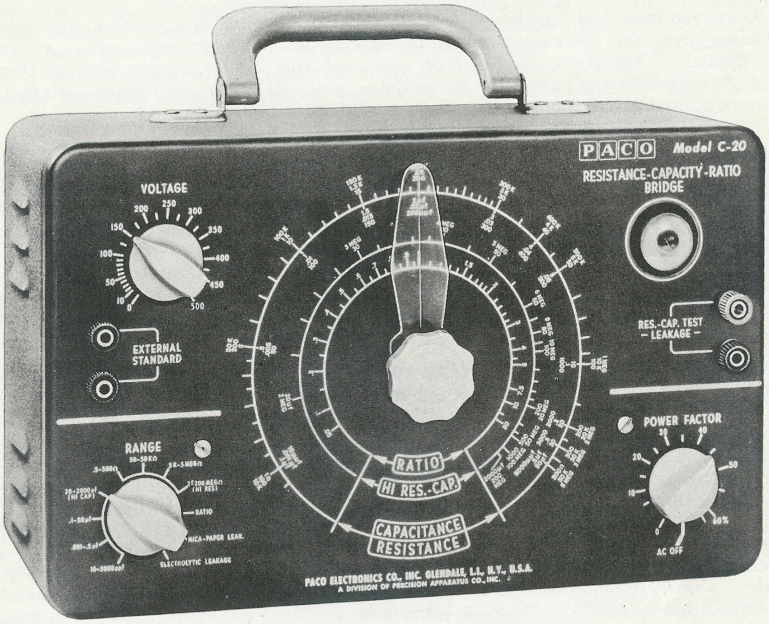
Manual . . . Net Price: $1.00

ASSEMBLY
and
OPERATING MANUAL
for

PACO

RESISTANCE-CAPACITY RATIO BRIDGE KIT
Model C-20

PACO ELECTRONICS CO., INC.
A DIVISION OF *PRECISION* APPARATUS CO., INC. 70-31 84th STREET, GLENDALE 27, L. I., N. Y.



SPECIFICATIONS

CAPACITANCE:

10 μμf to 2000 μf in 4 ranges: 10 μμf to 5000 μμf
.001 μf to .5 μf
.1 μf to 50 μf
20 μf to 2000 μf (separate HI-CAP. scale)

POWER FACTOR . . . . . 0 to 60% (on capacitors from .1 μf to 2000 μf)

RESISTANCE:

.5 ohm to 200 megohms in 4 ranges: .5 ohm to 500 ohms
50 ohms to 50K ohms
5K ohms to 5 megohms
2 megohms to 200 megohms (separate HI-RES. scale)

CAPACITOR LEAKAGE . . . . . Sensitive leakage test for all types of capacitors at rated voltages between 0 and 500V DC.

CAPACITOR TEST VOLTAGE . . . . . Continuously variable between 0 and 500V DC.

RATIO TEST . . . . Enables quick reactance or resistance ratio between any two capacitors, inductors or resistors, between .05 to 1 and 20 to 1. Can be used to determine turns ratio of transformer windings between .05 to 1 and 20 to 1.

POWER REQUIREMENTS. . . . . 117 volts, 60 cps. AC only, 25 watts.

Pages 2-7 were soldering and warranty information no longer useful thus deleted

All parts, after being checked against the parts list, should be placed where they are readily available and will not be lost or damaged. You may find it advantageous to group parts and place them in suitable containers.

To aid you in the placement of components, a system of alphabetical and numerical coding has been set up. Certain components such as switches and controls, have been coded with letter designations relating to the function of the component. For example, the designation "CT" indicates a control, and the designation "S" indicates a switch. In kits having more than one of this type of component, distinction between them is made by adding a second letter to the first in alphabetical sequence. For example, the designation SA indicates one switch, and the designation SB indicates a second switch, etc. All capacitors have been coded with "C" designations in numerical sequence (C1, C2, etc.), and all resistors have been coded with "R" designations (R1, R2, etc.). These capacitor and resistor designations are carried on the schematic diagram, in the parts list, and in the step-by-step instructions and wiring diagrams.

Other components such as tube sockets and terminal strips, have been assigned single letter designations having no particular reference to function. These designations are usually assigned in the order in which the component is installed, and will not always be the same in other kits. For example, the letter "A" may indicate a tube socket in one kit and perhaps a terminal strip or other component in another kit.

Numbers have been assigned to terminals on the various components. Thus a designation such as SA2 indicates terminal 2 of switch "SA"; SB3 indicates terminal 3 of switch "SB", etc.

You are now ready to proceed with the construction of your PACO R/C Checker kit.

ASSEMBLY PROCEDURE

( ) 1. Insert the three 3/8" rubber grommets in holes M, N and Q (Fig. 1).

( ) 2. Mount the transformer T1 at G (Fig. 2). Push the two black, the one yellow, the one white and the one green lead through the grommet at N. Then push the two red and the two brown leads through the grommet at M. Mount the transformer to the chassis with two #6 binding head screws, one lockwasher and two #6 nuts. On one screw use a #6 solder lug (P) instead of a lockwasher as shown in Figure 1.

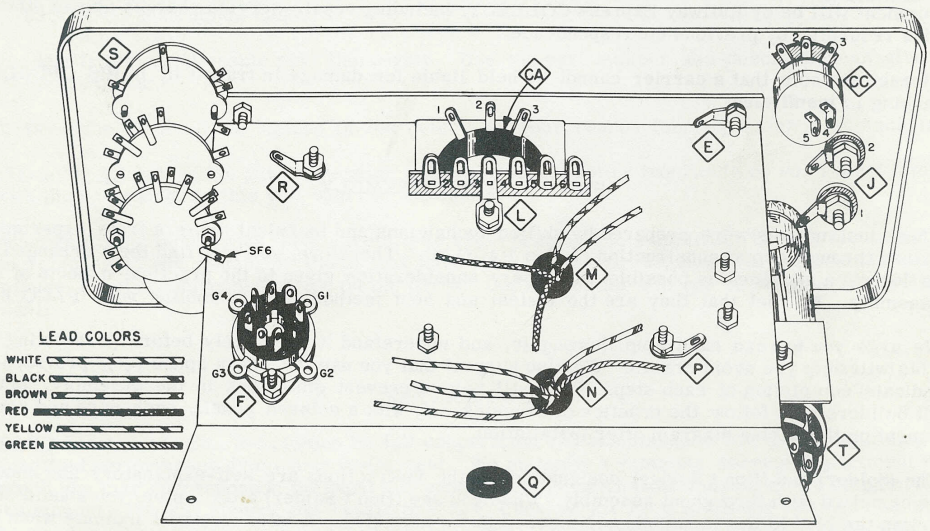


Figure 1

NOTE

A lockwasher is always mounted between the nut and chassis, not under the screw head.

( ) 3. Mount the Z bracket at H with two #6 binding head screws, lockwashers and nuts (Fig. 2).

( ) 4. Slip a #6 solder lug on a #6 binding head screw. Pass the screw through hole U from the top of the chassis and mount the 6-lug terminal strip "L" under the chassis on the same screw using a #6 lockwasher and nut. Orient the solder lug on the top of the chassis and terminal strip on the bottom of the chassis as shown in Figures 1 and 2.

( ) 5. Place the saddle mount octal socket in hole F with the key-way as shown in Figure 1. Mount the socket using two #6 binding head screws, lockwashers and nuts.

( ) 6. Mount a #6 solder lug at R under the chassis (Fig. 1) with a #6 binding head screw, and nut.

( ) 7. Position the "U" spring clip as shown in Figure 2 and mount it to the top of the Z bracket with a #6 binding head screw, lockwasher and nut.

( ) 8. Mount the red binding post (P20-189-1) to the front panel at J1 (Fig. 2) using a shoulder-washer, flat washer, #8 solder lug and #8 nut. The procedure for mounting a binding post is shown in Figure 3.

( ) 9. Mount the three black binding posts (P20-189) at J2, K1, and K2 as shown in Figure 3.

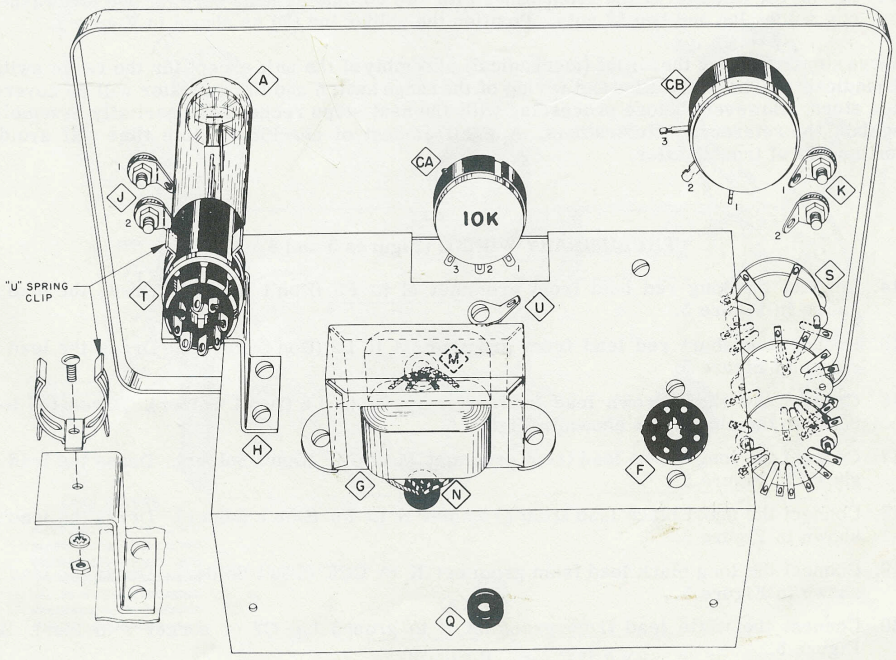


Figure 2

( ) 10. Bend over the positioning tab on the 1K control (P17-212) R14 (with switch) and mount it at CC (Fig. 1) using the control lockwasher, control bakelite washer and control nut. The procedure for mounting the control is shown in Figure 4. Position the control as shown in Figure 1.

( ) 11. Bend over positioning tab on the 10K wirewound control (P17-213) R11 and mount it at CA (Fig. 2) using the control lockwasher, control bakelite washer and control nut. Position the control as shown in Figure 2. Make sure you select the 10K control (R11) for this step not the 100K ohm control (R15).

( ) 12. Break off the bakelite positioning tab and mount the 100K wirewound control (P17-214) R15 at CB (Fig. 2). Position the control as shown in Figure 2.

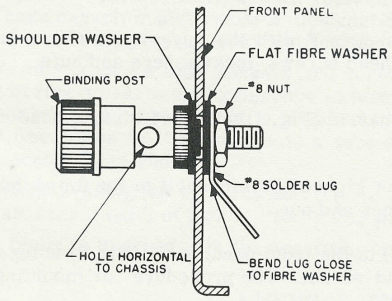


Figure 3 "SEE BLOW-UP NO.1"

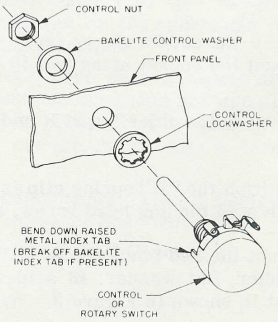


Figure 4 "SEE BLOW-UP NO.1"

( ) 13. Mount the chassis to the front panel with two #6 binding head screws, one lockwasher, one solder lug and two #6 nuts. Position the solder lug (E) as shown in Figure 1.

The above step completes the initial (mechanical) assembly of the unit except for the range switch and the indicator. The installation and wiring of the range switch and the indicator will be covered in later steps. However, before proceeding with the next steps recheck the partially assembled unit against the referenced illustrations. A small amount of checking at this time will avoid a greater amount of trouble later.

PRELIMINARY WIRING (Figures 5 and 6.)

( ) 14. Connect the long red lead from grommet M to F5 (Don't Solder). Dress the lead as shown in Figure 5.

( ) 15. Connect the short red lead from grommet M to L2 (Don't Solder). Dress the lead as shown in Figure 5.

( ) 16. Connect the short brown lead from grommet M to L6 (Don't Solder). Dress the lead close to the chassis as shown in Figure 5.

( ) 17. Connect the long brown lead from grommet M to CA3 (Don't Solder). Dress the lead as shown in Figure 5.

( ) 18. Connect the short black lead from grommet N to F4 (Don't Solder). Dress the lead as shown in Figure 5.

( ) 19. Connect the long black lead from grommet N to CC5 (Don't Solder). Dress the lead as shown in Figure 5.

( ) 20. Connect the white lead from grommet N to ground lug G2 of socket F (Solder). See Figure 5.

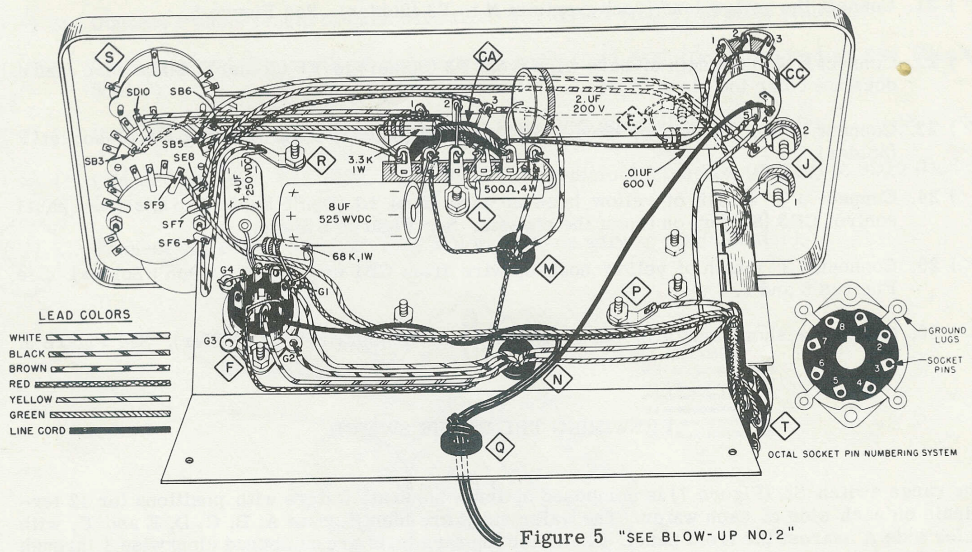


Figure 5 "SEE BLOW-UP NO. 2"

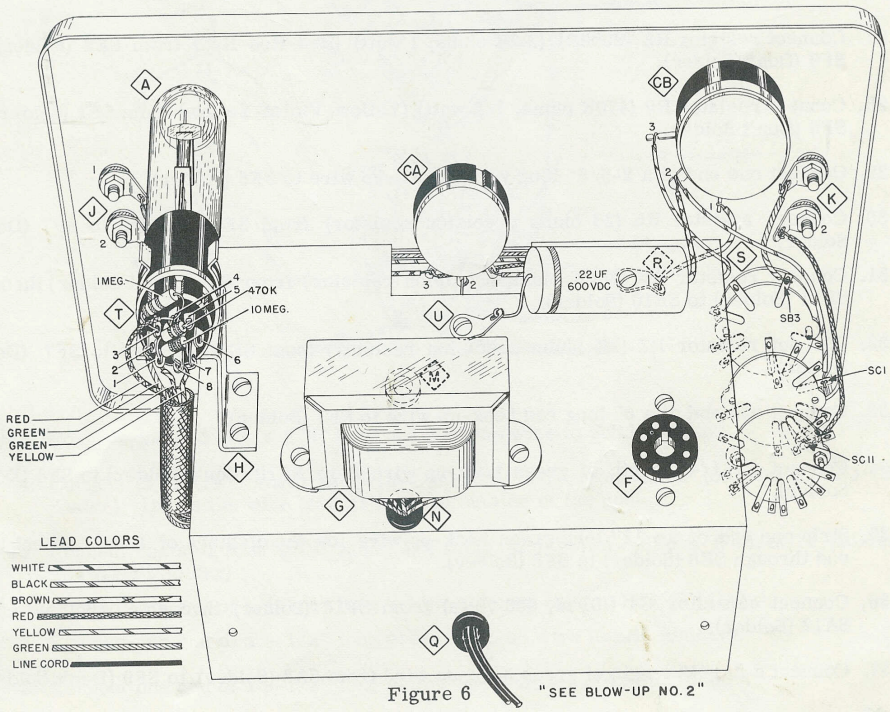


Figure 6 "SEE BLOW-UP NO. 2"

( ) 21. Connect the yellow lead from grommet N to F2 (Solder). See Figure 5.

( ) 22. Connect a short length of bare wire from F3 (Solder) to F5 (Solder). Make sure that it does not come too close to F4.

( ) 23. Connect a short length of bare wire from F7 (Solder) to ground lug G4 of socket F (Solder).

( ) 24. Connect a 7" length of yellow hook-up wire from L1 (Don't Solder) to the front panel control CB3 (Solder) on top of the chassis. See Figures 5 and 6.

( ) 25. Connect a 3" length of yellow hook-up wire from CB1 (Solder) to R (Don't Solder). See Figures 5 and 6.

( ) 26. Connect a short length of bare wire from L3 (Solder) to CA2 (Solder). See Figure 5.

PREWIRING THE RANGE SWITCH

The range switch S2 (Figure 7) is composed of three separate wafers with positions for 12 terminals on each side of each wafer. The wafer sides are identified as A, B, C, D, E and F, with wafer side A nearest the front panel. The wafer lug terminals are numbered clockwise 1 through 12, looking at the wafer from the front. Before proceeding, position the switch with the shaft away from you and lug F6 at the left pointing downward as shown in Figure 7 "A".

( ) 27. Connect resistor R8 (2200Ω) (2.2K ohms, 1 watt) (Red-Red-Red) from SE2 (Solder) to SF6 (Don't Solder).

( ) 28. Connect resistor R9 (470K ohms, 1/2 watt) (Yellow-Violet-Yellow) from SE1 (Solder) to SF6 (Don't Solder).

( ) 29. Connect one end of a 2-5/8" long yellow hook-up wire to SF6 (Solder).

( ) 30. Connect resistor R5 (20 ohms precision resistor) from SF12 (Solder to SF7 (Don't Solder).

( ) 31. Connect resistor R6 (200K ohms precision resistor) from SF7 (Don't Solder) through SE11 (Solder) to SE10 (Solder).

( ) 32. Connect resistor R7 (2K ohms precision resistor) from SE9 (Solder) to SF7 (Don't Solder).

( ) 33. Connect one end of a 6" long red hook-up wire to SF7 (Solder).

( ) 34. Connect a 1-1/4" length of green hook-up wire from SF10 (Don't Solder) to SF8 (Don't Solder).

( ) 35. Strip one end of an 11" long green hook-up wire for the distance of 1/2", connect this end through SE8 (Solder) to SF8 (Solder).

( ) 36. Connect capacitor C4 (.01 uf, 600 volts) from SF10 (Solder) through SB10 (Solder) to SA12 (Solder).

( ) 37. Connect a 2-1/4" length of green hook-up wire from SA8 (Solder) to SF9 (Don't Solder).

( ) 38. Connect a short length of bare wire from SC7 (Don't Solder) to SC10 (Solder).

( ) 39. Connect a 2-1/4" length of red hook-up wire from SC7 (Don't Solder) to SB5 (Don't Solder).

( ) 40. Connect capacitor C5 (.01 uf, 600 volts) from SC7 (Solder) to SA7 (Solder).

( ) 41. Connect resistor R12 (90K ohms precision resistor) from SD2 (Solder) to SD10 (Don't Solder).

( ) 42. Connect one end of a 5-1/2" long yellow hook-up wire to SD10 (Solder).

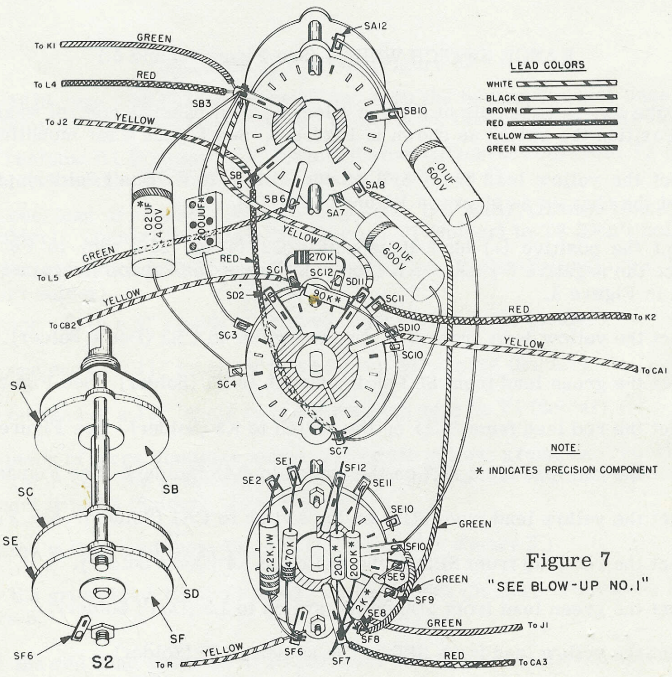


Figure 7
"SEE BLOW-UP NO.1"

( ) 43. Connect one end of a 3-5/8" long red hook-up wire to SC11 (Solder).

( ) 44. Connect a 2-1/4" length of yellow hook-up wire from SD11 (Solder) to SB3 (Don't Solder). Dress the wire lead around the outside of the post.

( ) 45. Connect resistor R16 (270K ohms, 1/2 watt) (Red-Violet-Yellow) from SC12 (Solder) to SC1 (Don't Solder).

( ) 46. Connect one end of a 4-1/4" long yellow hook-up wire to SC1 (Solder).

( ) 47. Connect one end of a 5-1/2" long green hook-up wire to SB6 (Solder).

( ) 48. Connect one end of a 9-1/2" long yellow hook-up wire to SB5 (Solder).

( ) 49. Connect capacitor C8 (200 uuf precision capacitor) from SC3 (Solder) to SB3 (Don't Solder).

( ) 50. Connect capacitor C9 (.02 uf, 400 volts) from SC4 (Solder) to SB3 (Don't Solder).

( ) 51. Connect one end of a 2-1/2" long green hook-up wire to SB3 (Don't Solder).

( ) 52. Connect one end of a 6" long red hook-up wire to SB3 (Solder).

NOTE

Recheck the switch wiring (steps 27 through 52) before proceeding.

RANGE SWITCH WIRING (See Figures 5 and 6.)

( ) 53. Mount the switch assembly at S using a lockwasher, bakelite control washer and control nut. Position the switch as shown in Figure 5. See Figure 4 for mounting details.

( ) 54. Connect the yellow lead from SF6 on the switch to R (Don't Solder). Dress the lead against the chassis as shown in Figure 5.

( ) 55. Connect the positive (+) lead of capacitor C2 (4 uf, 250 vdc) to F8 (Don't Solder); connect the negative (-) lead to R (Solder). Dress the capacitor against the chassis as shown in Figure 5.

( ) 56. Connect the yellow lead from SC1 on the switch to CB2 (Don't Solder). See Figure 6.

( ) 57. Connect the green lead from SB3 on the switch to K1 (Solder). See Figure 6.

( ) 58. Connect the red lead from SC11 on the switch to K2 (Solder). See Figure 6.

( ) 59. Connect the red lead from SF7 on the switch to CA3 (Solder). See Figure 5.

( ) 60. Connect the yellow lead from SD10 on the switch to CA1 (Solder). See Figure 5.

( ) 61. Connect the red lead from SB3 on the switch to L4 (Don't Solder).

( ) 62. Connect the green lead from SB6 on the switch to L5 (Don't Solder).

( ) 63. Connect the yellow lead from SB5 on the switch to J2 (Solder).

( ) 64. Connect the green lead from SE8 on the switch to J1 (Solder).

FINAL WIRING

( ) 65. Connect capacitor C7 (.22 uf, 600 volts) from CB2 (Solder) (use sleeving) to U (Solder). Make sure the capacitor is dressed against the chassis as shown in Figure 6.

( ) 66. Using sleeving, connect capacitor C1 (.01 uf, 600 volts) from CC5 (Solder) to E (Solder). Dress the capacitor as shown in Figure 5.

( ) 67. Using sleeving, connect capacitor C6 (2 uf, 200 volts) from CC1 (Solder) to L5 (Solder). Dress the capacitor against the front panel as shown in Figure 5.

( ) 68. Strip 1/2" from one end of a 6" length of red hook-up wire. Slip this end through CC2 to CC3 (Solder CC3, then CC2) and connect the other end to L4 (Don't Solder).

( ) 69. Connect resistor R10 (500 ohms, 4 watts) from L4 (Solder) to L6 (Solder).

( ) 70. Connect the positive (+) lead of capacitor C3 (8 uf, 525 vdc) to ground lug G1 of socket F (Don't Solder); connect the negative (-) lead to L2 (Don't Solder). Dress the capacitor close to the chassis as shown in Figure 5.

( ) 71. Connect resistor R4 (68K ohms, 1 watt) (Blue-Grey-Orange) from F8 (Don't Solder) to G1 at F (Solder).

( ) 72. Connect resistor R13 (3300Ω) (3.3K ohms, 1 watt) (Orange-Orange-Red) from L1 (Solder) to L2 (Solder).

INDICATOR WIRING (Figure 6)

( ) 73. Install a 1629 type tube (V1) in socket T and snap the tube and socket assembly into the spring clamp so that the socket key-way points down toward the chassis (Fig. 6).

( ) 74. Connect resistor R1 (1 megohm, 1/2 watt) (Brown-Black-Green) from T3 (Solder) to T4 (Don't Solder) on the ring-mount octal socket T (Figure 6).

( ) 75. Connect one lead of resistor R3 (10 megohms, 1/2 watt) (Brown-Black-Blue) to T1 (Don't Solder). Connect the other lead through T7 (Solder) to T8 (Don't Solder).

( ) 75A. Connect resistor R2 (470K ohms, 1/2 watt) (Yellow-Violet-Yellow) from T5 (Solder) to T1 (Don't Solder).

( ) 76. Connect one end of a 4" length of yellow hook-up wire to T8 (Solder).

( ) 77. Connect one end of a 11" length of red hook-up wire to T4 (Solder).

( ) 78. Connect one end of a 13" length of green hook-up wire to T1 (Solder).

( ) 79. Slip the piece of large diameter sleeving over the yellow, green, and red wires from T8, T1, and T4. Insert the green transformer lead through the opposite end of the sleeving and connect it to T2 (Solder). (See Figure 6.)

( ) 80. Connect the yellow lead from T8 to P (Solder). (See Figure 5.)

( ) 81. Connect the green lead from T1 to SF9 on the switch (Solder). Dress the lead as shown in Figure 5.

( ) 82. Connect the red lead from T4 to F8 (Solder). See Figure 5. Dress this lead alongside the green lead from T5. See Figure 5.

( ) 83. Slip approximately one foot of the line cord through the grommet at Q and tie a knot in the line cord 7" from the end inside the set. Slit the cord apart about 5". Connect one lead to CC4 (Solder). Twist the other lead around the red and green leads from the indicator socket T (see Figure 5) and connect it to F4 (Solder).

MECHANICAL ASSEMBLY

( ) 84. Loosen the set screw in one of the control knobs. Turn the POWER FACTOR control (D) counter-clockwise until a click is heard. Slip the knob on the shaft and line up the pointer with the mark AC-OFF on the front panel; then tighten the set screw.

( ) 85. Loosen the set screw in another control knob and place it on the RANGE switch (E). Orient the knob so that the set screw will bear against the flat on the shaft and then tighten the set screw. Rotate the switch to its extreme counter-clockwise position; the knob should point to the 10-5000 μμf position. If this does not occur, remove the knob, loosen the control nut and reposition the switch accordingly.

( ) 86. Turn the VOLTAGE control (C) fully counter-clockwise. Loosen the set screw in another control knob and slip it on the VOLTAGE control so that the indicator lines up with the 0 mark on the front panel. Then tighten the set screw.

( ) 87. Turn the bridge control (B) fully counter-clockwise. Loosen the set screw and mount the dial pointer assembly on the shaft. Line up the hairline on the pointer with the left line on the scale. Tighten the set screw lightly (it will be necessary to loosen it again when calibrating the dial).

( ) 88. Insert the 6X5GT tube (V2) in socket F.

NOTE

This completes the assembly of the PACO Model C-20. BEFORE PROCEEDING, RE-CHECK ALL WIRING CAREFULLY; LOOK FOR UNSOLDERED CONNECTIONS, COLD SOLDER JOINTS, ETC.

CALIBRATION

Included as part of the kit is a 200K ohm precision calibrating resistor. To calibrate the assembled kit, proceed as follows:

( ) 89. Connect the line cord plug to a 117-volt, 50-60 cps power source.

CAUTION

Be careful not to touch anything behind the front panel since high voltages exist at various points.

( ) 90. Rotate the power switch on the POWER FACTOR control clockwise until it clicks "on".

( ) 91. Turn the RANGE switch to the 5K-5MEG Ω range.

( ) 92. Connect the 200K Ω precision calibrating resistor to the RES. - CAP. TEST - LEAKAGE binding posts.

( ) 93. Rotate the main dial until a null indication appears on the balance indicator (eye) tube at the top right-hand of the front panel. A null is indicated by the maximum shadow angle or widest opening of the eye and shows that the component connected to the test terminals has been brought into balance with the internal bridge circuitry.

( ) 94. The pointer should now point to the 200K marking at the top center of the top dial marking. If not, loosen the knob set screw, rotate the knob until the pointer points to 200K and tighten the set screw. Recheck to make sure that re-positioning of the dial knob did not change the setting of the dial control. This one adjustment completes the calibration of the instrument.

The completed kit will have a certain amount of internal capacitance due to the normal placement of parts, spacing between wires, interelectrode capacitance within tubes and distributed capaci-

tance in the transformer windings. However, the lower this capacitance the better. The reason for this is as follows: Since the capacitance to be measured is placed in parallel with the kit's internal capacitance, the observed indication will be for the combined capacitance of both. From basic theory, the total capacitance of two capacitors in parallel is the sum of the two individual capacitances. Therefore, the internal capacitance must be subtracted from the indicated value to obtain the correct capacitance value for the capacitor being measured. Obviously, the smaller the internal capacity the more negligible its contribution to the indicated value and the less the necessity for considering its effect. On the higher capacity ranges the internal capacity can be totally neglected as being negligible with respect to the measured capacitor. However, on the lowest capacity range, the internal capacity must be subtracted from the indicated value.

Rotate the RANGE switch to the 10-5000 μμf range. Remove all test leads from the panel connectors and rotate the main dial. Near the left end of the dial a null indication will appear on the balance indicator (eye) tube. Without any test leads connected, this null indication represents the internal capacity of the unit as seen across the test terminals.

Assemble the cabinet handle to the cabinet as shown in Figure 8, using four #6-32 oval head screws, lockwashers and nuts; and insert the four rubber feet in the holes provided in the bottom of the cabinet. See Figure 9. Feed the a-c line cord through the rear cabinet opening and install the assembled kit into its cabinet with the two sheet metal screws from the back.

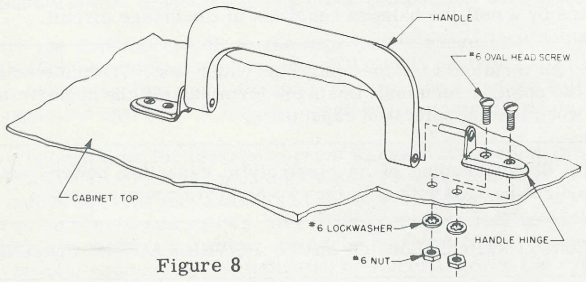


Figure 8

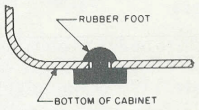


Figure 9

OPERATION

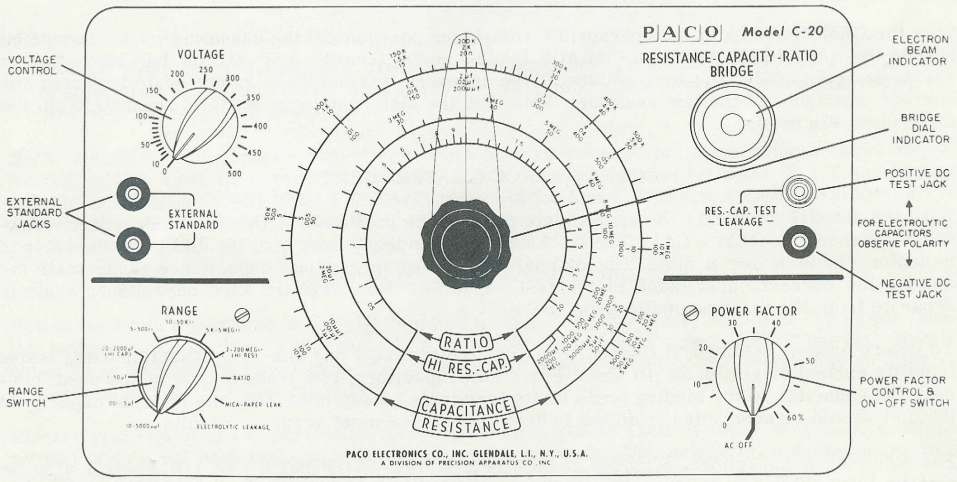


Figure 10

The operation of this unit is simple; a few minutes practice will provide you with a complete working familiarity with your instrument. The following table explains the front panel controls; detailed operating instructions follow the table. See Figure 10.

FRONT PANEL CONTROLS

Control	Purpose
VOLTAGE control (potentiometer)	Provides DC working voltages as marked (0 to 500 V) for capacitor leakage tests.
EXTERNAL STANDARD binding posts	For use with an external standard when utilizing the ratio test circuit.
RANGE switch	Permits selection of various circuits (including appropriate ranges).
Dial	Allows value determined by balance indicator eye to be read directly on the appropriate scale.
Balance indicator eye	Indicates by a null the balance condition of the bridge circuit.
RES. - CAP. TEST - LEAKAGE binding posts	Connection terminals for the component under test. The red terminal is for the positive terminal; the black terminal for the negative terminal when testing polarized capacitors.
POWER FACTOR control (potentiometer)	Permits direct reading of an electrolytic capacitor power factor. This control is used with only the two highest capacity ranges.
AC OFF switch	Power on-off switch. Located on the POWER FACTOR CONTROL.

RESISTANCE MEASUREMENTS

With the RANGE switch in the appropriate resistance position and the unknown resistor connected across the RES. - CAP. TEST - LEAKAGE binding posts, turn the dial until the balance indicator eye indicates a null. The dial pointer at the appropriate resistance range scale indicates the correct resistance of the test resistor. Note that the high resistance scale is separate from the three normally used.

CAPACITANCE MEASUREMENTS

With the RANGE switch in the appropriate capacitance position and the unknown capacitor connected across the RES. - CAP. TEST - LEAKAGE binding posts, turn the dial until the balance indicator eye indicates a null. The dial pointer on the appropriate capacitance range scale indicates the correct capacitance of the test capacitor. Note that the high capacitance scale is separate from the three normally used scales.

To insure proper readings, it is good practice to disconnect one side of a capacitor being tested from its normal circuit prior to test. For small capacitors, test leads should not be used; connect the capacitor to the binding posts by its terminals. Remember that the internal capacity of the unit should be subtracted from the indicated value for most accurate results.

For electrolytic capacitors, accurate results require that the POWER FACTOR control also be rotated for a balance indicator null. This is described more fully later under POWER FACTOR

MEASUREMENTS. Note that the terminals of an electrolytic capacitor must be connected to the proper positive and negative binding posts.

If trouble is encountered, consider that a capacitor which gives a null indication at the high end of the high capacitance range is usually a shorted one and that a capacitor which gives a null indication at the low end of the low range is usually an open one.

When measuring capacitance values always remember that the tolerances are usually very broad. Tolerances of minus 50% and plus 100% are fully common.

LEAKAGE MEASUREMENTS

The RANGE switch provides two leakage test circuits; one for mica and paper capacitors, the other for electrolytic capacitors. To test a capacitor for leakage, first turn the VOLTAGE control to 0 volts. Then connect the positive terminal of the capacitor to the red test binding post, and the negative terminal to the black test binding post.

CAUTION

If the polarity of the connection is reversed, the capacitor may be damaged. The capacitor should not be connected to any other components during this test.

Rotate the RANGE switch to the appropriate range (MICA-PAPER LEAK. or ELECTROLYTIC LEAKAGE position); then turn the VOLTAGE control to the rated d-c voltage of the capacitor while observing the eye indicator. The eye should close fully, and then should open slowly as the capacitor charges. If the eye opens to its maximum width, there is no leakage.

Allow enough time for leakage current to reach its normal value. For capacitors taken from the shelf, allow five minutes plus one minute for each month of shelf storage before considering the eye indication. Varying amounts of leakage will result in varying widths of opening. The capacitor can be considered satisfactory (with respect to leakage) for any eye opening from just-closed to wide open. The capacitor should be rejected if the eye remains fully closed (over-lapped). Intermittent leakage will be indicated by fluctuations of the eye opening, and any capacitor causing this effect should be suspected for future failure.

WARNING

Before removing the capacitor from the binding posts rotate the VOLTAGE control to 0 volts in order to discharge the capacitor. This safety procedure will prevent the operator from receiving a shock.

Mica, electrolytic and paper capacitors are tested in exactly the same manner; however, the RANGE switch must be in the appropriate position. The eye closes for about 3-1/2 ma leakage current in the ELECTROLYTIC LEAKAGE test; and for about 15 microamperes leakage current in the MICA-PAPER LEAKAGE test.

POWER FACTOR MEASUREMENTS

Power factor is a measure of the efficiency of a capacitor. However, the lower the power factor the better the capacitor. For example, a capacitor with a 20% power factor has an effective capacity of 98% of its rated capacity and a capacitor with a 50% power factor has an effective capacity of 87% of its rated capacity.

Electrolytic capacitors in particular have appreciable power factors since they have a definite amount of internal resistance in series with this capacitance. The bridge circuit, therefore, must compensate for this — which it does by the POWER FACTOR control.

When measuring an electrolytic capacitor, both the dial and POWER FACTOR control must be rotated in conjunction for the best balance indication. Obtain a null indication on the eye indicator by rotating the main dial, with the POWER FACTOR control set at 0%; then adjust the POWER FACTOR control for maximum eye opening. The capacitance is read from the pointer on the appropriate capacitance scale while the power factor is read directly from the dial markings around the POWER FACTOR control.

RATIO MEASUREMENTS

The ratio test circuit enables the quick determination of a reactance or resistance ratio between any two capacitors, inductors or resistors between .05 to 1 and 20 to 1. In addition, it can be used to determine turns ratio of transformer windings between .05 to 1 and 20 to 1.

Connect the standard (resistor, inductor or capacitor) to the EXTERNAL STANDARD binding posts, and the unknown component to the RES. - CAP. TEST binding posts. The unknown component must be of the same type as the standard, i.e., a capacitor would be compared for ratio against another capacitor but not a resistor, etc.

The RANGE switch is placed in the RATIO position, and the bridge dial rotated for a null indication on the eye indicator.

1. The unknown resistance equals standard resistance divided by dial ratio indicated.

2. The unknown inductance equals standard inductance divided by dial ratio indicated.

3. The unknown capacitance equals standard capacitance multiplied by the dial ratio indicated.

To obtain turns ratio of a transformer, connect one winding to the EXTERNAL STANDARD binding posts, and the other winding to the RES. - CAP. TEST binding posts. With the RANGE switch in the RATIO position, rotate the bridge dial for a null indication. If an indication cannot be obtained, reverse the connections to one winding, but <u>not</u> to both windings. Balance can NOW be obtained in most cases, except in those cases where the turns ratio is outside the limits of the instrument or where one of the windings is open.

The ratio indicated is that of the winding on EXTERNAL STANDARD binding posts to the winding on RES. - CAP. TEST binding posts. For example, if the ratio scale indication is 2, the transformer has 2 turns in the winding connected to the EXTERNAL STANDARD posts for every turn it has in the winding connected to the RES. - CAP. TEST posts.

THEORY

The PACO Model C-20 is basically an a-c bridge circuit designed primarily to measure unknown resistance and/or capacitance. An added feature, the ratio test circuit, permits a relative number to be obtained from comparison with a standard from which the absolute value of an unknown resistor, capacitor or inductor can be computed.

The RANGE switch selects predetermined components for three elements of the bridge, with the fourth element being the unknown part being tested.

The power factor control is used to balance the internal resistance inherent in electrolytic capacitors. The internal resistance of the electrolytic capacitor is in series with the capacity, therefore, the power factor control is in series with the standard bridge circuit capacitor. The power factor control is only effective on the high capacitance ranges since electrolytic capacitors are usually of high capacitance value.

Circuit balance is indicated by a null indication on the balance indicator eye. The null is the maximum shadow angle or widest opening of the eye.

The a-c power for the tube filaments is supplied by secondary winding Green — Yellow — White. The a-c power for the bridge circuit is supplied by secondary winding Brown — Brown. Power for the half wave rectifier tube (V2) is supplied by secondary winding Red — Red.

The electron tube balance indicator eye (V1) indicates the null condition for a balanced bridge circuit.

For leakage tests, the indicator eye (V1) is used as a current indicator. The capacitor under test is applied in series with a resistor across a DC power supply variable from 0 to 500 V. When the DC voltage is applied to the series R-C combination, any leakage current in the capacitor will flow through the resistor, causing a voltage drop. This voltage drop is applied to the indicator tube, which results in a change in eye opening. Current sensitivity is changed by varying the value of resistance, and this is done by switching from MICA-PAPER LEAKAGE to ELECTROLYTIC LEAKAGE, which reduces the sensitivity to allow for the normally larger leakage currents of electrolytic capacitors.

TROUBLE LOCATION

If you experience any difficulty with your unit, first recheck all the wiring including the range switch. If the trouble is not due to incorrect wiring, check the following voltages. The readings were taken with a PACO Model M40 Multimeter.

Remember that normal component tolerances may result in slightly different readings on your own unit.

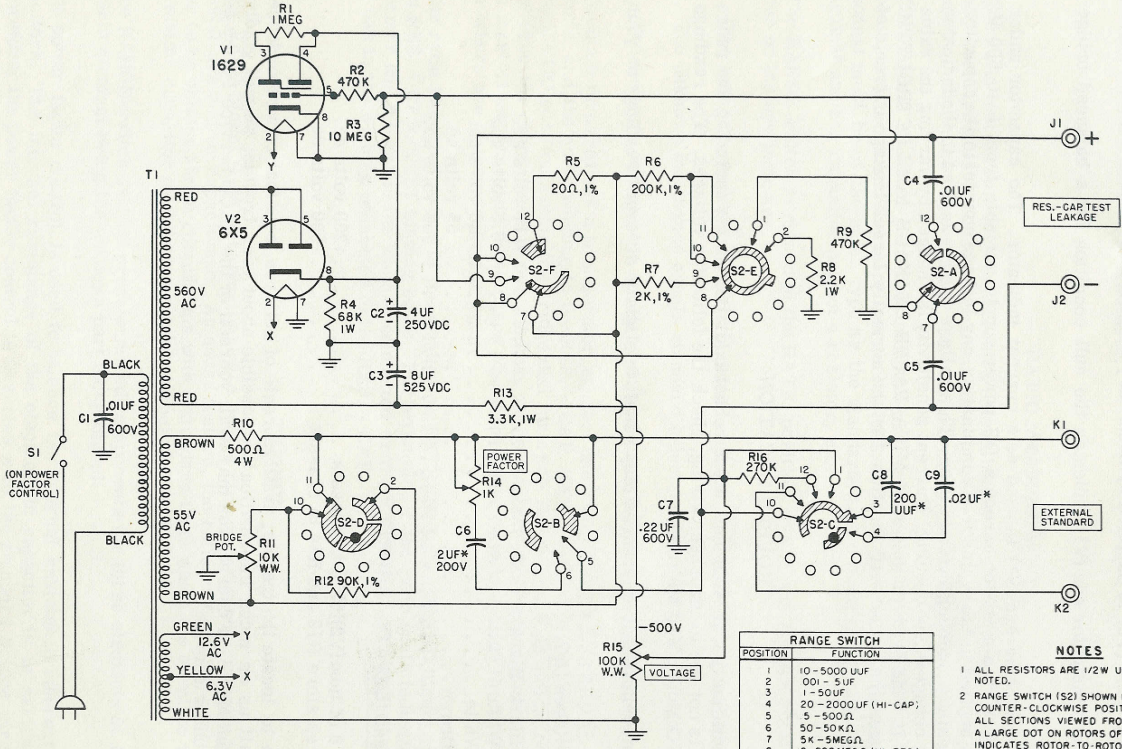
Transformer Voltages (AC)

Primary (Black-Black)	117 volts ac.
Yellow to White	6.3 volts ac.
Green to White	12.6 volts ac.
Brown to Brown	55 volts ac.
Red to Red	560 volts ac.

Operating Voltages (DC)

From pin 8 of tube(V2)(6X5) to chassis	+200 volts dc.
Between resistors R12 and R14 to chassis	-500 volts dc.

If you are still unable to locate the trouble, avail yourself of our free technical correspondence advisory service. Mail us as much information as possible about your trouble; we will gladly offer our advice. If you desire, of course, you may avail yourself of the PACO Service Policy as described more fully under service.



RANGE SWITCH	
POSITION	FUNCTION
1	10-5000 UUF
2	001-.5UF
3	1-50UF
4	20-2000UF (HI-CAP)
5	5-500Ω
6	50-50KΩ
7	5K-5MEGΩ
8	2-200 MEGΩ (HI-RES)
9	RATIO
10	MICA-PAPER LEAKAGE
11	ELECTROLYTIC LEAKAGE

NOTES

1. ALL RESISTORS ARE 1/2W UNLESS OTHERWISE NOTED.
2. RANGE SWITCH (S2) SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION (10-5000 UUF) ALL SECTIONS VIEWED FROM FRONT. A LARGE DOT ON ROTORS OF S2-C AND S2-D INDICATES ROTOR-TO-ROTOR CONNECTION AT THESE POINTS
3. ▭ INDICATES MARKING ON FRONT PANEL.
4. * INDICATES PRECISION CAPACITOR

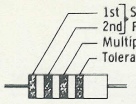
PACO MODEL C-20 SCHEMATIC

PARTS LIST

REF SYM	PART NO.	QTY	DESCRIPTION
			Resistors
R1	P15-827	1	1 megohm, carbon
R2, R9	P15-520	2	470K ohms, carbon
R3	P15-795	1	10 megohms, carbon
R4	P15-913	1	68K ohms, carbon, 1 watt
R5	P15-910	1	20 ohms, 1%, precision
R6	P15-891	1	200K ohms, 1%, precision
R7	P15-880	1	2K ohms, 1%, precision
R8	P15-718	1	2.2K ohms, carbon, 1 watt
R10	P15-914	1	500 ohms, power, 4 watts
R12	P15-228	1	90K ohms, 1%, precision
R13	P15-912	1	3.3K ohms, carbon, 1 watt
R16	P15-866	1	270K ohms, carbon
	P15-891	1	200K ohms, 1%, precision Cal. Res.
			Capacitors
C1, C4, C5	P16-216	3	.01 uf, 600V, tubular
C2	P16-218	1	4 uf, 250V, electrolytic
C3	P16-223	1	8 uf, 525V, electrolytic
C6	P16-219	1	2 uf, 200V, tubular, precision
C7	P16-230	1	.22 uf, 600V, tubular
C8	P16-215	1	200 uuf, silver mica, precision
C9	P16-217	1	.02 uf, 400V, tubular, precision
			Controls - Switches
R11	P17-213	1	10K ohms, control, wirewound, precision
R14	P17-212	1	1K ohms, control w/switch S1
R15	P17-214	1	100K ohms, control, wirewound
S1		1	Part of R14 (P17-213)
S2	P14-228	1	Range switch
			Binding Posts - Transformers - Tubes
J1	P20-189-1	1	Binding post, red
J2, K1, K2	P20-189	3	Binding post, black
T1	P18-168	1	Transformer
V1	P19-146	1	1629 "Eye" tube
V2	P19-111	1	6X5GT tube

REF SYM	PART NO.	QTY	DESCRIPTION
			Sockets - Terminal Strips
	P20-102	1	Octal socket, saddle mount
	P20-143	1	Octal socket, ring mount
	P23-261	1	6 lug terminal strip
			Knobs - Grommets - Feet
	P10-460	3	Pointer knob
	P30-106	1	Dial knob pointer assembly
	P29-132	3	3/8" rubber grommet
	P29-149	4	Rubber feet
			Hardware
	P24-244	11	#6-32 x 3/8" binding head screw
	P24-243	4	#6-32 x 3/8" oval head screw
	P24-215	2	#6 x 3/8" sheet metal screw
	P24-125	15	#6-32 hex nut
	P24-134	4	#8-32 hex nut
	P24-180	4	Control hex nut
	P24-246	12	#6 lockwasher
	P24-175	4	Control lockwasher
	P23-245	4	#8 fibre shoulder washer
	P23-247	4	#8 fibre flat washer
	P23-224	4	Bakelite control washer
	P23-248	4	#6 solder lug
	P23-249	4	#8 solder lug
			Wire - Sleeving
	P21-104	1	Length bare wire
	P21-147-1	1	Line cord
	P21-148	1	Roll of hook-up wire (red, green, yellow)
	P21-170	1	Length sleeving
	P21-174	1	Large vinyl sleeving
			Sheet Metal Parts
	P11-293	1	Chassis
	P11-294	1	"Z" bracket
	P13-381	1	Panel
	P22-170	1	Carrying case
			Miscellaneous
	P23-243	1	Handle
	P23-244	2	Handle hinge
	P23-262	1	Spring clip for eye tube
	P26-154	1	Instruction manual

COLOR BAND SYSTEM



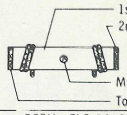
Resistors With Black Body Color Are Composition, Non-Insulated.
Resistors With Colored Bodies Are Composition, Insulated.
Wire-Wound Resistors Have The 1st Digit Color Band Double Width.

RESISTOR CODES (RESISTANCE GIVEN IN OHMS)

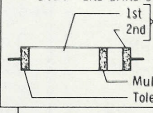
COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	±20%
BROWN	1	10	±1%
RED	2	100	±2%
ORANGE	3	1000	±3% *
YELLOW	4	10000	GMV*
GREEN	5	100000	±5% (RETMA Alternate)
BLUE	6	1000000	±6%*
VIOLET	7	10000000	±12 1/2%*
GRAY	8	.01 (RETMA Alternate)	±30% *
WHITE	9	.1 (RETMA Alternate)	±10% (RETMA Alternate)
GOLD		.1 (JAN and RETMA Preferred)	±5% (JAN and RETMA Pref.)
SILVER		.01 (JAN and RETMA Preferred)	±10% (JAN and RETMA Pref.)
NO COLOR			±20%

*GMV = guaranteed minimum value, or -0 + 100% tolerance.
±3, 6, 12 1/2, and 30% are ASA 40, 20, 10, and 5 step tolerances.

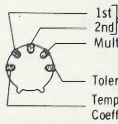
BODY-END-DOT SYSTEM



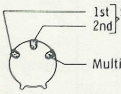
BODY-END BAND SYSTEM



DISC CERAMICS (5-DOT SYSTEM)



DISC CERAMICS (3-DOT SYSTEM)

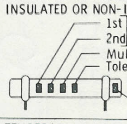


CERAMIC CAPACITOR CODES (CAPACITY GIVEN IN MMF)

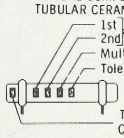
COLOR	DIGIT	MULTIPLIER	TOLERANCE 10MMF or LESS	TOLERANCE OVER 10MMF	TEMPERATURE COEFFICIENT PPM/°C	EXTENDED RANGE TEMP. COEFF. SIGNIFICANT FIGURE	EXTENDED RANGE TEMP. COEFF. MULTIPLIER
BLACK	0	1	±2.0MMF	±20%	0(NPO)	0.0	-1
BROWN	1	10	±0.1MMF	±1%	-33(N033)		-10
RED	2	100		±2%	-75(N075)	1.0	-100
ORANGE	3	1000		±2.5%	-150(N150)	1.5	-1000
YELLOW	4	10000			-220(N220)	2.2	-10000
GREEN	5		±0.5MMF	±5%	-330(N330)	3.3	-1
BLUE	6				-470(N470)	4.7	+10
VIOLET	7				-750(N750)	7.5	+100
GRAY	8	.01	±0.25MMF		+30(P030)		+1000
WHITE	9	.1	+1.0MMF	±10%	General Purpose Bypass & Coupling +100(P100) (Jan)		+10000
SILVER							
GOLD							

Ceramic capacitor voltage ratings are standard 500 volts, for some manufacturers, 1000 volts for other manufacturers, unless otherwise specified.

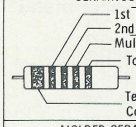
HIGH CAPACITY TUBULAR CERMICS INSULATED OR NON-INSULATED



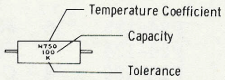
TEMPERATURE COMPENSATING TUBULAR CERAMICS



MOLDED-INSULATED AXIAL LEAD CERAMICS

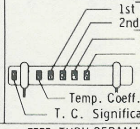


TYPOGRAPHICALLY MARKED CERAMICS



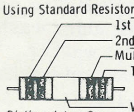
JAN LETTER	TOLERANCE 10MMF or LESS	TOLERANCE OVER 10MM1
C	±0.25MMF	
D	±0.5MMF	
F	±1.0MMF	±1%
G	±2.0MMF	±2%
J		±5%
K		±10%
M		±20%

ENTENDED RANGE T.C. TUBULAR CERAMICS



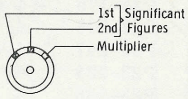
MOLDED CERAMICS

Using Standard Resistor Color-Code



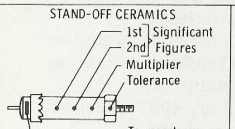
Distinguishes Capacitor From Resistor

BUTTON CERAMICS

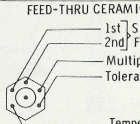


Viewed From Soldered Surface

STAND-OFF CERAMICS



FEED-THRU CERAMICS



MOLDED MICA CAPACITOR CODES (Capacity Given In MMF)

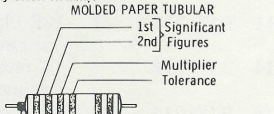
COLOR	DIGIT	MULTIPLIER	TOLERANCE*	CLASS OR CHARACTERISTIC
BLACK	0	1	20%	A
BROWN	1	10	1%	B
RED	2	100	2%	C
ORANGE	3	1000	3%	D
YELLOW	4	10000		E
GREEN	5		5%(RETMA)	F(JAN)
BLUE	6			G(JAN)
VIOLET	7			
GRAY	8			I(RETMA)
WHITE	9			J(RETMA)
GOLD		.1	5%(JAN)	
SILVER		.01	10%	

Class or characteristic denotes specifications of design involving Q factors, temperature coefficients, and production test requirements.
All axial lead mica capacitors have a voltage rating of 300, 500, or 1000 volts.
*or ±1.0 MMF whichever is greater.

MOLDED PAPER CAPACITOR CODES (Capacity Given In MMF)

COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	20%
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10000	
GREEN	5	100000	5%
BLUE	6	1000000	
VIOLET	7		
GRAY	8		
WHITE	9		10%
GOLD			5%
SILVER			10%
NO COLOR			20%

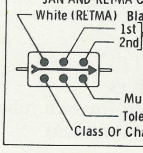
MOLDED PAPER TUBULAR



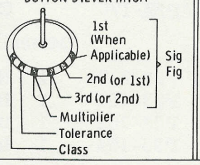
Indicates Outer Foil. May Be On Either End. May Also Be Indicated By Other Methods Such As Typographical Marking, Or Black Stripe.

Add Two Zeros To Significant Voltage Figures. One Band Indicates Voltage Ratings Under 1000 Volts.

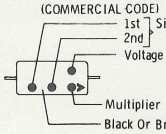
CURRENT STANDARD JAN AND RETMA CODE



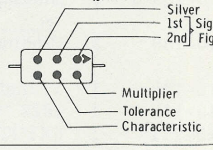
BUTTON SILVER MICA

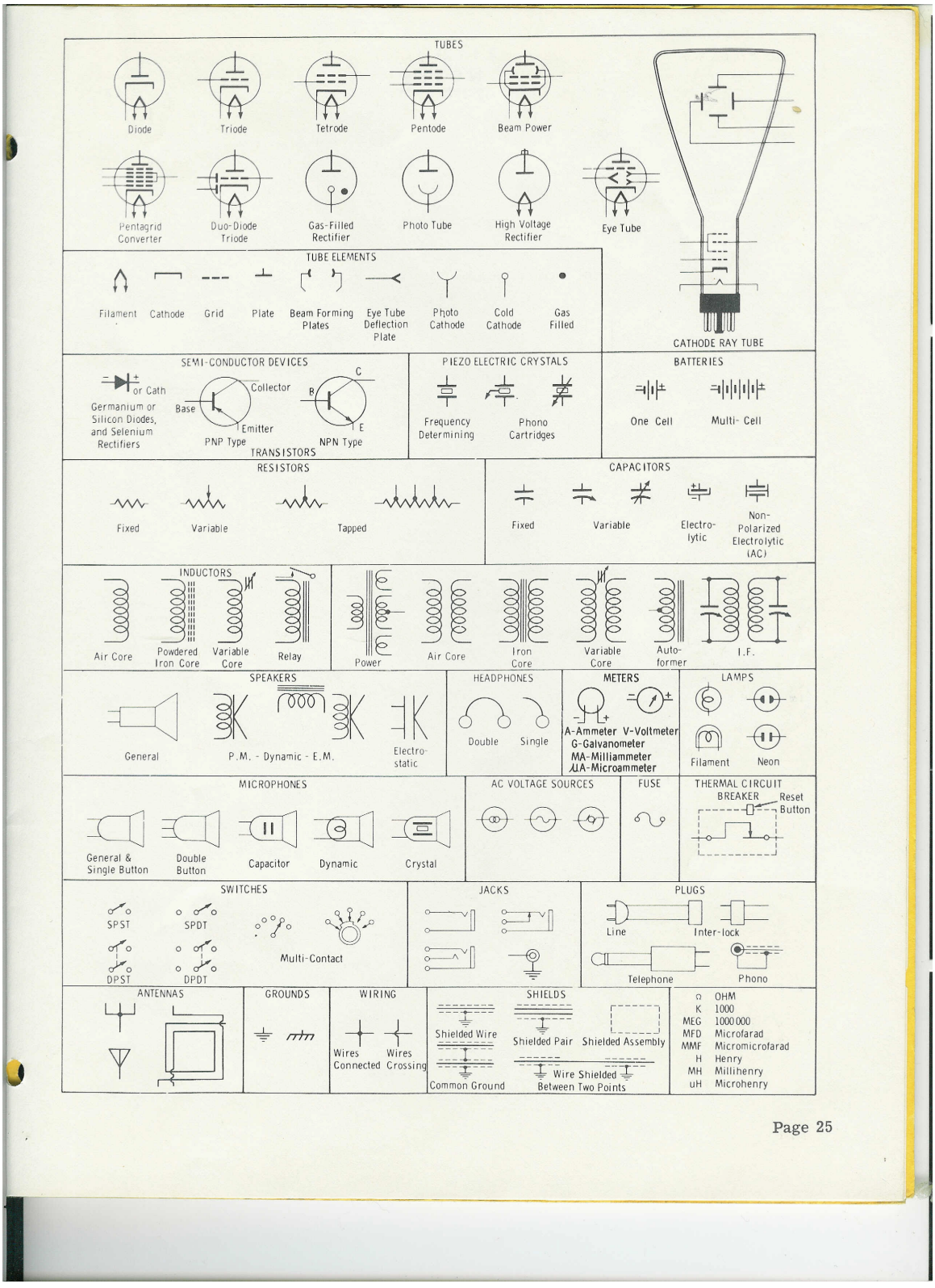


MOLDED FLAT PAPER CAPACITORS (COMMERCIAL CODE)



MOLDED FLAT PAPER CAPACITORS (JAN CODE)





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