NEW CONCEPT FOR CORNER INSULATION

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When winding toroidal coils, quite often unique insulation requirements surface. This is especially true in the larger custom wound core type toroidal or ring coils. See Figure 1.

The initial insulation requirement in special size units is to insulate the core in such a way as to prevent shorting or grounding of the windings. Many toroidal cores of soft magnetic lamination steel, when flat wound, have very sharp corners. See Figure 2. These knife-like corners tend to cut into the insulation making it increasingly difficult to provide adequate protection. The strong winding tension causes changing vector forces which can increase the tendency to penetrate insulation at the corners. The most commonly reported critical problem area is insulating the corners. Many core corners are razor sharp. See Figure 3. They

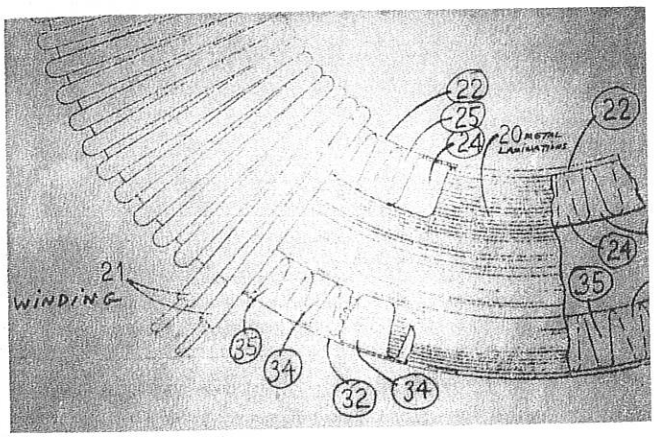

Figure 2: Corner insulation over metal core under winding (Illustration)

usually cannot have rounded edges for electrical/ magnetic design reasons. The magnet wound core is usually made up of layers of .010" to .014" thick metal. Any radius to be beneficial has to be at least 1/16" which necessitates it cutting into 5 or 6 layers of the core. This generally causes shorting of the core layers partially destroying their magnetic effect.

In the past, adequately insulating these sharp corners has been a tedious task. Insulating washers, and layers of wrap for the inside and outside diameters must be pre-cut, then all applied to the core metal, held and taped into place, prior to commencing winding around the toroidal shape. Either the washer or the diameter wraps must be slightly oversize and thick enough to

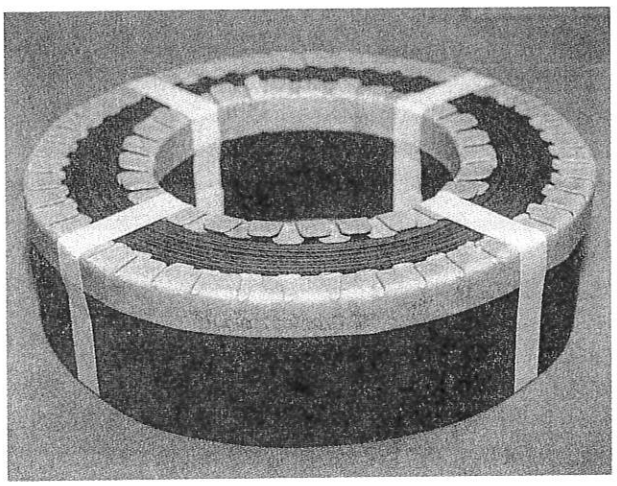

Figure 1: Core with corner insulation on I.D. & O.D. one side only.

ensure the metal corners are insulated sufficiently. There can be no movement of this insulation or the sharp corners could be exposed and therefore cause subsequent short circuit and damage to the coil.

In these electrical Kraft -or pressboard- insulated oil submerged units, undesirable heat can be retained in the core. If corner insulation can be used, much of the pressboard insulation can be eliminated allowing the heat caused by hysteresis and eddy currents to be reduced. In high voltage power toroids, surrounding the core with insulating pressboards traps heat in the core. This increases core losses the same way heat does in cell, core, or barrel wound power transformers.

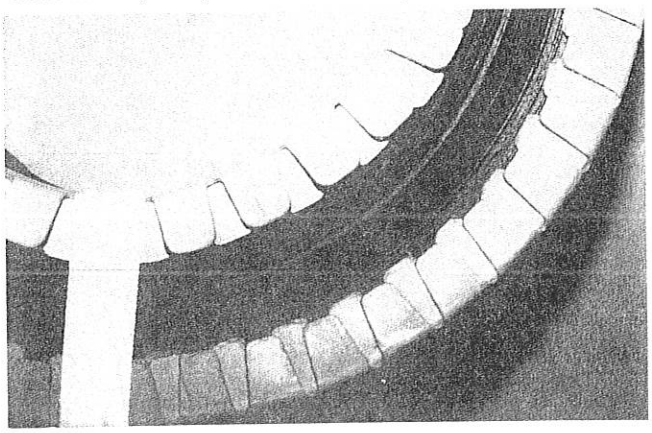

Figure 3: Inside and outside corner insulation

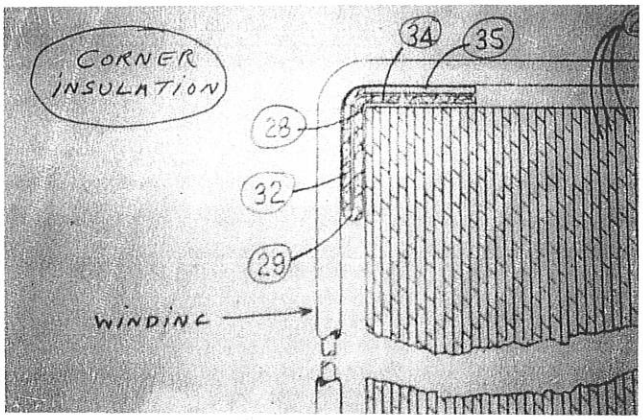

Figure 4: Cross section illustration of corner insulation on metal core.

In current transformer toroidal winding there is often a need to provide adequate insulation and protection between windings. This is generally most critical at the corners where a second winding could crush the underwinding. If the underwinding is of finer and therefore weaker wire, it could be damaged by a heavier secondary winding. Any wire crushing into the lower windings causes spreading, thus changing the geometric winding relation and desired electromotive forces. Space relationship is important in electromagnetic coil design. An interleaf or layer of insulation or a flat wrap separation is often needed between winding layers. Such a layer at and around the corners is difficult to position, hold, and accomplish. Often corner insulation is needed between multiple winding layers of the same size wire. Insulating and supporting these winding corners is beneficial, and corner insulation use can not only negate the need for inter-layer insulation, but also render corner support and allow more open space for additional cooling and adequate air insulation.

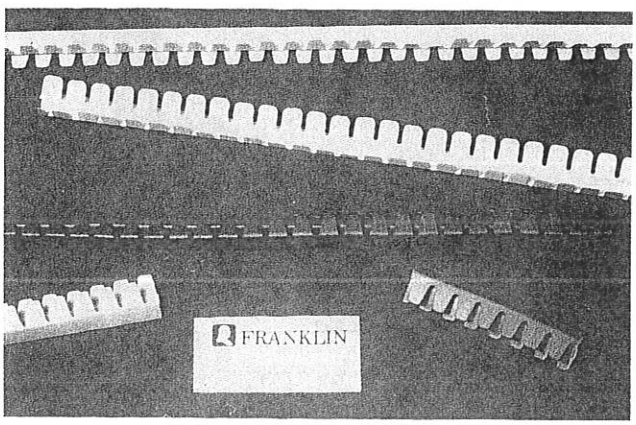

Figure 5: T-COR #6-320 inside and outside corner insulation.

Another area of concern is to insulate securely for mechanical, as well as electrical load. Some cores can weigh well over 10 lbs. At a 9 "G" design factor, the corner insulation must be able to withstand a 90 lb. force. See Figure 4. Some current transformer units (CTs) stack 4 to 6 coils of approximately 10 to 15 lbs. per coil. In shipment or normal coil use, this theoretically, could exert the total load on the bottom coil unless they are restrained individually. In some water cooled ring wound toroidal power transformer units the mechanical strength (cut resistance) of the corner insulation is of equal or greater concern than the electrical insulation capability. Two strips of the .030" corner insulation can build up the protection at the corner to .060" thickness.

To improve efficiency during manufacture of gramme ring windings or toroids, winding foremen strive to maintain or improve quality yet produce faster and

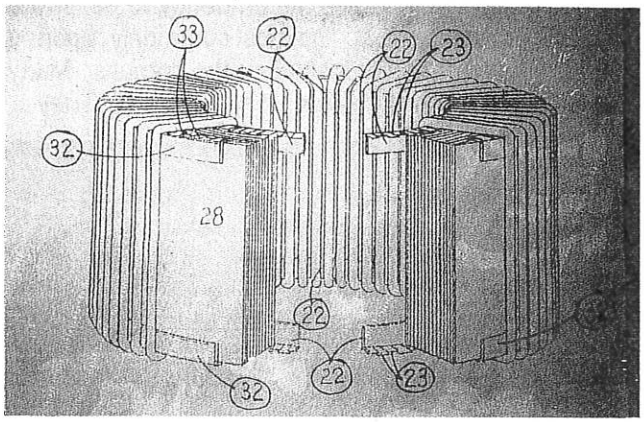

Figure 6: Illustration of T-COR corner insulation on all core corners.

better with less difficulty. Franklin Fibre-Lamitex Corporation's newly designed corner insulation has extra corner protection capability. Franklin's T-COR #6-320 is a cost effective new corner insulation of special design which provides a suitable, convenient solution for increasing manufacturing efficiency. See Figure 5. It is easy to position, locate, and cover the corner, thus locating layers of insulation in the corners. At the same time, it provides flexibility to follow the round contour, and open around the inside diameter of the core or under layer coil winding. The outside diameter configuration allows the insulation to flex and close around the diameter as it follows the core or winding outside corner. See Figure 6.

In most types of electric apparatus there are many wire or cable leads that need to be further insulated or protected after assembly or after being in use.

in many cases it is very difficult or impractical, or impossible to disconnect the wire leads. In such cases, a solid tubular insulation cannot be slipped over the cable. Additional insulation must be pieced on in segments or wrapped on. Two pieces of corner insulation can be used opposing each other at 180° to cover the cable or wire(s) and be held in position with tape or lacing. This will allow some flexibility. See Figure 7. If it is desirable to rigidly hold such undisconnectable wires or cable in a straight line position, then a wrap of Franklin sinusoidal corrugated insulation can be used. After wrapping around the cable, it can be either taped or laced into place. See Figure 8.

In electric motor, generator, alternator, and similar apparatus repair, there are areas found to be in need of additional insulation or protection. Whether the stator

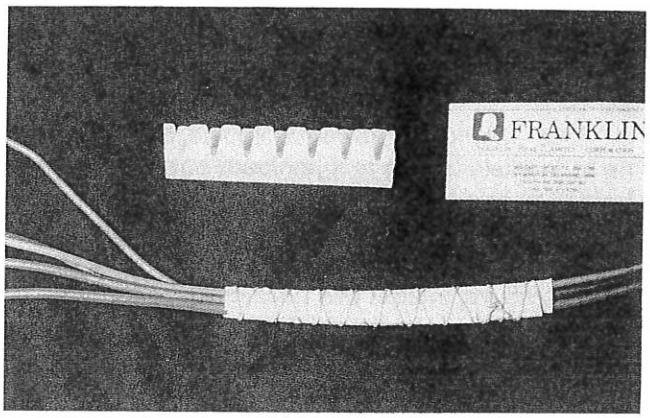

Figure 7: T-COR insulation 180° opposing to cover cable that is undisconnectable.

is ring armature wound or standard wound this is especially true at motor stator winding ends. Corner insulation can be effective in providing additional protection in a location that would normally be difficult to insulate. See Figure 9. Repair specialists can readily spot or know of these locations.

Franklin T-COR corner insulation (Patent applied for) is available in both an inside (to open out) or outside (to close in) design. Corner insulation is available in roll put ups presently in 1/2" and 1" sizes. Other sizes, such as 1/4", 3/8", and 3/4" are possible. Larger sizes of 1-1/2" and 2" are planned. Size is determined by the length of the "teeth" projections which is the same as the length of the insulation plain wrap-around portion. A 1/2" size is measured as a 1/2" x 1/2" right angle. The insulation is double folded and of a unique design to always provide at least one layer of insulation at the corner.

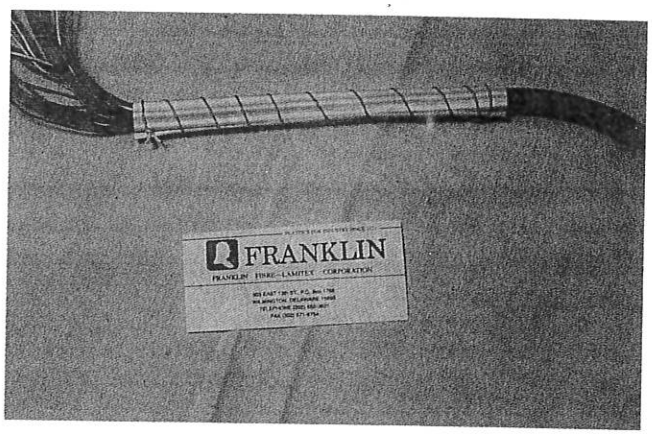

Figure 8: Corrugated insulation cable wrap for straight non-flex.

Nomex .015" thick material will yield a .030" thick overall double folded angle.

Corner insulation is available in Vulcanized Franklin Fibre, rated at 120°C under UL File #E48013; 100% Rag Paper, rated at 105°C under UL File #E41590M; and Nomex, rated at 220°C under File #E34739A. Other suitable UL approved materials and some special combinations of insulating materials are available. Different materials can be tried, but formability may not be as acceptable.

Many other applications for corner insulation will be developed quickly, as this product becomes readily available in the Fall of 1995.

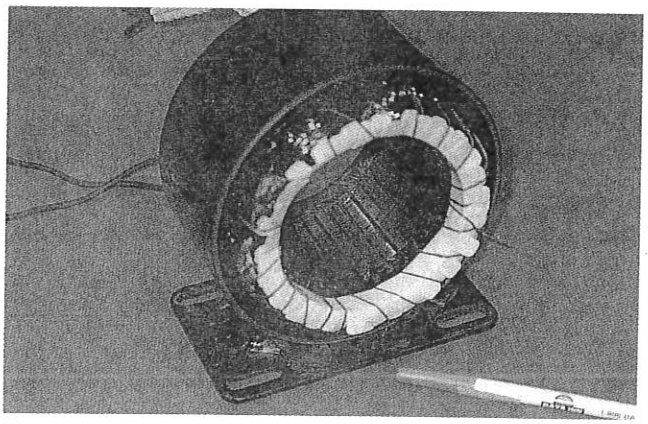

Figure 9: Motor stator end windings with T-COR insulation laced on for additional protection.

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