Manual ... Net Price: $1.00

ASSEMBLY
and
OPERATING
MANUAL
for

PACO

MODEL C-25
"IN-CIRCUIT"
CAPACITOR TESTER

PRECISION APPARATUS, INC.
GLENDALE, N. Y. 11227

Figure 1. PACO Model C-25 "In-Circuit Capacitor Tester

FEATURES AND SPECIFICATIONS

SIMPLE SEQUENTIAL TEST - Reveals open or shorted capacitors, including electrolytic types.

SHARP, NON-CONFUSING READINGS - On wide-angle EM-84 Indicator.

ELECTROLYTIC DIAL - Indicates actual electrolytic values while capacitor is in-circuit; any electrolytic which yields a capacity reading on Electrolytic Dial is automatically revealed as not open or shorted.

CHECKS BY-PASS COUPLING, BLOCKING AND FILTER CAPACITORS - Of all types including electrolytics.

OPEN TEST - Provides positive open circuit test for capacitors as low as 10 mmf.

SHORT TEST - Shows up shorted capacitors of all types, even if circuit resistance is as low as 10 ohms for 60 cycles.

ELECTROLYTIC TEST - Indicates in-circuit electrolytic capacity from 2 mfd to 400 mfd in two ranges; capacitor is automatically proved non-shorted and not open if Capacity Reading can be obtained.

TUBES - 6C4 - Oscillator, EM 84 - Fluorescent eye (rectangular column type) indicator.

POWER REQUIREMENTS - 110 to 125 volts, 50 to 60 cycle AC, 13 watts (approximate).

RUGGED RIPPLE-FINISH STEEL CABINET - With attractive easy-reading 2-color panel.

DIMENSIONS - 7-1/2 X 5-3/8 X 4-1/4 inches.

SHIPPING WEIGHT - 6 pounds.

GENERAL DESCRIPTION

The PACO Model C-25 "In-Circuit" Capacitor Tester is one of the most valuable time-saving, trouble-shooting instruments on the service bench. It instantly reveals open or shorted capacitors without removing them from the circuit. It also discloses dried-out electrolytics as well as shorted or open electrolytics by directly indicating actual capacitance, in one quick test without removing the capacitor from the circuit - by virtue of the exclusive PACO Capacity Dial.

GENERAL KIT CONSTRUCTION INFORMATION

INTRODUCTION

The PACO kit you have just purchased is a high quality instrument and when assembled and used in accordance with the instructions in this manual, will provide many years of trouble-free service. Therefore the first, and we feel, most valuable advice we can offer in this manual is that you work carefully and patiently. By so doing, you will experience more satisfaction in your new instrument, and greater confidence in your ability.

THE MANUAL

We suggest that you spend a little time NOW and read this entire manual thoroughly before starting the actual construction of the kit. This will familiarize you with the contents and the general procedure to be followed.

The step-by-step instructions will help you assemble the instrument with a minimum possibility of error. Further assistance may be gained from using the larger folded-in diagrams supplied with this manual. These are enlargements of the smaller size figures referred to in the step-by-step instructions. They should be attached in some way to the wall above your work bench for greater ease in reference.

We advise you to keep this manual after the kit has been constructed, for future assistance in the use and maintenance of your PACO instrument.

UNPACKING

We cannot stress too strongly the need for exercising care throughout these instructions. This is especially true now as you unpack the kit. Parts may easily become damaged through carelessness here. Do not throw any packing materials away until all parts are accounted for. Each part should be checked against the parts list at the back of the manual in order to make certain all parts are present and are correct as to value and type. The color code chart at the back of this manual will assist you in identifying doubtful parts. Please notify us promptly if any shortage or erroneous part is discovered. Return the inspection slip with your letter in order to expedite the handling. Keep in mind however, that minor differences in some parts do not indicate an error. A .05MFD capacitor for example, may sometimes be found in the kit where a .047MFD is called for in the parts list. Such substitutions are checked carefully before they are made, and you can be assured they will work satisfactorily. The registration card which accompanies each PACO kit, MUST be filled in and returned to the company immediately after purchase. Our warranty applies only to registered instruments.

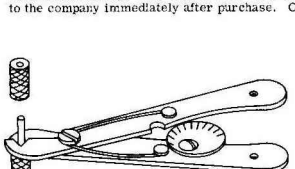


Figure 2. Wire Stripper

TOOLS REQUIRED FOR ASSEMBLY AND WIRING OF PACO KITS

Only standard type tools are required in the construction of PACO kits - a good quality soldering iron with a small tip (50 or 60 watts); a pair of long-nose pliers; a pair of diagonal or side-cutting pliers; a small assortment of screwdrivers, and a few small end-wrenches or a small adjustable wrench. An inexpensive wire stripper, shown in figure 2, is most helpful for removing insulation from wires.

ASSEMBLY AND WIRING

The position of wires and parts in this instrument is quite critical in some cases, and changes may affect the operation. Follow the diagrams closely and you should encounter little, if any difficulty, for the layout has been thoroughly prechecked and tested for best results.

When wiring, remove only about 1/4 inch of insulation from the ends of hook-up wire. Excessive removal of insulation may result in the exposed wire shorting to nearby terminals or wiring. If the wire has a brown, baked enamel coating (transformer leads for example) be sure to scrape the enamel off, with sandpaper or a knife, to expose the copper wire before making a terminal connection. Leads on parts (resistors, capacitors, etc.) should be trimmed to proper length before mounting. Do not cut leads too short! All parts should fit between the designated points without strain.

SOLDER - SOLDERING IRON - SOLDERING

General

We wish to emphasize the importance of proper soldering technique. If you have had little or no experience in soldering, we suggest you spend some time practicing with an old tube socket and some scraps of wire before doing any soldering on your kit.

Solder

Solder for radio and television work is a 60/40 alloy of tin and lead (60 percent tin and 40 percent lead). A rosin flux is provided in the solder, usually as a single or multiple core. The rosin in the core flows evenly over the junction as the solder melts. Only good quality radio and television type rosin-core must be used. THIS IS IMPORTANT! ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE ANY PACO INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUX HAS BEEN USED. To remove any doubt about your solder, we suggest you make certain the solder you buy is clearly labeled "for radio and television use".

Soldering Iron

The soldering iron transfers the correct amount of heat to a junction or terminal, so that the solder will flow smoothly, producing a good mechanical and electrical bond. Soldering irons can be grouped into the barrel types, the gun and trigger heat types, and the pencil types. The choice of soldering iron is a personal one and is usually based on previous experience.

The barrel type is the most common of the three types. The tip of this iron can be changed to match the soldering operation. For the soldering required in the construction of this kit a small diameter tip is best. A wattage rating of 50 to 125 watts, which is the most widely used in radio and television work, is more than adequate.

Copper Tips

The copper soldering tip requires a certain amount of upkeep because of corrosion and pitting. The corrosion is a black scale (Cupric oxide) that is produced when copper is heated in the presence of air. The pitting is caused by the copper in the tip alloying with the solder.

The oxide coating or scale can be brushed or scraped from the tip. This scale occupies a larger area than the metallic copper. When the tip is left in the barrel of an iron for a long time, this oxide will form and will cause the tip to bind in the barrel. The tip should be removed periodically and cleaned.

Pitted copper soldering tips can be remedied only by removing some of the metal. This is accomplished by filing or grinding the pitted area until a smooth, clean surface is exposed. The tip is then heated to the temperature at which the solder begins to melt. Solder is then rubbed over the cleaned surface until it adheres and spreads over all of the cleaned area.

Sometimes the copper oxidizes rapidly and prevents easy tinning. When this occurs, a piece of steel wool should be used to wipe the surface. A heavy piece of cloth can also be used to clean the iron.

Soldering

The actual process of soldering is more than just sticking some solder to a piece of metal. The metal to be soldered should be heated with the soldering iron; then the rosin core solder is applied. The solder should actually flow across the metal surface.

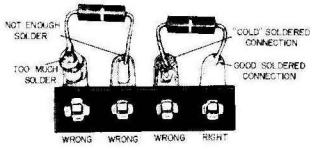
Keep in mind that solder will not flow smoothly into a connection unless the joint itself has been heated enough to melt the solder. Unless this is done, "cold" solder or "high resistance" joints often result. (See figure 3.) Note that "cold" solder joints have a "dull" and "grainy" appearance. A good solder connection will present a smooth and "shiny" appearance. Other causes of "cold" solder joints are poor mechanical connections; melting drops of solder on the joint with the iron; leads and wires not sufficiently cleaned of dirt, wax, and corrosion; and moving leads before the solder has "set" or hardened. When in doubt as to the condition of a joint, it may be tested by moving the leads slightly and observing whether they are loose. Loose leads indicate a "cold" connection. When correcting a cold solder condition, always apply new solder. As a rule, simply reheating a joint will not do the job.

To obtain a good solder connection, follow the directions given below carefully:

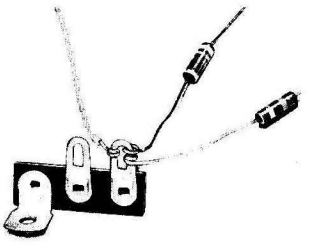
1. Hold the iron against the terminal to heat the metals being joined. A small amount of solder may be placed on the tip of the iron to aid in heat transfer. Do not load the tip with solder -- it will just roll off into the equipment.

2. When the temperature of the junction reaches the melting point of the solder, the solder on the iron will begin to flow away from the iron and into the junction. Apply more solder at this time. The amount depends upon the size of the junction. Apply only enough solder to make a good electrical and mechanical bond. Do not cover the wires and terminals with excessive amounts of solder.

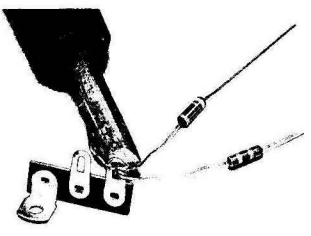
3. The iron should be left on the junction only until the solder has flowed to all of the surfaces. A large soldering iron will quickly "sweat" the solder into the junction. A smaller iron will require a little more time. Do not try to rub the solder into the terminal, instead, hold the iron in one place. If the terminal does not solder completely, it may be necessary to move the iron to another point.



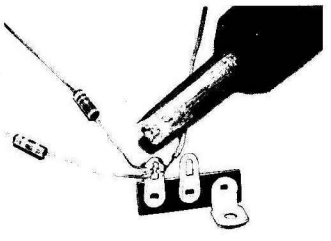
Examples of Good and Bad Soldering



Make a Good Mechanical Connection



Apply Heat to Junction



NOT Too Much Solder

Figure 3. Technique of Soldering

THE PACO WARRANTY

PACO Electronics Co., Inc., hereafter referred to as the Company, guarantees all parts supplied with any PACO kit to be free of defects in material and workmanship under normal use and service for a period of ninety (90) days from the date of purchase. The Company's obligation under this warranty is limited to those parts which are returned transportation prepaid, with prior permission of the Company, and in the judgement of the Company are defective under the terms of this warranty. This warranty is in lieu of all other warranties, and the Company neither assumes, nor authorizes any other person to assume for them, any other liability in connection with the sale of PACO kits.

We urge the assembler to follow the instructions provided in this manual. The Company assumes no responsibility for any damages or injuries sustained in the assembly or operation of PACO instruments.

All prices and specifications are subject to change without notice. The Company reserves the right to discontinue instruments and to alter specifications at any time without incurring any obligation to incorporate new features in PACO instruments previously sold.

The registration card, which accompanies each PACO kit, MUST be filled in and returned to the Company immediately after purchase. This warranty applies only to registered instruments.

INFORMATION REGARDING THE PACO WARRANTY

All material and parts supplied with PACO kits have been carefully selected to meet design requirements and should perform their functions satisfactorily. However, on occasion, improper instrument operation may be traced to a faulty tube or component. Should replacement of a part be necessary, write directly to PACO Electronics Co., Inc., and supply the following information:

1. Identify the model and serial number of the kit in which the part is used.
2. Identify the questionable part thoroughly. Use part number and description as given in the parts list.
3. Completely describe the nature of the defect, or your reason for requesting a replacement.

Please do not return the part in question until you receive notice from us to do so. Do not tamper with the component as this will void our warranty.

When returning tubes, pack them carefully to avoid breakage in shipment. Broken tubes will not be replaced in any instance. Parts that have been broken or damaged through carelessness, misuse or improper installation on the part of the kit builder will likewise not be eligible for replacement.

SERVICE POLICY

PACO Electronics Co., Inc., offers its full cooperation and assistance to help you in obtaining the specified performance from your instrument. We maintain a complete Service Department with whom you may correspond in the event you continue to experience operational difficulties with your completed instrument. We will inspect and repair this "In-Circuit" Capacitor Tester kit for a minimum service charge of $3 50 plus the cost of necessary parts, provided this instrument has been constructed and completed in accordance with the instructions given in this manual. This special repair service is available for a period of one year from the date of purchase. Repair service for PACO instruments that have been in use longer, will be available for PACO owners at most economical charges.

Instruments not entirely completed or that have been modified in design, will not be accepted for repair. Instruments which show evidence of the use of acid core solder or paste fluxes will be returned not repaired.

Instruments for repair or service MUST be returned to us, transportation charges PREPAID, in accordance with the shipping instructions printed below.

SHIPPING INSTRUCTIONS

When returning a PACO instrument for repair or service, be sure that all parts are securely mounted. Be sure to fasten the screws located at the back of the carrying case. Always pack carefully in a rugged, oversized container, using a generous supply of padding such as excelsior, shredded paper, or crumpled newspaper. Do not ship in the original kit carton, as this carton is not considered adequate for safe shipment of the completed instrument. Attach a tag to the instrument giving your name, address, and trouble experienced. Never return an instrument unless it is accompanied by a full explanation of difficulties encountered. The more explicit the details, the more rapidly your instrument can be handled and processed.

Please ship PREPAID and address to:

PACO ELECTRONICS CO., INC.,
ATLAS TERMINAL BUILDING #1
(3RD FLOOR)
COOPER AVENUE AT 80TH STREET
GLENDALE 27, L. I., N. Y.
ATT: SERVICE DIVISION

A FRAGILE label should appear on at least four sides of the carton.

Return shipment to you will be made via Railway Express COLLECT, including repair-service charges unless otherwise requested by previous correspondence.

Please take note that a Carrier cannot be held liable for damage in transit if, in HIS OPINION, packing is insufficient.

STEP-BY-STEP ASSEMBLY

GENERAL ASSEMBLY INFORMATION

These instructions were prepared by skilled technicians and technical writers from experience gained by actually constructing this PACO kit. Therefore, you will find them arranged in a logical sequence, with every consideration given to the practical aspects of kit assembly. We feel the instructions offer the fastest and best method of assembling your PACO kit.

We urge you to read each step thoroughly and understand the step completely before performing it. This will help you avoid errors. We also suggest you use the check space, ( ), to indicate completion of each step. This will help you avoid omissions.

As an aid in placing components correctly, a system of alphabetical and numerical coding has been set up. Electrical parts (resistors, capacitors, switches, coil, power transformer, tubes, and sockets) are identified by one or two letters followed by a number. The coding is the same as the reference symbols used in the schematic diagram and parts list at the back of the manual. Other parts, such as knobs, chassis, panel, and carrying case are identified by name and PACO part number. Where the reference symbol is followed by a dash and number in the wiring instructions, the number identifies a specific terminal on a part. For example, XV1-6 refers to terminal 6 on socket XV1.

Mounting holes on the chassis and the coil mounting strip are assigned single-letter designations. These designations are assigned alphabetically in the order in which the component part is installed in the step-by-step assembly procedure.

NOTE: Refer to the back of the manual for the methods of identifying color-coded resistors and capacitors.

You are now ready to proceed with the construction of your PACO "In-Circuit" Capacitor Tester.

CHASSIS ASSEMBLY

REFER TO FIGURES 4, 5, AND 6.

( ) 1. Mount the 7-pin miniature tube socket XV1 on the underside of the chassis in the hole marked "A". Orient the tube socket so that the blank space between pins 1 and 7 faces away from hole "B". Use two No. 4-40 x 5/16-inch screws, two No. 4 lockwashers, and two No. 4-40 nuts to secure the socket to the chassis.

( ) 2. Mount the 9-pin miniature socket XV2 on the top side of the chassis in the hole marked "B". Orient the tube socket so that the blank space between pins 1 and 9 faces hole "C". Use two No. 4-40 x 5/16-inch screws, two No. 4 lockwashers, and two No. 4-40 nuts to secure the socket to the chassis.

( ) 3. Place two 3/8-inch grommets into the holes marked "C" and "D".

( ) 4. Mount transformer T1 (P18-203) and the large solder lug above the chassis over holes marked "E" and "F" so that the transformer leads face the front flap of the chassis. Use two No. 8-32 x 3/8-inch screws, two No. 8 lockwashers, and two No. 8-32 nuts to secure the transformer and "large solder lug" to the chassis. Position the lug under the screw head at hole "E" with the wire attachment end facing the front of the chassis.

( ) 5. Mount the two-lug terminal strip TB1 on the underside of the chassis at hole marked "G", placing the grounded lug towards the front flap of the chassis. Use a No. 4-40 x 5/16-inch screw, a No. 4 lockwasher, and a No. 4-40 nut to secure the terminal strip.

( ) 6. Mount the rotary switch S1 (P14-265) through the hole marked "H" so that the locating key on the switch passes through hole marked "I". Use a 3/8-inch control nut to secure the switch to the chassis flap.

( ) 7. Mount the dual potentiometer R5 and R6 (P17-234) through the hole marked "J" so that the locating tab passes through hole "K". Secure the potentiometer with a 3/8-inch control nut.

( ) 8. Mount the slide switch S2 (P14-256) on the outside of the front flap at holes marked "L" and "M". Orient the switch so that the two terminals are nearer to hole "L" than "M". Secure the switch to the chassis flap with two No. 4-40 x 5/16-inch screws, two No. 4 lockwashers, and two No. 4-40 nuts.

( ) 9. Attach the wire tube end holder to the chassis flap at the hole marked "N". Use a No. 4-40 x 5/16-inch screw, No. 4 lockwasher and No. 4-40 nut. Use the loop farther from the bend for mounting. Position the other loop directly over the 9-pin miniature socket when tightening the screw. Be sure that the screw head is on the outside of the chassis flap.

( ) 10. Mount the "small solder lug" on the underside of the chassis at hole marked "O" (figure 6). Use a No. 4-40 x 5/16-inch screw, No. 4 lockwasher, and No. 4-40 nut to secure the lug. Position the lug so that one of the holes in the wire attachment end lines up with hole "S".

( ) 11. Place the coil mounting strip on the top side of the chassis (figure 6) so that mounting strip holes "P", "Q", "R", and "S" line up with the corresponding marked holes in the chassis. Mount the 40,000-ohm (40K) potentiometer R10 (P17-235A) through hole "P" from the underside of the chassis with terminals facing the front flap of the chassis. Secure the potentiometer with a 3/8-inch lockwasher and a 3/8-inch control nut. Put the lockwasher on the underside of the chassis. Make sure that holes "Q", "R", and "S" of the mounting strip line up with the corresponding holes in the chassis after tightening the nut.

( ) 12. Mount the trimmer capacitor at holes marked "Q" and "R" on the coil mounting strip. Bend the trimmer mounting tabs out, as shown in figure 6. Secure the trimmer with two No. 4-40 x 5/16-inch screws, two No. 4 lockwashers, and two No. 4-40 nuts. Place a "small solder lug" under the nut and lockwasher at hole "R". Orient the lug so that one of the holes in the wire attachment end lines up with hole "T".

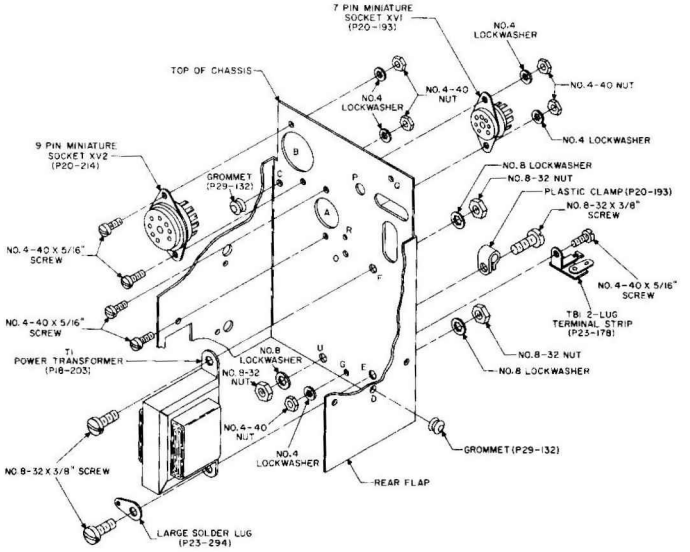


Figure 4. Chassis Assembly

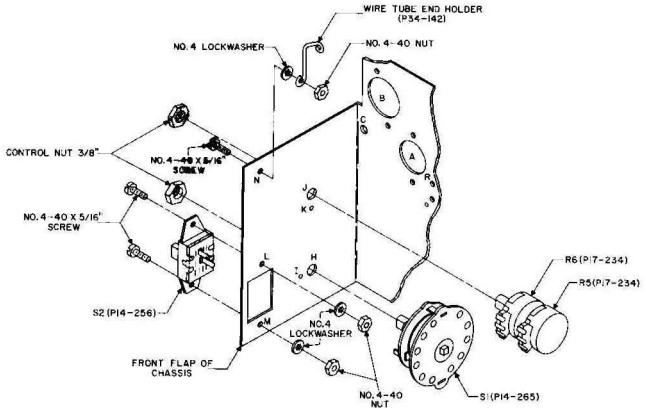


Figure 5. Front Flap Assembly

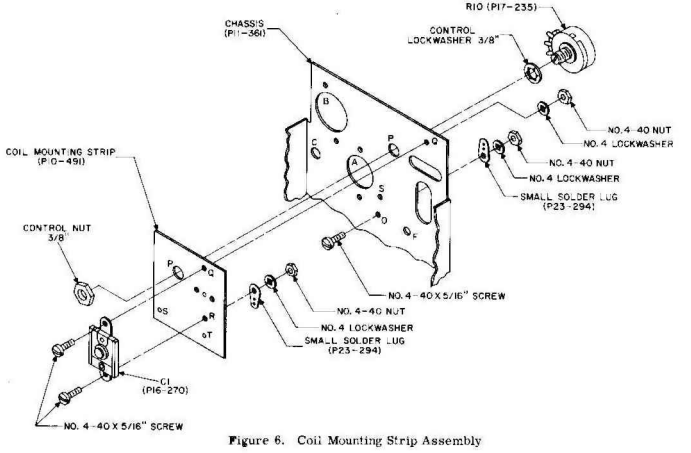


Figure 6. Coil Mounting Strip Assembly

GENERAL WIRING INFORMATION

General

The proper location and connection of wires is perhaps the most important aspect of kit building. This PACO instruction book provides you with complete, step-by-step wiring instructions along with wiring illustrations.

Wiring Diagrams

The main wiring illustrations in this instruction book are duplicated in a larger, folded diagram placed at the back of the book. Use the larger diagram for simplicity of reading. Place the diagrams on the workbench and check off each wire as it is installed. In this way a quick check can be made of the wiring at any time. Also, if wiring is interrupted, you can tell at a glance where to resume wiring.

Wire Leads

In the instructions you will be given the length of each wire required. A wire list, indicating the length of each wire required and the color, is provided below. A scale is also provided for measuring the length of the wire. All the wires for the complete construction of this kit may be pre-cut to the proper size, stripped, and sorted in groups of length and color.

Stripping the Wire

After cutting the wire to the proper lengths, carefully remove 1/4 inch of insulation from each end of the wire. Be careful not to nick the wire when removing the insulation.

Connecting the Wire

When connecting the wires to the designated terminals, do not depend on soldering to provide a "good mechanical connection". Insert the stripped end of the wire in the terminal hole and wrap it around the terminal to be sure of a good mechanical connection.

Wire List
Length (Inches)

Color	1-3/4	2-1/4	3	3-1/2	4-1/4	4-3/4	5-1/2	6	6-1/2
Red		1			1	2	1		
Green			1	1				1	
Yellow	1							1	1

STEP-BY-STEP WIRING

REFER TO FIGURE 7

NOTE: It is important that resistor and capacitor leads be trimmed to fit. Do not cut leads too short! All parts should fit between the designated points without strain.

( ) 1. Connect a 56 ohm resistor R3 (green-blue-black-silver) between S1-12 (Solder : 1) and S1-2 (Don't Solder).

( ) 2. Connect a 47K resistor R4 (yellow-violet-orange) between S1-5 (Don't Solder) and S1-6 (Don't Solder).

( ) 3. Connect a 22K resistor R2 (red-red-orange) between S1-2 (use spaghetti) (Solder : 2) and S1-6 (use spaghetti) (Solder : 2).

( ) 4. Connect a 6-inch length of yellow wire between S1-11 (Solder : 1) and terminal 1 of two-lug terminal strip TB1 (Don't Solder). Dress the wire along the edge of the chassis.

( ) 5. Connect a 3-1/2-inch length of green wire between S1-10 (Solder : 1) and R6-1 (Don't Solder). Dress the wire against the chassis flap.

( ) 6. Connect a 4-3/4-inch length of red wire between S1-9 (Solder : 1) and R5-3 (Solder : 1). Dress the wire against the chassis flap.

( ) 7. Connect a 5-1/2-inch length of red wire between S1-1 (Solder : 1) and R6-2 (Don't Solder). Dress the wire against the chassis flap.

( ) 8. Connect a 22 ohm resistor R7 (red-red-black-silver) between R6-2 (use spaghetti) (Solder : 2) and R5-2 (use spaghetti) (Solder : 1). Do not cut leads.

( ) 9. Connect a 4-3/4-inch length of red wire to S1-5 (Solder : 2). Pass the other end of the wire through grommet C and connect it to XV1-6 (Don't Solder). Dress the wire along the fold of the front chassis flap.

( ) 10. Connect a 6-inch length of green wire to R6-1 (Don't Solder). Pass the other end of the wire through grommet C and connect it to XV2-5 (Don't Solder).

( ) 11. Connect the yellow lead of transformer T1 to R6-1 (Solder : 3).

NOTE: The yellow and blue leads of the transformer are cut accurately to size. Do not shorten or extend these leads.

( ) 12. Connect the blue lead of transformer T1 to terminal lug E near the transformer (Don't Solder).

( ) 13. Connect the green lead of transformer T1 to terminal lug E (Don't Solder).

( ) 14. Connect a 220K resistor R1 (red-red-yellow) between S1-7 (Solder : 1) and terminal lug E (Solder : 3). Do not cut the leads.

( ) 15. Connect the black lead of transformer T1 to S1-8 (Don't Solder).

( ) 16. Connect the other black lead of transformer T1 to S2-2 (Solder : 1).

( ) 17. Pass the free end of the line cord through grommet D at the back chassis flap. Make a knot in the cord 5 inches from the end. Connect one end of the cord to S1-8 (Solder : 2). Connect the other end of the cord to S2-1 (Solder : 1).

( ) 18. Pass the red lead of transformer T1 through grommet C and connect it to socket XV2-6 (Don't Solder).

( ) 19. Connect a 3-inch length of green wire between XV2-5 (Solder : 2) and XV1-4 (Solder : 1). Dress the wire to the chassis.

( ) 20. Connect a 2-1/4-inch length of red wire between XV2-4 (Solder : 1) and R10-2 (Don't Solder). R10-2 is the center terminal of the potentiometer. Dress the wire to the chassis.

( ) 21. Remove all insulation from a 2-inch length of green wire and connect it to R10-2 (Solder : 2). Pass the other end through R10-3 (Solder : 1), then through the ground lug on XV1 near terminal 3, and then to XV1-3 (Solder : 1). Now solder XV1 ground lug near terminal 3.

( ) 22. Connect a 1-3/4-inch length of yellow wire between XV2-3 (Solder : 1) and R10-1 (Solder : 1).

( ) 23. Connect a 2.2 megohm resistor R9 (red-red-green-silver) to XV2-1 (Solder : 1). Pass the other end of the resistor through XV1-5 (Don't Solder) to XV1-1 (Don't Solder).

( ) 24. Connect a 470K resistor R8 (yellow-violet-yellow-silver) between XV2-6 (Don't Solder) and XV1-5 (Solder : 2).

( ) 25. Connect an 820K resistor R11 (gray-red-yellow-silver) through XV2-9 (Don't Solder) to XV2-7 (Solder : 1). Connect the other end of the resistor to XV2-6 (Don't Solder).

( ) 26. Connect a 0.1 mfd tubular capacitor between XV2-6 (use spaghetti) (Solder : 4) and XV2-9 (use spaghetti) (Solder : 2). Recheck to see if all four wires are properly soldered to XV2-6.

( ) 27. Connect a 1000 mmf (0.001 mfd) capacitor between XV1-1 (Solder : 2) and the XV1 ground lug near XV1-1 (Solder : 1).

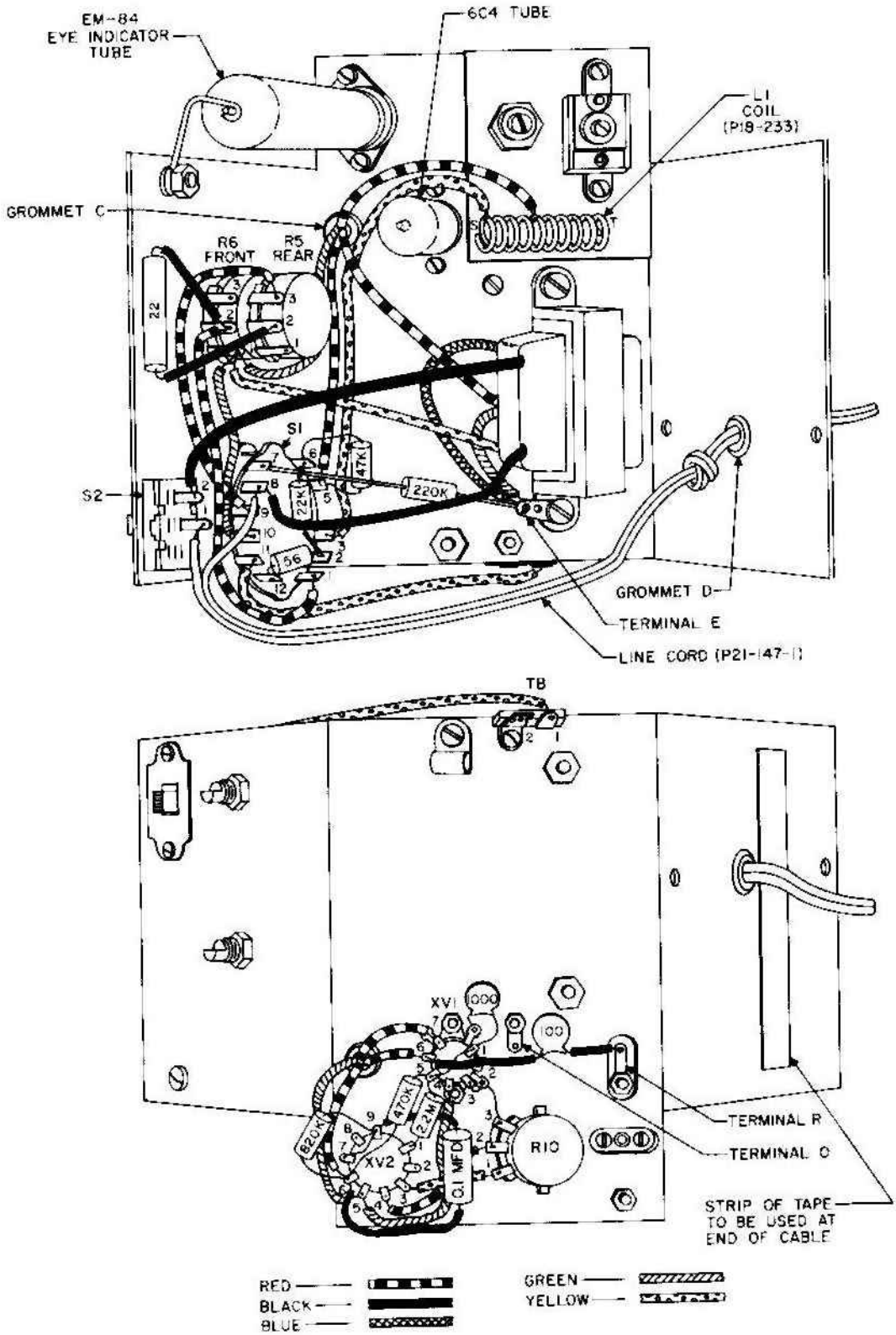


Figure 7. Wiring Diagram

( ) 28. Prepare coil L1 as follows: (Refer to figure 8 for details.)

( ) a. Orient the coil as shown in the figure. Insert the blade end of a screwdriver through the coil to hold it steady.

( ) b. Apply a small drop of solder with the soldering iron one turn and five turns from the left end of the coil. Be sure solder does not bridge across turns.

( ) c. Tin one end of a 6-1/2-inch length of yellow wire. Place the tinned end on the drop of solder at the one-turn tap and apply heat to the solder point. When the solder has melted, remove the heat and allow to cool while holding the wire steady. After cooling, check for a good connection. Check also that the solder does not short out any turns.

( ) d. Similarly connect a 4-1/4-inch length of red wire at the five-turn tap and check solder connection as in the previous step.

( ) 29. Set the ends of the coil into holes "S" and "T" (figure 7) in the coil mounting strip. Squeeze or spread the coil slightly, if necessary, to accomplish this. Then, turn the chassis over and guide the coil ends through the solder hole in terminal lugs "O" and "R". Move or bend the lugs, if required. Press coil flush against coil mounting strip. Do not crimp the coil ends. Cut off excess of coil ends and solder one coil end to the terminal lug "O". If coil does not fit through small holes, it may be necessary to loosen R10 slightly and shift the coil mounting strip accordingly. Then retighten R10.

( ) 30. Connect a 100 mmf (0.0001 mfd) capacitor C2 between XV1-6 (Solder : 2) and terminal lug R (Solder : 2). Use spaghetti on both capacitor leads.

( ) 31. Connect the yellow wire from coil L1 to S1-3 (Solder : 1). Dress the wire away from the tube socket and against the flap fold.

( ) 32. Pass the red wire from coil L1 through grommet "C" and connect it to XV1-7 (Solder : 1).

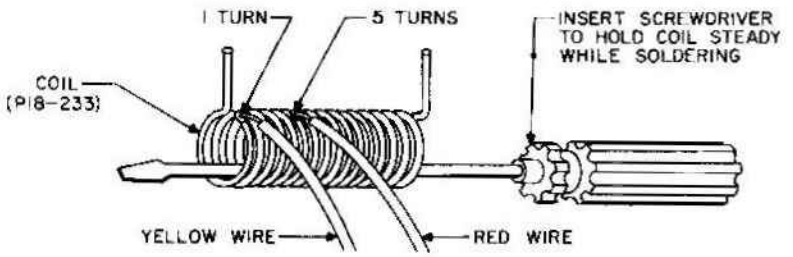


Figure 8. Soldering Leads to Coil

PREPARATION OF TEST CABLE

REFER TO FIGURES 9 AND 10.

( ) 33. Prepare and connect one end of the test cable as follows:

( ) a. Remove approximately 1-1/2 inches of the black, outer insulation from one end of the coaxial cable.

( ) b. Push back the shield until it bulges as shown in figure 9. With a small screwdriver work open the braid, at about the point indicated in the figure, reach into the opening with the screwdriver, bend the cable back as shown, and pull the inner conductor up through the shield opening and out.

( ) c. Remove 3/4 inch of the clear, inner insulation from the inner conductor.

( ) d. Place the plastic clamp on the cable, near the cable end, with the flat side of the clamp facing the chassis. Mount the clamp to the chassis at hole "U". Use a No. 8-32 x 3/8-inch screw. No 8 lockwasher, and No. 8-32 nut.

( ) e. Flatten the shield and connect it to terminal 2 of two-lug terminal strip TB1 (Solder : 1)

CAUTION: Avoid excessive use of heat when soldering shield and inner conductor to terminal strip to prevent melting of insulation.

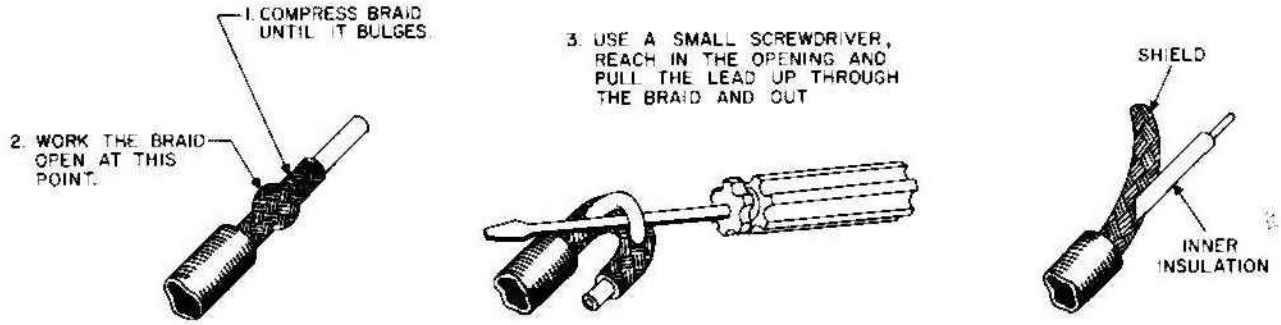


Figure 9. Removal of Shield from Coaxial Cable

( ) f. Connect the inner conductor to terminal 1 of terminal strip TB1 (Solder : 2).

( ) 34. Slide a 3/8-inch grommet into the hole marked "V" in the front panel. Pass the free end of the cable through the grommet from rear to front of panel. Mount the panel to the chassis using two 3/8-inch fiber washers and control nuts. Check to see that the 470K resistor leads are clear of the panel and other components.

( ) 35. Prepare the black and red test leads as follows:

( ) a. Remove 3/8 inch of insulation from each end of the red and black test leads.

( ) b. Twist the exposed strands on each end of the wires and tin the wires at each end.

( ) c. Insert the tinned end of one wire into the small hole of a minigator clip. Insert the wire far enough in the hole so that the insulation is against the end of the minigator clip.

( ) d. Bend over the two lugs at the end of the minigator clip so that they hold the wire firmly.

( ) e. Clip the wire protruding from the minigator short and solder at the hole in the minigator clip. It will be helpful to clip the minigator to something to hold it steady while soldering (such as the edge of this book). Be careful not to leave a large lump of solder which would prevent the minigator clip insulator from going on.

( ) f. In the same manner, install the other minigator clip on the other tinned wire.

( ) g. After the minigator clips have cooled down, install the minigator clip insulator over the clips. This is done by just slipping the insulator on the clip. Line up the slot in the insulator with the jaw edges of the minigator clip.

( ) 36. Prepare the free end of the cable as follows:

( ) a. Push the rubber sleeving up the free end of the cable until about two inches of the cable are exposed.

( ) b. Remove about 1-1/2 inches of the black, outer insulation from the end of the cable.

( ) c. Carefully cut off one inch of the outer shield, leaving 1/2 inch of the shield exposed.

( ) d. Remove about 3/4 inch of the inner insulation from the inner conductor.

( ) e. Tin one side of the shield end and solder the tinned end of the black test lead to the shield.

CAUTION: Avoid excessive heat when soldering test lead to shield or inner conductor to prevent melting of insulation.

( ) f. Cut the inner conductor of the cable to 1/4-inch length and then solder the tinned end of the red test lead to the inner conductor.

( ) g. Wind a small length of insulating tape around the soldered connections and then push the rubber sleeving down over the soldered connections. (This tape will be found attached to one side of the chassis.)

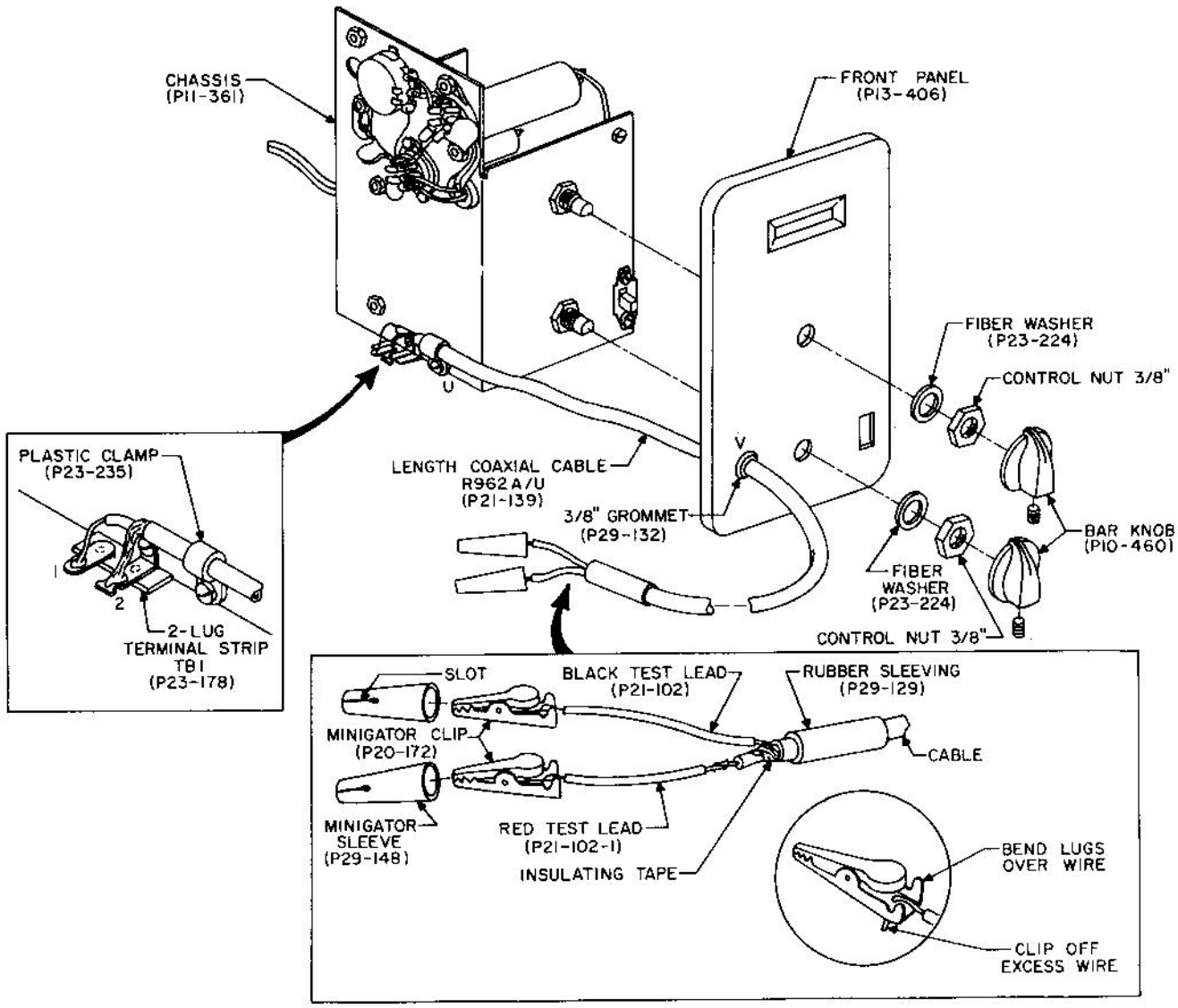


Figure 10. Test Cable Preparation and Front Panel Assembly

( ) 37. Refer to figure 7 and install both tubes in their respective sockets. Adjust the wire tube end holder so that it presses on the tube tip and holds the tube erect.

( ) 38. Refer to figure 10 and install the bar knobs on the rotary switch and dual potentiometer shafts. Note the positioning of the knobs on the flatted shafts. Tighten knob screws with s small screwdriver.

( ) 39. Carefully check the wiring for short circuits and cold or unsoldered connections. Also check that all steps have been completed by looking for the check mark in front of each step.

CALIBRATION

( ) 1. Connect the "In-Circuit" Capacitor Tester line cord to a 117-volt, 60-cycle AC line.

CAUTION: Serious damage will result if the instrument is connected to any other type of power line.

( ) 2. Throw the ON-OFF switch to the ON position. The tubes should light up and after a brief warmup the "eye" columns will glow with green fluorescence.

( ) 3. Put the Selector Switch in the 2-40 MFD ELECTROLYTICS position and short the minigator clips.

( ) 4. Adjust the 40K calibrating potentiometer R10 (EM-84 Tube Bias Control) on the coil mounting strip so that the "eye" columns are open approximately 1/4 inch.

( ) 5. Set the Selector Switch to the OPEN TEST position and separate the minigator clips.

( ) 6. With an insulated screwdriver, adjust the trimmer capacitor for a maximum closure of "eye" columns.

CAUTION: Do not tighten the trimmer screwdriver control to its completely clockwise position.

( ) 7. Readjust the 40K calibrating potentiometer R10 for a little more than maximum closure of the columns. This will result in a thin bright vertical line in the center of the indicator tube. The correct thickness can be compared to the line under the words "ALL CAPACITORS" and "ELECTROLYTICS ONLY", on the "In-Circuit" Capacitor Tester panel.

( ) 8. With minigator clips shorted, check that the "eye" is completely closed for each position of the Selector Switch, except the OPEN TEST position. If necessary, readjust the 40K potentiometer R10 slightly as in step 7, with minigator clips shorted.

( ) 9. After completing the calibration, throw the ON-OFF switch to OFF, disconnect the line cord, and proceed to final assembly.

WHAT TO DO IN CASE OF TROUBLE

If the instrument does not operate properly and you are unable to calibrate it in the manner described, we suggest the following check procedure be observed:

1. Recheck all wiring and make certain all connections have been properly made. Most troubles encountered after completion of kit assembly are the result of incorrect wiring. Having someone else check the wiring often reveals mistakes that are consistently overlooked.

2. Check the 6C4 and EM-84 tubes, using a reliable tube tester such as PACO Model T-60. This instrument uses tubes which require no special selection, and replacement should be no problem.

3. Apply power to the tester, set the Selector Switch to the SHORT TEST position, and separate the minigator clips from each other and from ground. Measure the voltage from the 6C4 grid (pin 6) to ground with the high impedance AC facilities of a Vacuum Tube Voltmeter, such as PACO Model V-70. The voltage reading should be approximately 5 to 6 volts AC. If the correct voltage is obtained, disconnect power and measure the resistances from tube socket pins to chassis ground as shown in the following table:

Tube	Pin	Resistance	Tube	Pin	Resistance
6C4	1	475K	EM84	5	0.5 Ohm
EM84	1	2.7 Megohms		6	2800 Ohms
	2	No connection		7	820K
	3	Will vary with setting of R10		8	No connection
	4	0		9	820K

If any measured resistances differ by more than ±20% from the listed values, check the appropriate wiring and and parts.

If the 6C4 grid voltage is not approximately 5 to 6 volts AC, trace the wiring of the grid circuit against the schematic (figure 12) in the back of the manual. Note that in the schematic diagram, the Selector Switch is shown in the SHORT TEST position.

FINAL ASSEMBLY

REFER TO FIGURE 11.

( ) 1. Fasten the handle on the "In-Circuit" Capacitor Tester carrying case, using two No. 10-32 x 1/2-inch screws, two No. 10 eyelets, two No. 10 lockwashers, and two No. 10-32 nuts.

( ) 2. Push the four rubber feet into the four holes in the bottom of the case so that the flat portion is outside of the case.

( ) 3. Set the instrument into the carrying case, fitting the lips of the panel around the case. Secure the instrument to the case with two No. 6 x 3/8-inch sheet metal screws. The "In-Circuit" Capacitor Tester is now ready for use.

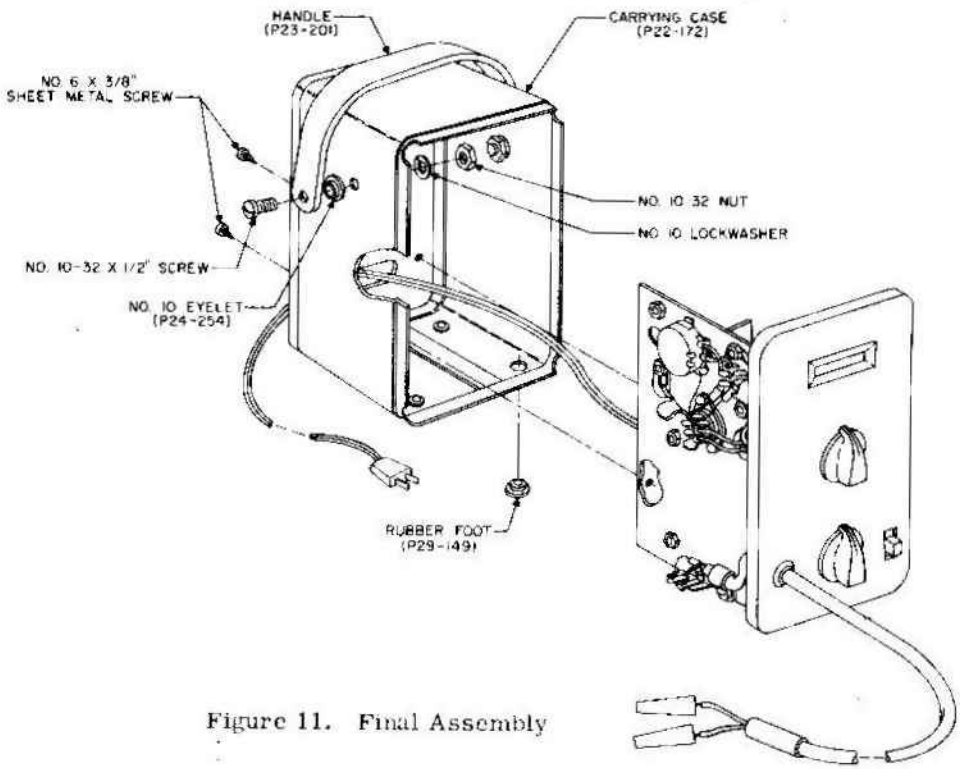


Figure 11. Final Assembly

CIRCUIT DESCRIPTION

The PACO Model C-25 "In-Circuit" Capacitor Tester was especially designed for use by television and radio service technicians as a valuable aid for rapidly isolating troubles caused by faulty capacitors in a set without disconnecting the capacitors. The design of the instrument is such that normal circuit shunt resistances and stray capacitances will not interfere with the qualitative checks made on all capacitors and the measurement of capacitances for electrolytics. Operation of the tester is simple and trouble-free. Whether the Selector is in the OPEN TEST or SHORT TEST position, an open "eye" indicates a good capacitor and a closed "eye" indicates a defective capacitor. The condition of electrolytics can be determined directly while measuring their capacitances so that additional open and short tests for electrolytics are not required. When measuring the capacitances of electrolytics, the "eye" remains open for open electrolytics and remains closed for shorted electrolytics. The circuits of the tester, for each position of the Selector Switch, function as described below. (See schematic diagram at back of the manual.)

1. SHORT TEST. When a shorted capacitor is connected to the minigator clips, the normal 6C4 grid potential obtained from the 6.3-volt filament winding of the transformer drops to zero. The resulting decrease in the 6C4 plate voltage, which is directly coupled to the EM84 grid, produces a sharp decrease in EM84 plate current and the "eye" closes.

2. OPEN TEST. In this position of the Selector Switch, the 6C4 grid potential is provided by an oscillator at a frequency of approximately 40 megacycles. At this frequency, the coaxial cable represents a 1/4-wavelength line so that when an open capacitor is connected to the minigator clips, the open line appears as a short

circuit at the one-turn coil tap, a 1/4-wavelength away. The shorted turn reduces the feedback voltage and the grid voltage drops. The drop in grid voltage causes the "eye" to close, as described above. The oscillator is so designed that sufficient grid potential is developed to keep the "eye" open when a good capacitor is connected to the minigator clips.

3. ELECTROLYTICS (2-40 MFD). In this position, the filament voltage is applied across the variable resistance of the dual potentiometer and the impedance of the capacitor under test to ground. The voltage on the capacitor is applied to the 6C4 grid. Since the voltage increases as the capacitance decreases, the resistance of the dual potentiometer in series with capacitor must be increased to maintain the grid voltage at a fixed level. The value of the resistance in the circuit when the "eye" closes is therefore a means of measuring the capacitance of an unknown electrolytic. The "eye" closes when the grid voltage is approximately 5 to 6 volts AC.

4. ELECTROLYTIC (40-400 MFD). For the higher ranges of electrolytics, the high-resistance potentiometer (5K) of the dual control is shorted out to compensate for the lower impedances of the electrolytics. The 6C4 grid voltage required to close the "eye" is also 5 to 6 volts AC for the higher ranges.

HOW TO USE THE "IN-CIRCUIT" CAPACITOR TESTER

WARNING: The voltages present in radio and television sets are dangerous to life. Before proceeding with any capacitor tests, disconnect the line cord of the set under test from the power line and short the terminals of all capacitors to ground to eliminate any shock hazards and to protect the tester from any voltages which may be present. This is particularly true of capacitors with high voltage ratings.

The "In-Circuit" Capacitor Tester is easy to operate. Connect the tester line cord to a 117-volt, 60-cycle AC line and throw the ON-OFF switch to ON. After a brief warmup, the "eye" columns should be visible. The tester is now ready for checking capacitors.

CAUTION: The tester is designed for operation only on a 110 to 120-volt, 60-cycle line. Serious damage will result if any other type of power line is used.

TESTING FOR OPEN AND SHORTED CAPACITORS

Inasmuch as the open and short test is intended to locate capacitors which are either opened or shorted while connected in the operating circuit, it becomes apparent that other shunting components such as resistors and coils must not interfere with the test results. The short test circuit is therefore designed to produce a closed "eye" indication for a shorted capacitor even when shunted by a resistance as low as approximately 7 ohms. This means that the Capacitor Tester will indicate a directly shorted capacitor in practically all operating circuits. On the other hand, capacitors, other than electrolytics, that are not completely shorted may not show up as defective because of the inherent nature of an in-circuit test. For a direct short, however, the indication is positive and reliable. If one side of a capacitor is grounded to the circuit, connect the black lead to that side.

After disconnecting the set under test from the power line and discharging capacitors to be tested, connect the minigator clips to the capacitor being tested. To test for a shorted capacitor, set the Selector Switch to the SHORT TEST position. The eye will close if the capacitor is shorted. To test for an open capacitor (not less than 7 MMFD), set the Selector Switch to the OPEN TEST position. The eye will close if the capacitor is open.

NOTE: For multi-section capacitors, connect one of the minigator clips to the common terminal (or ground). Then connect the other minigator clip successively to other terminals. It is not necessary to consider the polarity of the capacitors when performing any of the tests.

The electrolytic capacitance check facilities of the Model C-25 is not intended to yield exact capacitance readings. It is intended to search out electrolytics whose capacitance has been drastically reduced because of drying-out of the electrolytic, etc.

It is not necessary to perform separate tests on electrolytics to determine if the electrolytics are open or shorted. If while measuring the capacitance, the "eye" remains either open or closed for all settings of the potentiometer control in both ranges, the electrolytic is defective.

MEASURING CAPACITANCE OF ELECTROLYTICS

After disconnecting the set under test from the power line and discharging capacitors to be tested, connect the minigator clips to the electrolytic being tested (see note above for connecting to multi-section capacitors). Set the Selector Switch to the required range, as indicated by the capacitance of the capacitor. Adjust the potentiometer control for minimum "eye" opening. If a minimum "eye" opening cannot be obtained using the higher range, switch to the lower range and readjust the potentiometer control for minimum "eye" opening. The setting of the knob pointer then indicates the approximate value of the electrolytic capacitor. Very few, if any,

popular electronic circuits (including transistorized equipment) would be encountered where in-circuit shunt resistance in the equipment would seriously affect the accuracy of the capacitance reading. If an occasional test point is encountered, wherein the shunt resistance across the capacitor (as determined from the schematic of set under test) is considerably less than the values listed for the capacitance ranges given below, the accuracy of the reading will be somewhat decreased.

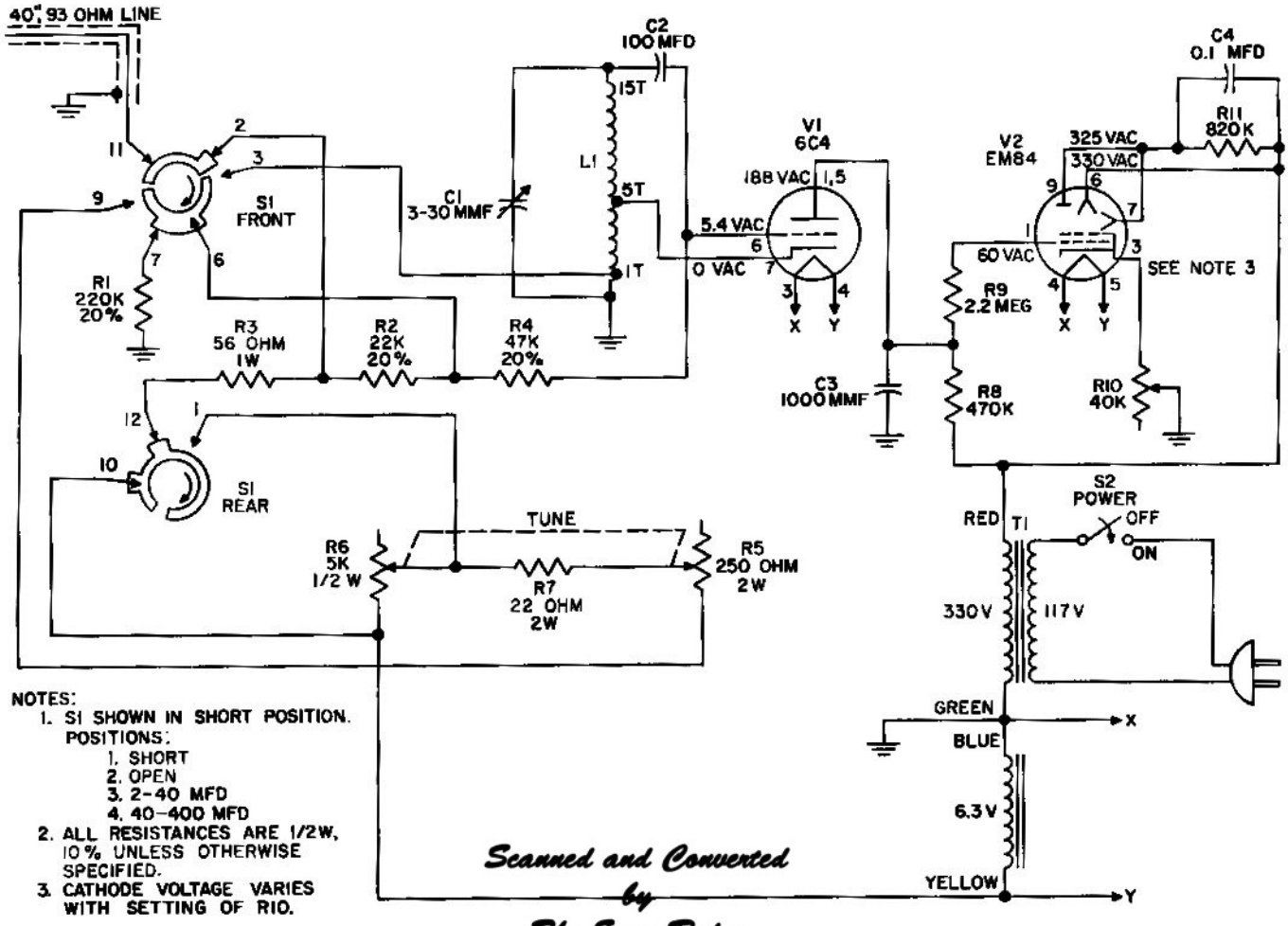
Capacitance (mfd)	Shunt Resistance (ohms)
5 to 10	1500
10 to 20	750
20 to 40	375
40 to 80	200
80 to 150	100
150 to 300	50
300 to 400	25

MAINTENANCE SUGGESTIONS

Your PACO tester is capable of fulfilling continuous service requirements over a period of several years. However, in order for the user to fully realize these capabilities, the same degree of care in operation and maintenance should be accorded your instrument that would be given any fine piece of equipment.

There is always the possibility that repairs will be necessary with any electronic test equipment. Should your tester require servicing, just remember that the same logical process of elimination applies here as it does for any electronic circuit, and you should experience no difficulty. The checks outlined under "WHAT TO DO IN CASE OF TROUBLE" will aid you considerably. Proper operating voltages are shown on the schematic. A variation of ±15% in these readings is entirely acceptable.

The tubes used in this instrument can be checked periodically with a tube checker such as the PACO Model T-60.



Scanned and Converted by The Easy Rider

Figure 12. Schematic Diagram

PARTS LIST

Ref. Symbol	Part No.	Quantity	Description
		RESISTORS	
R1	P15-768	1	220K Ohms 20% 1/2W Carbon
R2	P15-546	1	22K Ohms 20% 1/2W Carbon
R3	P15-988	1	56 Ohms 10% 1W Carbon
R4	P15-695	1	47K Ohms 20% 1/2W Carbon
R7	P15-986	1	22 Ohms 10% 2W Carbon
R8	P15-728	1	470K Ohms 10% 1/2W Carbon
R9	P15-725	1	2.2 Megohms 10% 1/2W Carbon
R11	P15-971	1	820K Ohms 10% 1/2W Carbon
		CAPACITORS	
C1	P16-270	1	3-30 mmf Trimmer
C2	P16-204	1	100 mmf Ceramic Disc
C3	P16-249	1	1000 mmf Ceramic Disc
C4	P16-150	1	0.1 mfd Tubular 200 WVDC
		CONTROLS - SWITCHES	
R5 and R6	P17-234	1	Dual 250/5K Ohm Potentiometer
R10	P17-235A	1	40K Ohm Potentiometer
S1	P14-265	1	Rotary Switch
S2	P14-256	1	SPST Slide Switch
		TUBES - SOCKETS	
V1	P19-117-1	1	Type 6C4 Tube
V2	P19-164	1	Type EM-84 Tube
XV1	P20-193	1	7-Pin Miniature Tube Socket
XV2	P20-214	1	9-Pin Miniature Tube Socket
		WIRE - INSULATION	
	P21-147-1	1	Line Cord
	P21-148	1	Roll Hookup Wire (Red, Green, and Yellow)
	P21-170	1	Length of Spaghetti
	P21-139	1	Length Coaxial Cable
	P21-102	1	Length Black Test Lead

PARTS LIST (Continued)

Ref. Symbol	Part No.	Quantity	Description
		WIRE - INSULATION (Continued)	
	P21-102-1	1	Length Red Test Lead
	P29-129	1	Length Rubber Sleeving
		SHEET METAL PARTS	
	P22-172	1	Carrying Case
	P13-406	1	Front Panel
	P11-361	1	Chassis
		HARDWARE	
	P24-254	2	No. 10 Eyelet
	P24-255	11	No. 4-40 x 5/16" Screw
	P24-267	3	No. 8-32 x 3/8" Screw
	P24-257	2	No. 10-32 x 1/2" Screw
	P24-215	2	No. 6 x 3/8" Sheet Metal Screw
	P24-158	11	No. 4-40 Nut
	P24-134	3	No. 8-32 Nut
	P24-138	2	No. 10-32 Nut
	P24-180	5	Control Nut 3/8"
	P24-175	1	Control Lockwasher 3/8"
	P24-253	11	No. 4 Lockwasher
	P24-247	3	No. 8 Lockwasher
	P24-248	2	No. 10 Lockwasher
	P23-294	2	Small Solder Lug
	P23-249	1	Large Solder Lug
	P23-224	2	Fiber Control Washer
		MISCELLANEOUS	
L1	P18-223	1	Coil
T1	P18-203	1	Power Transformer
	P20-172	2	Minigator Clip
	P29-148	2	Minigator Sleeve
	P23-178	1	2-Lug Terminal Strip

PARTS LIST (Continued)

Ref. Symbol	Part No.	Quantity	Description
		MISCELLANEOUS (Continued)	
	P10-460	2	Bar Knob
	P29-132	3	3/8" Grommet
	P29-149	4	Rubber Foot
	P23-235	1	Plastic Clamp
	P23-201	1	Handle
	P34-142	1	Wire Tube End Holder
	P10-491	1	Coil Mounting Strip
	P35-110	1	Length Insulating Tape (attached to side of chassis)
	P26-262	1	Instruction Book

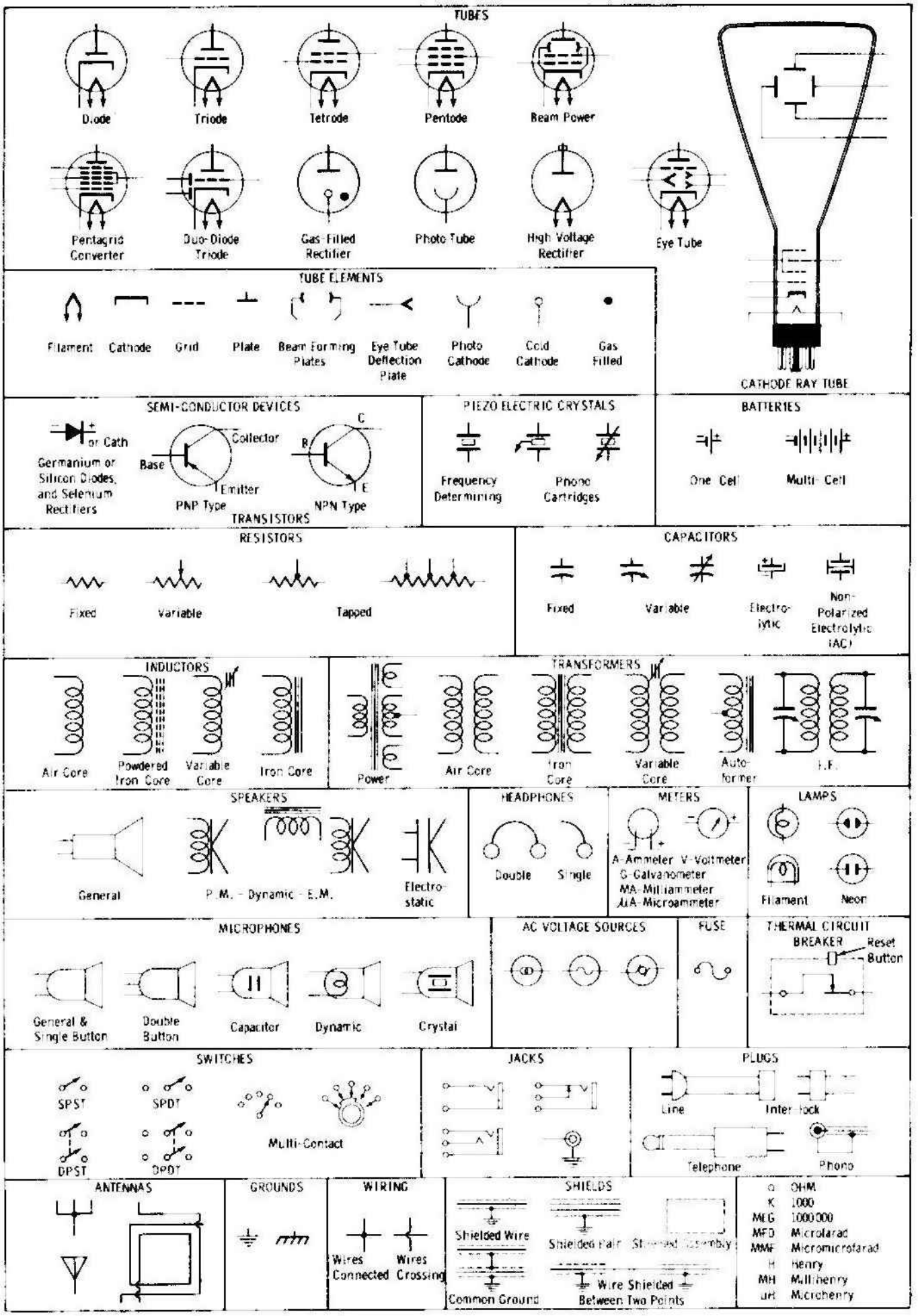

TUBES
Diode
Triode
Tetrode
Pentode
Beam Power
Pentagrid Converter
Duo-Diode Triode
Gas-Filled Rectifier
Photo Tube
High Voltage Rectifier
Eye Tube
CATHODE RAY TUBE
TUBE ELEMENTS
Filament
Cathode
Grid
Plate
Beam Forming Plates
Eye Tube Deflection Plate
Photo Cathode
Cold Cathode
Gas Filled
SEMI-CONDUCTOR DEVICES
or Cath
Germanium or Silicon Diodes, and Selenium Rectifiers
Collector
Base
Emitter
PNP Type
NPN Type
TRANSISTORS
PIEZO ELECTRIC CRYSTALS
Frequency Determining
Phono Cartridges
BATTERIES
One Cell
Multi-Cell
RESISTORS
Fixed
Variable
Tapped
CAPACITORS
Fixed
Variable
Electro-lytic
Non-Polarized Electrolytic (AC)
INDUCTORS
Air Core
Powdered Iron Core
Variable Core
Iron Core
TRANSFORMERS
Power
Air Core
Iron Core
Variable Core
Auto-former
I.F.
SPEAKERS
General
P.M. - Dynamic - E.M.
Electro-static
HEADPHONES
Double
Single
METERS
A-Ammeter V-Voltmeter
G-Galvanometer
MA-Milliammeter
μA-Microammeter
LAMPS
Filament
Neon
MICROPHONES
General & Single Button
Double Button
Capacitor
Dynamic
Crystal
AC VOLTAGE SOURCES
FUSE
THERMAL CIRCUIT BREAKER
Reset Button
SWITCHES
SPST
SPDT
DPST
DPDT
Multi-Contact
JACKS
PLUGS
Line
Inter-lock
Telephone
Phono
ANTENNAS
GROUNDS
WIRING
Wires Connected
Wires Crossing
SHIELDS
Shielded Wire
Shielded Pair
Common Ground
Wire Shielded Between Two Points
Ω OHM
K 1000
MEG 1000000
MFD Microfarad
MMF Micromicrofarad
H Henry
MH Millihenry
μH Microhenry

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

The first line of test instrument kits engineered and produced under the auspices of a major test equipment manufacturer

The Finest

Electronic

Test Instruments

IN KIT FORM

PRECISION APPARATUS, INC.

80-00 COOPER AVENUE

GLENDALE, N. Y. 11227