The AEROVOX Research Worker

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Methods of Testing Capacitors

By the Engineering Department, Aerovox Corporation

To answer the requests of many engineers and servicemen in the radio industry, this one issue of the Research Worker is devoted to a general description of testing and inspection of raw material and capacitors in various stages of production of Aerovox Capacitors. Ed.

THE testing of capacitors consists of two parts. (1) Production testing to determine whether the individual capacitor meets customers' specifications or our standard specifications as to capacity, power factor and insulation resistance; (2) life testing to determine whether the capacitors are properly designed to meet the certain conditions of temperature and humidity at various voltages and cycles of operation.

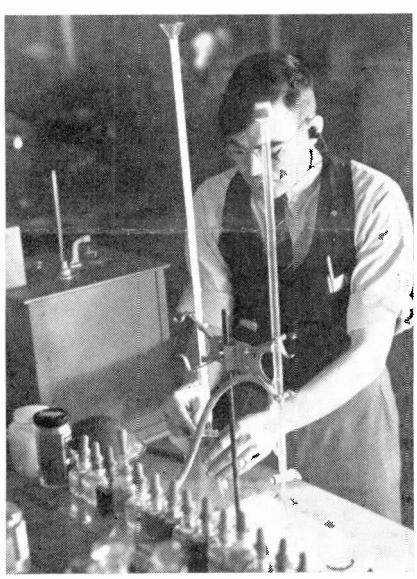
Final capacity test on paper capacitors.

The individual testing of capacitors in production is primarily determined by customers' specifications and the type of capacitor, that is, paper, electrolytic, or mica. Paper capacitors, such as tubular by-pass or coupling capacitors, or large paper blocks, are tested for capacity on microfarad meters similar to the Weston Type 372. The leakage test is conducted on megohm meters similar to the Biddle Megger and the special type leakage meters developed by Aerovox.

The breakdown test is a flash test at three times the rated operating voltage, the capacitor being charged and then discharged through a resistance circuit. The exact value of flash voltage is determined primarily by the insulation used in the capacitor and by the customer's specification.

ELECTROLYTIC CAPACITOR TESTS

Electrolytic capacitors are individually tested: first, as sample capacitors made from rolls of foil after preforming; secondly, each section is tested at its proper voltage after being wound and formed; and, finally, after the sections have been assembled and formed down to the exact operating voltage.



Chemical analysis by titration.

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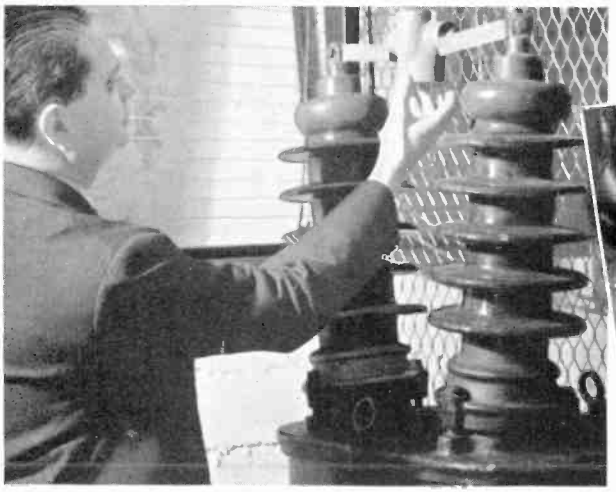
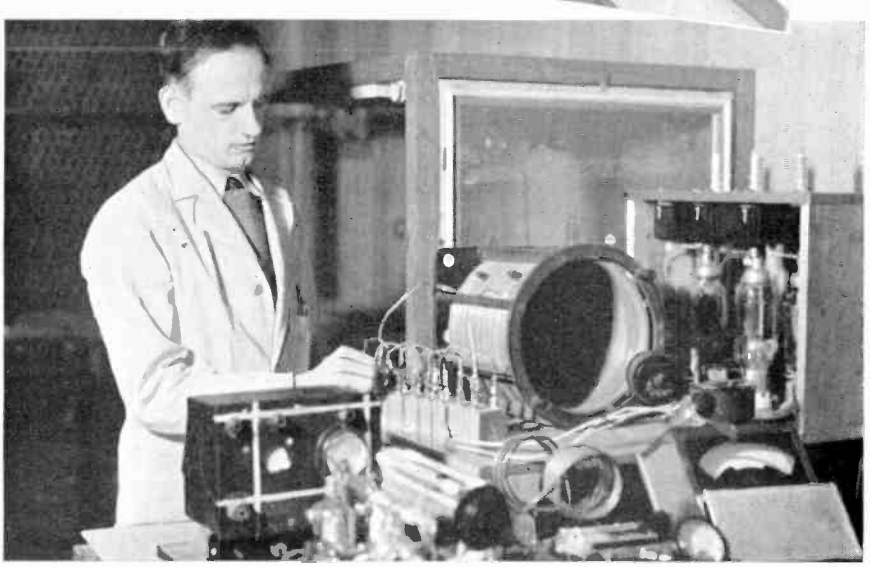


Upper left:
Voltage breakdown of impregnating material in standard A.S.T.M. cup.

Upper right:
Gauging and sorting mica for thickness.

Right
Final test of mica capacitors for capacity and Q.

Bottom:
Subjecting bakelite-cased mica transmitting capacitors to a r.f. current-carrying-capacity heat run.



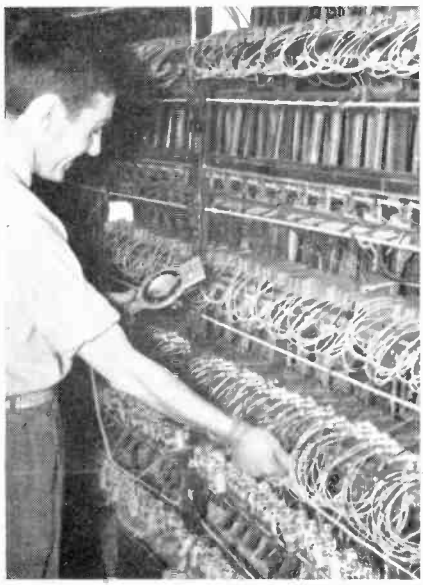
Electrolytic capacitors are tested for capacity and electrical leakage by means of a microfarad meter and special leakage circuit device using two-range milliammeters to determine the leakage with greater accuracy. All electrolytic capacitors are spot-checked usually on a Wien bridge where they are measured for capacity, power factor, and leakage, the test being performed at rated d.c. voltage and 60 or 120 cycles per second a.c., depending upon the customer's specifications and the particular use for which the unit is designed.

MICA CAPACITOR TESTS

All mica capacitors are individually measured for capacity, voltage-breakdown, power factor, electrical leakage and, sometimes, Q.

The capacity measurement is made on a microfarad meter, Weston Model 372, an oscillator, or on a Q checker. The particular type of instrument used for any measurement is determined by the capacity of the capacitor and the accuracy required. Capacitors of capacity up to 1000 mmfd. are normally tested on the oscillators or the Q checkers, while capacitors above 1000 mmfd. are usually tested on microfarad meters, except where extreme accuracy and relative values of Q are desired. The oscillators are capable of selecting capacitors with an accuracy of plus or minus 3% while the Q checkers are capable of selecting capacitors to within 1% of the specified capacity, or plus or minus ½ a mmfd.—whichever is the larger value.

The power factor is usually determined at 1000 cycles by means of a General Radio Type 216B capacity bridge using General Radio Type 222 precision variable condensers as standards. This bridge is also used for a spot-check of standard production runs and has an accuracy well within ½ of 1% and can be read to better than 1/10 of a mmfd. for values up to 250 mmfd. The entire bridge is built into a specially shielded com-



Final tests for leakage of electrolytic capacitors.

partment which is heated slightly above room temperature at all times to eliminate the effects of humidity on the accuracy and characteristics of a bridge and the standard capacitors. The substitution method is used for all measurements on this bridge.

All individual capacitors are flash-tested before molding as well as after; this last as a final check, after the capacitors have been molded, cleaned, and tested for capacity and leakage. The flash test for mica capacitors is normally 1000 volts for 500 volt capacitors and in proportion to the rated voltage for other values. The voltages may be a.c. or d.c. depending on the construction of the unit and its application. The leakage testers, which are integral parts of the flash testers, use meters similar to those used for paper condensers.

LIFE TESTING

To determine the validity of a design it is necessary that the capacitors be subjected to some type of life test or accelerated life test. This test may take several forms in order to determine the capacitors' ability to withstand voltages at high temperatures or in atmospheres of high relative humidity and temperature.

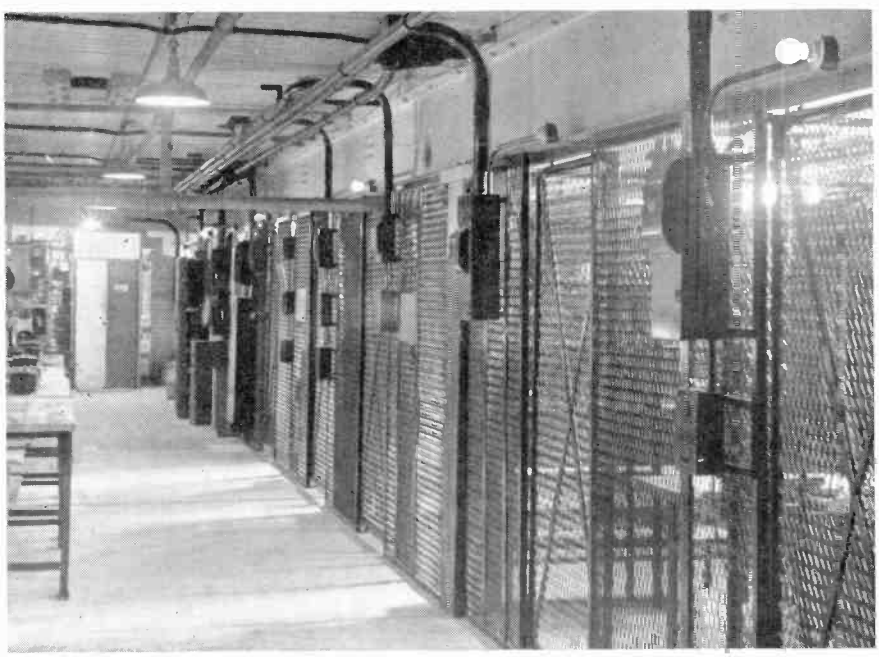
To determine the life of the capacitor at voltages greater than the rated voltage, capacitors are usually subjected to voltages of 2, 3, and 4 times rated voltage at room temperature and room humidity. That is, capacitors are connected in series with a current limiting resistor of 5 to 10,000 ohms and are operated continuously on this test until all units have failed. The broken-down units are removed as they fail to meet the test. To determine the life of the capacitors in humidity the capacitors are connected to a voltage source delivering twice the rated voltage through current limiting resistors, as before, while the capacitors are in an atmosphere having a relative humidity of between 95 and 100%, and a temperature of 100 degrees F. This humidity and temperature condition is obtained by placing the heaters in the pan of water at the bottom of the humidity tank, which is totally enclosed, and the condensation of the vapor in the tank is allowed to drip on the capacitors under test. These capacitors are also tested at temperatures higher than atmospheric or room temperature by placing them in ovens operating at 100 degrees F. and higher. The voltage impressed on the units under this test may be 2, 3, or 4 times the rated voltage of the condenser.

In addition to the above test on paper capacitors, tubular capacitors are also tested for maximum operating temperature, for wax-drip, for end-fill sealing and on bump tests to determine the tenacity of the bond between the end-fill and the paper tube. Similarly, oil and wax capacitors are tested under heat and vacuum for any leaks that may develop in the container or the terminals. Here again, customers' special specifications or requirements determine the type of test.

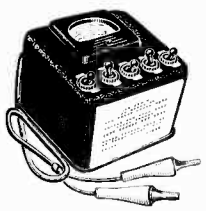
Electrolytic capacitors are placed in life test with both d.c. and a.c. voltages applied, the magnitude of the voltages being determined by the type of unit, the percentage of ripple being determined by the construction of the capacitors and the materials used therein. The temperatures at which these capacitors are tested are determined usually by the customer's specifications although 150° F is considered a standard test temperature. Electrolytic capacitors may be tested in humidity, although this is not a standard test.

Interior view of higher temperature room for testing oil-impregnated capacitors.

Mica capacitors are also tested for life under various conditions of temperature, voltage and humidity. Mica transmitting capacitors are usually given a radio frequency heat run at a specified frequency and current to determine the efficiency of the unit under actual operating conditions.



A partial view of the life-test vaults. These vaults are protected by heavy iron grilles, doors and safety switches.



● This is the AEROVOX CAPACITOR SELECTOR. Clip it in place of defective capacitor. Flip toggle switches for different capacities and note when adequate starting torque is obtained within 3 seconds and under 138 volts peak. Read required capacity from "On" switches. This instrument has been reduced to

New Price **$10.00**

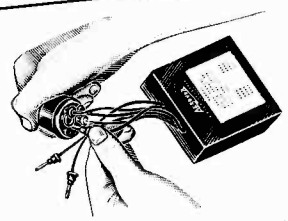
● If you service electric refrigerators, you know the riddle—"What Replacement shall I use, in the absence of positive identification by means of capacitor label or motor nameplate?"

But now it's easy to answer that riddle. If there's no identification whereby you can pick the right replacement from AEROVOX up-to-the-minute listings, then use the AEROVOX CAPACITOR SELECTOR. Tells you what capacity is needed.

Then, to get that capacity, take an AEROVOX EMERGENCY UNIT, plug in necessary sections to make up total capacity, clip in place, and Presto! Refrigerator is back at work. Later, at your convenience, install permanent capacitor.

Ask Your Jobber . . .

He'll gladly show you these two aids to prompt, positive, profitable electric refrigerator servicing. Ask for latest data. Or write us direct.



● This is the AEROVOX EMERGENCY UNIT. Provides any capacity from 17½ to 152½ mfd., by plugging in different sections. Slips in place of defective capacitor, for an emergency replacement. Gets motor started in a jiffy. Later, at serviceman's convenience, it is replaced by standard replacement capacitor. Now reduced to

New Price **$4.00**

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New Bedford, Mass.

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