Purpose: measurements and computation of dielectric constant, power factor, loss factor and DC leakage for various types of base shell material.

Definitions:

1. Dielectric Constant of an insulating material: the ratio of the capacitance of a condenser using the material as a dielectric, measured at a specified frequency, to the capacitance of the same condenser with a vacuum as the dielectric (the dielectric constant of air under normal conditions may be considered equal to that of a vacuum). In symbolic form, the dielectric constant $K = Cp/Ca$. (See Section 4).

2. Dielectric Power Factor: for a physical capacitor represented in series notation the power factor is = $\cos \theta = \sin \delta = \sin \tan^{-1} WC_sR_s$. C_s = capacitance in farads; R_s = series resistance in ohms; θ = dielectric phase angle, which is the angular difference in phase between the sinusoidal voltage applied to the dielectric and the component of RESULTING CURRENT which has the same frequency as the applied voltage. For small power factors (when $\cot \theta$ is less than 0.1), the dielectric power factor = WC_sR_s. For most dielectric measurements this value will suffice. (See Fig. 1).

3. Dielectric Loss Factor: the product of the dielectric constant and the tangent of the loss angle, δ, of the material. The loss factor may be expressed as being equal to $K \times \tan \delta$ or $K \times \cot \theta$. This is the power loss per unit volume of insulating material under specified test conditions. For small power factors, $\tan \delta = \sin \delta = WC_sR_s$. The loss factor is expressed in a more convenient form, therefore, as the dielectric constant times the power factor, or $K \times WC_sR_s$.

4. Determination of Ca: (with air as the dielectric between flat opposing parallel circular plates):

$$Ca = 0.1766 \frac{D^2}{t} \quad \text{(dimensions in inches);}$$

$$Ca = 0.06954 \frac{D^2}{t} \quad \text{(dimensions in Cm);}$$

where D = diameter of sample dielectric, t = thickness of sample dielectric, and Ca = capacitance in μμf.

Measurements:

1. Dielectric Constant:
   a. Measure Cp on General Radio Bridge, Model 516-C, at the specified frequency. The capacitor is formed by a metallic electrode on each side of the dielectric sample (vaseline will hold on thin sheets of aluminum foil). A guard ring and shield may be used to minimize edge effects and stray capacitance; however, these effects are usually negligible for the accuracy desired. Place capacitor thus formed across unknown position in RF bridge and adjust C-dial for null with maximum gain of generator supplying specified signal to RF bridge. Use a convinent audio detector to determine null position. (See Fig. 2).

b. Calculate Ca from equation in preceding section 4. Note: Measurements must be made with a micrometer.
c. Compute K = Cp/Ca.

2. Dielectric Power Factor: measure Rs and Cs on radio frequency bridge at specified frequency or by the susceptance variation method. Sample dielectric will be a base with pins. Fill pins with wax. and form two electrodes by filling base with clean mercury for inner electrode (held by vaseline). Place sample across unknown position on RF bridge and adjust R and C dials for a null using same procedure as described above. (See Fig. 3).

3. Dielectric Loss Factor: this may be computed by multiplying the dielectric constant by the power factor (K x WC_sR_s).

4. DC Leakage: determined by measuring the current flow between adjacent pins on a sample base with a specified potential applied and under a given temperature. The leakage, expressed in megohms, is computed as R = E/I. The voltage should be applied between several pairs of adjacent pins. Use the High Voltage Pulse Test Set, Model #733BR, to obtain the voltage specified, and measure the current flow with an ultrasensitive microammeter. For high temperature measurements the base sample should be suspended in a heating box for 30 minutes before applying the specified potential. The heating box should be connected to a variac calibrated in terms of the desired temperature. Note: Increase voltage gradually to prevent arcing between pins.

Equipment: Harrison.
1. GR Type 516-C Radio Frequency Bridge.
2. Signal Generator.
3. Audio Detector.
4. High Voltage Pulse Test Set, Model #733BR.
5. Ultrasensitive Microammeter.
6. Heating Box (supplied by Chem. Section).

Lancaster

1. Boonton 160-A Q Meter.
2. 5000 volt 1 Milliampere Max. Radio Freq. Rectified DC Supply.
3. Ultrasensitive Microammeter.
4. Heating Oven.

References: ASTM Bulletin D9, Electrical Insulating Materials, December 1942.

See Page 3 for Figures.

Fig. 1

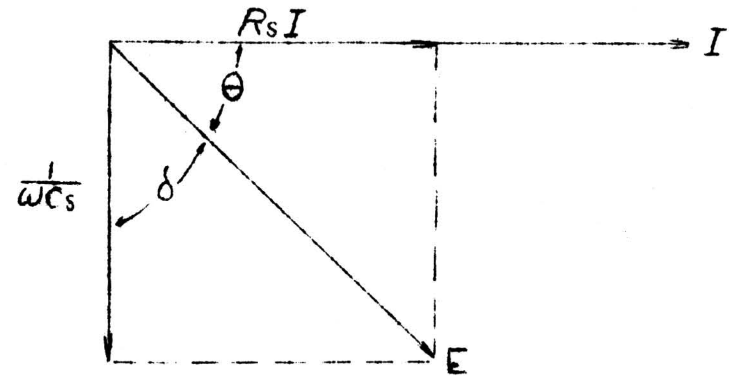


Fig. 2

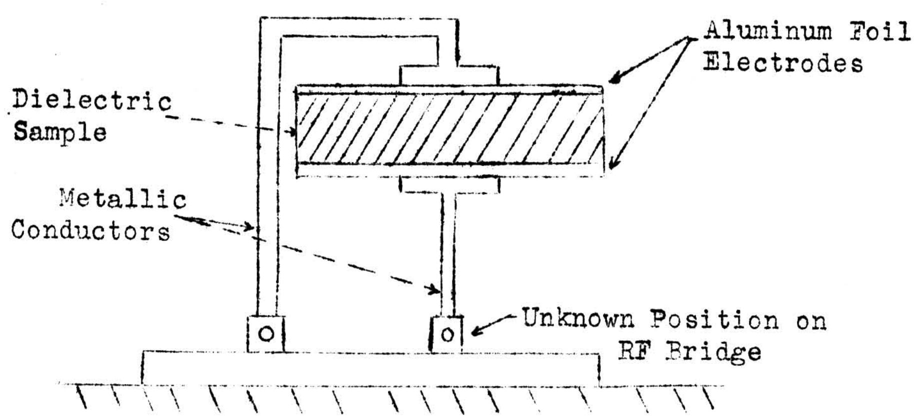
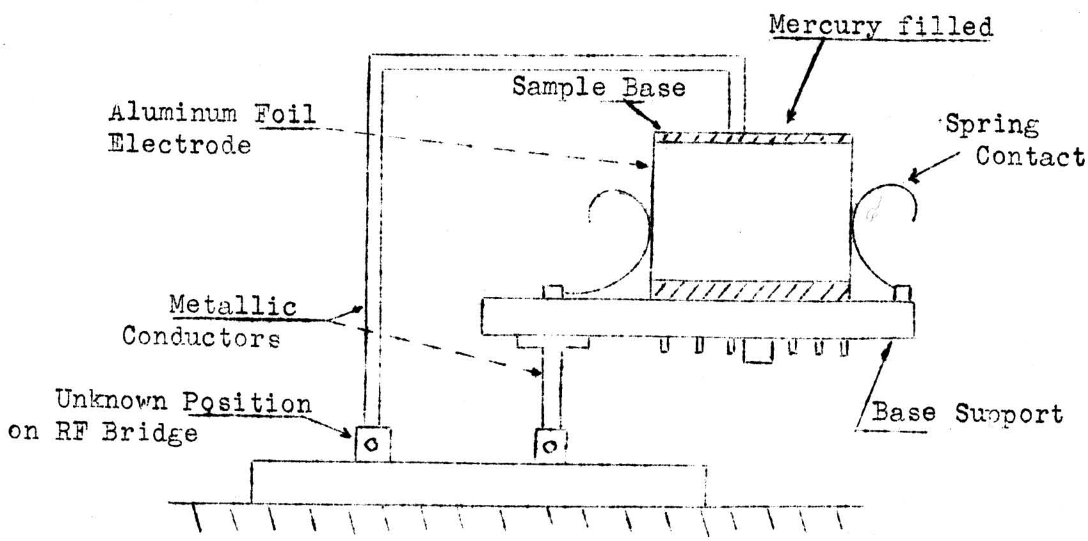


Fig. 3



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