

VRPS TALK 1/17/26

ELECTROLYTIC CAPACITOR DISCUSSION
SILVER-MICA FAILURE IN IF TRANSFORMERS
TROUBLESHOOTING WITH AN INFRARED
CAMERA

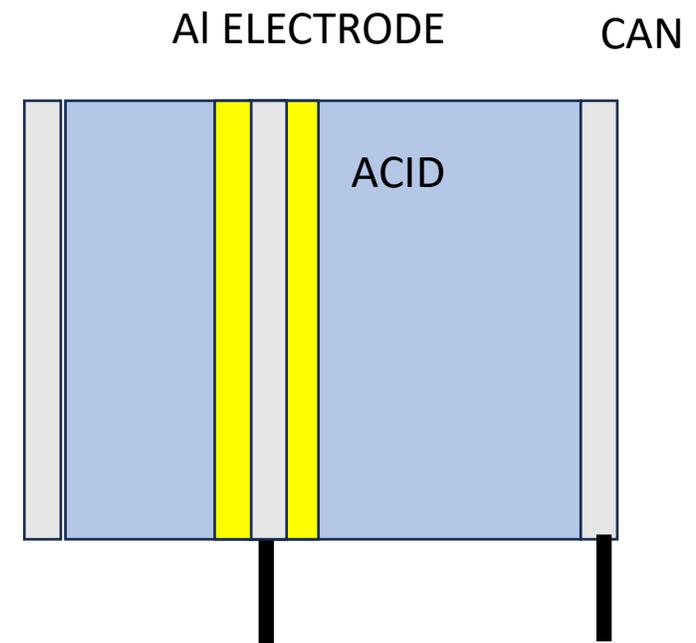
ELECTROLYTIC CAPACITORS - TYPES

- WET ELECTROLYTICS- 1920s
- DRY ELECTROLYTICS - 1930s- PRESENT
- TANTALUM ELECTROLYTICS – NOT USED IN RADIOS, USED FOR SMALL SIZE, HIGH CAPACITANCE/VOLUME, HIGH RELIABILITY

WET ELECTROLYTICS 1920s – EARLY 1930s



- CAN FILLED WITH ACID
- ACID DRIES UP
- CAPACITANCE → ZERO



DRY ELECTROLYTIC STRUCTURE



ALUMINUM
SHEET

ALUMINUM
SCREEN

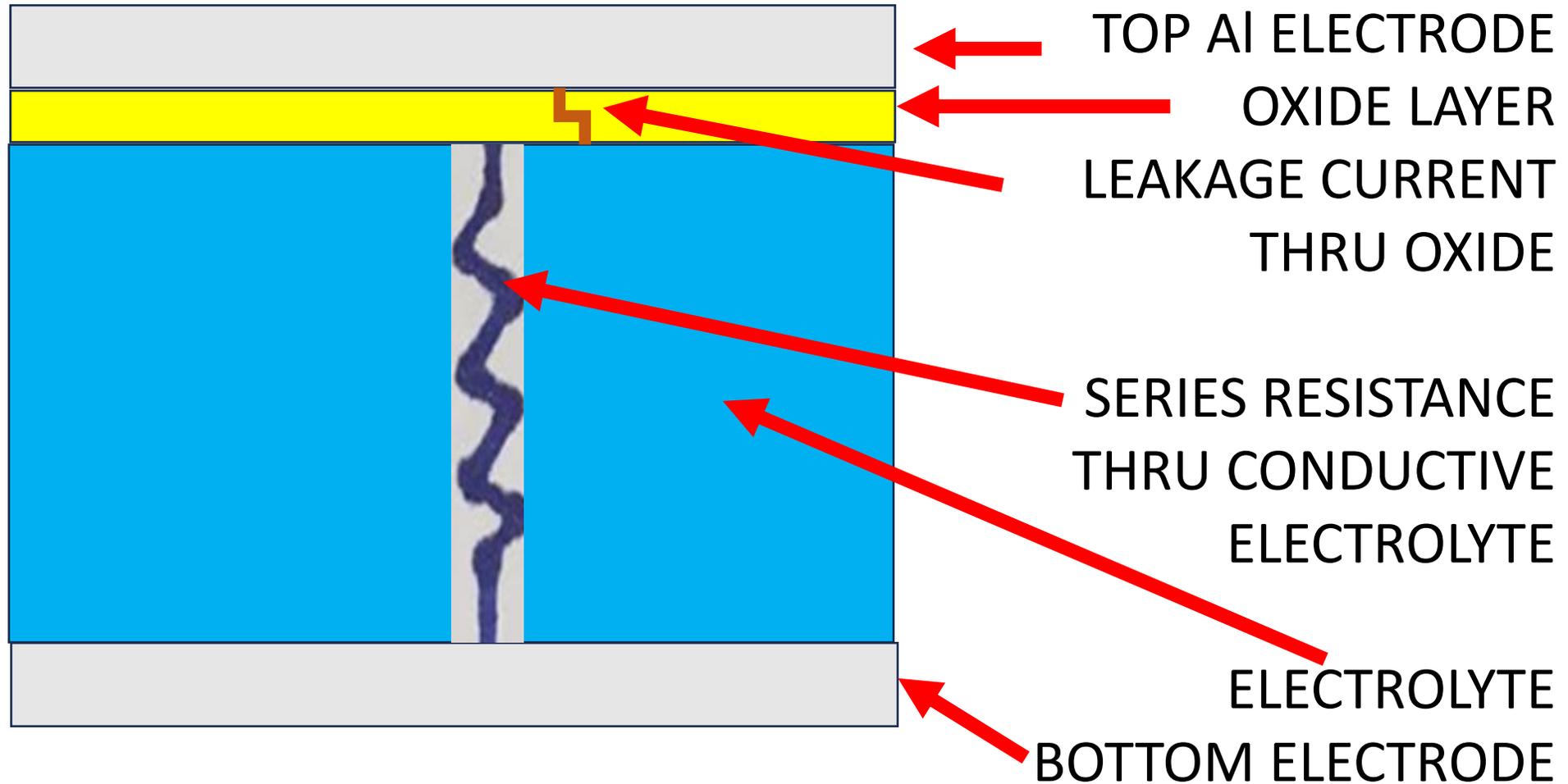
CONDUCTIVE ELECTROLYTE IN FELT PAD

TYPICAL LIFETIME ~ 25 – 40 YEARS

NEED TO CHECK CAPACITANCE AND LEAKAGE AND POWER FACTOR
I REPLACE ALL ELECTROLYTICS IN TUBE RADIOS

WHY DO ELECTROLYTICS GO BAD?

CORROSION UNDER OXIDE LAYER CAUSES LEAKAGE



2 ELECTROLYTIC FAILURE MODES

1

- LEAKAGE, CAPACITANCE MAY BE OK
 - IN ALL TYPES, ALL VOLTAGE IS ACROSS ALUMINUM OXIDE LAYER- ABOUT A MICRON THICK
 - LEAKAGE IS THRU DEFECTS IN OXIDE DUE TO CORROSION
 - DEFECTS INCREASE WITH AGE DUE TO THERMAL EXPANSION
 - EXCESS LEAKAGE HEATS THE ELECTROLYTE
 - LEAKAGE INCREASES WITH TEMPERATURE
- RESULT: HIGH LEAKAGE HEATS CAP. MAY SHORT OR SPRAY CORROSIVE JUICE OUT

2

- LOW CAPACITANCE, LEAKAGE MAY BE OK
 - ELECTROLYTE EVAPORATES OUT,
 - SERIES RESISTANCE INCREASES, CAPACITANCE DECREASES
- RESULT: NO FILTERING, CAP IS OPEN, GET HUM

REFORMING LEAKY ELECTROLYTICS

- SOME LEAKY CAPS CAN BE “REFORMED” IF NOT TOO BAD
- "REFORMING" AT LOW CURRENT REGROWS OXIDE SLOWER THAN ELECTROLYTE IS HEATED
- BUT IT DOESN'T CORRECT THE UNDERLYING FAILURE MECHANISM AND **REFORMING DOESN'T LAST**
- REFORMING DOESN'T CORRECT POWER FACTOR
- I DON'T RECOMMEND IT- NEW CAPS ARE CHEAP

REFORMING PROCEDURE

- APPLY VOLTAGE AND RAISE SLOWLY— MAYBE 10 VOLTS EVERY 10 MINUTES
- VOLTAGE SUPPLY CAN BE FROM CAP TESTER, VARIABLE POWER SUPPLY, OR THE RADIO POWERED THRU A VARIAC
- BEST METHOD IS TO MONITOR LEAKAGE CURRENT DURING REFORMING. WHEN CURRENT DROPS BELOW SOME CHOSEN VALUE, RAISE VOLTAGE AGAIN.

POWER FACTOR

- POWER FACTOR = % POWER WASTED IN INTERNAL SERIES RESISTANCE OF THE ELECTROLYTE
- SERIES RESISTANCE INCREASES AS ELECTROLYTE DRIES UP
- OVER ABOUT 5- 10% IS INDICATOR IT IS GOING BAD. WILL WORK BUT GOING BAD. MOST CAP TESTERS HAVE A POWER FACTOR TEST.
- ESR IS ONE OF KEY PARAMETERS IN CAP SELECTION FOR CERTAIN EQUIPMENT DESIGN. NOT TOO CRITICAL IN RADIO WORK.

CAPACITOR TESTING- SPRAGUE TO-6



TESTS:
CAPACITANCE,
LEAKAGE
POWER FACTOR

HAS METER TO
MEASURE
ELECTROLYTIC
LEAKAGE CURRENT

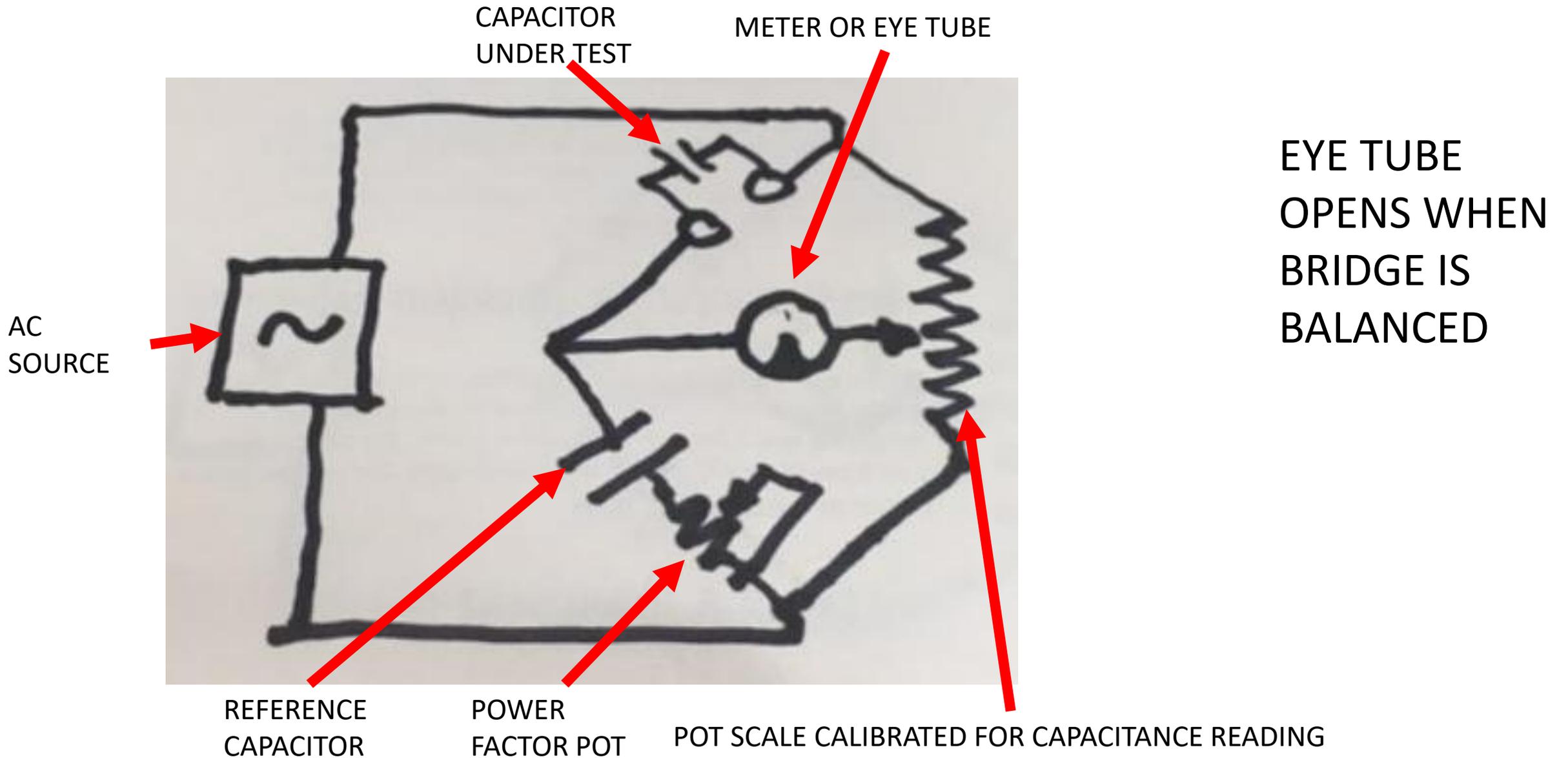
CAPACITOR TESTING- HEATHKIT

TESTS:
CAPACITANCE,
LEAKAGE, POWER
FACTOR

LEAKAGE CURRENT
CURRENT INDICATED
BY EYE TUBE (ONLY
GOOD FOR
ELECTROLYTICS)

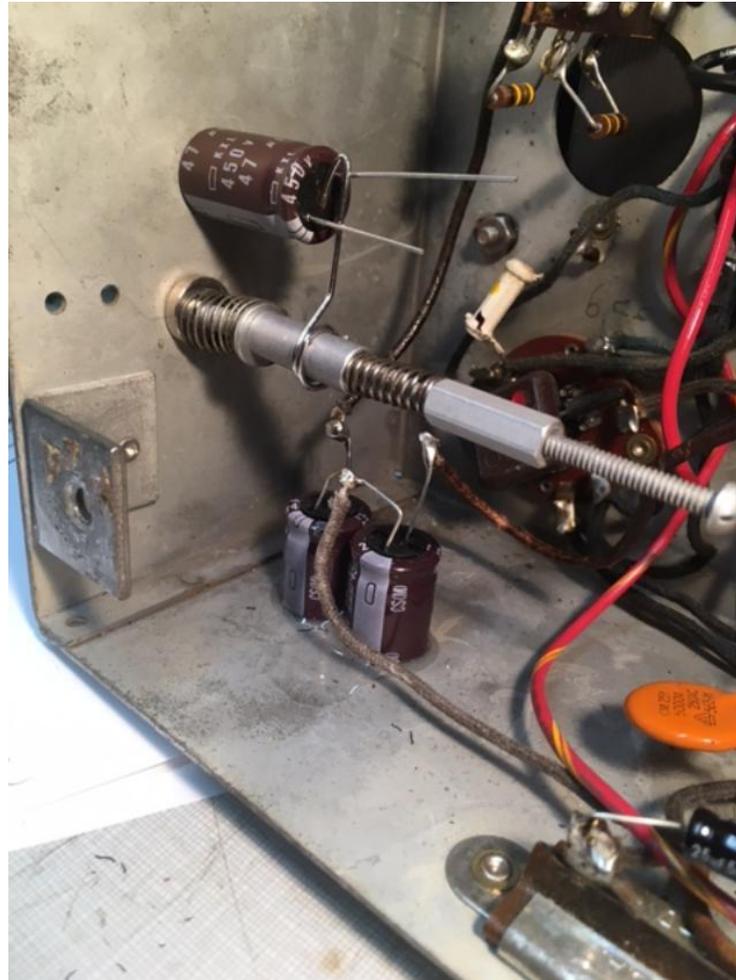


WHAT'S IN A CAPACITANCE BRIDGE?



MOUNTING RADIAL ELECTROLYTICS

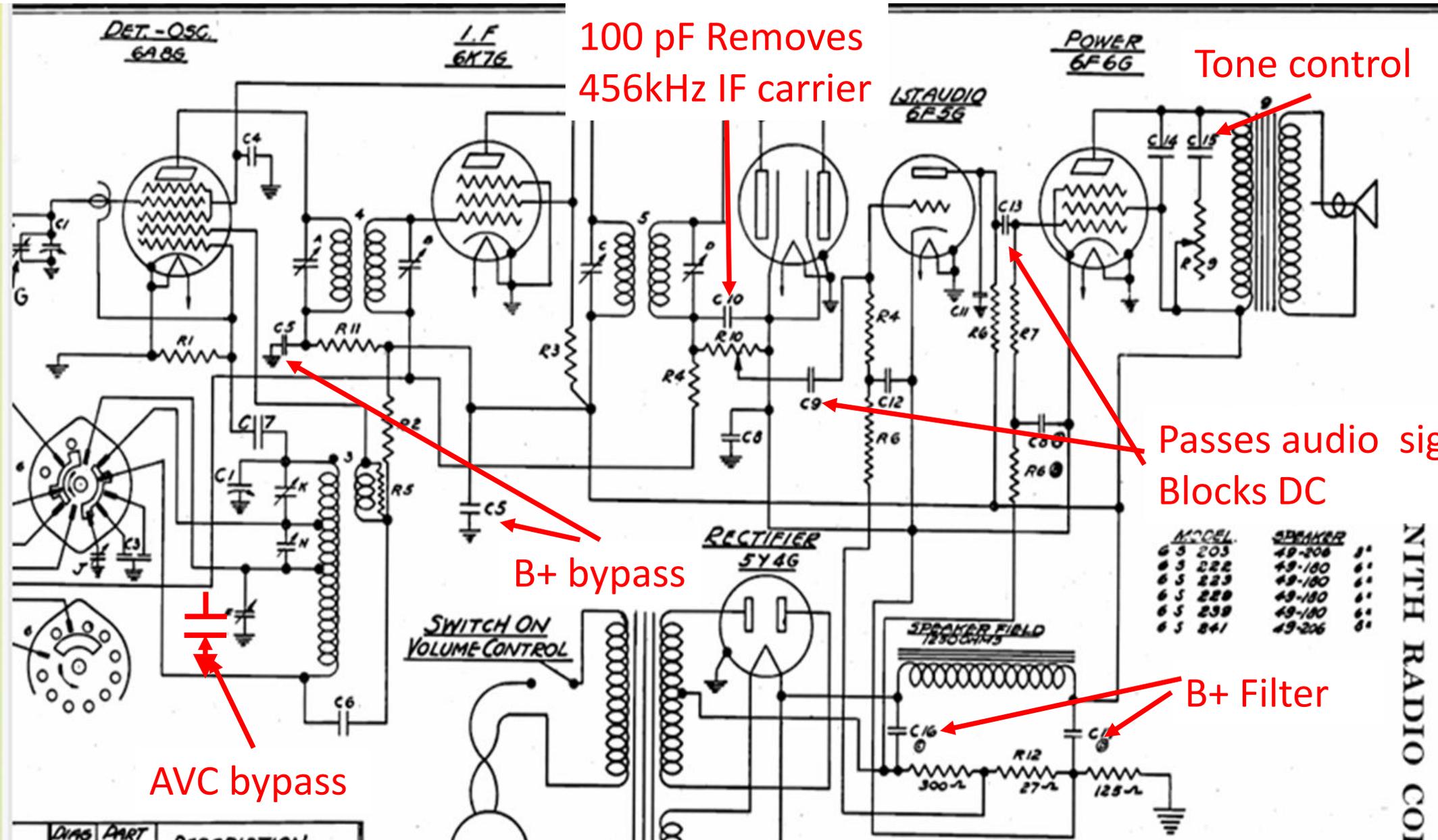
EPOXY TO CHASSIS AND CURL LEADS TO FORM NEW TERMINALS



CAPACITOR FUNCTION IN CIRCUITS

- POWER SUPPLY FILTER- SUPPLIES CURRENT TO LOAD WHEN RECTIFIED VOLTAGE IS DECREASING
- COUPLING BETWEEN STAGES - PASSES AC SIGNAL, BLOCKS DC
- BYPASS CAPS - STABILIZES VOLTAGE BETWEEN STAGES
 - VARYING CURRENT THRU TUBES CAUSES VARIATION IN PLATE & SCREEN VOLTAGE AT OTHER TUBES
 - SUPPLIES MOMENTARY CURRENT TO KEEP VOLTAGE STABLE
 - “ BYPASSES AC VARIATIONS TO GROUND”

WHAT ARE THESE CAPS THERE FOR?



MODEL	SPEAKER	
6 S 203	49-206	3"
6 S 222	49-180	6"
6 S 223	49-180	6"
6 S 228	49-180	6"
6 S 238	49-180	6"
6 S 241	49-206	6"

NITH RADIO CO

SELECTING CAPACITOR TYPES FOR APPLICATIONS

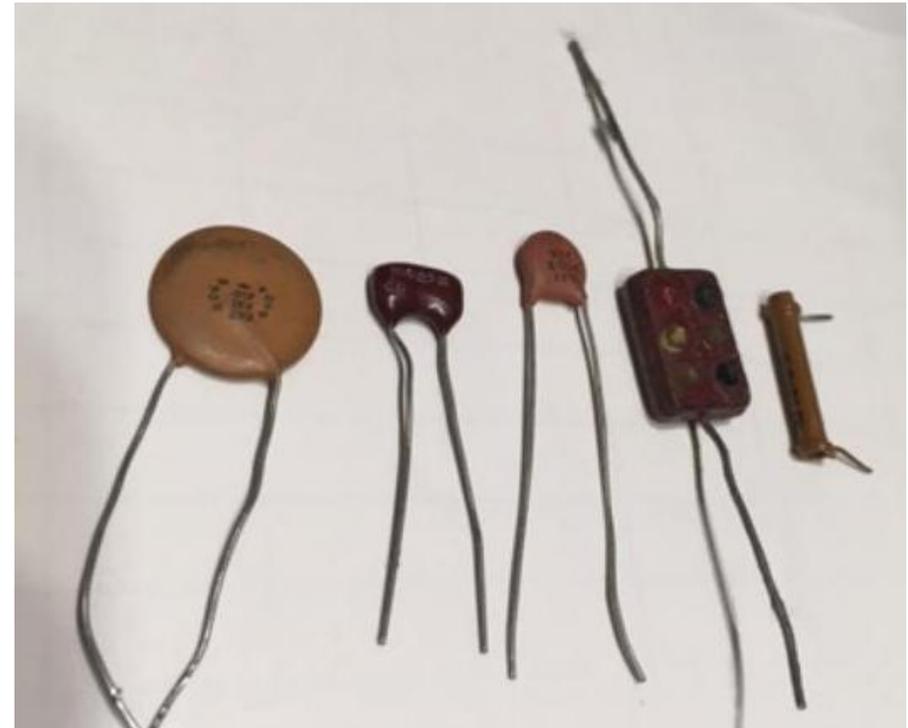
- FACTORS IN CAPACITOR SELECTION
 - VOLTAGE RATING
 - % TOLERANCE
 - TEMPERATURE RATING (85 C OR 105 C FOR FILTER CAPS)
 - TEMPERATURE COEFFICIENT OF CAPACITANCE (RF APPLICATIONS)
 - EQUIVALENT SERIES RESISTANCE (FILTER APPLICATIONS)
 - ALLOWED RIPPLE CURRENT
 - DIELECTRIC ABSORPTION (HIGH FREQUENCY APPLICATIONS)
 - A FEW OTHERS
- FORTUNATELY, IN RADIO REPAIR, VOLTAGE IS THE ONLY CONCERN

ORANGE DROP, YELLOW MYLAR & FILM CAPS AND DISC CERAMICS ALL EQUIVALENT FOR AUDIO AND BYPASS APPLICATIONS. USE MICA OR SILVER-MICA OR CERAMICS FOR REPLACEMENT IN RF CIRCUITS

0.1 mfd 0.05 mfd 0.01 mfd



CERAMIC & SILVER MICA

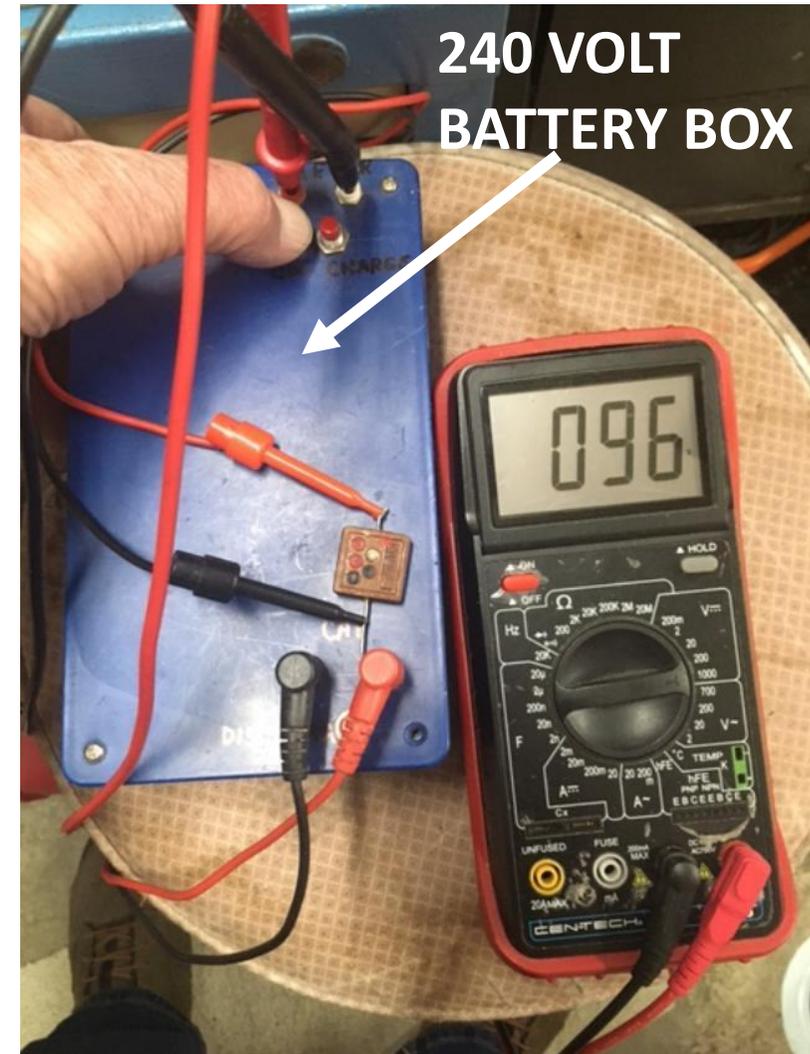


LARGE MICAMOLD CAP IS PAPER, NOT MICA
GET RID OF THEM



DO MICA CAPS HAVE SAME PROBLEM? NO, BUT CAN SOMETIMES BE LEAKY

SILVER IS ON OPPOSITE SIDES OF MICA SHEETS
THIS ONE HAS ABOUT 15 MEGOHMS LEAKAGE

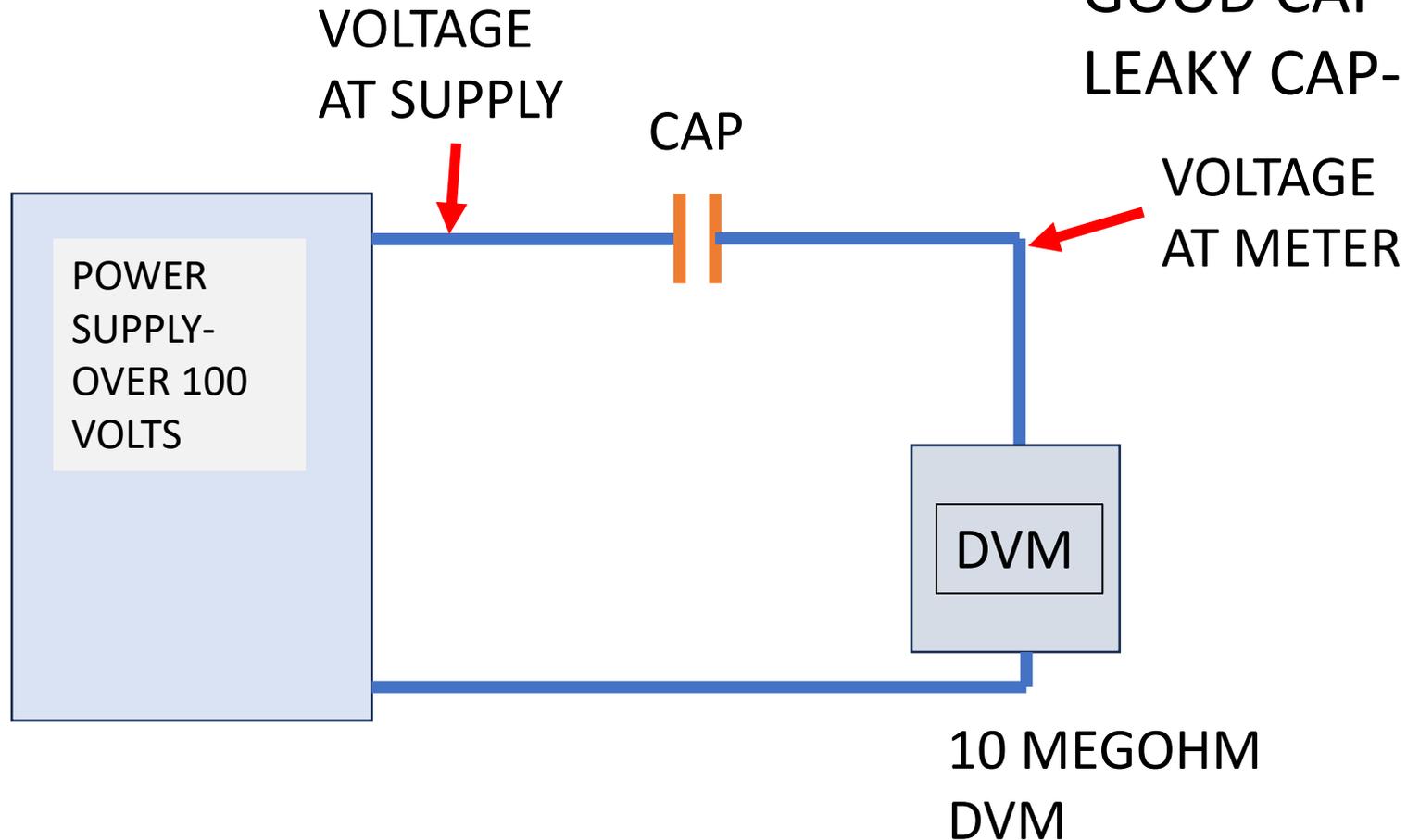


TESTING CAPACITORS FOR LEAKAGE

PAPER, MYLAR, MICA (NOT ELECTROLYTICS)

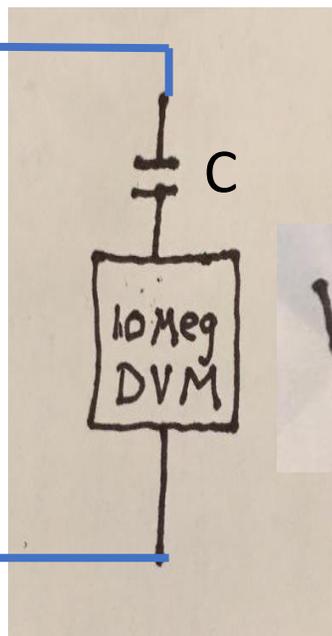
GOOD CAP- $V = \text{ZERO}$

LEAKY CAP- $V = \text{METER READING}$

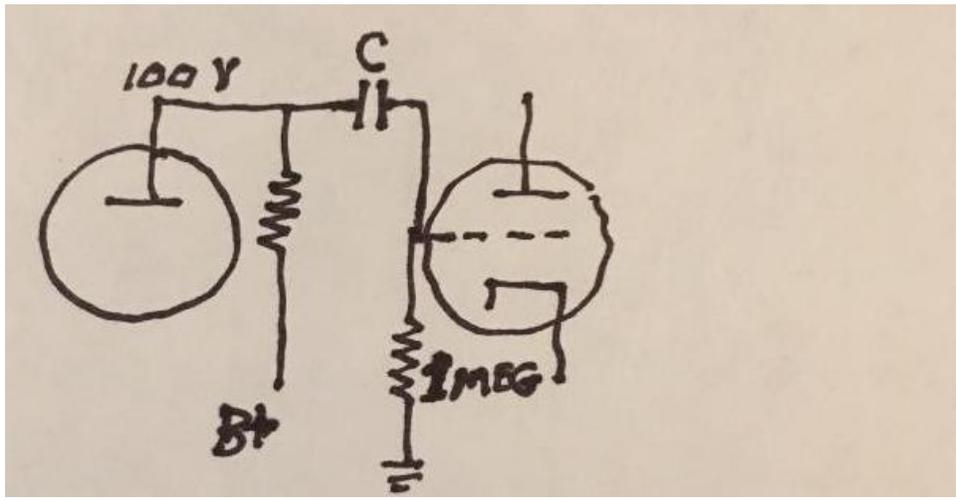


CAPACITOR LEAKAGE TEST- WHAT DO LEAKAGE NUMBERS MEAN? HOW MUCH IS TOO MUCH?

VOLTAGE SOURCE
 $V_{in} = 240$



$$V_{DVM} = \frac{10M}{R_C + 10M} V_{IN}$$



EXAMPLE: $V_{dvm} = 40 V$

$$R_C = (240 * 10Meg - 40 * 10Meg) / 40 = 50 Meg$$

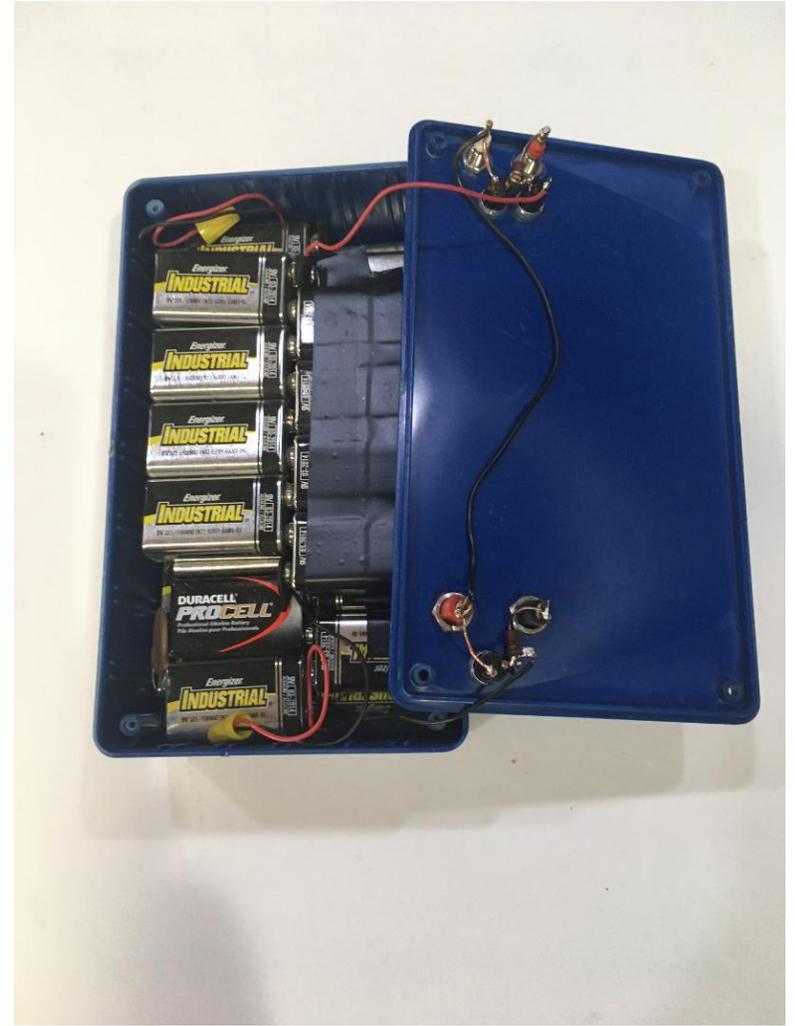
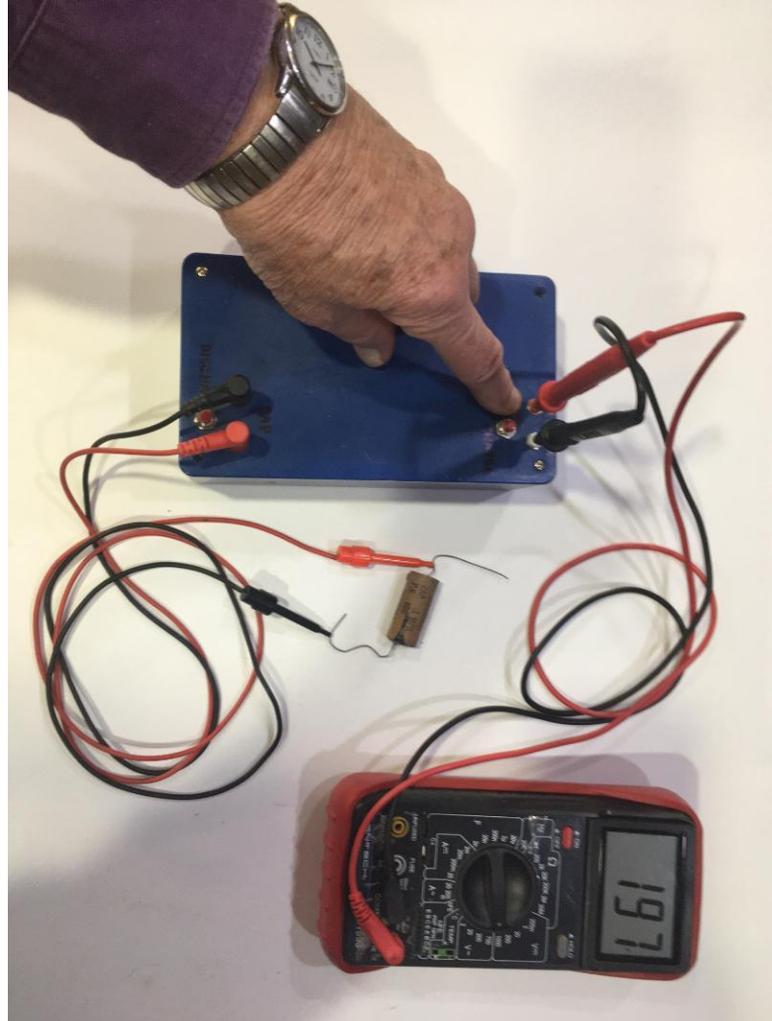
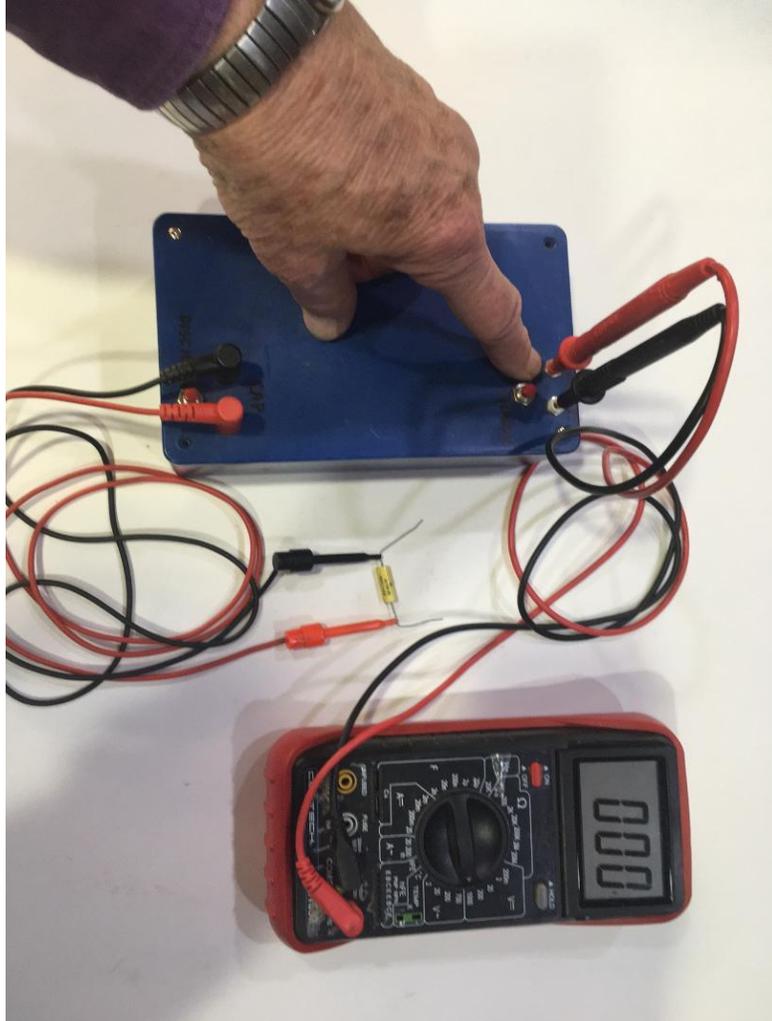
IF LEAKAGE IS 50 Meg and PLATE IS 100 V,

$$V_{grid} = 100 * 1Meg / (50 Meg + 1Meg) = 2 Volts$$

NOTE: LEAKAGE INCREASES WITH HEAT

TESTING CAPACITOR LEAKAGE WITH BATTERY BOX, 240 VOLTS ALSO GOOD FOR IF TRANSFORMER TESTS

DVM = ZERO -> NO LEAKAGE. DVM = 240 -> SHORT. IN BETWEEN = MEASURE OF LEAKAGE



CAPACITOR SOURCES

- I buy with quantity discount from Mouser on line :
 - 10uf and 22uf, 450 V electrolytic, 105 C, **radial leads**, about \$1 in lots of 10
 - Film caps: .01uf 400V, \$2 /10, \$17 /100
 - .047uf 400V, \$3.40 /10, \$24 /100
 - .1uf 400V, \$4.60/10, \$32/100

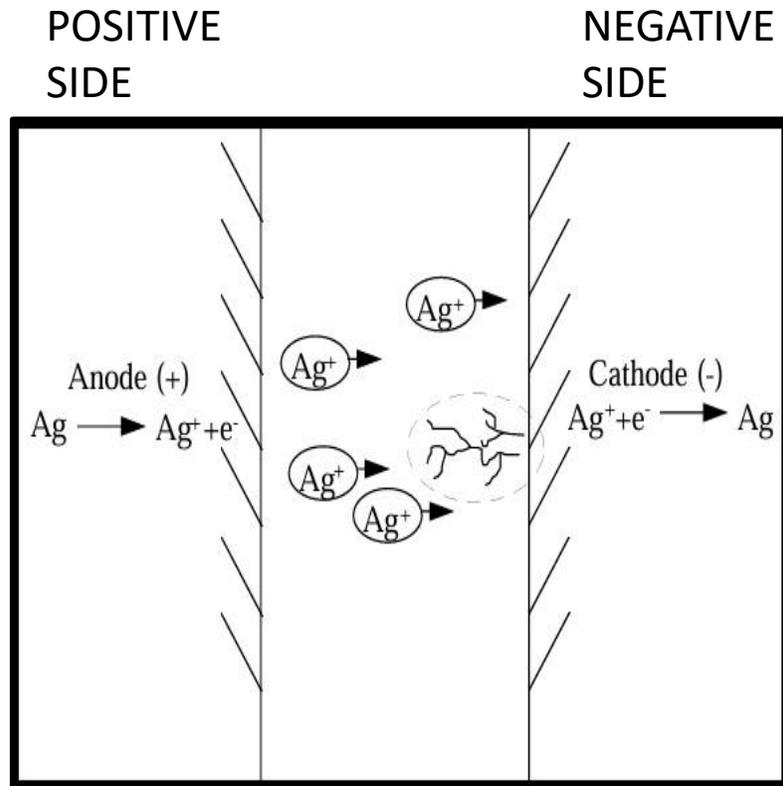
Just Radios.com is good source for axial types

SILVER-MICA FAILURE IN IF TRANSFORMERS

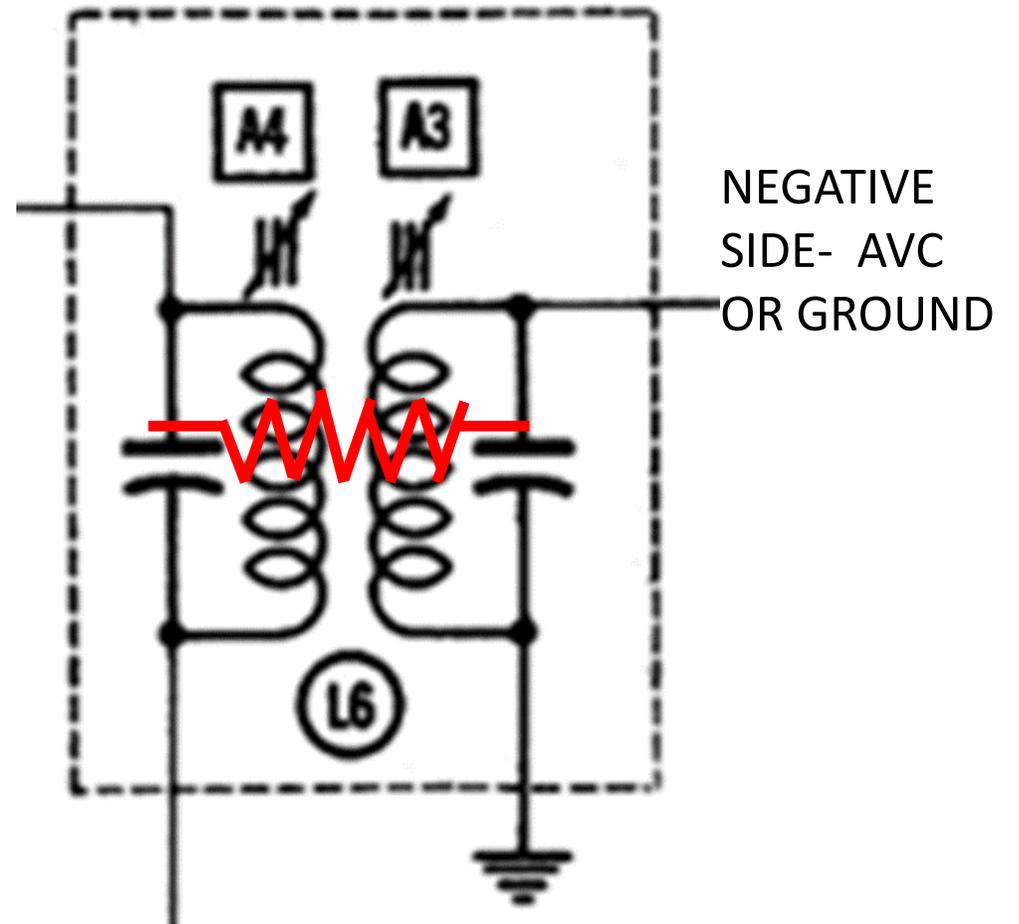
- FAILURE DUE TO ELECTROCHEMICAL NATURE OF ATOMS IN AN ELECTRIC FIELD
- SILVER CHLORIDE IS AN IONIC MOLECULE SUSCEPTIBLE TO BEING TRANSPORTED IN LESS THAN A MONOLAYER OF WATER

IF TRANSFORMERS AND SILVER-MICA PROBLEM

CHEMISTRY: E FIELD OF 20 V/mm IS ENOUGH.
OCCURS IN MONOLAYER OF SURFACE MOISTURE.
Ag ATOM +Cl MIGRATES IN E FIELD TO NEG SIDE



POSITIVE
SIDE-
TO PLATE



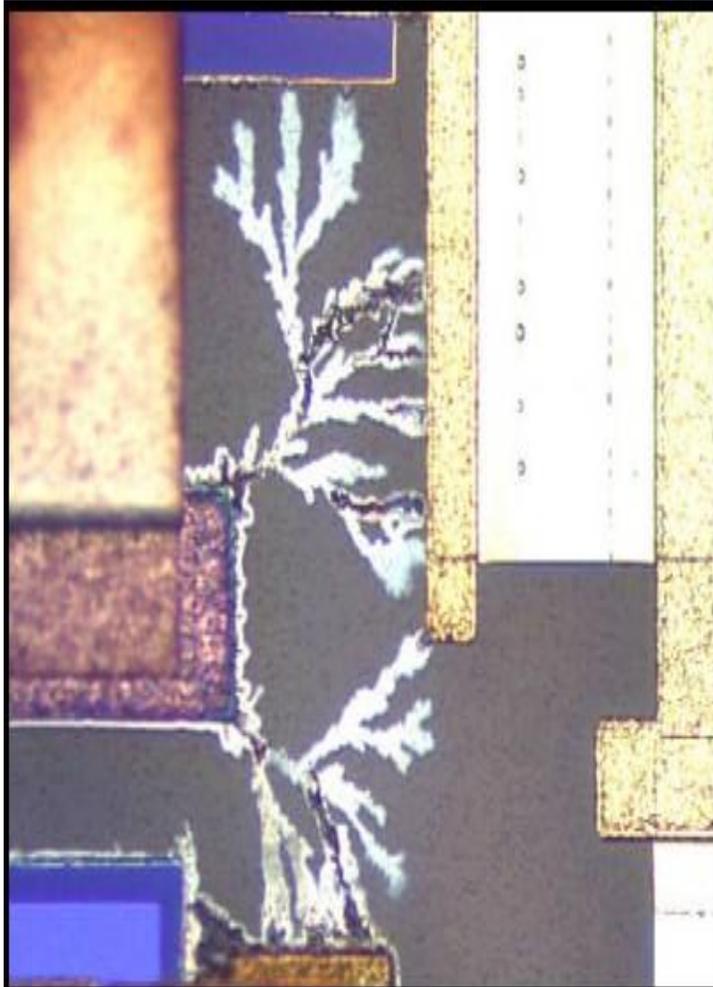
IF TRANSFORMERS AND SILVER-MICA PROBLEM

Ag ATOMS COME FROM POS SIDE,
DEPOSIT ON NEG SIDE

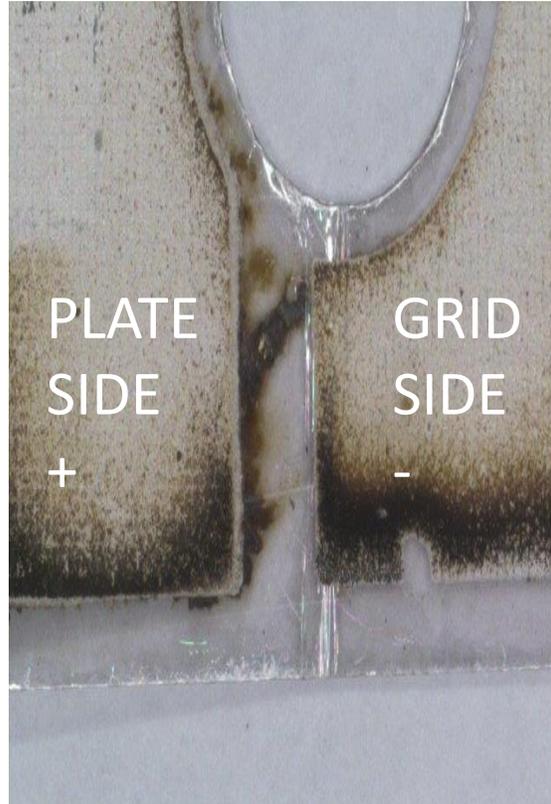
ELECTROMIGRATION

NEG SIDE

POS SIDE



CERAMIC HYBRID CKT

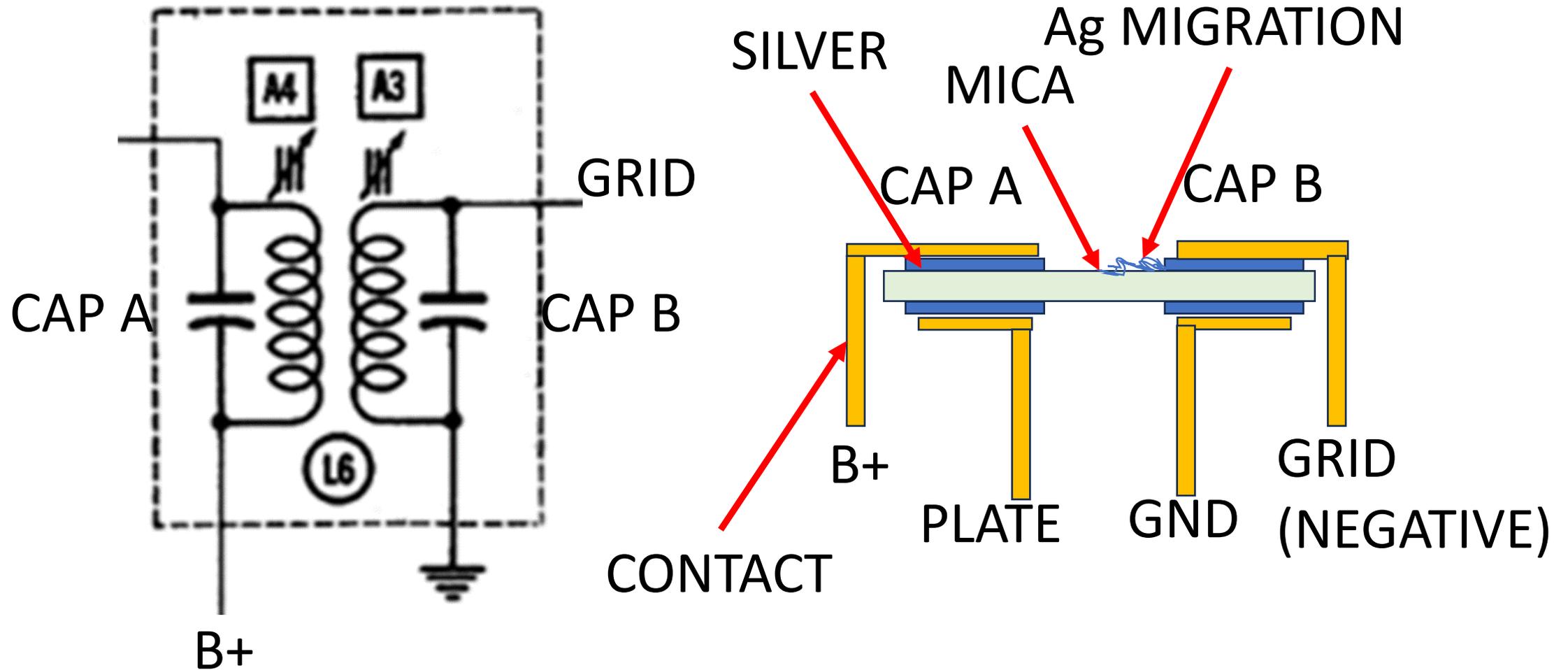


Ag ELECTRODES ON
SAME SIDE OF MICA IN
TRANSFORMER



MAGNIFIED

SILVER MIGRATION ONLY ONE SURFACE, NOT THRU MICA



TYPES OF IF TRANSFORMERS

VULNERABLE TO Ag-MICA PROBLEM?

1930s NO



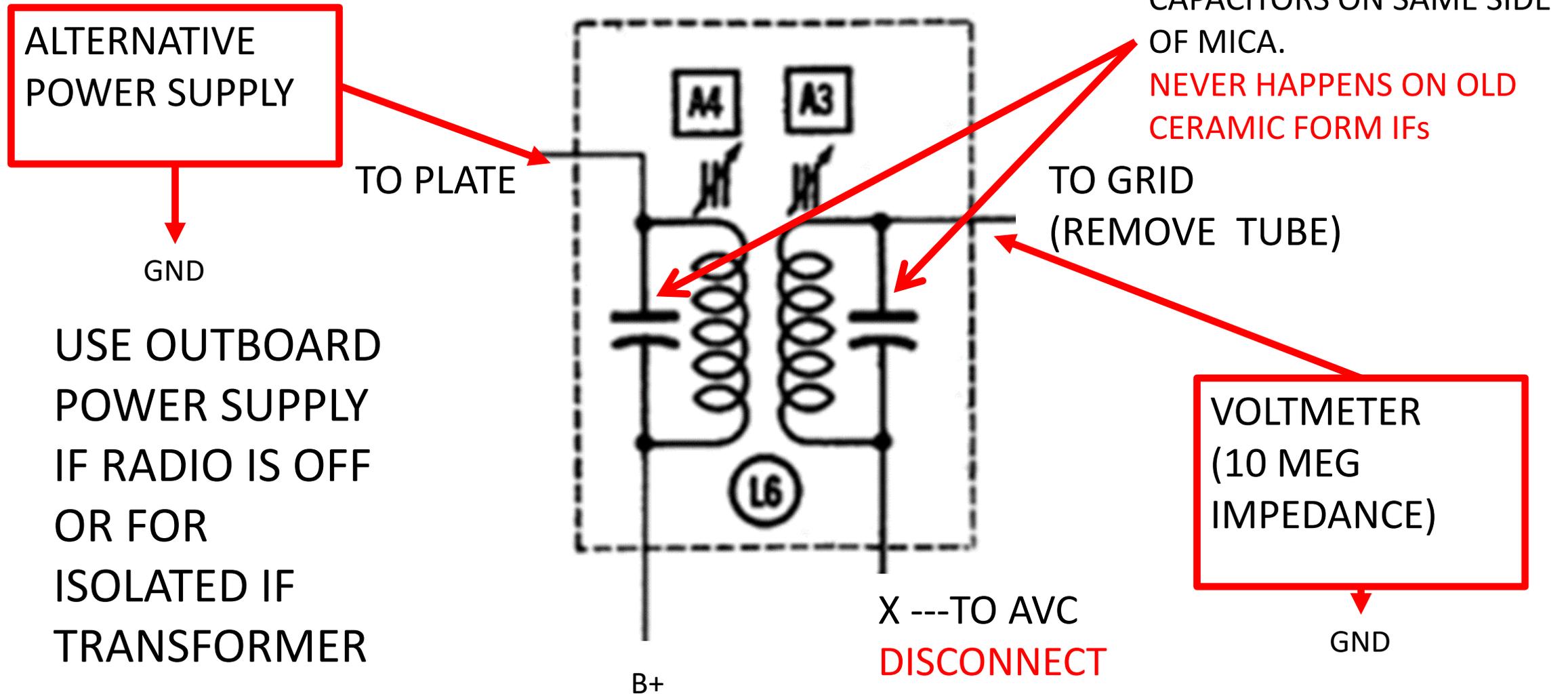
1940s NO



1950S-1960s YES

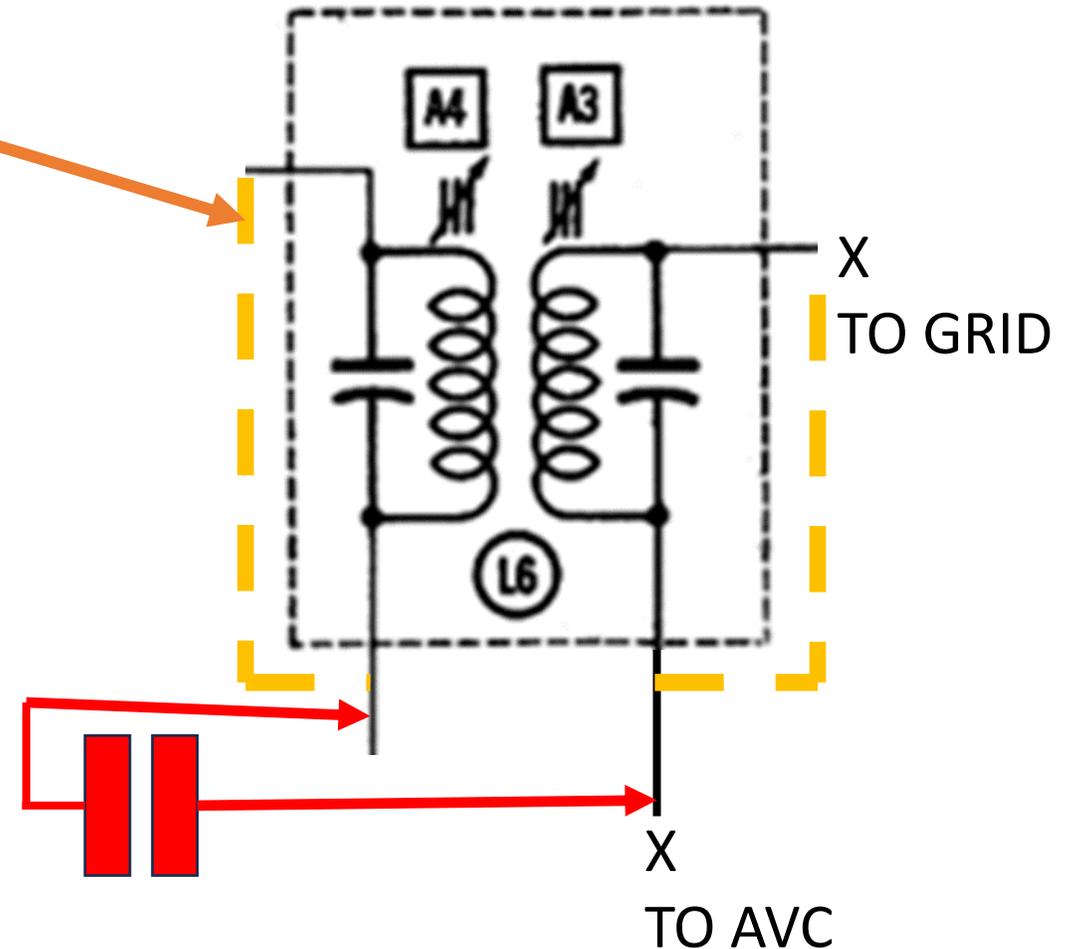


TESTING IF TRANSFORMERS FOR LEAKAGE



CAPACITIVE DISCHARGE TO CLEAR SILVER-MICA SHORTS- EMERGENCY MEASURE

- SHORT ACROSS BOTH COILS.
 - DON'T WANT CURRENT THRU COILS.
- DISCONNECT AVC LINE & PULL TUBES
- CHARGE 0.1 UF CAPACITOR TO ~400 V
- DISCHARGE CAP COIL TO COIL
- MAY NOT WORK. PROBABLY WILL REGROW IN TIME
- CANT REGROW WHEN RADIO IS OFF
- REPLACE IF TRANSFORMER WHEN POSSIBLE



REPLACING IFs: ADAPTER PLATE TO REPLACE LARGER CANS



- IN GENERAL, 3/4 INCH TYPES CAN REPLACE OLDER LARGE CANS.
- PERFORMANCE MAY CHANGE
- MUST KEEP SAME RESONANT FREQUENCY
- 455 KC AND 456 KC CAN BE INTERCHANGED AND RETUNED

LINE CURRENT INRUSH LIMITER

5 OHM NEGATIVE TEMP COEFFICIENT RESISTOR- HOT RESISTANCE ~ 1 OHM

PEAK LINE VOLTAGE IS $120 \times 1.41 = 169$ VOLTS

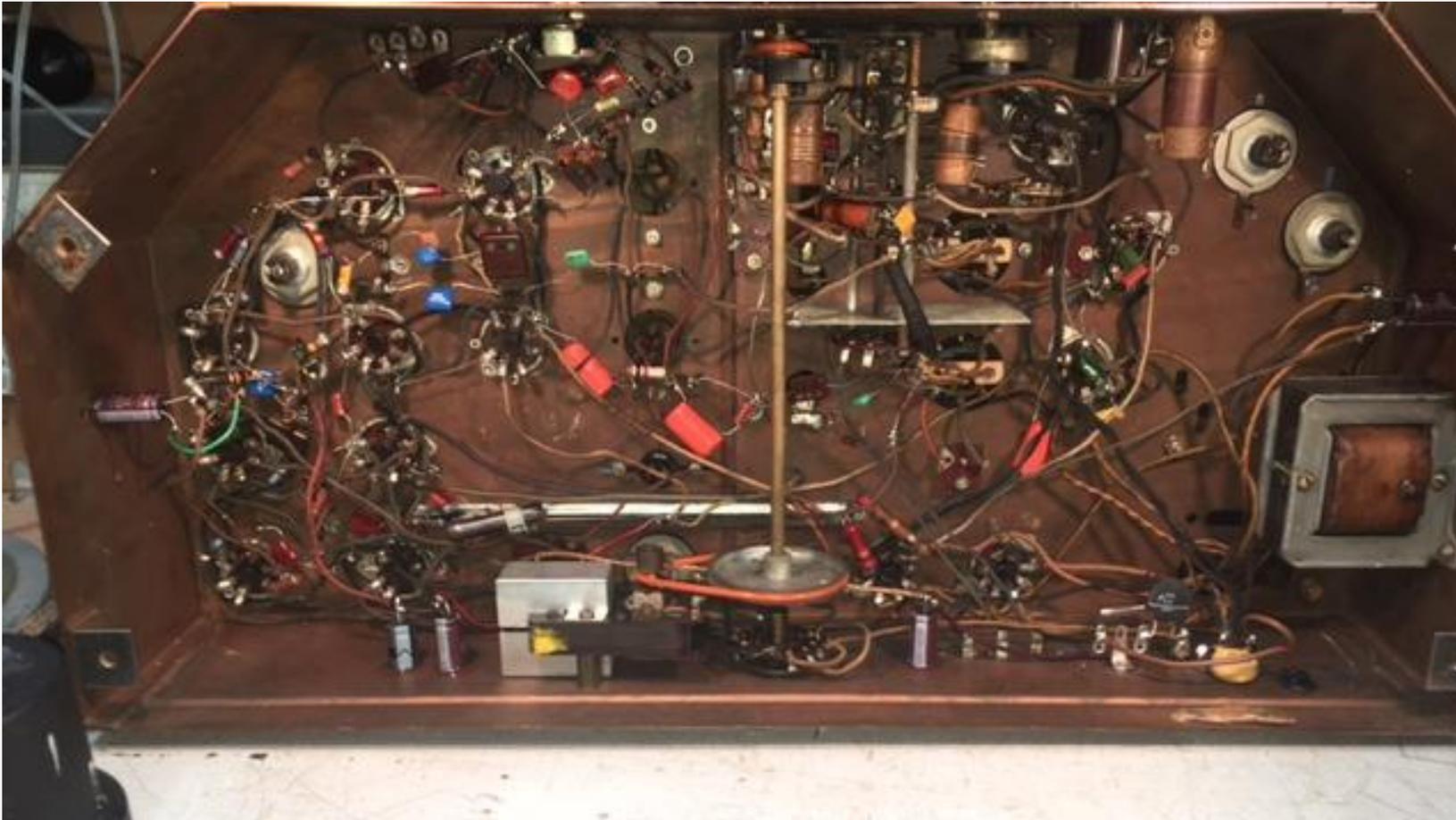
POWER TRANSFORMER PRIMARY RESISTANCE IN A 10-15 TUBE RADIO IS ABOUT 2 OHMS. FIRST CYCLE INRUSH CURRENT CAN BE $169/2 = 85$ AMPS



ADDING A 5 OHM
LIMITER TO
TRANSFORMER
PRIMARY REDUCES
THE PEAK POSSIBLE
SURGE TO 24 AMPS.

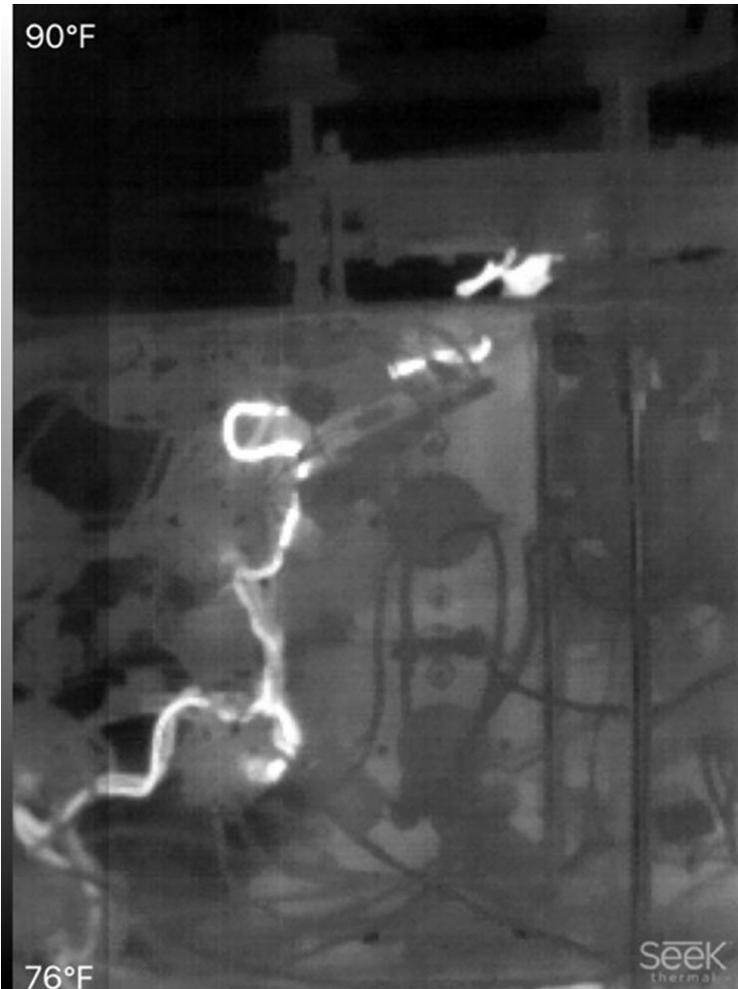
I ADD ONE TO EVERY
TRANSFORMER SET

TROUBLESHOOTING WITH AN IR CAMERA



- 15 TUBE ZENITH
- NO SOUND
- CURRENT DRAW 2
 AMPS, NOT 1.5
- FAINT SMOKE

THERMAL IMAGE SHOWS HOT WIRE



- CAMERA RESOLUTION IS UNDER 0.1 DEGREE
- HOT WIRE IS A FILAMENT LEAD
- TRANSFORMER CENTER TAP IS GROUNDED, BOTH SIDES OF FILAMENT SHOULD BE ~ 3 VOLTS
- ONE SIDE MEASURED 0.3 VOLTS
- FOUND SHORT TO GROUND AT A PILOT LIGHT SOCKET