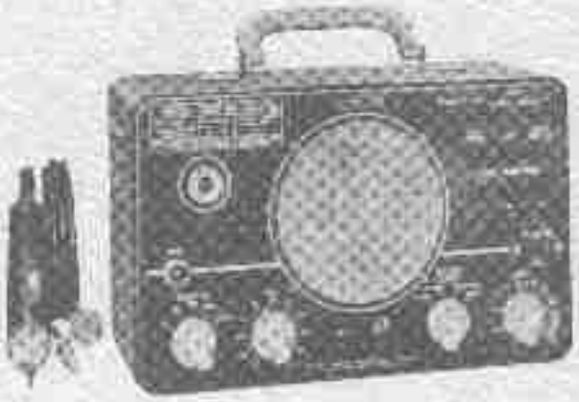
Manual . . . Net Price: $1.00

ASSEMBLY
and
OPERATING
MANUAL
for



PACO

AUDIO-RF
SIGNAL TRACER KIT
Model Z-80

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

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 large 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.

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. Screwdriver handled nut-drivers may be used in place of wrenches in most cases.

ASSEMBLY AND WIRING

The position of wires and parts in this instrument is quite critical in most 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.

SOLDERING

We wish to emphasize at this point the extreme importance of proper soldering technique. Much engineering skill and effort has gone into making your PACO instrument capable of high quality performance. In order for you to fully realize these capabilities, good solder joints are essential. If you have had little or no previous 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.

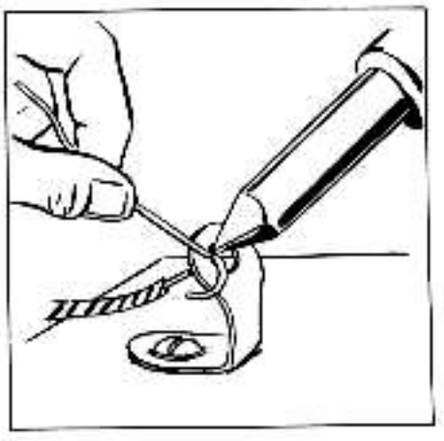
Only good quality television and radio type solder with a non-corrosive core should be used: **THIS IS IMPORTANT! ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE ANY PACO INSTRUMENT IN WHICH ACID CORE SOLDER OR PASTE FLUX HAS BEEN USED.**

To remove any doubt about your solder, we suggest you make certain the roll you buy has been clearly labeled for television and radio use.

Prior to soldering, be sure terminals and leads are clean and free of wax or corrosion. Make a good mechanical connection by crimping the leads on the terminals with your pliers. Do not rely on solder alone for mechanical strength.

Keep the tip of your iron properly tinned in accordance with the instructions of the soldering iron manufacturer. It should have a "bright" appearance and be free of excess solder. An old rag can be used to wipe the hot tip clean.

When using your iron, avoid applying excessive heat as this could cause damage to insulation or parts. It could also result in a flux flooding condition which could cause a leakage path between adjacent terminals on switches and tube sockets. BY THE SAME TOKEN, INSUFFICIENT HEAT WILL OFTEN RESULT IN A "COLD" OR HIGH RESISTANCE SOLDER CONNECTION. THIS USUALLY HAS A DULL AND "GRAINY" APPEARANCE. A good soldered joint will present a smooth and "shiny" appearance.



Proper technique to obtain good results involves applying the iron to the joint, holding it there momentarily until the joint heats, and then applying solder to joint and iron simultaneously. Apply the iron long enough to cause solder to flow smoothly into the joint. Do not simply melt drops of solder on to the joint. . . . Solder must FLOW into the joint to be effective.

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 SIGNAL TRACER Kit for a service charge of $4.00 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. Always pack carefully in a rugged, oversized container, preferably wood, 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 diffi-

culties encountered. The more explicit the details, the more rapidly your instrument can be handled and processed.

Please ship Via Railway Express PREPAID and address to:

PACO ELECTRONICS CO., INC.,
70-31 — 84th 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 will be by 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

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

We urge you to read each step thoroughly, and understand it completely before performing it. This will help you to avoid errors. We also suggest that you use the check space, ( ), provided to indicate completion of each step. This will help you avoid omissions in the assembly. Many kit builders also follow the practice of crossing out, with a colored pencil, each wire and component on the wiring diagram after installation.

The "(Solder)" and "(Don't Solder)" designations in the instructions are self-explanatory and should be complied with throughout assembly. When you see "(Don't Solder)" after a step, you should only crimp the lead to the terminal, and proceed to the next step. A later step will indicate when all leads have been connected to this terminal, and Soldering is to be done.

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 "C" 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.

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 SIGNAL TRACER.

MECHANICAL ASSEMBLY

REFER TO FIGURE 1 THROUGH 3

( ) 1. Insert a red Bakelite pin jack in hole at front panel location A. Position so that flat side of solder lug is horizontal, and secure the jack with Tinnerman fastener, as shown in Figure 2. After jack has been installed, bend the solder lug up toward top of panel.

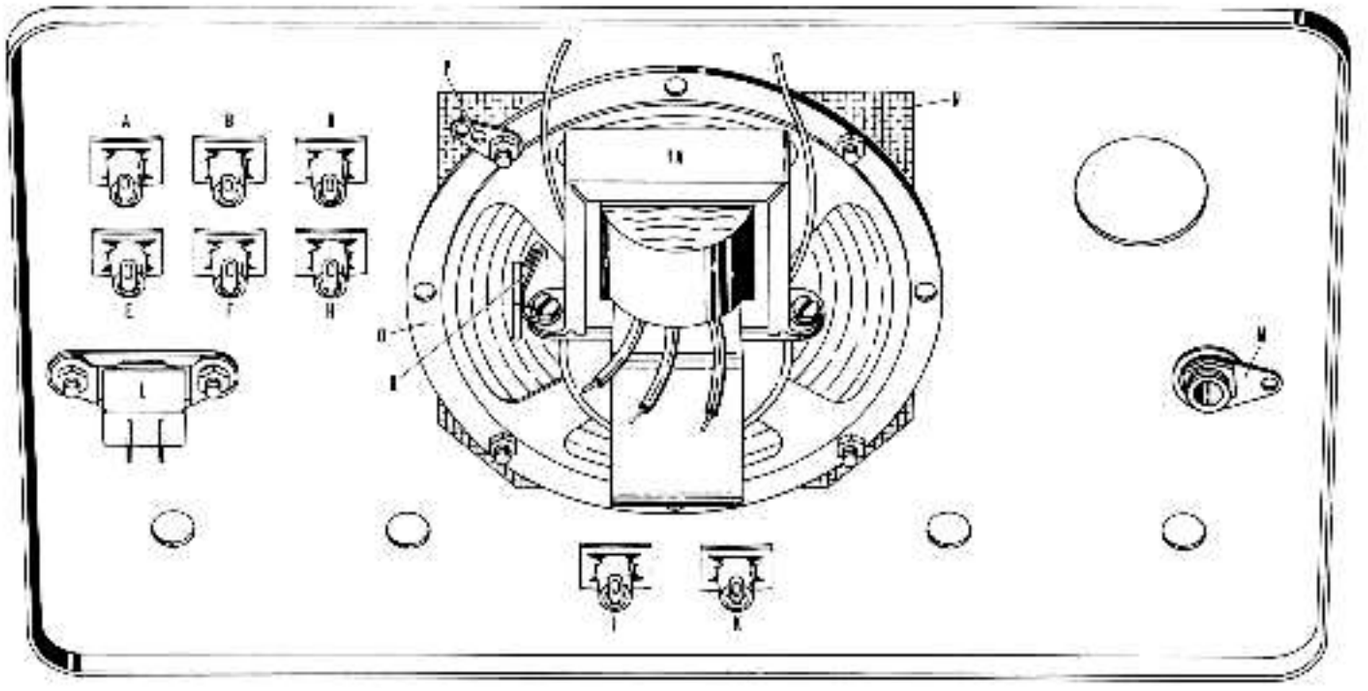


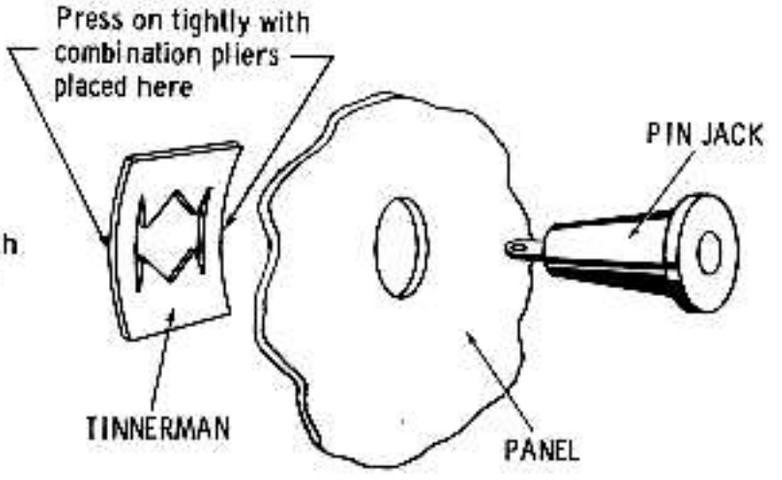
FIGURE 1

( ) 2. In the same manner, install another red Bakelite pin jack in hole at panel location D.

( ) 3. In the same manner, install another red Bakelite pin jack in hole at panel location E.

( ) 4. In the same manner, install another red Bakelite pin jack in hole at panel location F.

( ) 5. In the same manner, install another red Bakelite pin jack in hole at panel location H.



NOTE – Push Tinnerman on jack with fingers. Then secure tightly with combination pliers as indicated.

FIGURE 2

( ) 6. In the same manner, install another red Bakelite pin jack in hole at panel location J.

( ) 7. In the same manner, install a black Bakelite pin jack in hole at panel location B.

( ) 8. In the same manner, install another black Bakelite pin jack in hole at panel location K.

( ) 9. Install the WATTMETER LOAD receptacle in cutout at panel location L. Use two #6-32 x 3/8" BH screws, two #6 lockwashers, and two #6-32 hex nuts.

( ) 10. Install the INPUT coaxial connector in hole at panel location M. Use a control lockwasher, ground lug, and control hex nut. Orient ground lug to side of panel. See Figures 1 and 3.

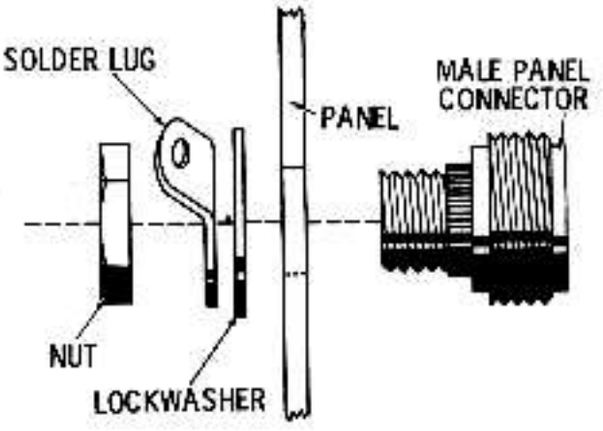


FIGURE 3

( ) 11. Place grille cloth N (flocked side out, sheared corners at bottom) over large hole in center of panel. Mount speaker O (transformer strap at top) over grille cloth N. Use four #6-32 x 3/8" BH screws, three #6 lockwashers (NOTE: Use #6 solder lug at location P instead of #6 lockwasher), and four #6-32 hex nuts.

( ) 12. Mount output transformer TA, and one-lug terminal strip Q on transformer strap of speaker O. Orient transformer so that the two enameled leads are closest to panel. Use two #6-32 x 3/8" BH screws, two #6 lockwashers, and two #6-32 hex nuts.

REFER TO FIGURES 4 THROUGH 6

( ) 13. Insert a rubber grommet in hole at chassis location R.

( ) 14. Insert another rubber grommet in hole at chassis location V.

( ) 15. Insert another rubber grommet in hole at chassis location W.

( ) 16. Insert another rubber grommet in hole at chassis location X.

( ) 17. Insert another rubber grommet in hole at chassis location Y.

( ) 18. Insert another rubber grommet in hole at chassis location Z.

( ) 19. Install a seven-pin miniature tube socket in hole at chassis location AA. Use two #4-40 x 1/4" BH screws, two #4 lockwashers, and two #4-40 hex nuts. Position socket as shown in Figure 4. Also see Figure 5. (NOTE: Do NOT bend socket terminals flat; the illustrations show them flat only for purposes of clarity.)

( ) 20. In the same manner, install another seven-pin miniature tube socket in hole at chassis location BB. Use two #4-40 x 1/4" BH screws, two #4 lockwashers, and two #4-40 hex nuts. Position socket as shown in Figure 4. Also see Figure 5.

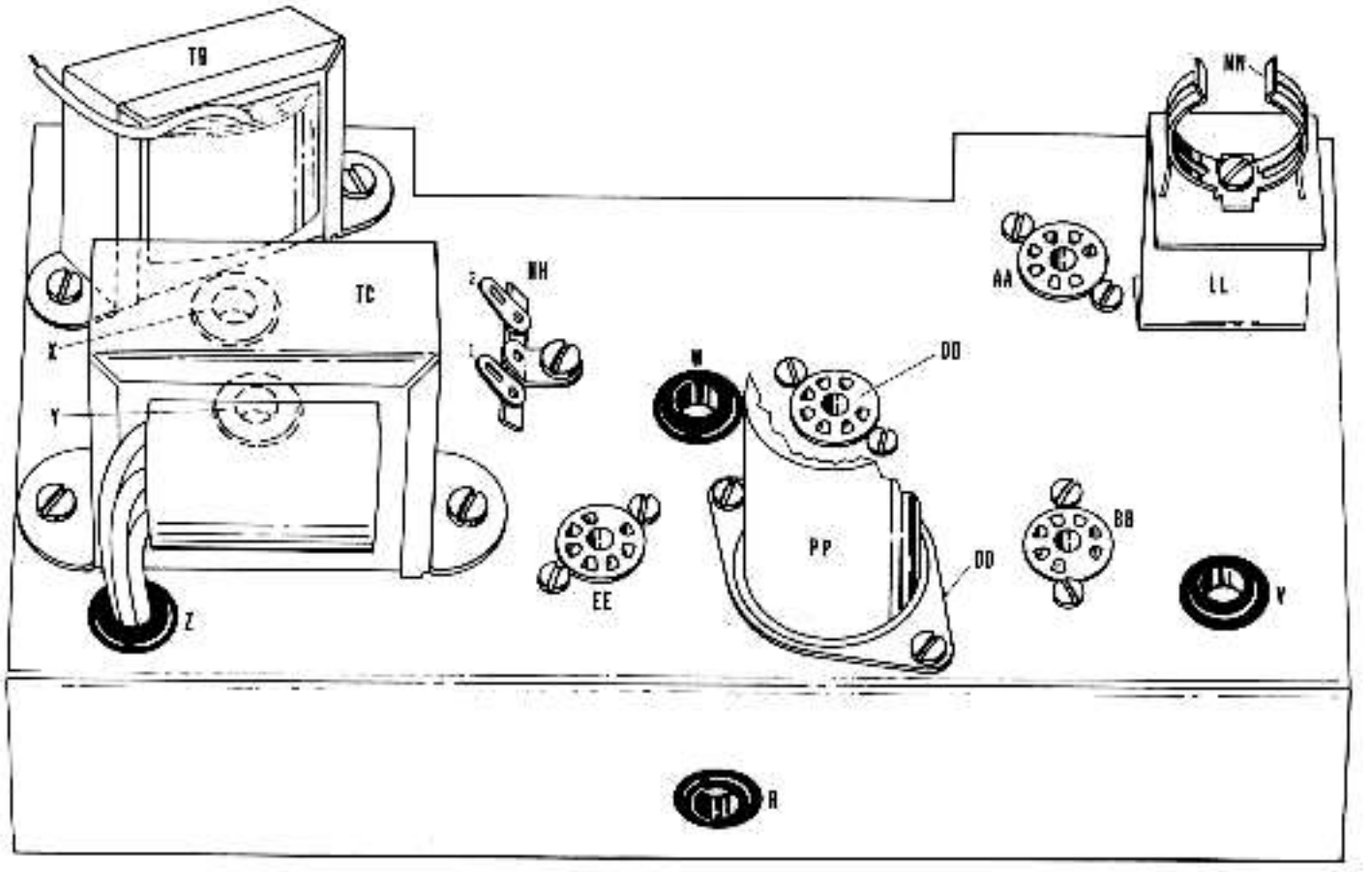


FIGURE 4

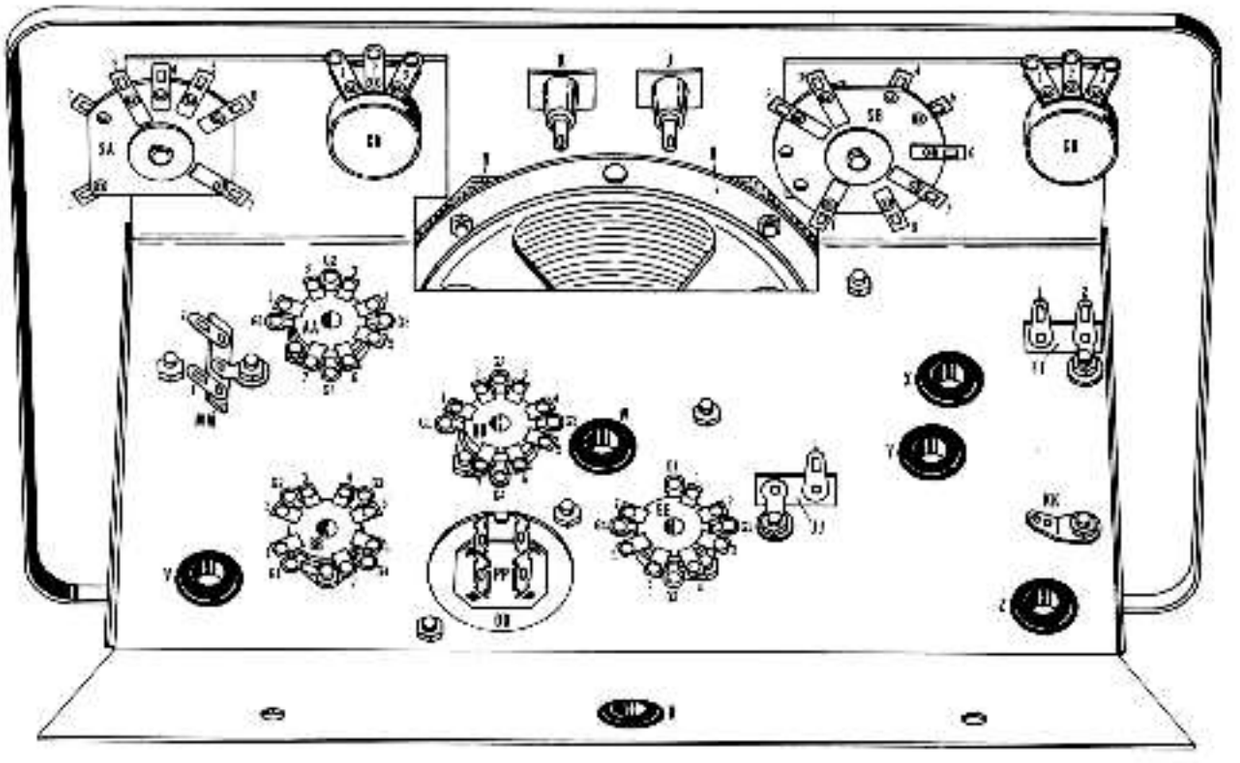


FIGURE 5

( ) 21. In the same manner, install another seven-pin miniature tube socket in hole at chassis location DD. Use two #4-40 x 1/4" BH screws, two #4 lockwashers, and two #4-40 hex nuts. Position socket as shown in Figure 4. Also see Figure 5.

( ) 22. In the same manner, install another seven-pin miniature tube socket in hole at chassis location EE. Use two #4-40 x 1/4" BH screws, two #4 lockwashers and two #4-40 hex nuts. Position socket as shown in Figure 4. Also see Figure 5.

( ) 23. Mount current transformer at chassis location TB. Position transformer so that the two red leads and one black lead are at grommet X. Pass these leads through grommet X before mounting. Under the chassis, mount two-lug terminal strip FF (one lug grounded) on the transformer mounting screw nearest side of chassis. Use two #6-32 x 3/8" BH screws, two #6 lockwashers, and two #6-32 hex nuts. See Figures 4 and 5.

( ) 24. Mount two-lug terminal strip (no lugs grounded) at chassis location HH. Use a #6-32 x 3/8" BH screw, #6 lockwasher, and #6-32 hex nut.

( ) 25. Mount power transformer at chassis location TC. Position transformer so that the green and green-yellow leads are at grommet Z, and the black, red, and red-yellow leads are at grommet Y. Pass these leads through grommets Y and Z before mounting. Under the chassis, mount one lug terminal strip JJ, and #6 solder lug KK on the transformer mounting screws. Bend solder lug KK to approximately 30° angle from chassis. Use two #6-32 x 3/8" BH screws, one #6 lockwasher, and two #6-32 hex nuts. See Figures 4 and 5.

( ) 26. Mount eye-tube bracket at chassis location LL. Under the chassis, mount two-lug terminal strip MM (no lugs grounded) on bracket mounting screw nearest socket AA. Use two #6-32 x 3/8" BH screws, two #6 lockwashers, and two #6-32 hex nuts.

( ) 27. Mount eye-tube spring clip NN on bracket LL. Use a #6-32 x 3/8" BH screw, #6 lockwasher, and #6-32 hex nut.

( ) 28. Install electrolytic capacitor mounting wafer on top side of chassis at location OO. Use two #6-32 x 3/8" BH screws, two #6 lockwashers, and two #6-32 hex nuts.

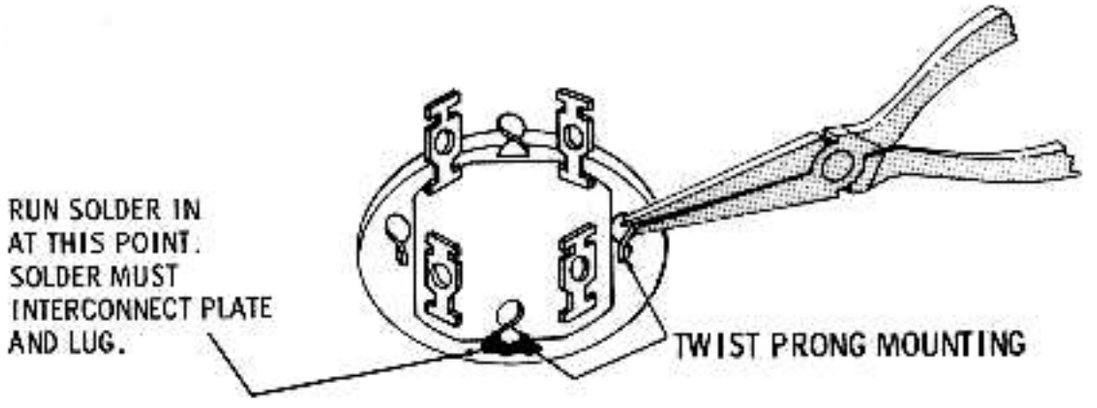


FIGURE 6

( ) 29. Insert the metal electrolytic capacitor PP from the top into mounting wafer slots. Position terminals as shown in Figure 5. Hold capacitor firmly in place and twist prongs with pliers to secure. See Figure 6. Solder the mounting lug without the hole to the mounting plate as shown in Figure 6.

REFER TO FIGURES 5 AND 7

( ) 30. Place the chassis against the panel, lining up the four holes for switches SA, and SB, and controls CA and CB.

( ) 31. Install the MULTIPLIER switch at location SA. Use a control lockwasher, Bakelite panel washer, and control hex nut. Before tightening the nut, have switch in full counterclockwise position. Orient switch so that the flat side of the shaft is directly opposite the X1 marking on the panel. Check by placing pointer knob on shaft and tightening set screw. Reposition switch if pointer does not line up with X1 marking. Retighten pointer knob on shaft.

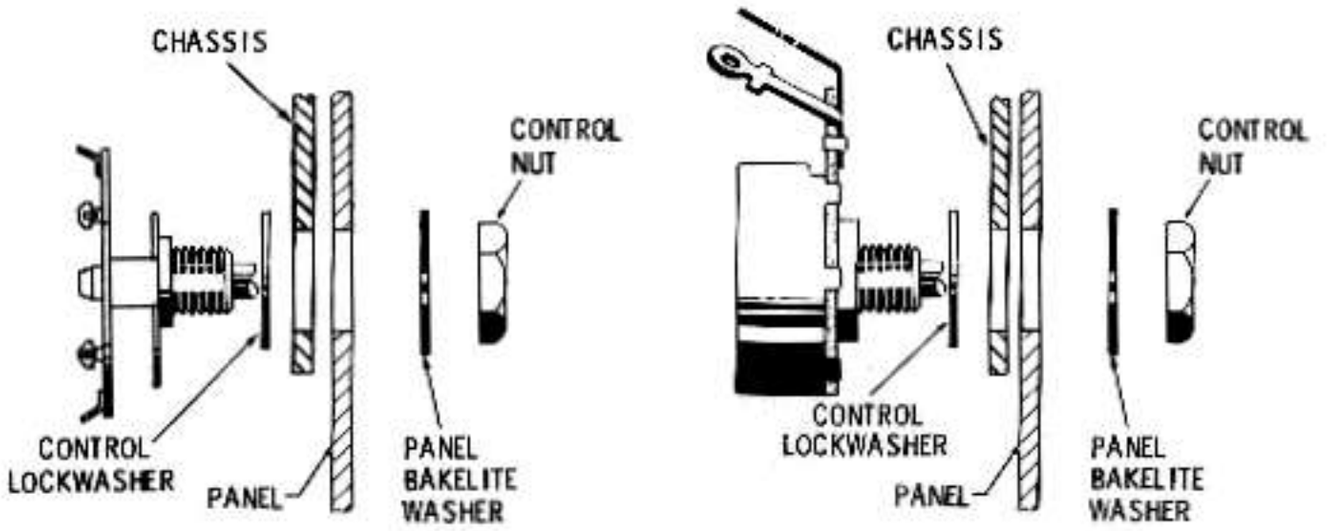


FIGURE 7

( ) 32. Install the FUNCTION SELECTOR switch at location SB. Use a control lockwasher, Bakelite panel washer, and control hex nut. Before tightening the nut, have switch in full counterclockwise position. Orient switch so that the flat side of the shaft is directly opposite the AC OFF marking on the panel. Check by placing pointer knob on shaft and tightening set screw. Reposition switch if pointer does not line up with AC OFF marking. Retighten pointer knob on shaft.

( ) 33. Install the 500KΩ GAIN control at location CA. Orient the control as shown in Figure 5. Use a control lockwasher, Bakelite panel washer, and control hex nut.

( ) 34. Install the 50KΩ WATTS control at location CB. Orient the control as shown in Figure 5. Use a control lockwasher, Bakelite panel washer, and control hex nut.

WIRING

REFER TO FIGURE 8

( ) 35. Connect the green-yellow lead of the power transformer extending through grommet Z, to G3 on socket EE (Solder). Position along rear and side of chassis.

( ) 36. Twist together the two red leads of the power transformer extending through grommet Y. Connect one of these leads to EE1 (Solder), and the other lead to EE8 (Solder).

( ) 37. Connect the red-yellow lead of the power transformer extending through grommet Y, to G1 on socket EE (Solder).

( ) 38. Twist together the two green leads of the power transformer extending through grommet Z. Connect one of these leads to EE3 (Don't Solder), and the other lead to EE4 (Don't Solder).

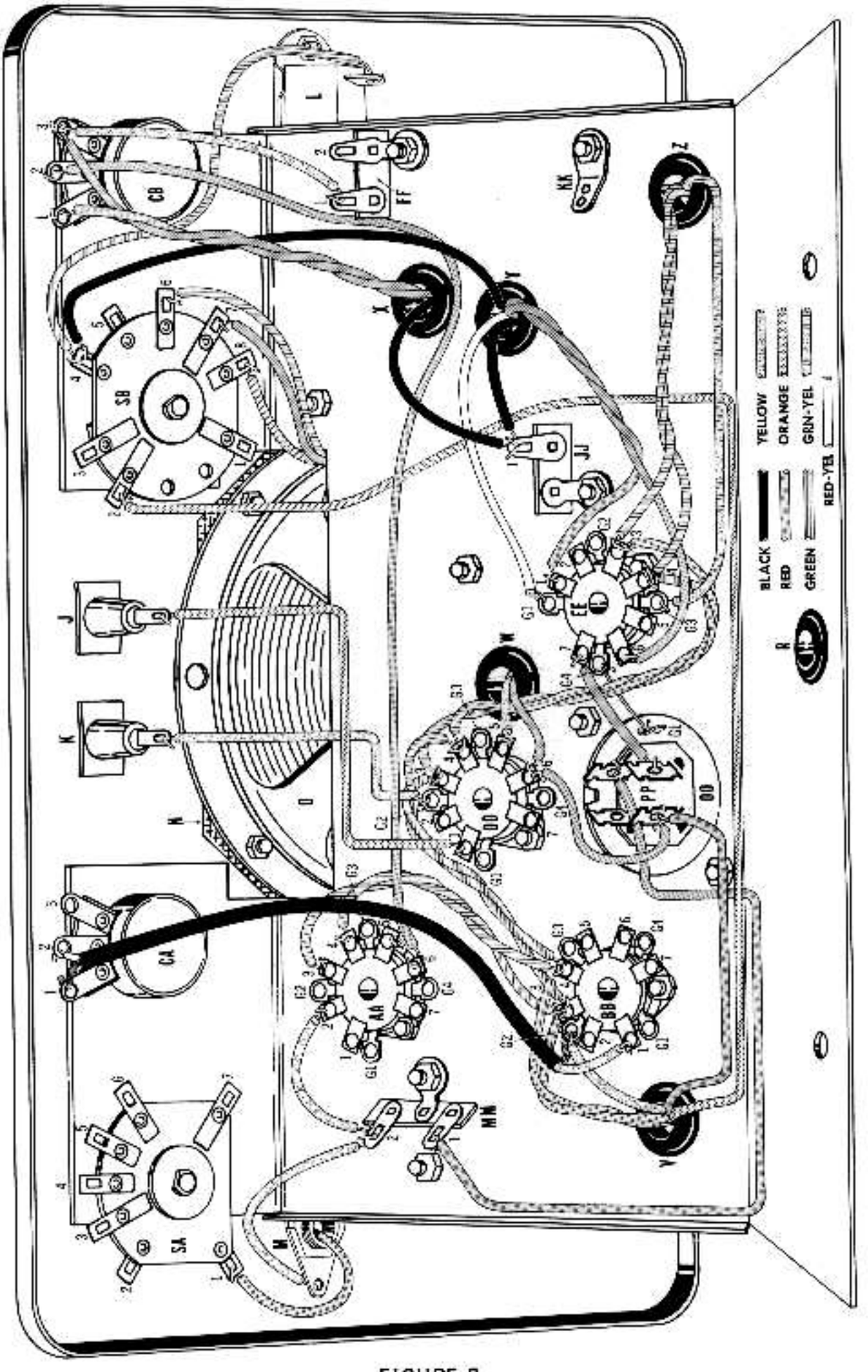


FIGURE 8

( ) 39. Connect the long black lead of the power transformer extending through grommet Y, to SB4 (Don't Solder). Position along chassis between grommet X, and terminal strip FF.

( ) 40. Connect the short black lead of the power transformer extending through grommet Y, to JJ1 (Don't Solder).

( ) 41. Connect the black lead of the current transformer extending through grommet X, to JJ1 (Don't Solder).

( ) 42. Twist together the two red leads of the current transformer extending through grommet X. Connect one of these leads to CB1 (Solder), and the other lead to CB3 (Don't Solder).

( ) 43. Connect a length of bare wire from G4 on socket EE (Solder), to G1 on electrolytic capacitor PP (Solder).

( ) 44. Connect a 3-1/4" length of yellow hook-up wire from G2 on socket DD (Solder), to pin jack K (Solder). Dress yellow wire as shown in Figure 8.

( ) 45. Twist together two 19" lengths of green hook-up wire. This twisted pair will be used for wiring the heater circuits. Cut off lengths as required.

( ) 46. Cut off a 4-1/4" length of green twisted pair and remove 1/4" of insulation from both ends. Connect one of the wires to EE3 (Solder), and the other wire to EE4 (Solder).

( ) 47. Connect the other two ends of the same twisted pair to DD3 (Don't Solder), and DD4 (Don't Solder). Dress these wires close to chassis.

( ) 48. Cut off a 3-3/4" length of green twisted pair and remove 1/4" of insulation from both ends. Connect one of the wires to DD3 (Solder), and the other wire to DD4 (Solder).

( ) 49. Connect the other two ends of the same twisted pair to BB3 (Don't Solder), and BB4 (Don't Solder). Dress these wires close to chassis.

( ) 50. Cut off another 3-3/4" length of green twisted pair and remove 1/4" of insulation from both ends. Connect one of these wires to AA3 (Solder), and the other wire to AA4 (Solder).

( ) 51. Connect the other two ends of the same twisted pair to BB3 (Don't Solder), and BB4 (Don't Solder). Dress these wires close to chassis and run as much of their length as possible along beside the twisted pair connecting socket DD to socket BB.

( ) 52. Cut off a 5-1/4" length of green twisted pair and remove 1/4" of insulation from both ends. Connect one of these wires to BB3 (Solder), and the other wire to BB4 (Solder). Insert the loose end of this pair through grommet V and leave disconnected at this time. Dress these wires close to chassis.

( ) 53. Connect a 3-3/4" length of yellow hook-up wire from MM2 (Don't Solder), to ground lug on INPUT connector M (Solder). Dress yellow wire close to chassis.

( ) 54. Connect a 2-1/4" length of green hook-up wire from SA1 (Don't Solder), to eyelet in INPUT connector M (Solder).

CAUTION: In soldering a wire to the eyelet in the connector, use only enough heat to make a good connection and to form a small "crown" of solder over

the eyelet. Excessive heat may cause solder to flow into the eyelet, possibly resulting in a shorted condition.

( ) 55. Connect a 1-1/2" length of yellow hook-up wire from MM2 (Don't Solder), to AA2 (Solder).

( ) 56. Connect an 8-1/2" length of red hook-up wire from MM1 (Don't Solder), to PP — (Don't Solder). Dress red wire as shown in Figure 8.

( ) 57. Connect a 10-1/2" length of red hook-up wire from CB2 (Solder), through AA6 (Don't Solder) to AA5 (Solder), now solder AA6. Dress red wire as shown in Figure 8.

( ) 58. Connect one end of a 4-1/2" length of yellow hook-up wire to G2 on socket BB (Don't Solder). Insert the other end through grommet V and leave disconnected at this time.

( ) 59. Prepare the 6" length of coaxial cable in the following manner:

a. Remove 3/4" of the black, outer insulation from both ends.
b. Unbraid the spiral shield at each end back to the black, outer insulation.
c. Twist the shield wires into stranded wire shape, and tin at each end.
d. Remove 1/4" of the yellow, inner insulation from both ends.
e. Tin the stranded inner conductor at both ends.

( ) 60. Connect the inner conductor of one end of the previously prepared 6" coaxial cable to CA2 (Solder). Connect the tinned shield wire at the same end to CA1. Before soldering, pull the shield wire through the lug until the black, outer insulation is in contact with the control cover. Be certain that shielding does not touch CA2 or the control cover. Now solder CA1 and trim off excess wire.

( ) 61. Dress the 6" coaxial cable straight down to the chassis and back to socket BB, parallel to the twisted green heater wires. Connect the tinned shield wire to G2 on BB, leaving approximately 1/4" of the shield wire between the black insulation, and G2 (Solder). Trim off excess wire. Now connect inner conductor to BB1 (Solder).

( ) 62. Connect a 1-3/4" length of red hook-up wire from EE7 (Solder), to PP ● (Don't Solder).

( ) 63. Connect one end of a 7-3/4" length of red hook-up wire to PP ■ (Don't Solder). Insert the other end through grommet V, and leave disconnected at this time. Dress red wire as shown in Figure 8.

( ) 64. Connect a 3-1/2" length of red hook-up wire from PP ■ (Don't Solder), to DD6 (Don't Solder). Dress red wire as shown in Figure 8.

( ) 65. Connect one end of a 3-1/2" length of red hook-up wire to DD6 (Solder). Insert the other end through grommet W, and leave disconnected at this time.

( ) 66. Connect one end of a 4" length of yellow hook-up wire to DD5 (Solder). Insert the other end through grommet W, and leave disconnected at this time.

( ) 67. Connect a 4-3/4" length of orange hook-up wire from DD1 (Solder), to pin jack J (Don't Solder). Dress orange wire as shown in Figure 8.

( ) 68. Connect one end of a 16" length of orange hook-up wire to SB2 (Solder). Dress the wire as shown in Figure 8, insert the other end through grommet V, and leave disconnected at this time.

( ) 69. Connect one end of a 7-1/4" length of orange hook-up wire to SB8 (Solder). Insert the other end through speaker cut-out and leave disconnected at this time.

( ) 70. Connect one end of a 6-3/4" length of red hook-up wire to SB7 (Solder). Insert the other end through speaker cut-out and leave disconnected at this time.

( ) 71. Connect one end of a 6-1/2" length of green hook-up wire to SB6 (Solder). Insert the other end through speaker cut-out and leave disconnected at this time.

( ) 72. Connect a 4-1/2" length of green hook-up wire from SB4 (Solder), to L1 (Solder). Dress green wire under control CB as shown in Figure 8, being careful to keep wire away from sharp edge of chassis.

( ) 73. Connect a 3" length of yellow hook-up wire from CB3 (Solder), to FF1 (Don't Solder).

REFER TO FIGURE 9

( ) 74. Connect the short, black lead from top of current transformer TB to L2 (Solder). Dress the wire close to chassis.

( ) 75. Connect the enameled wire from output transformer TA closest to terminal strip Q, to Q1 (Don't Solder).

( ) 76. Connect the remaining enameled wire of transformer TA to O2 (Don't Solder).

( ) 77. Connect a 3-1/2" length of yellow hook-up wire from O2 (Solder), to solder lug P (Don't Solder).

( ) 78. Connect a 3" length of yellow hook-up wire from pin jack B (Solder), to solder lug P (Don't Solder). Dress yellow wire against panel.

( ) 79. Connect the loose end of the red hook-up wire extending through speaker cut-out from SB7 to Q1 (Don't Solder). Dress red wire as shown in Figure 9.

( ) 80. Connect the loose end of the green hook-up wire extending through speaker cut-out from SB6, to pin jack D (Solder). Dress green wire as shown in Figure 9.

( ) 81. Connect the loose end of the orange hook-up wire extending through speaker cut-out from SB8, to pin jack A (Don't Solder). Dress orange wire as shown in Figure 9.

( ) 82. Connect a 5-1/2" length of orange hook-up wire from pin jack A (Solder), to O1 (Solder). Dress orange wire as shown in Figure 9.

( ) 83. Connect a 6-1/2" length of yellow hook-up wire from pin jack E (Solder), to HH2 (Don't Solder). Dress yellow wire as shown in Figure 9.

( ) 84. Connect a 6-1/2" length of red hook-up wire from pin jack F (Solder), to HH1 (Don't Solder). Dress red wire as shown in Figure 9.

( ) 85. Connect the loose end of the yellow hook-up wire extending through grommet W from DD5, to HH2 (Don't Solder). Dress yellow wire as shown in Figure 9.

( ) 86. Connect the loose end of the red hook-up wire extending through grommet W from DD6, to HH1 (Don't Solder). Dress red wire as shown in Figure 9.

( ) 87. Connect the brown lead from transformer TA to pin jack H (Solder).

( ) 88. Connect the blue lead from transformer TA to HH2 (Solder).

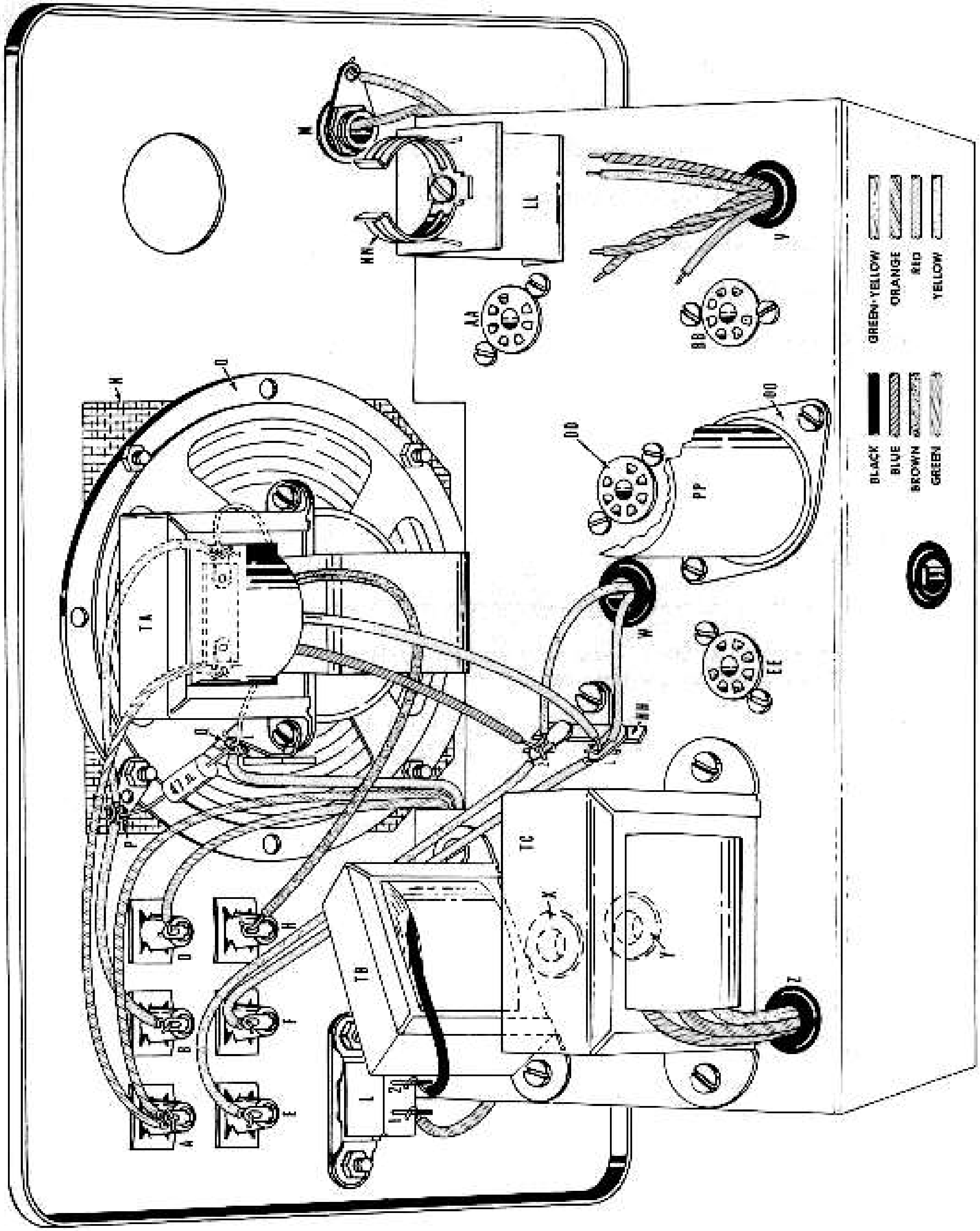

GREEN-YELLOW
ORANGE
RED
YELLOW
BLACK
BLUE
BROWN
GREEN
TA
TB
TC
PP
LL
AA
BB
DD
EE

FIGURE 9

( ) 89. Connect the red lead from transformer TA to HH1 (Solder).

( ) 90. Connect a 47Ω resistor (yellow-violet-black) from Q1 (Solder), to solder lug P (Solder).

REFER TO FIGURE 10

( ) 91. Connect a 4700 MMF ceramic capacitor (.0047MFD) from SA1 (Solder), to SA6 (Don't Solder). Use spaghetti on both leads.

( ) 92. Connect a 910K resistor (white-brown-yellow) from SA6 (Solder), to SA5 (Don't Solder).

( ) 93. Connect a 91K resistor (white-brown-orange) from SA5 (Solder), to SA4 (Don't Solder).

( ) 94. Connect a 9100Ω resistor (white-brown-red) from SA4 (Solder), to SA3 (Don't Solder).

( ) 95. Connect a 1000Ω resistor (brown-black-red) from SA3 (Solder), to MM2 (Don't Solder).

( ) 96. Connect a 470K resistor (yellow-violet-yellow) from SA2 (Don't Solder), to MM2 (Don't Solder).

( ) 97. Connect a 1 MEG resistor (brown-black-green) from MM2 (Solder), to AA1 (Don't Solder).

( ) 98. Connect a 4700MMF ceramic capacitor (.0047MFD) from AA1 (Solder), to SA7 (Solder).

( ) 99. Connect a 100K resistor (brown-black-yellow) from SA2 (Solder), to MM1 (Don't Solder).

( ) 100. Connect a 220K resistor(red-red-yellow) from MM1 (Solder), to AA7 (Don't Solder).

( ) 101. Connect a 4700MMF ceramic capacitor (.0047MFD) from AA7 (Solder), to CA3 (Solder). Use spaghetti on both leads.

( ) 102. Connect the positive (+) lead (use spaghetti) of the 25MFD, 25VOLT electrolytic capacitor to DD2 (Don't Solder); connect the negative lead to G3 on socket DD (Don't Solder).

( ) 103. Connect a 270 OHM, 1 WATT resistor (red-violet-brown), from DD2 (Solder), to G3 on socket DD (Solder).

( ) 104. Connect a 470K resistor (yellow-violet-yellow) from DD7 (Don't Solder), to G1 on socket DD (Solder).

( ) 105. Connect a 4700MMF ceramic capacitor (.0047MFD) from BB5 (use spaghetti) (Don't Solder), to DD7 (Solder).

( ) 106. Connect a 220K resistor (red-red-yellow) from BB5 (Solder), to PP ▲ (Don't Solder).

( ) 107. Connect an 1800 OHM resistor (brown-gray-red) from G1 on socket BB (Don't Solder), through BB7 (Don't Solder), to BB2 (Solder).

( ) 108. Connect the positive (+) lead (use spaghetti) of the 10 MFD, 25VOLT electrolytic capacitor to BB7 (Solder); connect the negative lead to G1 on socket BB (Don't Solder).

( ) 109. Connect the outside foil lead of a .047 MFD, 400VOLT paper tubular capacitor to G1 on socket BB (Solder); connect the other lead (use spaghetti) to BB6 (Don't Solder).

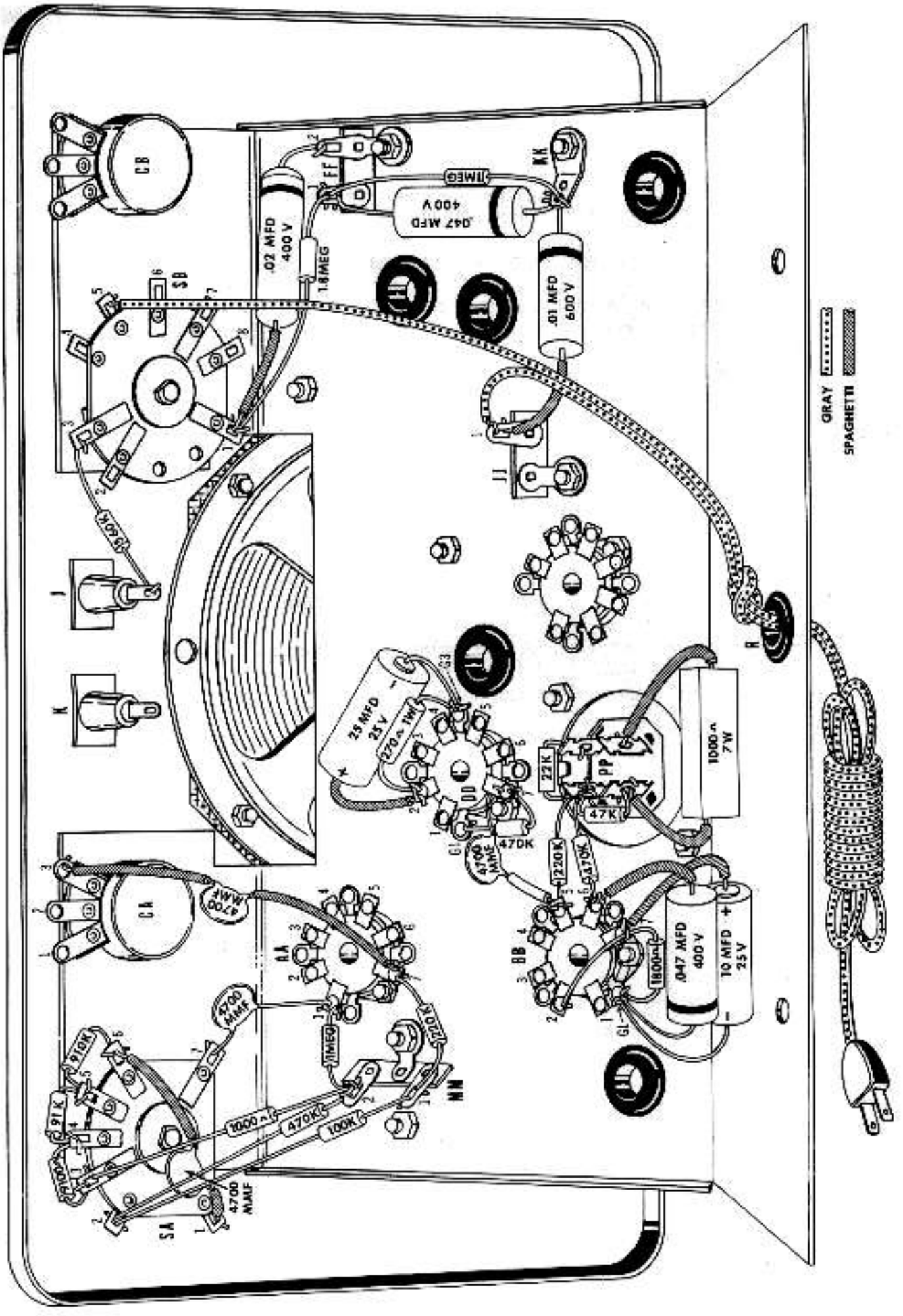

CB
.02 MFD 400 V
1.6MEG
TIMEG
.047 MFD 400 V
.01 MFD 600 V
KK
FF
SB
GRAY
SPAGHETTI
25 MFD 25 V
270Ω 1W
22K
47K
1000Ω 7W
47DK
4700 MMF
220K
470K
.047 MFD 400 V
10 MFD 25V
1800Ω
CA
AA
BB
DD
PP
910K
91K
1000Ω
100K
SA

FIGURE 10

( ) 110. Connect a 470K resistor (yellow-violet-yellow) from BB6 (Solder), to PP ▲ (Don't Solder).

( ) 111. Connect a 22K resistor (red-red-orange) from PP ▲ (Don't Solder), to PP — (Solder).

( ) 112. Connect a 47K resistor (yellow-violet-orange) from PP ▲ (Solder), to PP ■ (Don't Solder).

( ) 113. Connect the 1000Ω, 7 watt, large rectangular resistor from PP ■ (Solder), to PP ▬ Solder). (Use spaghetti on both leads.)

( ) 114. Connect a 560K resistor (green-blue-yellow) from pin jack J (Solder), to SB3 (Solder).

( ) 115. Connect the outside foil lead of a .02 MFD, 400VOLT paper tubular capacitor to FF2 (Solder); connect the other lead (use spaghetti), to SB1 (Don't Solder).

( ) 116. Connect a 1.8 MEG resistor (brown-gray-green) from SB1 (Solder), to FF1 (Don't Solder).

( ) 117. Connect the outside foil lead of a .047MFD, 400 VOLT paper tubular capacitor to solder lug KK (Don't Solder). Connect the other lead to FF1 (Don't Solder).

( ) 118. Connect a 1 MEG resistor (brown-black-green) from FF1 (Solder), to KK (Don't Solder).

( ) 119. Connect the outside foil lead of a .01 MFD, 600VOLT paper tubular capacitor to KK (Solder); connect the other lead to JJ1 (use spaghetti), (Don't Solder).

( ) 120. Insert the line cord from the rear of the chassis through grommet R. Tie an overhand knot approximately 5-1/2" from the end of the cord inside the chassis for strain relief. Separate the ends for a distance of 2-1/4 inches.

( ) 121. Connect one lead of the line cord to SB5 (Solder); connect the other lead to JJ1 (Solder).

FINAL WIRING AND ASSEMBLY

REFER TO FIGURE 11

( ) 122. Place the 1629 tube in spring clip NN with the tube keyway pointing down toward the chassis. The tube should be seated in the clip so that the clip fits around the Bakelite base. See Figure 11.

( ) 123. Mount the octal socket QQ on the 1629 tube base. Pins 1 and 8 on the socket should be closest to the chassis.

( ) 124. Connect a 1 MEG resistor (brown-black-green) from QQ3 (Solder), to QQ4 (Don't Solder).

( ) 125. Connect a 1 MEG resistor (brown-black-green) from QQ5 (Don't Solder), to QQ8 (Don't Solder).

( ) 126. Insert all the wires extending from grommet V, through the 1-1/2" length of vinyl tubing.

( ) 127. Connect the yellow wire extending from the tubing to QQ8 (Solder).

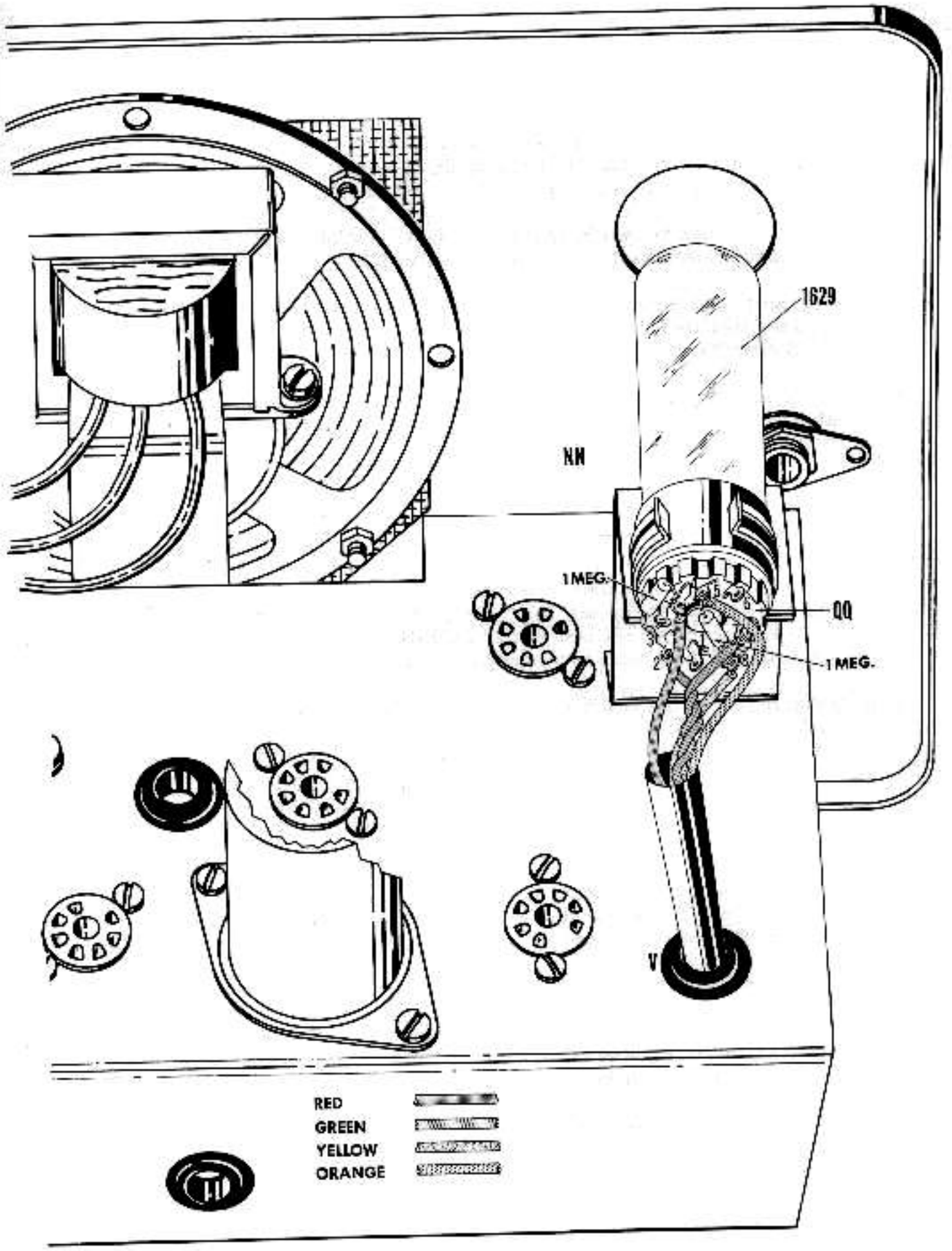


FIGURE 11

( ) 128. Connect one of the green wires extending from the tubing to QQ2 (Solder); connect the other green wire to QQ7 (Solder).

( ) 129. Connect the red wire extending from the tubing to QQ4 (Solder).

( ) 130. Connect the orange wire extending from the tubing to QQ5 (Solder).

( ) 131. Before installing the knobs on the GAIN and WATTS controls, rotate both controls fully counterclockwise, then place the knobs over the shafts so that the pointers line up respectively with the "0" marking on the GAIN control, and the "30" marking on the WATTS control. Then tighten the set screws firmly against the shafts.

( ) 132. Insert the tubes in their respective sockets: 12AV6 in socket AA, 12AU6 in socket BB, 12AQ5 in socket DD, and 12X4 in socket EE.

( ) 133. Carefully inspect instrument construction, and check dress or arrangement of wiring. Be sure that the wiring or components are not positioned in such a manner that short circuits will occur.

Be sure that all solder connections have been made. Shake the instrument so that all loose solder, wire cuttings, and insulation may fall out.

PRELIMINARY TEST

Before connecting the Signal Tracer to the AC power line, connect an ohmmeter from pin 7 of V5 (Socket EE) to ground, and check the B+ resistance to ground. If the circuit is normal, the reading obtained will be 50K OHMS or higher. (Be sure to allow for electrolytic capacitor charging action and wait for the meter pointer to come to a complete stop before taking the reading.) If the resistance measures less than 50K OHMS, the rectifier circuit should be checked thoroughly for shorts, and the trouble corrected before the instrument is connected to the AC line.

Plug the Signal Tracer line cord into a 117 Volt, AC, 60 Cycle source. Set the MULTIPLIER switch to the X1000 position, rotate the GAIN control to approximately "30" on the calibrated scale; and set the FUNCTION SELECTOR switch to the INT SPKR position. After about 15 or 20 seconds of warm-up time, all tubes should light; a circular fluorescent pattern, open at the bottom, should be seen on the face of the eye-tube, and a faint rushing noise should be audible in the speaker. Touching the eyelet of the INPUT connector should produce a fairly loud hum, and cause corresponding action on the eye-tube pattern.

If there is any sign of trouble, such as smoke or evidence of overheating, the tubes do not light, no pattern on the eye tube or no sound from the speaker, disconnect the instrument from the power source immediately and check for errors in wiring or other sources of trouble.

Refer to the section "WHAT TO DO IN CASE OF TROUBLE" for more detailed trouble-shooting procedure.

If the instrument does respond in the manner indicated, it will be safe to leave it turned on to thoroughly warm up while the balance of the kit is assembled.

PREPARATION OF TEST CABLE

REFER TO FIGURES 12 THROUGH 16

RF-AF PROBE — Assemble as follows:

( ) 134. Remove approximately 3/16" of insulation from both ends of the small black flexible wire, and tin both ends.

( ) 135. Push the probe tip into a piece of cardboard, place the cardboard flat on the bench so that the tip is in a vertical position, and insert a short piece of solder into the hole in the rear of the tip. Heat the end of the tip until the solder melts, then quickly insert the tinned wire into the melted solder in the hole. If necessary, melt additional solder into the hole to fill it up. Make certain solder does not run down over the threads. Allow the tip to cool, insert the black flexible wire into the rounded end of the red probe head, then screw the tip into the red probe head.

( ) 136. Remove 1-3/8" of the black,outer insulation from one end of the long coaxial cable, being very careful not to cut any wires of the spiral wound shield.

( ) 137. Unwind the spiral shield back to the black outer insulation, twist the loose wires of the shield into a compact strand, then fold the shield back over the insulation.Clip off excess shield, leaving approximately 3/8" of the shield folded back. See Figure 12.

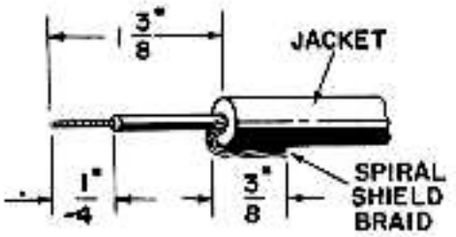


FIGURE 12

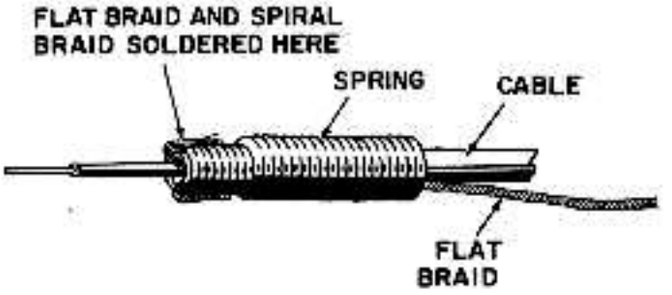


FIGURE 13

( ) 138. Remove 1/4" of the insulation from the inner conductor and tin the exposed stranded wire.

( ) 139. Insert the flat braided wire into the large diameter end of the probe cable spring, leaving approximately 3/8" of the braid extending beyond the small diameter end of the spring. See Figure 13.

( ) 140. Slide the spring and braid together over the prepared cable end with the small diameter end of the spring toward the prepared cable end. Fold the 3/8" length of the spiral cable shield back over the spring; fold the 3/8" length of the flat braid back over the spring, then solder both shield and braid to the spring. See Figure 13.

NOTE: Exercise caution when soldering shield to spring. Overheating may melt insulation between shield and inner wire, resulting in wire shorting to shield.

( ) 141. Slip the loose end of the flat braid into the end of the alligator clip and solder. (This procedure may be simplified by attaching the clip to some object such as a piece of cardboard, placing something fairly heavy over the cardboard to hold it in place over the edge of the workbench, then soldering.)

( ) 142. Slide the black probe end over the cable and spring, with the larger diameter portion of the probe end toward the rear. See Figure 14.

( ) 143. Slide the probe housing over the cable and spring, with the switch cut-out toward the front. See Figure 14.

( ) 144. Connect the tinned inner conductor of the cable to the SPST slide switch terminal at the "ON" end of the switch (Don't Solder). See Figure 14.

( ) 145. Connect the small,black flexible wire from the probe tip to the SPST slide switch terminal at the "OFF" end of the switch (Don't Solder). See Figure 14.

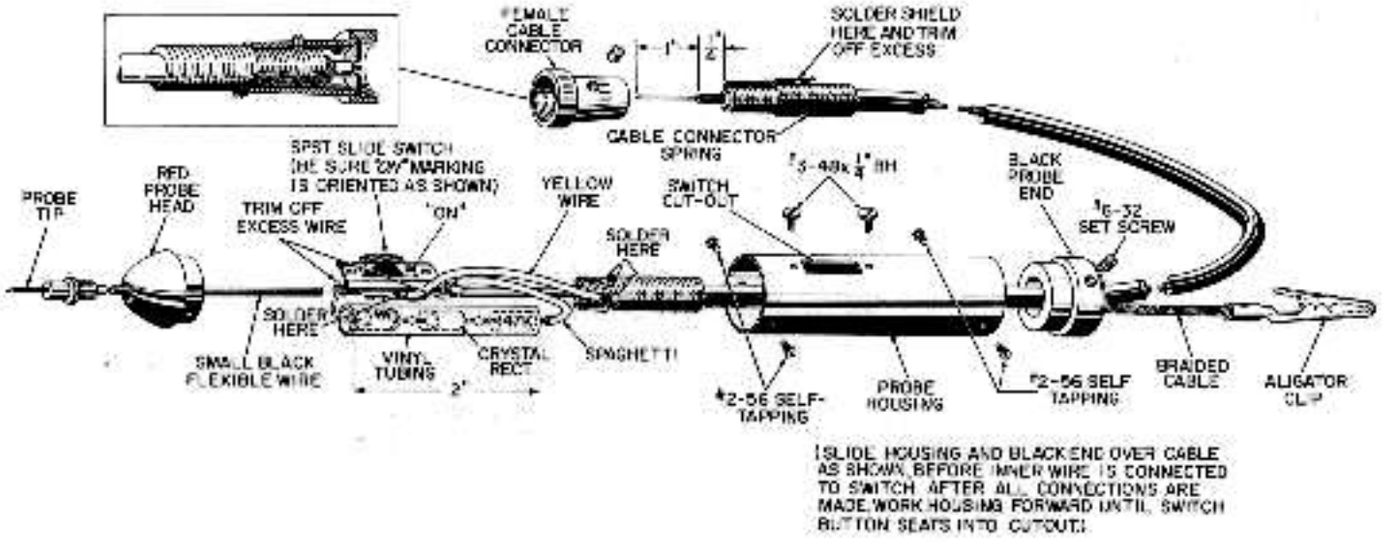


FIGURE 14

( ) 146. Connect color coded end of the .0068MFD tubular ceramic capacitor (blue-grey-red) to the cathode (color coded) end of the crystal rectifier. Connect as close together as possible (Solder).

CAUTION: Before soldering this connection grasp the crystal diode lead with a pair of long nose pliers between connection and crystal body. This will prevent the heat of the molten solder from damaging the crystal. See Figure 15.

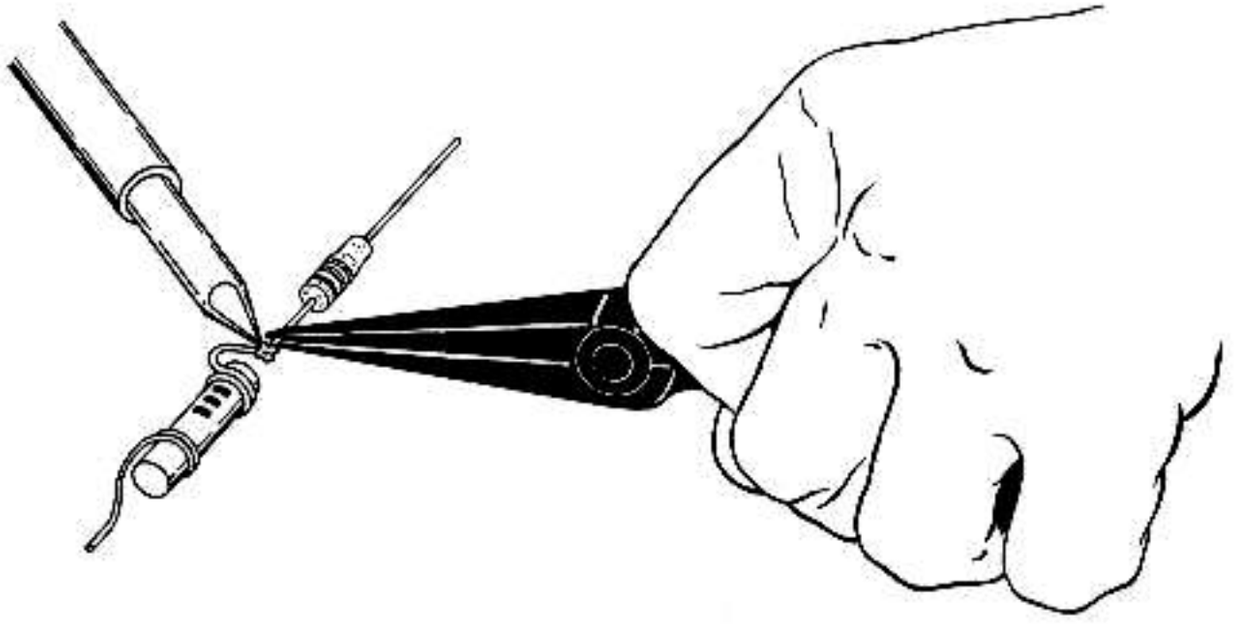


FIGURE 15

( ) 147. Connect the other end of the crystal rectifier to a 47K OHM resistor (yellow-violet-orange). Connect as close together as possible (Solder). Leave the loose lead of the resistor long, and slide a 1-1/8" length of spaghetti over it. See Figure 16.

CAUTION: Protect rectifier against excessive heat as in Step 146, before soldering.

( ) 148. Trim the loose lead of the .0068 ceramic capacitor to a length of approximately 1/2" and connect it to the SPST slide switch terminal at the "OFF" end of the switch (Solder).

( ) 149. Slide the 2" length of vinyl tubing over the resistor-rectifier-capacitor network, bend the long resistor lead back and connect it to the SPST slide switch terminal at the "ON" end of the switch (Solder). See Figure 14.

( ) 150. Connect one end of a 2-1/2" length of yellow hook-up wire to the probe cable spring (Solder). Connect the other end to the side of the slide switch housing (Solder). See Figure 14.

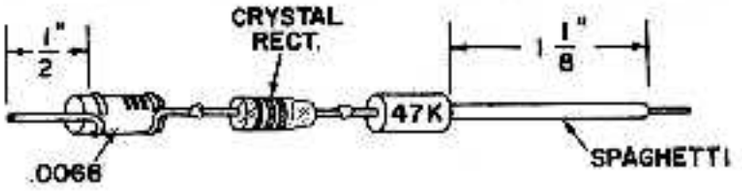


FIGURE 16

( ) 151. Carefully work the probe housing over the slide switch assembly until the switch button seats into the cut-out in the probe housing. Secure the switch with two #3-48 x 1/4" BH screws. Inspect to make sure that screws do not touch switch terminals.

( ) 152. Fit the probe head into the probe housing, line up the holes, and secure with two #2-56 self-tapping screws.

( ) 153. Fit the black probe end into the rear of the probe housing, line up the two holes in the rear of the probe housing with those in the probe end, and secure with two #2-56 self-tapping screws.

( ) 154. Insert the #6-32 set screw into the threaded hole in the black probe end, and tighten firmly but not excessively against the probe cable spring.

This completes the assembly of the RF-AF probe.

FEMALE COAXIAL CABLE CONNECTOR

Install as follows:

( ) 155. Remove 1-1/4" of the black, outer insulation from the loose end of the probe cable, being very careful not to cut any wires of the spiral wound shield.

( ) 156. Loosen the set screw in the female cable connector body and remove the connector spring. Slide the connector spring over the end of the cable, with the small diameter end of the spring toward the cable end. See Figure 14.

( ) 157. Unwind the spiral shield back to the black outer insulation, twist the loose wires of the shield into a compact strand, then fold the shield back until the end extends onto the large diameter section of the spring. See Figure 14.

( ) 158. Remove 1" of the insulation from the inner conductor, and tin the exposed stranded wire.

( ) 159. Insert the prepared end of the cable into the female connector, and guide the tinned inner wire through the eyelet in the center of the connector. Push the connector

over the connector spring as far back as it will go, making sure that the set screw is not over the folded back portion of the spiral shield. Tighten the set screw securely against the spring.

( ) 160. Trim off the excess shield 1/4" from the end of the connector and solder to the large diameter portion of the spring.

NOTE: Exercise caution when soldering shield to spring. Overheating may melt insulation between shield and inner wire, resulting in wire shorting to shield.

( ) 161. Trim off the inner conductor flush with the eyelet in the connector (Solder).

CAUTION: In soldering inner conductor to eyelet in connector, use only enough heat to make a good connection and to form a small "crown" over the eyelet. Excessive heat may cause solder to flow into the eyelet, possibly resulting in a shorted condition.

CARRYING CASE ASSEMBLY

( ) 162. Install the handle hinges and handle on top of the carrying case. The handle hinges mount over the holes provided on top of the case with two #6-32 x 3/8" oval head screws, two #6 lockwashers, and two #6-32 hex nuts for each hinge. See Figure 17. To perform this assembly, first mount one of the hinges, then place one end of the handle on the mounted hinge. Next insert the other hinge into the hole at the other end of the handle, and mount this hinge to the carrying case.

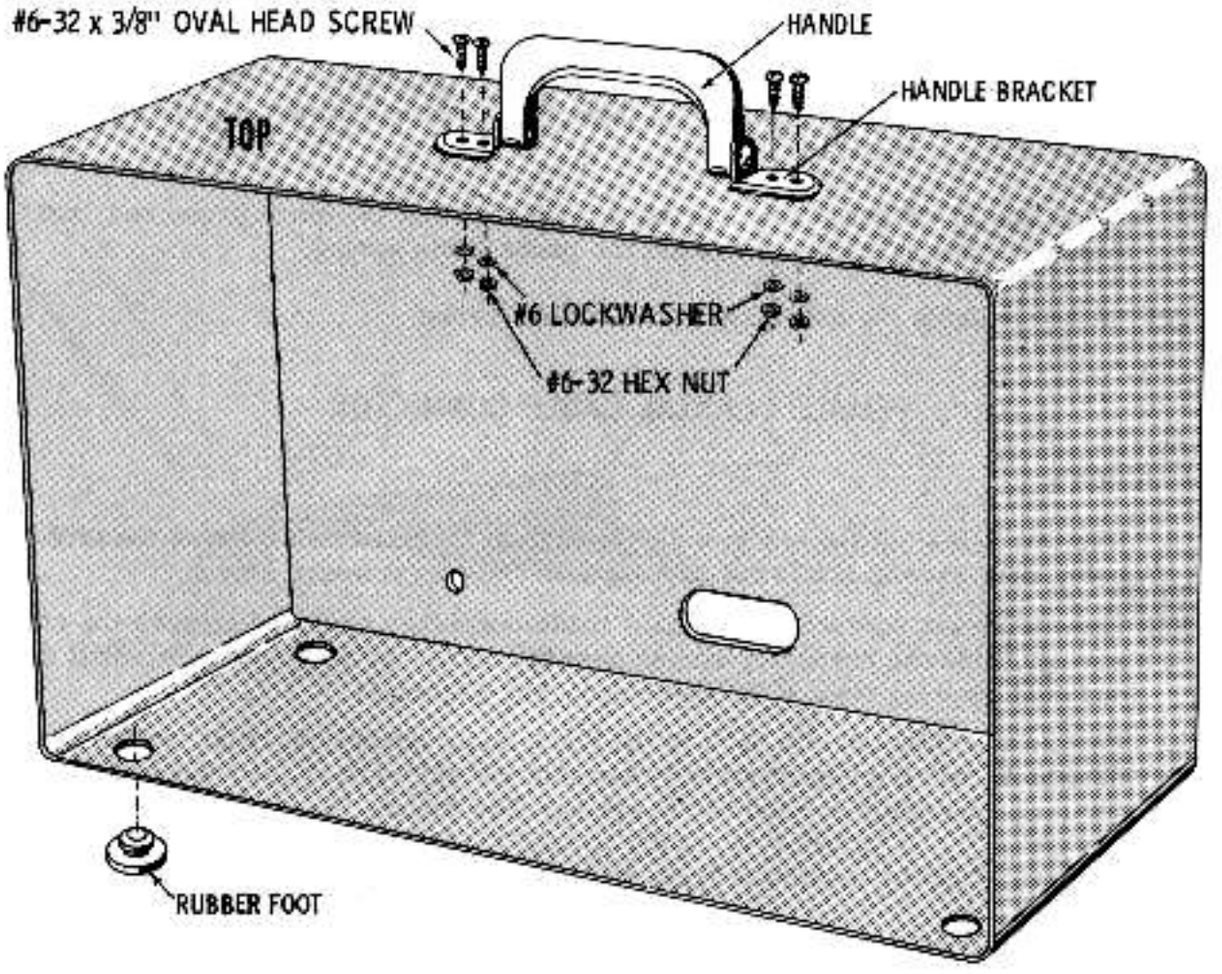


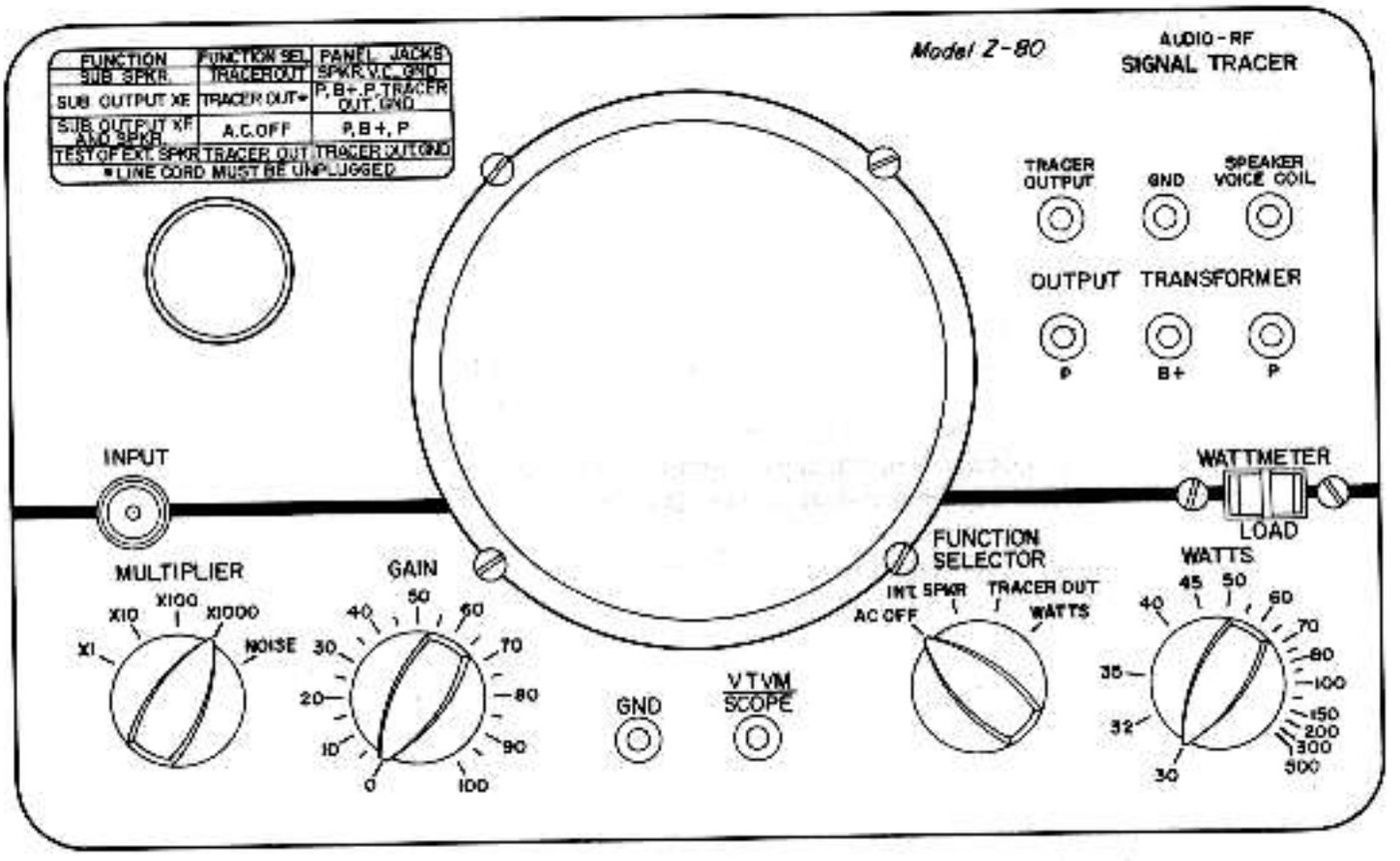
FIGURE 17

( ) 163. Insert the four rubber feet into the holes provided at the bottom of the carrying case. Install each foot so that the flat portion is outside the case. See Figure 17.

FINAL ASSEMBLY

( ) 164. Pass the line cord through the large hole in the rear of the carrying case, and slide the instrument in until the flanged edges of the panel fit snugly around the front lips of the carrying case.

( ) 165. Fasten the rear of the instrument chassis to the rear of the carrying case by securing the two #6 x 3/8" BH, self-tapping screws in the holes provided.



FRONT PANEL

WHAT TO DO IN CASE OF TROUBLE

If the instrument does not function properly we suggest the following check procedure be observed.

1. Recheck all wiring and make certain all connections have been properly made. Inspect each soldered terminal closely. Check switches and tube sockets for evidence of rosin between contacts. Any excess rosin present could cause leakage between contacts, and should be removed by cleaning with alcohol and a stiff brush. Check all components for correct value and proper location in the circuit. If possible, have someone else perform these checks with you. This often reveals mistakes that are consistently overlooked. One of the most common mistakes in the Z-80 Signal Tracer kit is the inadvertent interchanging of resistors with values such as 1800Ω and 1.8 megohms.

2. Check all voltages as shown on the schematic. These measurements were taken with a PACO V-70 VTVM having an input resistance of 11 megohms. Readings may vary considerably when taken with other instruments having different input characteristics. A variation of ± 20% in these readings is entirely acceptable.

3. Check all tubes either with a good quality tube tester, such as the PACO Model T-60, or by substituting tubes known to be good and observing instrument performance.

4. If hum in the speaker seems to be excessive, a simple check can be made to determine if it is originating within the Z-80 circuitry. To begin, it should be pointed out that due to the open circuit condition at the INPUT connector when the probe is disconnected from the instrument, or at the unshielded probe tip when the probe is connected to the instrument, a rather loud hum at maximum gain (GAIN fully clockwise; MULTIPLIER on X1) is normal. Shorting the INPUT connector to ground, or shorting the probe tip to the probe ground lead should reduce the hum to a much lower level. If the hum is not reduced by shorting the input, then it is definitely originating within the Z-80 circuitry: —

   There are many sources of excessive hum, of which the most common are: defective power supply filtering, poor lead dress, defective tubes, and poor soldered connections, particularly "ground" connections. Check the lead dress throughout the circuit carefully and make certain it has been done exactly according to the step-by-step instructions and the wiring diagrams. Also check all chassis "ground" connections, especially those associated with the input amplifier V1 (12AV6). Finally, check the tubes and the power supply filter components.

5. Check all construction visually for wire clippings and drops of solder which could become lodged against, and cause shorting of, such elements as control terminals, switch contacts, and tube socket pins.

CIRCUIT DESCRIPTION

Many valuable and convenient features have been included in the PACO Model Z-80 Signal Tracer.

The basic circuit consists of a high-gain three stage audio amplifier. Coarse and fine gain attenuators, and visual and aural signal indicators are provided. Provision is made to switch out the internal speaker if only visual indication is desired. An external VTVM may be connected for actual measurement of signal voltages, or an oscilloscope may be connected for waveform indication. An RF-AF probe is provided for connection to the circuits under test, and contains a crystal diode for RF and IF signal demodulation. The diode can be switched out for use with audio signals.

A noise test circuit applies a DC voltage to the probe for locating noisy components. Such components, when connected to the probe, generate a noise signal which can be seen on the eye-tube or heard in the loudspeaker.

A calibrated wattmeter (500 watts maximum) is provided for checking the power consumption of electrical equipment.

Provision is made to use the instrument as a substitution speaker and/or output transformer. External speakers may also be connected for testing purposes.

The amplifier has sufficient gain to check the output of low-level microphones, tuners, photo-electric cells, and magnetic or reluctance-type phono pickups. There is also enough gain available to detect the presence of RF signals at the antenna of a receiver under test.

The unit receives its power from a transformer operated, full-wave power supply. A 12X4 duo-diode (V5) serves as the B+ rectifier.

A 12AV6 high-gain triode (V1) is used as a preamplifier. A four-step attenuator having a 10 to 1 ratio between steps is located in the input circuit of this stage. The attenuator, (labeled MULTIPLIER on the front panel) used in conjunction with the calibrated GAIN control, permits accurate measurement of stage gains. Maximum gain is obtained with the MULTIPLIER in the X1 position; minimum gain in the X1000 position. The diode section of the 12AV6 is used as the wattmeter rectifier.

A 12AU6 pentode (V2) serves as a voltage amplifier. The continuously variable, calibrated GAIN control is located in the input circuit of this stage.

A 12AQ5 beam power tube (V3) serves as the output or power amplifier. A 1629 electron beam eye-tube (V4) monitors the signal at the 12AQ5 grid.

A push-pull output transformer and a 5" loudspeaker complete the basic tracer circuitry. Panel terminals permit connection to the primary or secondary windings of the output transformer or to the speaker voice coil for substitution purposes.

For wattmeter indication, the load current, or actual current drawn from the AC power line of a device under test flows through the primary of a current transformer. This current, through transformer action, develops a voltage drop across the WATTS control. A part of this voltage is rectified by the diode section of the 12AV6, and the resulting DC voltage is indicated by the 1629 eye-tube. The voltage applied to the diode is controlled by the WATTS control which is calibrated to read the actual wattage consumption of the device under test.

Four section filtering of the full-wave power supply provides an exceptionally low hum level. The hum heard at maximum gain is actually grid circuit hum due to the extension of the input grid circuit into the coaxial cable and probe.

SIGNAL TRACER APPLICATIONS

The versatility of the Signal Tracer will come as no surprise to the technician with many years of experience in the field of radio and audio servicing. However, those of you making your first acquaintance with this valuable instrument may be impressed by its usefulness which is, in fact, limited only by the ability and the imagination of the operator. New Signal Tracer applications are continually being discovered by electronics men in many branches of science. PACO Electronics Co., in designing the Model Z-80 has taken into account all of the more important known Signal Tracer applications, and has provided every feature necessary for performing these applications with the Model Z-80.

Following is a list of some of the most often encountered tasks that may be performed with the Z-80:

1. Locating "dead" stages in AM and FM radio receivers, TV receivers, and audio amplifiers.
2. Locating the origin of hum, noise, and distortion in receivers and amplifiers.
3. Finding open tube filaments in series filament circuits.
4. Locating intermittent troubles in receivers and amplifiers.
5. Locating the stage responsible for weak signal conditions in receivers and amplifiers.
6. Locating oscillating or "motorboating" stages in receivers and amplifiers.

7. Locating defective speakers and output transformers.

8. Measuring stage gain in amplifier circuits.

9. Measuring the power consumption of electrical devices consuming up to 500 watts.

10. Amplifier has sufficient gain to be useful as a small public-address system.

11. Amplifier may be used for checking phono pickups, tuners, microphones, photo-electric cells, etc.

USING THE SIGNAL TRACER

The primary purpose of the Signal Tracer is just what the name implies — to "trace" or follow a signal through a receiver or amplifier until some point in the circuit is reached where the signal departs from normal. Supplementary tests are then made at the faulty stage, usually with a volt-ohmmeter, to determine the defective component. The signal tracer, being a device which works directly with the primary factor in any electronic circuit — the signal — thus makes possible rapid and accurate isolation of faulty stages. This is often the most time consuming part of troubleshooting procedure. It usually is a simple matter to determine the defective component, once the trouble has been isolated to a particular stage. However, attempting to isolate a trouble by working with the secondary factors in a circuit — voltage, resistance, capacitance, and inductance — is often very confusing and time consuming. This is particularly true when checking circuits which require the signal as an actuating force, such as AGC, and AFC networks. Signal Tracing, however, requires no translating of volt-ohm static readings into circuit effects and theorized operation. It is immediately apparent when the signal becomes distorted or is interrupted because the actual effects can be heard from the loudspeaker. No guess work is involved.

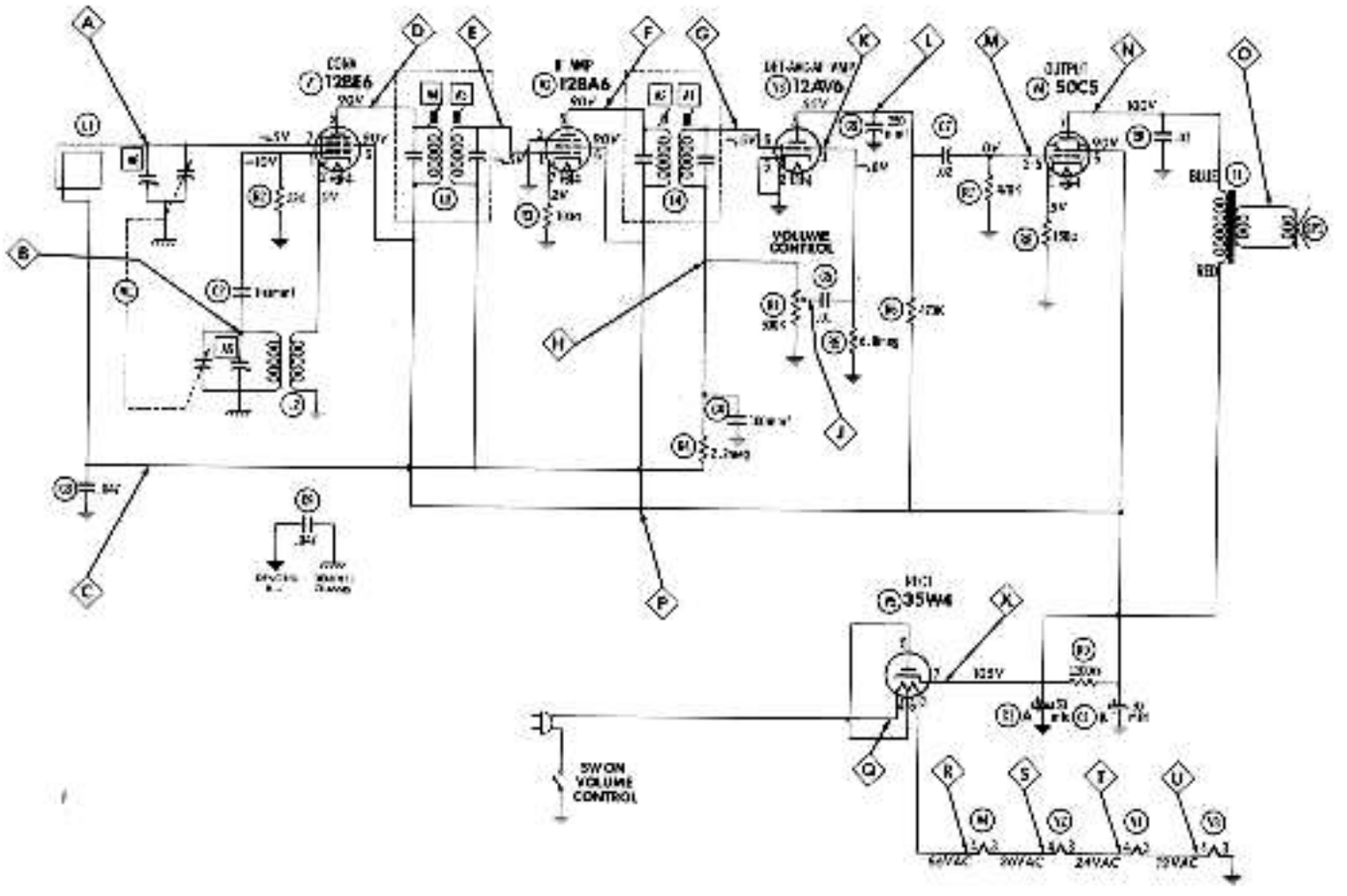


FIGURE 18

The basic method of tracing a signal through a typical 5-tube AC-DC AM receiver (See Figure 18) using the PACO Z-80 will now be described. The most likely component causing the interruption or distortion of the signal at each point in the circuit will be noted.

There are many other tasks that may be performed with the Z-80 and these will be described in detail later on.

Preliminary Tests - Power Supply And Tube Filaments

Turn the receiver "ON" and allow the tubes to warm up. Should one or more of the tube filaments be open, none of the tubes will glow. The defective tube may be quickly isolated with the Z-80 as follows:

With the instrument connected to the 117 volt, 60 cycle AC line, turn the FUNCTION SELECTOR to the INT SPKR position. Set the MULTIPLIER to X1000, and the GAIN control to approximately 30 on the calibrated scale. Connect the probe ground lead to the receiver B- line, set the probe switch to the AF position, then in sequence, touch the probe tip to points Q, R, S, T, and U indicated on Fig. 18. A 60 cycle hum will be heard in the Z-80 speaker at each successive point until the open filament has been passed. For example, let us assume the filament of tube V1 to be open. When points Q, R, S, and T are touched, the hum will be heard. However, at point U, no hum will be heard other than the normal, low-level hum originating from the Tracer power supply. It will take very little practice on the operator's part to quickly master this procedure for finding open tube filaments in series circuits.

With all tube filaments glowing properly, the next step is to check for the presence of B+ at the output of the rectifier tube V5. A voltmeter should be used to accurately determine the value of the B+ voltage. However, the Z-80 may be used in lieu of a volt-meter by touching the probe tip to point X (probe switch still in AF position). Presence of 60 cycle hum at this point indicates the rectifier is functioning. No hum indicates defective tube V5 or faulty connection between pins 6 and 5 of the rectifier tube. Now touch the probe tip to point P. Hum should still be audible, but at a much reduced level. No reduction in hum level at this point, plus the presence of a rather strong signal indicates open output filter capacitor, C1B. No hum indicates open filter resistor R9.

RF Signal Tracing

With the tube filaments and the power supply functioning properly, the next step is to tune the receiver to a strong local station. One of several things will now become apparent:

A. The receiver will function normally.

B. No signals will be audible in the receiver speaker, in which case the procedure will be determine at what point the signal is interrupted.

C. Signals will be audible in the receiver speaker, but weak; in which case the procedure will be to determine in what stage the normal, expected gain does not occur.

D. Gain of the receiver will be normal, signals will be audible but distorted, noisy, or with excessive hum. The procedure here will be to determine at what point in the circuit any of the preceding irregularities first occur.

E. The receiver will function intermittently, between normal operation and any one or more of the preceding abnormal conditions. The procedure here will be according to the symptom, but will require waiting for the trouble to start before proceeding.

Regardless of the type of signal disturbance to be isolated, either end of the receiver (antenna or speaker) may be used as a starting point. In this case however, we have arbitrarily chosen to start at the antenna. Refer again to Fig. 18. With the probe ground lead connected to the receiver B-, set the probe switch to RF, set the FUNCTION SELECTOR to INT SPKR, set the MULTIPLIER to X1 or X10. Touch the probe tip to point A, and rotate the Z-80 GAIN control

clockwise to the desired listening level. In receivers having a "weak signal" condition, the receiver will have to be tuned to a strong local station. If the antenna and tuning system are functioning properly, the station will be heard in the Z-80 speaker clearly, and with ample volume. Lack of signal at this point indicates antenna coil L1, open or shorted to ground, shorted tuning capacitor (rotor plates touching the stator plates), or shorted trimmer, A6. It is possible that the tuning capacitor rotor plates may be contacting the stator plates at only one or a few points throughout its rotation. In this case, stations may be tuned in at some points on the dial but not at others. Considerable noise will be heard also, as the tuning capacitor is rotated.

Next, check the oscillator section of the converter V1 by touching the probe tip to point B. Turn the receiver off momentarily, and then on again. If the oscillator begins functioning normally, a thump (followed by a rushing noise) will be heard in the Z-80 speaker. Lack of oscillator signal indicates an open or shorted oscillator transformer L2, shorted oscillator tuning capacitor, or trimmer A5, open resistor R2, or defective converter tube V1.

Next touch the probe tip to point C. No signal or a very weak signal is normal at point C. An appreciable signal at this point however, indicates capacitor C3 is open.

Now return the probe tip to point A, and note the amount of signal. Then, without changing the setting of the Z-80 GAIN or MULTIPLIER controls, move the probe tip to point D. An increase in signal strength should be observed due to the gain of the converter stage. The exact amount of gain here varies according to the type of tube used and the design of the circuit. For more detailed information on stage gain figures, and how to perform direct gain measurements accurately, refer to the section "DIRECT STAGE-BY-STAGE GAIN MEASUREMENTS" located elsewhere in this manual. For our purposes in this section, however, it will be sufficient to note only that each stage does show what appears to be a normal amount of gain. It will require only a little practice and experience on the new user's part to familiarize himself with what to expect in the way of gain from each type of amplifier stage he will encounter.

No signal at point D with a normal signal present at point A, indicates defective converter tube V1, open or shorted primary winding of IF transformer L3, or oscillator inoperative or misaligned. Signal at point D but with little or no gain indicates defective tube V1, misaligned IF transformer L3, no voltage at screen (pin 6) of V1, or weak output from oscillator. Distorted signal at point D indicates defective tube V1, defective IF transformer L3, or defective oscillator circuit.

Now move the probe tip to point E. A smaller amount of signal than was noted at point D is to be expected here, because the gain of the IF transformer L3 is normally less than 1. No signal at point E indicates open secondary winding of IF transformer L3, or shorted IF amplifier tube V2. Weak or distorted signal at point E indicates defective or misaligned IF transformer L3, or defective tube V2.

Having noted the amount of signal at point E, move the probe tip to point F. With the normally large gain of IF amplifier V2, the Z-80 MULTIPLIER will have to be switched to the X100 or X1000 position to prevent overloading the tracer amplifiers and to reduce the signal to a more suitable listening level. No signal at point F indicates defective tube V2, open or shorted primary winding of IF transformer L4, or open cathode resistor R3. Weak or distorted signal at point F indicates defective tube V2, defective or misaligned IF transformer L4, defective cathode resistor R3, or no voltage at screen (pin 6) of V2.

Now move the probe tip to point G. Here again the signal should be less then it was at point F, due to the IF transformer L4 having a gain of less then 1. No signal at point G indicates open secondary winding of IF transformer L4, or shorted detector section of tube V3. Weak or distorted signal at point G indicates defective or misaligned IF transformer L4, or defective tube V3.

If normal signal is present at the detector (point G), it is then known that the trouble must lie in the audio section of the receiver, between the detector and the speaker.

AF Signal Tracing

Move the probe switch to the "AF" position, and touch the probe tip to point H. No signal at this point indicates defective detector section of tube V3, shorted Volume Control R1, or shorted RF bypass capacitor C4. Weak or distorted signal at point H indicates defective tube V3, open or partially shorted Volume control R1, or defective RF bypass capacitor C4.

Next, move the probe tip to point J. With normal signal present at point H, the strength of the signal at point J will be dependent on the setting of Volume Control R1. Rotate the control from minimum to maximum several times, and the signal should increase and decrease smoothly without sudden interruptions, scratch or noise. If not, the control is defective and must be cleaned or replaced.

Move the probe tip to point K, keeping in mind that the level of signal here is also dependent on the setting of the Volume Control R1. With the control set to maximum, the signal level should be the same as at point H. No signal at point K indicates an open coupling capacitor C5. A weaker signal at point K than at point H with R1 at maximum, indicates C5 to be partially open or to be greatly decreased in value.

With the probe tip still at point K, adjust the Volume Control R1 for a signal which just over-rides any hum present. This setting will allow the Z-80 to pick up a good quality signal without excessive hum for the remainder of the signal tracing procedure.

Having noted the level of signal at point K, move the probe tip to point L. A substantial amount of gain should be noted. No signal at point L indicates defective triode section of tube V3, or open plate load resistor R6. Weak or distorted signal at point L indicates defective tube V3, defective resistor R6, defective bypass capacitor C6, leaky or shorted coupling capacitor C7.

Next move the probe tip to point M. The signal should be the same level as at point L. No signal at point M with normal signal at point L indicates open coupling capacitor C7.

Now move the probe tip to point N, and again a definite gain in signal should be noted. No signal at point N indicates defective output tube V4, open primary winding of output transformer T1, or open cathode resistor R8. Weak or distorted signal at point N indicates defective tube V4, defective cathode resistor R8, defective bypass capacitor C8, defective output transformer T1, or no voltage at screen (pin 6) of V4.

Next, move the probe tip to point O. (NOTE: If one side of the speaker is not grounded, as is the case in the receiver shown in Figure 18, the user should connect one side of the speaker to ground before testing at point O, or he should connect the probe tip and probe ground lead of the Z-80 directly across the speaker voice coil.) The signal level here should be much lower than at point N, due to the step-down turns ratio of the output transformer, necessary to match the impedance of the speaker voice coil to the impedance of the output tube. Weak or distorted signal at point O indicates open speaker voice coil or open secondary winding of output transformer T1.

The preceding information will furnish the signal tracer user with the fundamental knowledge necessary for signal tracing AM receivers, FM receivers, audio amplifiers, TV receivers, and other signal amplifying devices. Space does not permit going into detail on every type of circuit here, but the user need only remember that the basic method of signal tracing is the same for any circuit: The signal is followed through, stage by stage, from the input of the circuit to the output, until some point is reached where the signal departs from normal. Anyone who possesses a basic understanding of electronic circuits will find it a simple matter to apply signal tracing procedure to practically any signal amplifying device he may encounter.

Noise Testing

In testing for noisy resistors and controls, or for intermittent and leaky capacitors, the Model Z-80 probe switch must at all times be set to the AF position. When components are to be tested for noise, the receiver or other device must be disconnected from any power source during the test. Set the Z-80 FUNCTION SELECTOR to the INT SPKR position, and the MULTIPLIER to the NOISE position. GAIN is set to "50" or higher on the calibrated scale. This places approximately 150 volts DC between the probe tip and ground. The user should recognize this, and take proper precautions against the shock hazard! The actual shock hazard, however, is relatively harmless because for safety, the maximum short-circuit current has been limited to approximately 1-1/2 MA. This current is too small to damage any components found in typical electronic equipment.

To test a component for noise, connect it between the probe tip, and the probe ground lead. Components in good condition will cause a sharp "click" to be heard in the Z-80 speaker. Noisy components or "cold" solder joints will cause a less well-defined "click", "fuzzy" or "frying" sounds.

Wattmeter

The Model Z-80 may be used as a wattmeter to measure the power consumption of electrical devices consuming up to 500 watts. To make use of this feature, connect the Z-80 to the 117V, 60 cycle AC power source, set the FUNCTION SELECTOR to the WATTS position, and plug the device to be tested into the WATTMETER LOAD receptacle. (NOTE: NEVER switch the FUNCTION SELECTOR to the AC OFF position with a load plugged into the WATTMETER LOAD receptacle, or the FUNCTION SELECTOR may be damaged.) Rotate the WATTS control until the eye-tube pattern just closes. The power consumption of the device under test will then be indicated directly on the calibrated scale of the WATTS control.

The wattmeter function of the Z-80 can be of valuable assistance in troubleshooting. If the wattmeter indicates excessive power consumption in a receiver, the cause can be isolated by disconnecting the various loads, one at a time from the B+ line until the power drain is down to approximately the rated value as listed on the receiver label. In a transformer-operated power supply, remove the rectifier from its socket. If the power drain drops to less than the rated value, the excessive load is in the B+ circuit. If the power drain remains excessive, a shorted transformer winding or heavy load in either the primary or heater circuits can be the cause. In transformerless receivers heavy loads can be caused by a heater-cathode leak in a tube somewhere in the middle of a series heater string, or by defective electrolytic filter capacitors, etc. Disconnect the B+ line from the rectifier and note the new wattmeter reading. If power drain remains excessive, measure the AC voltages in the heater string with either a multimeter such as the PACO Model M-40 or VTVM such as the PACO Model V-70. If power drain drops, reconnect the B+ line to the rectifier and disconnect the various loads, such as the filter capacitors, output transformer, I.F. transformers, etc. one at a time until the heavy load is isolated. Reconnect each load before removing the next.

The wattmeter has been calibrated for a 117 volt line, for use with unity power factor loads. Errors will be introduced if the line voltage differs appreciably from 117 volts, or if the power factor is less than 90%. Most electronic equipment will have power factors of about 90%. Motors will have much smaller power factors, and the readings will be in error. If the line voltage is high, a 60 watt load, which will draw 60 watts at 117 volts, will draw more than 60 watts. These factors should be kept in mind when using the wattmeter.

Testing Speakers And Output Transformers

In determining the quality of speakers and output transformers, there is no more practical method than by direct substitution of the components themselves with others known to be good. The Model Z-80 provides the user with a quick and simple means of performing such substitutions through the use of external pin jacks located on the front panel. The various testing possibilities that may be performed in this category will now be explained:

A. SUBSTITUTE SPEAKER — To use the internal speaker of the Z-80 as a substitute in receivers having the output transformer mounted separately from the speaker, set the FUNCTION SELECTOR to TRACER OUT; disconnect the secondary leads of the receiver output transformer from the receiver speaker, and connect them to the Z-80 pin jacks marked SPEAKER VOICE COIL, and GND. The Z-80 line cord may be unplugged during this operation if desired.

B. SUBSTITUTE OUTPUT TRANSFORMER AND SPEAKER — To use both the output transformer and speaker of the Z-80 as substitutes in receivers having the output transformer mounted on the speaker, set the FUNCTION SELECTOR to AC OFF (unplug the Z-80 line cord if desired), and disconnect the primary leads of the receiver output transformer. The primary leads of the Z-80 output transformer are available at the pin jacks marked "P", "B+," and "P". In receivers employing single-ended output stages, the receiver output transformer primary leads are connected to the output tube plate, and B+. To perform the substitution therefore, connect the plate of the receiver output tube to one of the "P" pin jacks, and connect the "B+" pin jack to the receiver B+ point where the B+ primary lead of the receiver output transformer was connected.

NOTE: Some single-ended output stages employ output transformers having a tapped primary for hum cancellation. In such circuits, one end of the receiver output transformer primary is connected to the output tube plate, the other end of the primary is con-

nected to the output tube screen, and the tap is connected to B+. Do not confuse this type of circuit with the "push-pull" type to be explained later.

To substitute the Z-80 output transformer and speaker in receivers employing the "tapped primary" circuit, connect the plate of the receiver output tube to one of the "P" pin jacks as was done previously, then connect the "B+" pin jack to the receiver "B+" point and also to the screen of the receiver output tube.

In receivers employing "push-pull" output stages, two output tubes are used, and the output transformer primary is center-tapped. One end of the primary is connected to the plate of one of the output tubes, the other end of the primary is connected to the plate of the other output tube, and the center tap is connected to the receiver B+. To substitute the Z-80 output transformer and speaker in these circuits, first disconnect the receiver output transformer primary leads, then connect the plate of one of the output tubes to one of the "P" pin jacks, connect the plate of the other output tube to the other "P" pin jack, and connect the "B+" pin jack to the receiver B+.

C. SUBSTITUTE OUTPUT TRANSFORMER — To use the Z-80 output transformer alone as a substitute, the Z-80 line cord MUST be disconnected from the power source. The FUNCTION SELECTOR must be set to TRACER OUT. The output transformer primary is then available at the "P", "B+", and "P" pin jacks. The secondary is available at the TRACER OUTPUT and GND pin jacks.

D. TESTING EXTERNAL SPEAKERS — To check the quality of an external speaker, the Z-80 must be connected to an AC power source and the probe must be connected to a signal source. Set the FUNCTION SELECTOR to TRACER OUT, then connect the voice coil of the external speaker to the TRACER OUTPUT and GND pin jacks.

Additional Uses Of The Z-80 As An Amplifier

In addition to its basic function of amplification in signal tracing work, the high-gain, three stage audio amplifier contained within the Model Z-80 is useful for other tasks requiring high gain amplification of audio signals. It may be used as a small public-address system by connecting a suitable microphone (either crystal or dynamic) to the INPUT connector. The FUNCTION SELECTOR should be set to INT SPKR, and the GAIN and MULTIPLIER controls adjusted as required.

The amplifier also serves as a convenient test amplifier for checking phono pickups, tuners, microphones, photo-electric cells, etc. Control settings for these uses are the same as listed previously for use as a P.A. system.

DIRECT STAGE-BY-STAGE GAIN MEASUREMENTS

Accurate and rapid measurement of the actual working gain of any amplifier stage with the Model Z-80 is made possible by the four step attenuator, having a 10 to 1 ratio between steps, in the input circuit, and the use of an eye-tube as a visual indicator in the output circuit.

To determine the gain of an individual stage, it will be necessary to use a sine wave RF signal generator having provisions for audio frequency modulation.

Using the typical AC-DC AM receiver of Fig. 18 as an example, the procedure for measuring the gain of the various stages will now be described: —

To measure the gain of the converter stage V1, first tune the receiver to a point on the dial free of broadcast signals. Then, with the signal generator set up for modulated RF output, and connected between the receiver B- line and point A, tune the signal generator to the receiver dial setting. To insure against overloading keep the output of the signal generator low enough to produce a clear, undistorted tone in the receiver speaker, with the receiver volume control adjusted to normal listening level.

Now touch the Z-80 probe, switched to RF, to point A and adjust the GAIN and MULTIPLIER controls until the eye-tube pattern just closes. If it is desired to use just the visual indicator,

the internal speaker can be switched out without affecting the visual indicator, by setting the FUNCTION SELECTOR to TRACER OUT.

Now note the settings of the GAIN and MULTIPLIER controls. For example, if the GAIN control is set to 20 and the MULTIPLIER is set to X1, the reading is taken as 20 times 1 or 20. Move the probe to point D, and readjust the GAIN and MULTIPLIER controls until the eye tube pattern again just closes. Then again note the settings of the GAIN and MULTIPLIER controls. Stage gain is determined by dividing the output (point D) settings, by the input (point A) settings. For example, if the settings for point D were 40 and X10, or 400, the stage gain would be 400 divided by 20, or 20.

The same procedure is followed in measuring the gain of IF amplifier stage V2. The signal generator may be left connected to point A for this measurement, as well as for the remaining stage gain measurements in the typical receiver. For the IF amplifier, take signal tracer readings at points E, and F with the probe still switched to RF. When measuring the gain of audio stages V3 and V4 however, switch the probe to AF. For stage V3, take readings at points K and L, and for stage V4, points M and N.

Typical gain figures for the various stages in a receiver of this type vary considerably, and it is impossible to state that a particular stage gain will always fall within a certain range of figures. We can, however, list approximate ranges for each stage, and say that, in most cases, the gain will be between these limits. The user should bear in mind however, that should he encounter a stage gain falling outside the limits of the ranges we have listed here, it does not necessarily indicate the stage is faulty.

Approximate gain figures for the various stages in a typical AC-DC AM receiver are as follows:

CONVERTER	— 10 — 60
IF AMP	— 70 — 250
AF AMP	— 20 — 60
OUTPUT	— 5 — 20

MAINTENANCE SUGGESTIONS

Your PACO Signal Tracer is capable of fulfilling continuous daily service requirements over a period of many years. However, in order for you 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 instrument. Should your Signal Tracer require servicing, you will find by applying the same, logical processes of elimination used for troubleshooting any electronic circuit, you will, in most cases, locate the trouble with little difficulty. The checks outlined under "WHAT TO DO IN CASE OF TROUBLE", as well as the information given under "CIRCUIT DESCRIPTION", will aid you considerably. Proper operating voltages are shown on the schematic and these may vary up to ± 20% and still be acceptable.

The tubes used in this instrument should be checked periodically either by substitution or with a tube checker such as the PACO Model T-60. Always be sure they are in good operating condition.

Faulty operation of your Signal Tracer may often be traced to the RF-AF probe and its associated cable and connectors, especially after having been in use for some time. It is important, therefore, that the probe be kept in good operating condition. Check often and carefully for signs of trouble such as breakage, soldered connections developing resistance and cable shield shorting to the inner conductor.

PARTS LIST

RESISTORS

Part No.	Quantity	Description
P15-856	1	47 Ohms, 10%, Carbon
P15-937	1	270 Ohms, 1 Watt, 10% Carbon
P15-824	1	1000 Ohms, 10%, Carbon
P15-661	1	1000 Ohms, 7 Watts, 5%, W.W.
P15-932	1	1800 Ohms, 10% Carbon
P15-541	1	9100 Ohms, 5%, Carbon
P15-793	1	22K Ohms, 10%, Carbon
P15-652	2	47K Ohms, 10%, Carbon
P15-934	1	91K Ohms, 5%, Carbon
P15-731	1	100K Ohms, 10%, Carbon
P15-694	2	220K Ohms, 10%, Carbon
P15-728	3	470K Ohms, 10%, Carbon
P15-933	1	560K Ohms, 10%, Carbon
P15-935	1	910K Ohms, 5%, Carbon
P15-656	4	1 Megohm, 10%, Carbon
P15-585	1	1.8 Megohm, 10%, Carbon

CAPACITORS

P16-233	1	10 Mfd. 25V.	ELECTROLYTIC
P16-212	1	25 Mfd. 25V.	
P16-234	1	20 Mfd. 450V. 20 Mfd. 450V. 10 Mfd. 350V. 10 Mfd. 350V.	
P16-235	1	.0066 Mfd. (Cer.)	TUBULAR
P16-216	1	.01 Mfd. 600V.	
P16-159	1	.02 Mfd. 400V.	
P16-195	2	.047 Mfd. 400V.	
P16-168	4	4700 MMF Disc.	

CONTROLS - SWITCHES

P17-194-1	1	50K Ohm Control (WATTS)
P17-174	1	500K Ohm Control (GAIN)
P14-243	1	4 Position Rotary Switch (FUNCTION SELECTOR)
P14-242	1	5 Position Rotary Switch (MULTIPLIER)
P14-248	1	SPST Slide Switch

TRANSFORMERS

P18-170	1	Current Transformer
P18-171	1	Power Transformer
P18-172	1	Output Transformer

TUBES - CRYSTAL RECTIFIERS

P19-151	1	12AQ5 Tube
P19-154	1	12AU6 Tube
P19-152	1	12AV6 Tube
P19-153	1	12X4 Tube
P19-146	1	1629 Tube
P32-121	1	Crystal Rectifier

SOCKET CONNECTORS - TERMINAL STRIPS

P20-193	4	7 Pin Miniature Tube Socket
P20-143	1	Octal Tube Socket

SOCKET CONNECTIONS - TERMINAL STRIPS (Cont.)

Part No.	Quantity	Description
P20-194	1	AC Receptacle (WATTMETER LOAD)
P20-108	1	Coaxial Cable Connector - Female - With Spring
P20-109	1	Coaxial Cable Connector - Male - With nut and ground lug (INPUT)
P20-119	1	Alligator Clip
P20-106	2	Pin Jack - Black
P20-106-2	6	Pin Jack - Red
P23-221	2	1 Lug Terminal Strip
P23-220	1	2 Lug Terminal Strip - One Lug Grounded
P23-225	2	2 Lug Terminal Strip - No Lugs Grounded

KNOBS - GROMMETS - FEET

P10-460	4	Pointer Knob
P29-132	6	Rubber Grommet, 3/8"
P249-149	4	Rubber Feet

HARDWARE

P24-237	4	#2-56 x 3/16" Self-Tapping Screw
P24-258	2	#3-48 x 1/4" Binding Head Screw
P24-255	8	#4-40 x 1/4" Binding Head Screw
P24-252	1	#6-32 x 3/16" Slotted Set Screw
P24-243	4	#6-32 x 3/8" Oval Head Screw
P24-244	18	#6-32 x 3/8" Binding Head Screw
P24-215	2	#6 x 3/8" BH, Self-Tapping Screw
P24-158	8	#4-40 Hex Nut
P24-125	22	#6-32 Hex Nut
P24-180	4	Control Hex Nut
P24-263	8	Tinnerman Push-On Speed Nut
P24-253	8	#4 Lockwasher
P24-246	20	#6 Lockwasher
P24-175	5	Control Lockwasher
P23-248	2	#6 Solder Lug
P23-224	4	Bakelite Control Washer

WIRE - SPAGHETTI - TUBING

P21-178*	1	6" Length, Coaxial Cable
P21-178*	1	42" Length, Coaxial Cable
P21-104	1	Length Bare Wire
P21-148	1	Roll of Hook-up Wire (Red, Green, Yellow, Orange)
P21-124	1	Length, Black Flexible Wire
P21-147-1	1	Line Cord
P21-179	1	Length, Flat Braided Wire
P21-170	1	Length, Spaghetti
P21-174*	1	1-1/2" Length Vinyl Tubing
P21-174*	1	2" Length Vinyl Tubing

* Specify length when ordering.

PARTS LIST (Cont.)

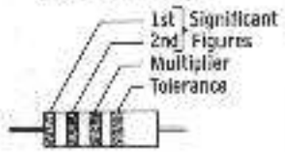
MISCELLANEOUS

Part No.	Quantity	Description
P10-462	1	Probe Housing
P10-463	1	Probe Head
P10-464	1	Probe End
P33-104A	1	Probe Tip
P34-105	1	Probe Cable Spring
P11-294	1	Mounting Bracket for Eye Tube
P23-262	1	Spring Clip for Eye Tube
P23-259	1	Electrolytic Capacitor Mounting Wafer

MISCELLANEOUS (Cont.)

Part No.	Quantity	Description
P11-296	1	Chassis
P13-387	1	Panel
P22-170	1	Carrying Case
P23-243	1	Carrying Case Handle
P23-244	2	Carrying Case Handle Hinge
P30-108	1	5" Speaker
P21-180	1	Wirecloth Speaker Grille
P26-168	1	Instruction Manual

COLOR BAND SYSTEM



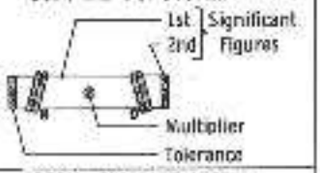
Resistors With Black Body Color Are Composition, Non-Insulated.
Resistors With Colored Bodies Are Composition, Insulated.
Wire-Wound Resistors Have The 1st Digit Color Band Double Width.

RESISTOR CODES (RESISTANCE GIVEN IN OHMS)

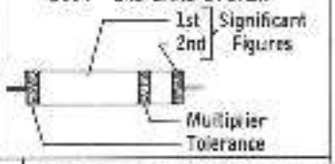
COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	±20%
BROWN	1	10	±1%
RED	2	100	±2%
ORANGE	3	1000	±1% ¹)
YELLOW	4	10000	GMV*
GREEN	5	100000	±5% (RETMA Alternate)
BLUE	6	1000000	±1%*
VIOLET	7	10000000	±0.1/2%*
GRAY	8	.01 (RETMA Alternate)	±50%,*
WHITE	9	.1 (RETMA Alternate)	±10% (RETMA Alternate)
GOLD		1 (JAN 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
¹) 2, 6, 12 1/2, and 20% are ASA 10, 20, 10, and 5 step tolerances.

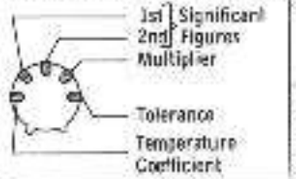
BODY-END-DOT SYSTEM



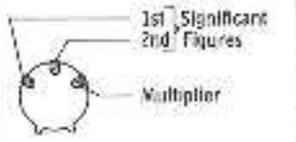
BODY-END BAND SYSTEM



DISC CERAMICS (5-DOT SYSTEM)



DISC CERAMICS (3-DOT SYSTEM)

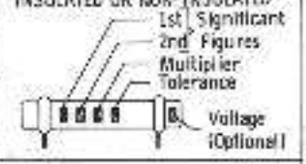


CERAMIC CAPACITOR CODES (CAPACITY GIVEN IN MMF)

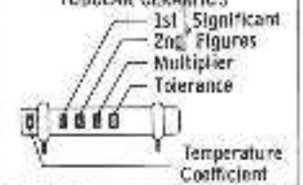
COLOR	DIGIT	MULTIPLIER	TOLERANCE 10MMF or LESS	TOLERANCE OVER 10MMF	TEMPERATURE COEFFICIENT PPM/°C	EXTENDED RANGE TEMP. COEFF. SIGNIFICANT FIGURE	EXTENDED RANGE TEMP. COEFF. MULTIPLIER
BLACK	0	1	±0.5MMF	±20%	0 (NPO)	0.0	-1
BROWN	1	10	±0.1MMF	±1%	-33 (N033)		-10
RED	2	100		±2%	-75 (N075)	1.1	-100
ORANGE	3	1000		±2.5%	-150 (N150)	1.5	-1000
YELLOW	4	10000			-220 (N220)	2.2	-10000
GREEN	5		±0.25MMF	±5%	-330 (N330)	3.3	+1
BLUE	6				-470 (N470)	4.7	+10
VIOLET	7				-750 (N750)	7.5	+100
GRAY	8	.01	±0.05MMF		-30 (P030)		+1000
WHITE	9	.1	±1.0MMF	±10%	General Purpose Bypass & Coupling (-1001P100) (Jan)		+10000
SILVER							
GOLD							

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

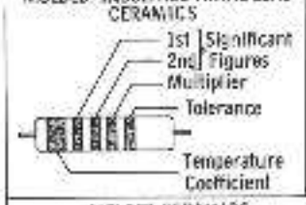
HIGH CAPACITY TUBULAR CERAMICS INSULATED OR NON-INSULATED



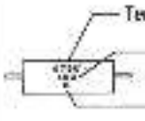
TEMPERATURE COMPENSATING TUBULAR CERAMICS



MOLDED-INSULATED AXIAL LEAD CERAMICS

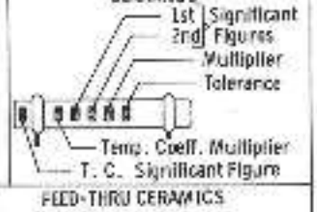


TYPOGRAPHICALLY MARKED CERAMICS



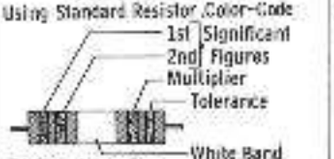
JAN LETTER	TOLERANCE 10MMF or LESS	TOLERANCE OVER 10MMF
C	±0.25MMF	
D	±0.5MMF	
F	±1.0MMF	±1%
G	±2.0MMF	±2%
J		±5%
K		±10%
M		±20%

EXTENDED RANGE T.C. TUBULAR CERAMICS



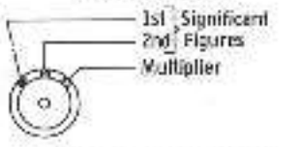
MOLDED CERAMICS

Using Standard Resistor Color-Code



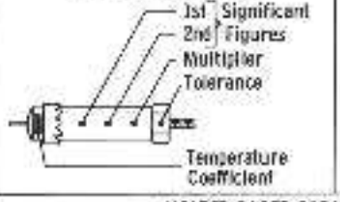
Distinguishes Capacitor From Resistor

BUTTON CERAMICS

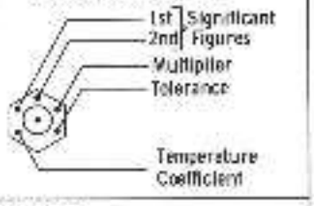


Viewed From Soldered Surface

STAND-OFF CERAMICS



FEED-THRU CERAMICS



MOLDED MICA CAPACITOR CODES (Capacity Given In MMF)

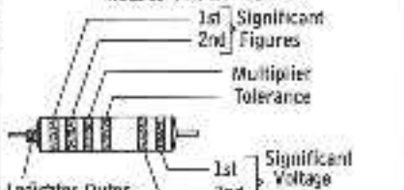
COLOR	DIGIT	MULTIPLIER	± TOLERANCE	CLASS OR CHARACTERISTIC
BLACK	0	1	20%	A
BROWN	1	10	1%	B
RED	2	100	2%	C
ORANGE	3	1000	3%	D
YELLOW	4	10000		E
GREEN	5		5% (RETMA)	F (JAN)
BLUE	6			G (JAN)
VIOLET	7			
GRAY	8			H (RETMA)
WHITE	9			J (RETMA)
GOLD		.1	5% (JAN)	
SILVER		.01	10%	

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 500, 900, 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%

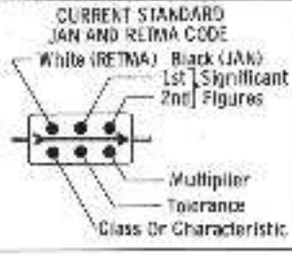
MOLDED PAPER TUBULAR



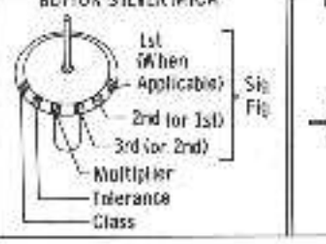
Indicates Outer Foil. May Be On Either End. May Also Be Indicated By Other Methods Such As Typographical Marking, Or Black Stripe.

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

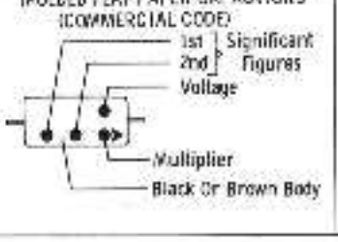
CURRENT STANDARD JAN AND RETMA CODE



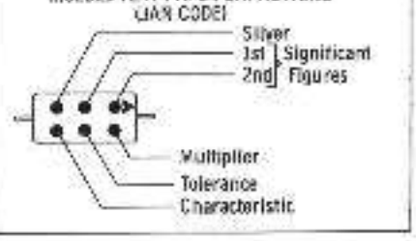
BUTTON SILVER MICA



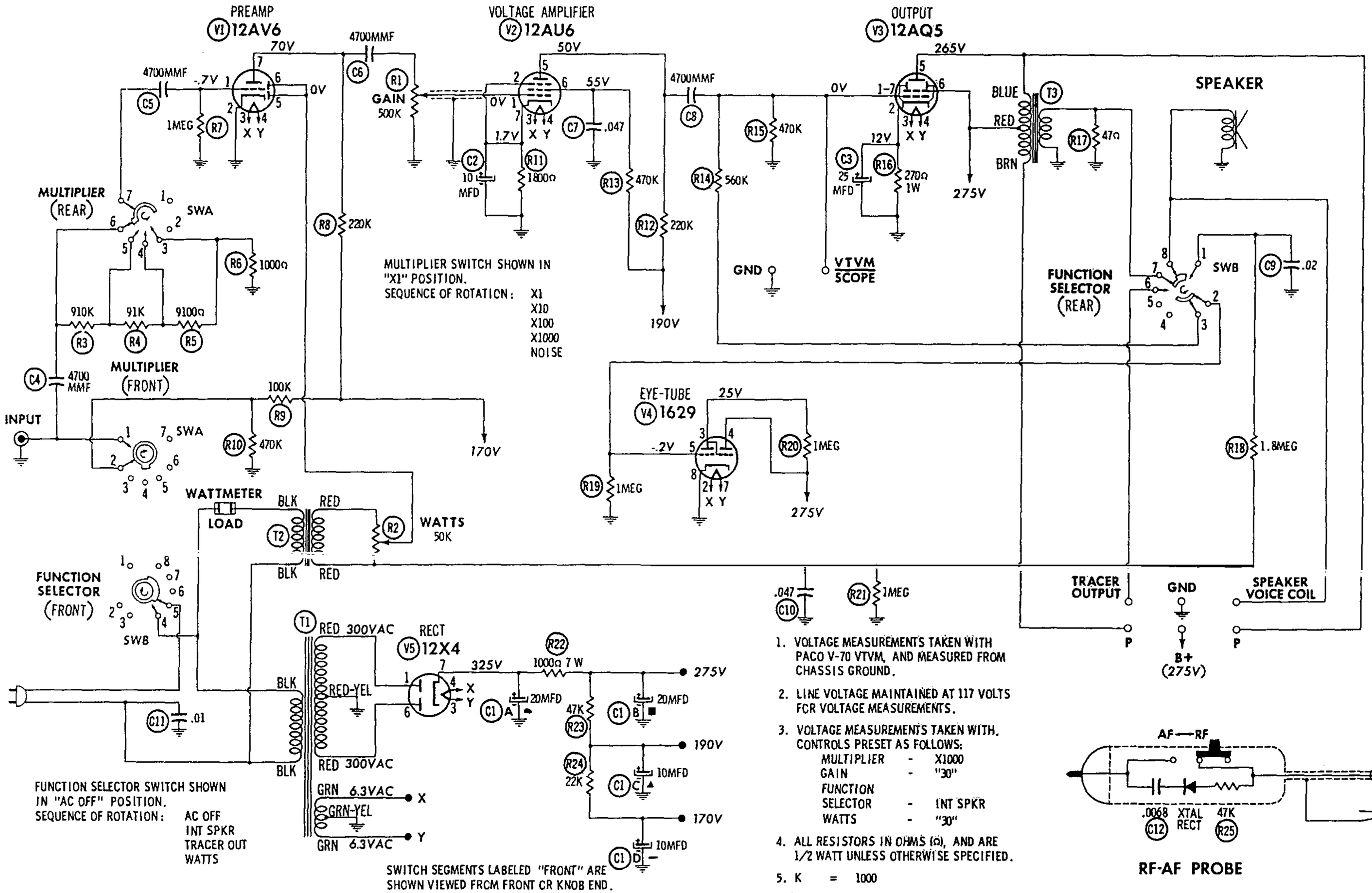
MOLDED FLAT PAPER CAPACITORS (COMMERCIAL CODE)



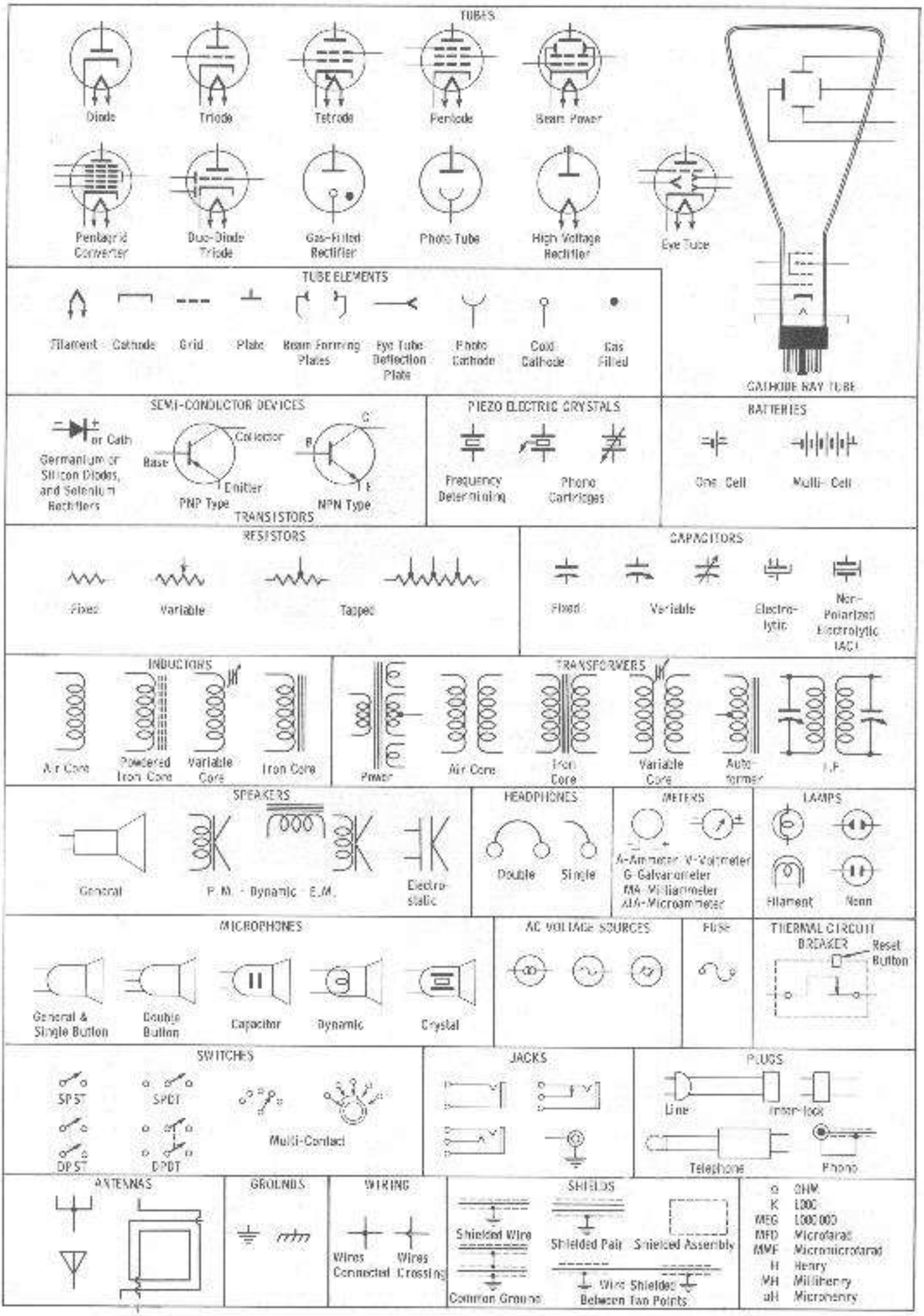
MOLDED FLAT PAPER CAPACITORS (JAN CODE)



SCHEMATIC DIAGRAM-MODEL Z-80 AUDIO-RF SIGNAL TRACER



1. VOLTAGE MEASUREMENTS TAKEN WITH PACO V-70 VTVM, AND MEASURED FROM CHASSIS GROUND.
2. LINE VOLTAGE MAINTAINED AT 117 VOLTS FOR VOLTAGE MEASUREMENTS.
3. VOLTAGE MEASUREMENTS TAKEN WITH CONTROLS PRESET AS FOLLOWS:
   - MULTIPLIER - X1000
   - GAIN - "30"
   - FUNCTION SELECTOR - INT SPKR
   - WATTS - "30"
4. ALL RESISTORS IN OHMS (Ω), AND ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED.
5. K = 1000
6. MEG = 1000000
7. ALL CAPACITORS IN MFD UNLESS OTHERWISE SPECIFIED.


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 (ACT)
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
MA-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
Shielded Assembly
Common Ground
Wire Shielded Between Two Points
Ω OHM
K 1,000
MEG 1,000,000
MFD Microfarad
MMF Micromicrofarad
H Henry
MH Millihenry
uH Microhenry

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