil section are the edges of the conductor. At least one edge of each conductor is exposed to the cooling medium. The edges of the conductor do not touch; only the flat sides are in contact, thus eliminating the danger of mechanical forces cutting the insulation. This type of winding permits free circulation of air for cooling, hotspots are eliminated and high thermal efficiency results.

Round-Wire Pancake Coils. The round-wire pancake coil (Fig. 4) is generally used for transformers having a current rating of less than 12 amperes. It is circular in form and consists of a number of layers with several turns of round, glass insulated wire per layer. This coil is wound on an insulating foundation ring with a length equal to the thickness of the coil. The layers of conductor are spaced from each other by glass insulating sleeves, consisting of a strip of glass fiber tape folded around the edge turns forming a double thickness of glass tape and a strip of mica.

Reinforcing segments are placed in the coil near the outer edge during the winding and are spaced so that they are directly under the radial spacers. The width of the segments is the same as the length of the insulating foundation ring. This construction gives maximum mechanical strength due to the fact that the pressure on the coil stack is transmitted from coil to coil through the foundation ring and the segments, thereby eliminating pressure on the wires of the coil.

Assembly of Windings. Coils of the cylindrical type require no further individual assembly after winding.

Continuous-wound pancake coils are pressed to size axially after which they are ready for treatment.

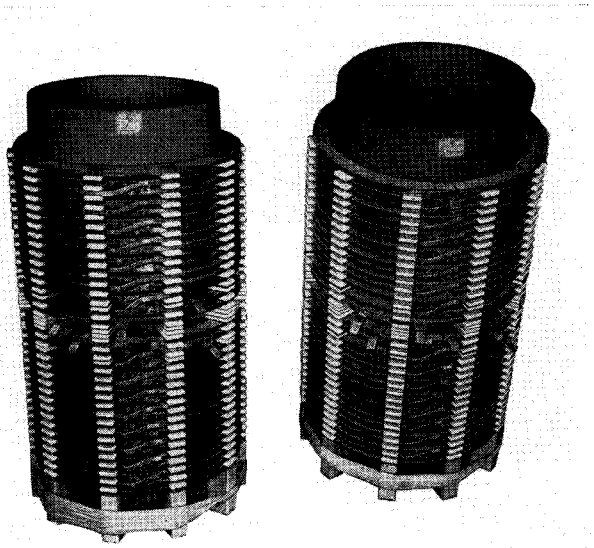

FIG. 3. Two Views of Type ASL Continuous-Wound Pancake Coil.

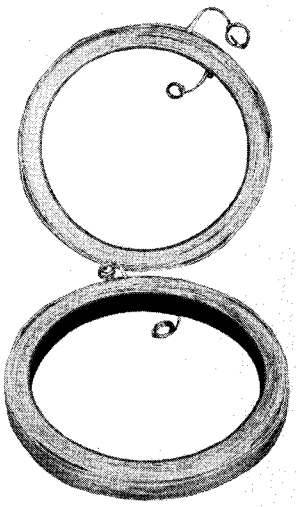

FIG. 4. Two Views of Round-Wire Pancake Coil.

Wire-wound pancake coils are assembled in stacks on their insulating cylinders (Fig. 5). They are separated, during stacking, from the insulating cylinder by temporary vertical spacers and from each other by permanent procelain radial spacers. The stack is pressed to size axially and the vertical spacers removed, after which it is ready for treatment.

The high and low voltage windings are assembled concentrically on the core, usually with the low voltage winding nearest the core leg. The inner winding is centered on the core leg by four glass rods placed in the four corners of the cruciform core between the core and the insulating cylinder. The outer coil is centered on the inner coil by porcelain pressure insulators and a steel pressure ring forming an air duct between the two for the unobstructed circulation of the cooling air.

The pressure rings and insulators at the ends serve to evenly distribute the pressure on the coils and to transmit stresses set up under short-circuit into the end frames.

All leads are made from bare copper rods and bars which are rigidly supported and spaced by porcelain insulators. The tap leads are terminated at the face of the coil in stub taps (see Instruction Leaflet I.L. 46-300-4 Operation-Maintenance of Dry Type Transformers for stub tap information).

Treatment. Each individual coil is given one dip in a high temperature, moisture resistant varnish which is baked on. After the coils are assembled on the core, the complete assembly is given two more dips in the same varnish and thoroughly baked after each dip. This varnish imparts a smooth glossy finish to the coils and makes them resistant to the collection of dirt and impervious to moisture.

Insulation. The Class B insulation of Type ASL transformers consists of insulating cylinders, glass-fiber tape, mica, porcelain spacers, glass spacers, and air ducts, so proportioned as to give the necessary dielectric strength and at the same time allow the cooling air to flow freely through the coils. All units are designed to withstand the proposed standards of impulse and low frequency test for dry type transformers as listed in Table I. All parts of the insulation structure and the bushings are properly coordinated.

TABLE NO. 1

PROPOSED DRY TYPE INSULATION LEVELS

Voltage Class in KV	Low Frequency Test in KV	Full Wave Impulse Level in KV 1.5 x 40 M.S.
1.20	4	10
2.50	10	20
5.00	12	25
8.66	19	35
15.00	31	50

Coil Bracing. The stresses which result when the transformer is short-circuited are transmitted to and absorbed by the steel end-frames. Steel channel end-frames are fastened to the top and bottom of the core. Pressure is transmitted from the windings through the pressure insulators, pressure rings, and jack screws to the end-frame.

Both the high and low voltage windings are pressed to a predetermined height and after assembly on the core are clamped by a common pressure ring or plate. This method of assembly has two important advantages; first, clamping each

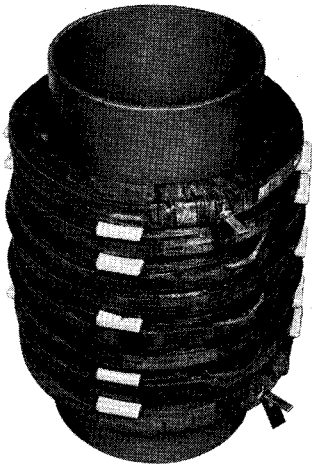

FIG. 5. Assembled Stack of Type ASL Round-Wire Coils Making One Complete Coil.

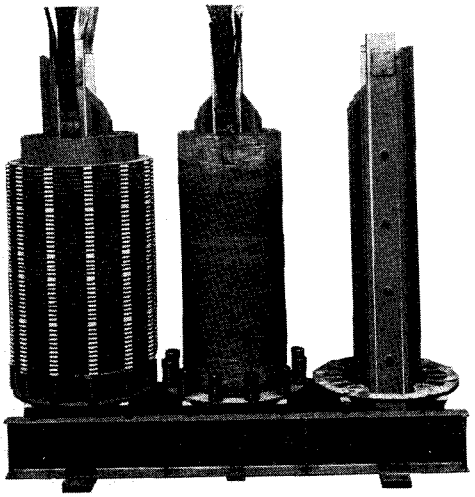

FIG. 6. Type ASL Core and Coil Assembly Using Continuous-Wound Coils.

winding permits building to an accurately determined column length; second, the use of a common pressure system for both windings assures that the electrical centers will be in the same horizontal plane and thereby prevent subsequent shifting. The second point is very important because the magnitude of the stresses developed on short-circuit depends on the vertical displacement of the electrical centers.

CORE

The cores for type ASL transformers are made from Hipersil, a high permeability, cold-rolled material which carries twenty to thirty percent more flux than hot-rolled Silicon steel. The use of this material gives a transformer of higher efficiency with from twenty to twenty-five percent reduction in total weight.

The magnetic circuit for the type ASL transformer is rectangular in shape with a rectangular opening, or openings. It is built up of I-plate Hipersil laminations which are stepped in width so as to produce an approximately circular iron section. In order to avoid conditions at the corners in which the flux must pass across the direction of the grain the I-plates are cut with 45 degree angles at each end. Punchings for the yoke are made slightly wider than the corresponding leg punchings in order to obtain an overlap as shown in Fig. 1. With this design the flux path at the corner is parallel with the grain of the material in both the yoke and leg punchings.

On each side of the top and bottom is bolted a steel channel or end-frame. See Fig. 1. The coils are clamped between steel pressure plates or rings which are adjustable by means of jack screws extending through the top flange of the bottom end frame and the bottom flange of the top end-frame. The reaction from the clamping forces and the short circuit forces in the winding are such that they tend to separate the top and bottom end frames. The end-frames are prevented from spreading by means of steel lock plates extending the full height of the core. Stops welded to the lock plates engage stops welded on the end-frames and provide the means to transmit the short-circuit and clamping forces from the end-frames to the lock plates.

The lock plates are bolted to each side of the leg punchings with insulated heat-treated core bolts and are insulated from the leg with sheets of asbestos.

HANDLING AND BRACING

The core and coil structure is lifted as a unit by means of lifting lugs bolted to the top end-frames. These lifting lugs are located as near as practical over the center of the outer legs of the core, thereby making the lift in line with the support of the structure. This method of lifting reduces the amount of deflection in the end-frames which might release the clamping forces on the windings.

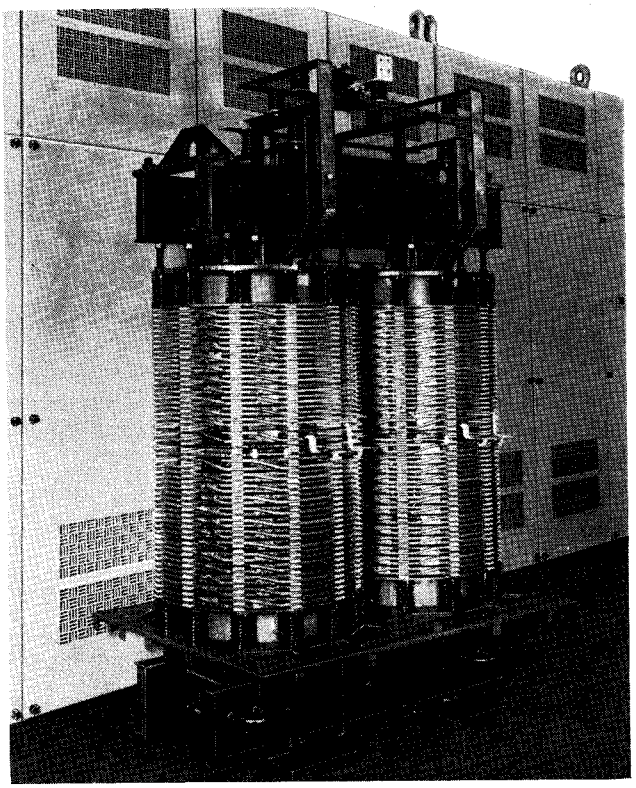

FIG. 7. Complete ASL Unit Substation Core and Coils Before Assembly into Case.

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