PRICE $1.00

Assembling and Using Your...

Heathkit

CONDENSER CHECKER

MODEL C-3

HEATH COMPANY

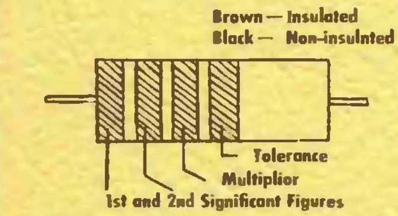
A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

595-44

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

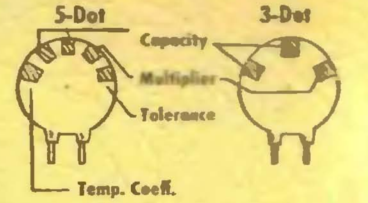
AXIAL LEAD RESISTOR



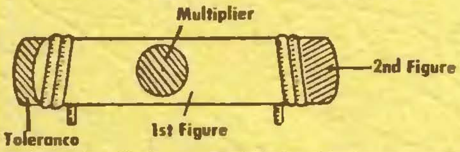
Wire wound resistors have 1st digit band double width

INSULATED UNINSULATED Color	FIRST RING BODY COLOR First Figure	SECOND RING END COLOR Second Figure	THIRD RING DOT COLOR Multiplier
BLACK	0	0	None
BROWN	1	1	0
RED	2	2	00
ORANGE	3	3	,000
YELLOW	4	4	0,000
GREEN	5	5	00,000
BLUE	6	6	000,000
VIOLET	7	7	0,000,000
GRAY	8	8	00,000,000
WHITE	9	9	000,000,000

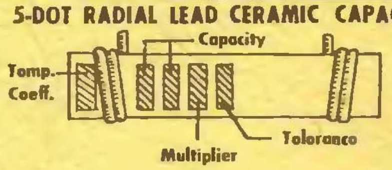
DISC CERAMIC RMA CODE



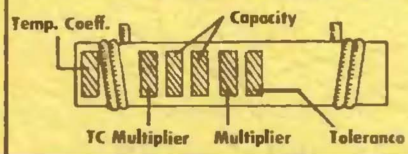
RADIAL LEAD DOT RESISTOR



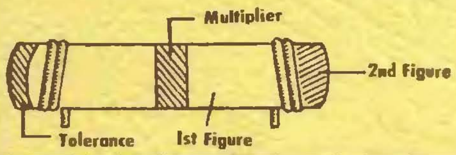
5-DOT RADIAL LEAD CERAMIC CAPACITOR



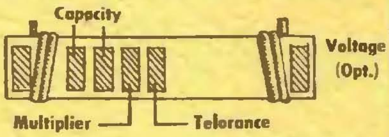
EXTENDED RANGE TC CERAMIC HICAP



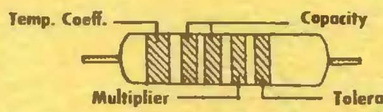
RADIAL LEAD (BAND) RESISTOR



BY-PASS COUPLING CERAMIC CAPACITOR



AXIAL LEAD CERAMIC CAPACITOR

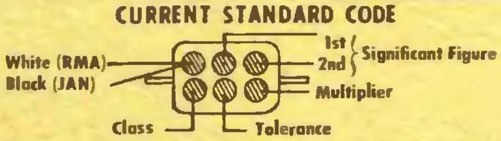


The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

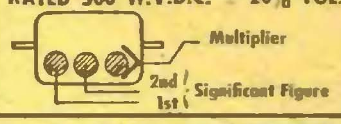
MOLDED MICA TYPE CAPACITORS

CURRENT STANDARD CODE



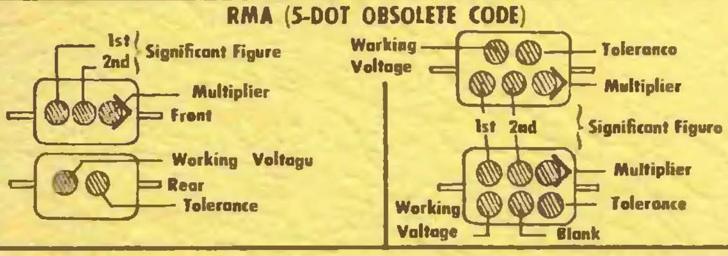
JAN & 1948 RMA CODE

RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL.

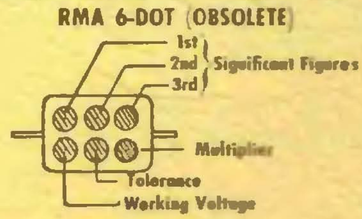


BUTTON SILVER MICA CAPACITOR

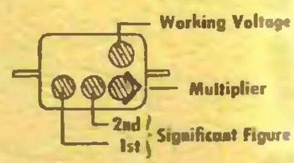
RMA (5-DOT OBSOLETE CODE)



RMA 6-DOT (OBSOLETE)

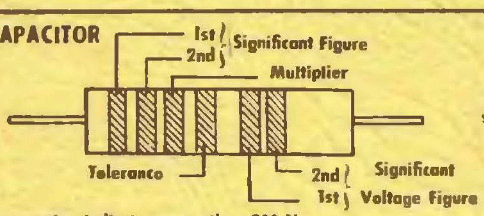


RMA 4-DOT (OBSOLETE)



MOLDED PAPER TYPE CAPACITORS

TUBULAR CAPACITOR

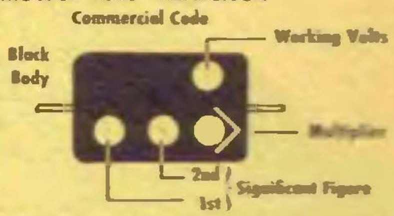


Normally stamped for value

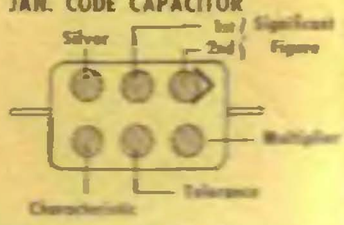
A 2 digit voltage rating indicates more than 900 V. Add 2 zeros to end of 2 digit number.

MOLDED FLAT CAPACITOR

Commercial Code



JAN. CODE CAPACITOR



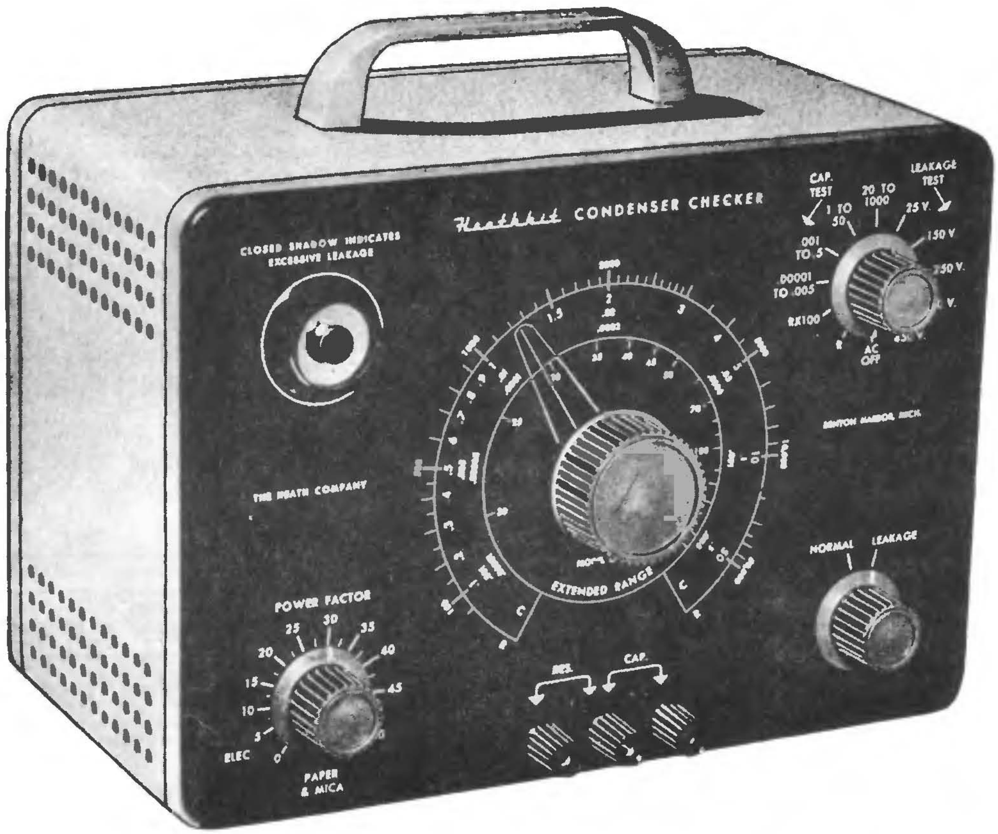
The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

Courtesy of Centralab

HEATHKIT CONDENSER CHECKER

MODEL C-3



SPECIFICATIONS

Power Requirements:	110-125 volts, 50-60 cycles a-c
Cabinet Size:	$9\frac{1}{2}$" wide x $6\frac{1}{2}$" high x 5" deep
Kit Shipping Weight:	7 pounds
Power Supply:	Power transformer—half wave rectifier
Capacity: 4 Ranges:	.00001 mfd - .005 mfd .001 mfd - .5 mfd .1 mfd - 50 mfd 20 mfd - 1000 mfd
D-C Leakage Test Polarizing Voltages: 5 Ranges:	25 volts d-c 150 volts d-c 250 volts d-c 350 volts d-c 450 volts d-c
Resistance Ranges: 2 Ranges:	100 ohms to 50,000 ohms 10,000 ohms to 5 megohms
Circuit:	A-c powered bridge for both capacitive and resistive measurements. Maximum opening of electron beam indicator denotes bridge balance.

ASSEMBLY AND OPERATION OF THE

NEW HEATHKIT MODEL C-3 CONDENSER CHECKER

The Heathkit Condenser Checker will offer excellent operating characteristics if properly constructed. To insure many years of trouble free service, the assembly and wiring should be undertaken without hurrying. Take your time to do a good job.

This manual is intended to facilitate proper construction, therefore, read the manual carefully and thoroughly before proceeding with construction. In this manner, you will become familiar with the contents of the manual and the relative location of various pictorials.

Unpack the kit carefully and check each part against the parts list. In so doing, you will become acquainted with the parts. If a shortage is found please notify us promptly and attach the inspection slip to your claim. Screws, nuts and washers are counted mechanically and if a few are missing please secure them locally.

Read the note on soldering inside of the back cover. Make a good mechanical connection with clean metal to clean metal. Use only the best quality rosin core radio type solder. Paste, fluxes or acids are difficult to remove and even minute quantities left behind will combine with moisture from the air to form a corrosive product. This corrosive product is generally a good conductor and may cause short circuits between switch contacts or tube socket lugs. After weeks or months, the corrosion may result in untimely failure of the instrument.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES ARE USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

Resistors and controls generally have a tolerance rating of plus or minus 20% unless otherwise stated. Therefore, a 10,000 ohm resistor may test anywhere from 8,000 to 12,000 ohms. The tolerance on condensers is generally even greater. Limits of -50% and 100% are common for paper tubular types. This Heathkit is designed to accommodate such variations.

Small changes in parts may be made by the Heath Company. All parts supplied will work just as well as the part for which it was substituted. By reading the color code on resistors, for instance, it will be readily understood that a value of 3.9 megohms is a substitute for the specified 3.3 megohms. Or a resistor color coded 8200 ohms is a substitute for the specified 10,000 ohms, provided the specified values are not supplied. Such changes would only be made if the specified parts are unobtainable at the time and are only made to insure a minimum delay in filling your order.

Follow the pictorial diagrams for the best placement of wiring. Make ground connections (connections to the chassis or panel) as shown in the pictorials. These grounding points have been chosen to minimize interaction between various parts of the circuit.

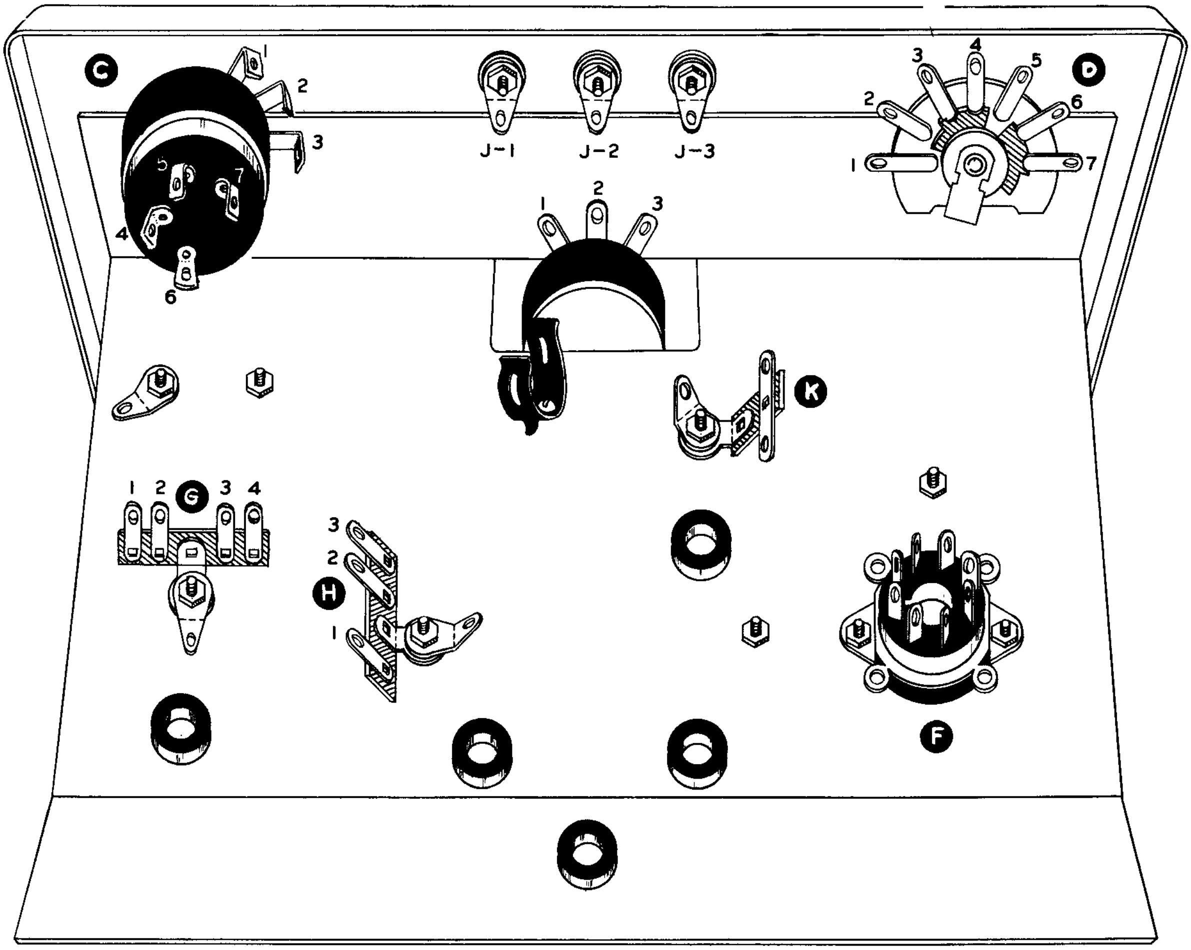
Use of bare wire where indicated will facilitate wiring but insulated wire may be used. Use spaghetti (insulated sleeving) over bare wires on condensers and resistors where necessary to prevent the leads from accidentally touching other bare wires or metal parts. Use lockwashers under all 6-32 nuts and between all controls and panel. Check off each construction step in the space provided ( ) as it is completed.

STEP-BY-STEP ASSEMBLY

Mounting of Parts

( ) Mount power transformer E on top of chassis rear center. Placement should be made so that the black leads and yellow leads are along the rear edge. Install 3-lug terminal H under chassis using the same transformer mounting 6-32 screw. See Pictorial 3. Next, slip a solder lug on the same screw and tighten assembly with a 6-32 nut. Another 6-32 screw through the remaining transformer mounting lug chassis lock washer and a 6-32 mounting nut completes the transformer mounting.

( ) Install the five 3/8 rubber grommets on chassis as shown in Pictorial 1.



PICTORIAL 1

( ) Dress power transformer leads as shown in Pictorial 3. Note: Green and green-yellow leads are not dressed through the chassis.

( ) Install saddle mounting octal socket F so that keyway is towards the power transformer. Use 6-32 screws, lockwashers and 6-32 nuts.

( ) Mount Z shaped mounting bracket on top of chassis using 6-32 mounting screws and under the chassis slip a solder lug over a 6-32 screw.

( ) Mount 4 lug terminal strip G under chassis using a 6-32 screw with a solder lug under the 6-32 nut. Refer to Pictorial 1.

( ) Mount spring base clamp on top of bracket M.

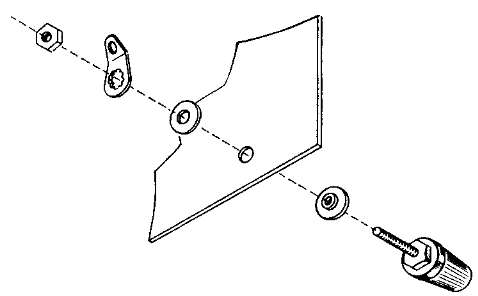
( ) Install spring clip as shown, next to terminal strip K.

( ) Install 1-lug terminal K under chassis. See Pictorial 1. Slip solder lug under the 6-32 nut.

( ) On top of chassis install 2-lug terminal L. See pictorial 2 for placement.

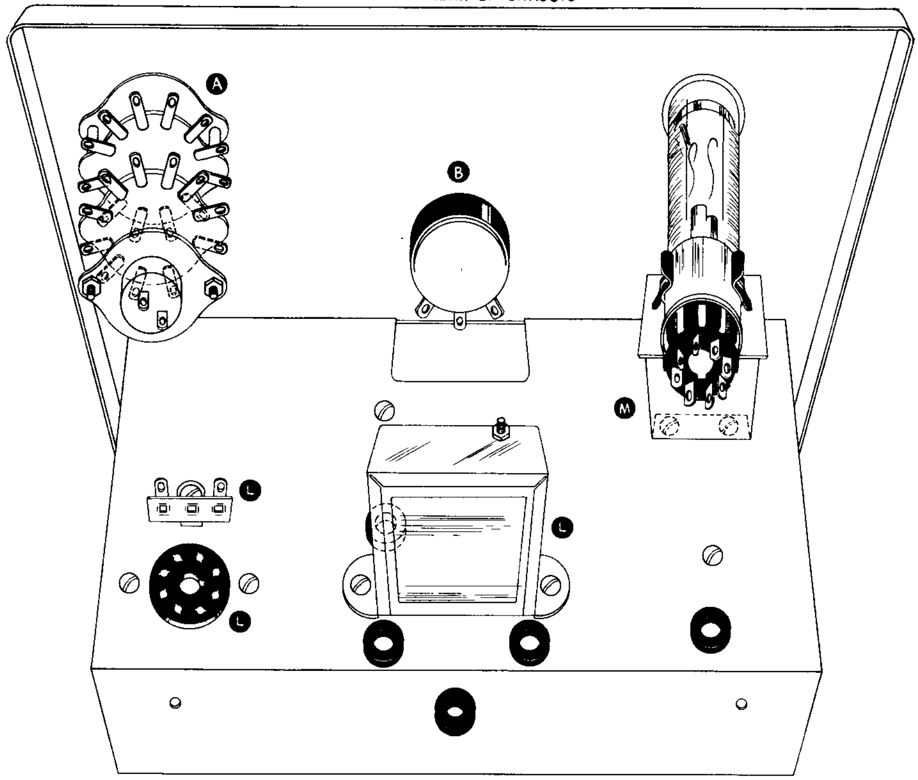
( ) Mount main control B in center panel opening. Use control lockwasher between control and panel. Use flat nickel washer under control Mounting nut. Position control so that terminal points downward.

( ) Install three binding posts in openings at bottom edge of panel. First install fiber shoulder washer on binding post threaded stud. Slip stud through panel opening and install a flat fiber washer, solder lug and 6-32 nut. Be sure that the entire assembly is properly centered in the panel opening to prevent a short circuit condition. Make sure that solder lugs are pointed downward and bent away from chassis edge.



( ) Fasten the panel to the chassis by mounting the power factor control C on left side of chassis. Use a control lock washer between the power factor control and chassis and run the control bushing through the panel. Use a flat nickel washer between control nut and panel.

TOP VIEW FROM REAR OF CHASSIS



PICTORIAL 2

( ) Repeat the same mounting procedure on the right side of the chassis by mounting the spring return rotary test switch D.

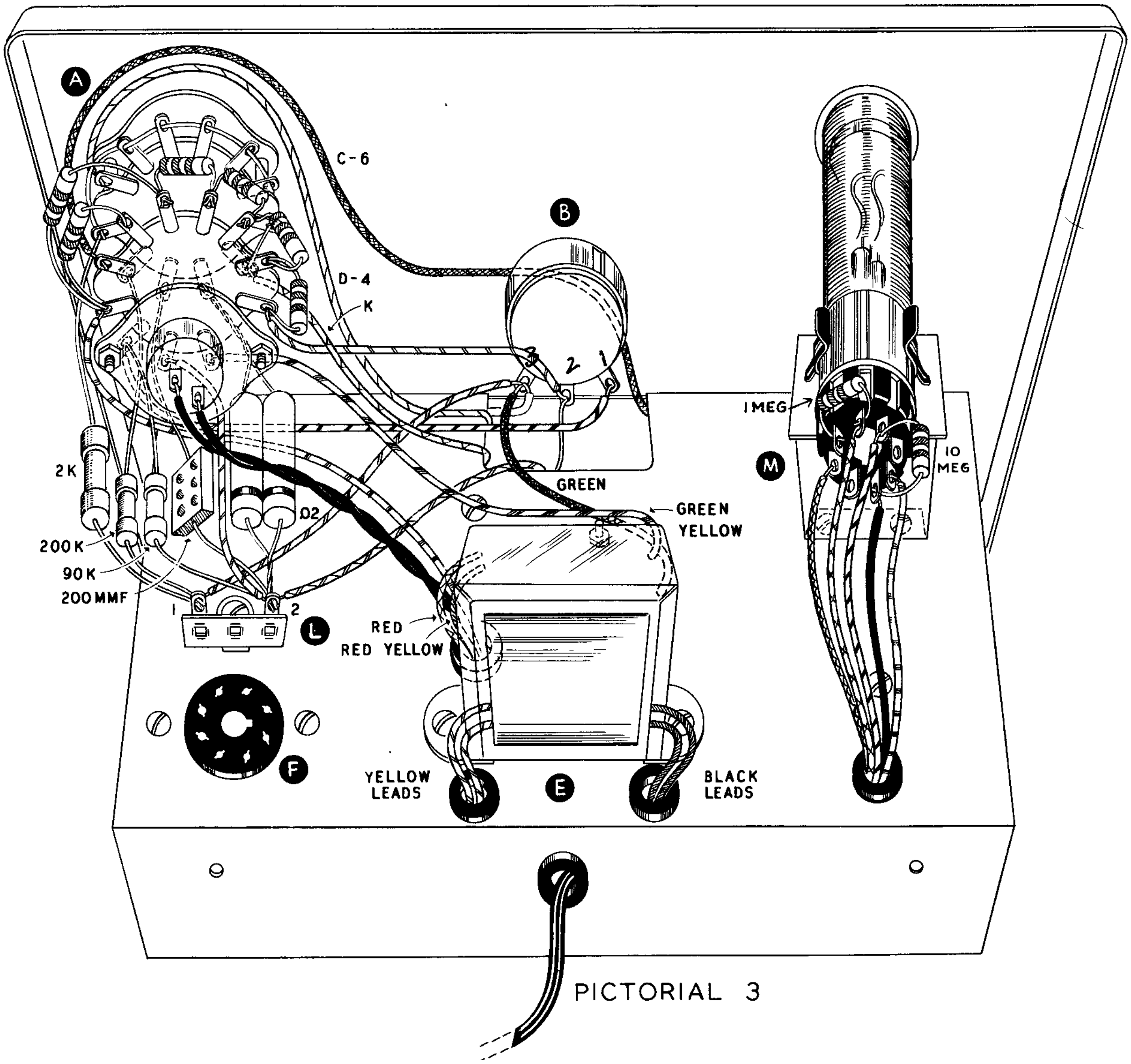
This completes the mechanical assembly except for the selector switch which will be installed on upper right corner of panel in a subsequent step. Before proceeding further, it would be well to carefully recheck all of the mounting of parts against the pictorials. This may save unnecessary difficulty after instrument construction.

WIRING HINTS

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals.

When mounting parts such as resistors or condensers trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby terminals. It is recommended that the wiring dress and parts layout as shown in this construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.



PICTORIAL 3

Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals and switch assemblies or tube sockets. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies.

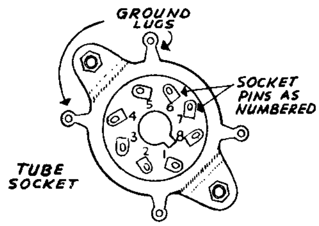
USE ONLY GOOD QUALITY ROSIN CORE RADIO TYPE SOLDER. ACID CORE SOLDER OR PASTE FLUXES SHOULD NEVER BE USED FOR KIT INSTRUMENT WORK. THE USE OF ACID CORE SOLDER OR PASTE FLUX WILL VOID ALL WARRANTIES.

WIRING

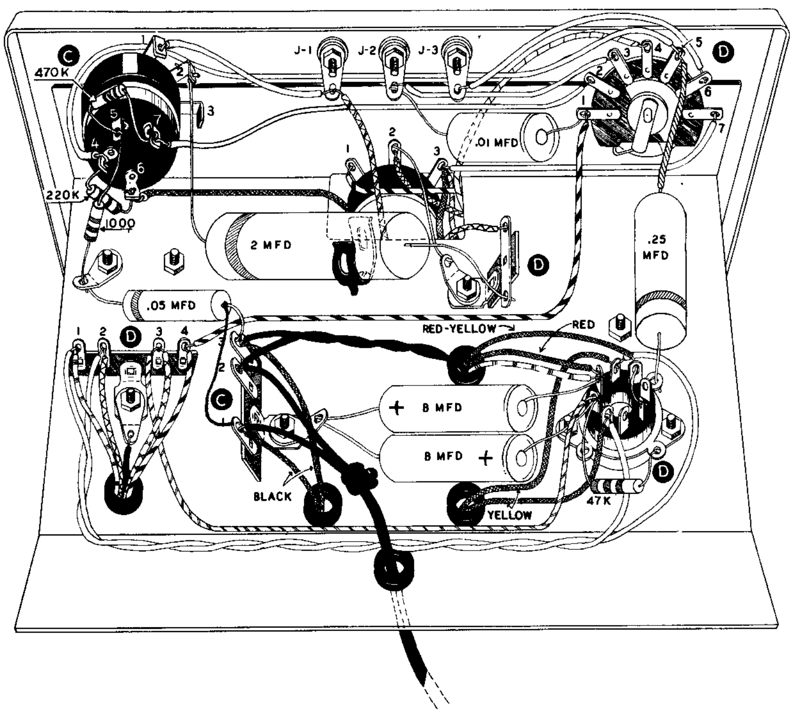
(S) means solder (NS) do not solder yet

( ) Connect one black transformer lead to H1 (NS). Connect remaining black transformer lead to H3 (NS).

The octal tube socket pins are numbered from 1 to 8 starting at the keyway and reading clockwise when viewed from the bottom. For additional assistance, octal sockets used in Heathkits are imprinted with the numbering system.



( ) Connect yellow transformer lead to F2 (NS).
( ) Connect remaining yellow transformer lead to F7 (NS).
( ) Connect the red transformer lead to F1 (NS).
( ) Connect the red-yellow transformer lead through F3 (S) to F5 (S).
( ) Twist together two 10 inch lengths of wire, connect one of the twisted wires to F2 (S).
( ) Connect the remaining wire to F7 (S).
( ) Dress the twisted wire along the rear chassis bend to 4-lug terminal G.
( ) Connect one of the twisted wires to G1 (NS).
( ) Connect the remaining twisted wire to G2 (NS).
( ) Install 8 mfd tubular filter condenser, positive lead to F8 (NS) and remaining lead to ground solder lug (NS) at terminal H.
( ) Install another 8 mfd tubular filter condenser, negative lead to F1 (NS) and positive lead to ground solder lug (S) at terminal H.
( ) Connect a wire from F8 (NS) to G3 (NS).
( ) Install a 47K (yellow-violet-orange) 1 watt resistor from F8 (S) to ground solder lug (S) on socket F.



PICTORIAL 4

( ) Connect a wire from panel control C4 (NS) to panel switch D5 (NS).
( ) Install a .25 mfd condenser from D5 (S) to ground solder lug (S) on socket F.
( ) Connect a wire from D6 (S) to J3 (S).
( ) Connect a wire from D7 (S) to B3 (NS).
( ) Connect a wire from D3 (S) to J2 (NS).
( ) Connect a wire from D2 (S) to C7 (NS).
( ) Connect a wire from D1 (NS) to G4 (NS).
( ) Connect a .01 mfd condenser from J2 (S) to D1 (S).
( ) Connect a wire from J1 (NS) to C1 (S).
( ) Connect a wire from J1 (S) to L2 (NS) on top of chassis.
( ) Install a 2 mfd condenser in the spring clip with band end to C2 (S) and to terminal K (S).
( ) Install a 470K (yellow-violet-yellow) resistor between C5 (NS) and C7 (S).
( ) Connect a 1K (brown-black-red) resistor from C5 (S) to ground solder lug (NS) on chassis.
( ) Install a 220K (red-red-yellow) resistor from C4 (S) to C6 (NS).
( ) Install a .05 condenser from H3 (NS) to chassis ground solder lug (S).
( ) Connect a short piece of bare wire from B2 (NS) to chassis ground solder lug (S)
( ) Connect a wire from terminal B3 (NS) to L1 (NS).

ELECTRON BEAM INDICATOR WIRING

( ) Install 1 meg (brown-black-green) resistor between lug 3 (S) of round octal socket and lug 4 (NS).
( ) Install a 10 meg (brown-black-blue) resistor from lug 5 (NS) of round octal socket to lug 8 (NS).

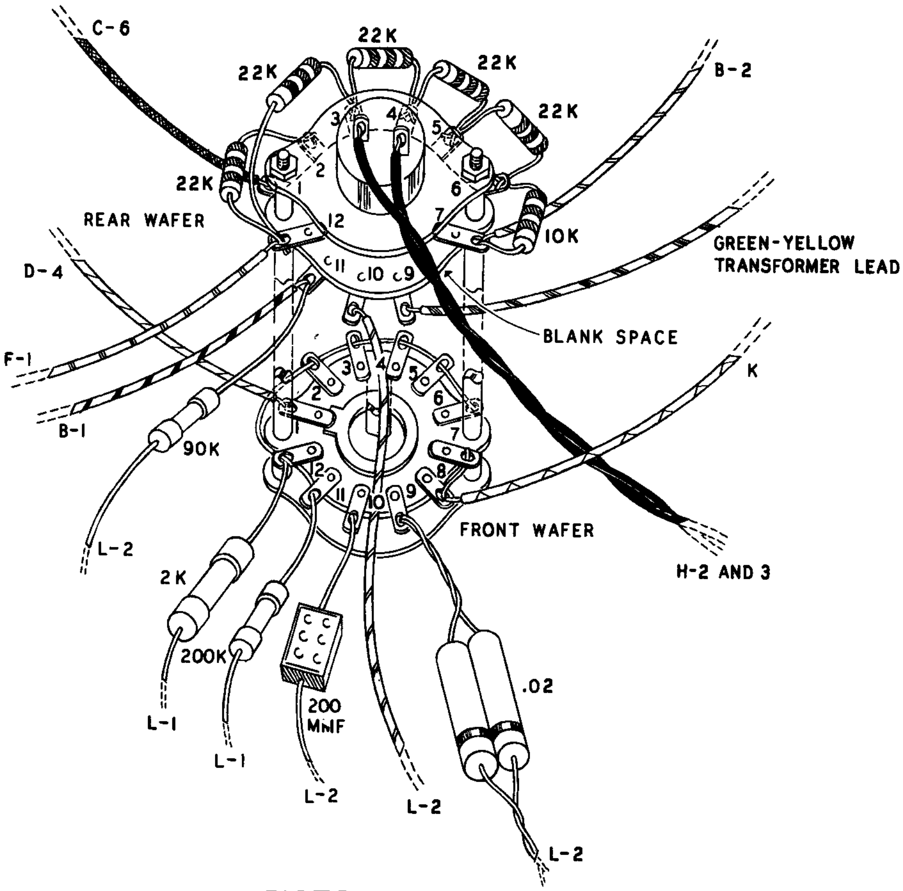
Install 1629 tube in round octal socket and snap the assembly into the spring base clamp. Point socket keyway down towards chassis and adjust horizontal positioning of tube so that it protrudes slightly through panel opening.

( ) Connect a wire from round octal socket lug 2 (S) to G2 (S).
( ) Connect a wire from round octal socket lug 4 (S) to G3 (S).
( ) Connect a wire from round octal socket lug 5 (S) to G4 (S).
( ) Connect a wire from round octal socket lug 7 (S) to G1 (S).
( ) Connect a wire from lug 8 (S) of round octal socket to ground solder lug under chassis at G (S).

SELECTOR SWITCH WIRING

The selector switch is composed of two separate wafers and the terminals for each wafer are numbered 1 through 12 in a clockwise manner when viewed from the rear. See Pictorial 5. The wafer that will mount closest to the front panel is designated "front wafer." The remaining wafer is designated "rear wafer." To properly orient the switch for wiring and panel mounting note that lug 8 on rear wafer is missing. This blank space on the switch should be positioned so that in the final panel assembly it will be on the under side. The following wiring steps of the switch are made before actually mounting the switch on the panel.

( ) Connect a bare wire from front wafer 12 (NS) and run through terminals, 2, 3, 4, 5 and 6 (S). Twisting the terminal lugs carefully will facilitate this wiring step.
( ) Connect a 10K (brown-black-orange) resistor between 7 (NS) and 6 (NS) on rear wafer.
( ) Mount the five 22K (red-red-orange) resistors on the rear switch wafer in the following manner:
( ) Connect a 22K resistor between 6 (S) and 5 (NS).
( ) Connect a 22K resistor between 5 (S) and 4 (NS).
( ) Connect a 22K resistor between 4 (S) and 3 (NS).
( ) Connect a 22K resistor between 3 (S) and 12 (NS).

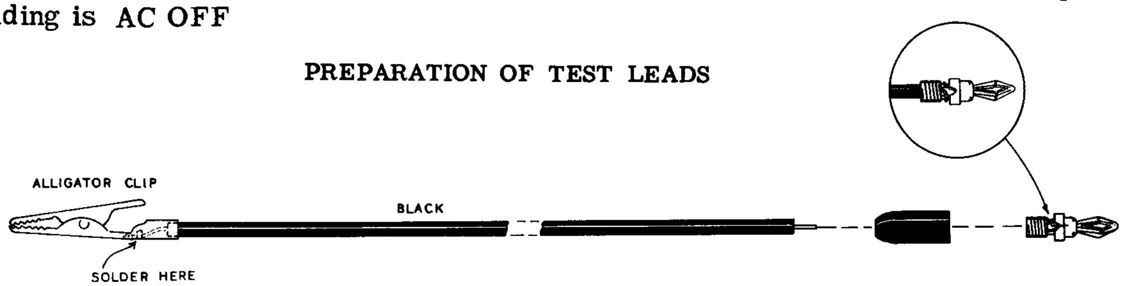


PICTORIAL 5

( ) Connect a 22K resistor between 2 (S) and 12 (NS).
( ) Connect an 8 inch length of wire to 1 (S) on front wafer.
( ) Connect a 5 inch length of wire through 8 (S) and to 7 (S) on front wafer.
( ) Connect the .02 precision condenser unit (two matched .01 condensers connected in parallel) to 9 (S) on front wafer.
( ) Connect 200 mmfd precision mica condenser to 10 (S) on front wafer.
( ) Connect the 200K precision resistor to 11 (S) on front wafer.
( ) Connect the 2K precision resistor to 12 (S) on front wafer.
( ) Connect a 10 inch length of wire to 1 (S) on rear wafer.
( ) Connect a 4 inch length of wire to 7 (S) on rear wafer.
( ) Connect a 2½ inch length of wire to 10 (S) on rear wafer.
( ) Connect a 5 inch length of wire to 11 (NS) on rear wafer.
( ) Connect a 90K precision resistor to 11 (S) on rear wafer.
( ) Connect an 8 inch length of wire to 12 (S) on rear wafer.
( ) Mount entire switch assembly on panel using control lockwasher between switch and panel. Use flat nickel washer under control nut. Dress wires and parts as shown in Pictorial 3.
( ) Connect wire from front wafer 1 to D4 (S).
( ) Connect wire from front wafer 8 and 7 to K (S).
( ) Connect .02 precision condenser to L2 (NS).
( ) Connect 200 mmfd mica condenser to L2 (NS).
( ) Connect the 2½" wire from rear wafer 10 to L-2 (NS).
( ) Connect 90K precision resistor from rear wafer to L2 (S).
( ) Connect 200K precision resistor to L1 (NS).
( ) Connect 2K precision resistor to L1 (S).
( ) Connect wire from rear wafer 1 to C6 (S).
( ) Connect wire from rear wafer 7 to B2 (S).

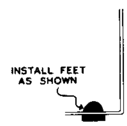
( ) Connect green-yellow transformer lead to rear wafer 9 (S).
( ) Connect green transformer lead to B3 (S).
( ) Connect wire from rear wafer 11 to B1 (S).
( ) Connect wire from rear wafer 12 to F1 (S).
( ) Twist together two 9 inch lengths of wire. Connect one wire to a-c switch terminal on rear of selector switch (S). See Pictorial 3 and 5.
( ) Connect the remaining wire to the other a-c switch terminal (S).
( ) Dress the twisted pair of wires through chassis grommet and connect one wire to H3 (S). Connect the other wire to H2 (NS).
( ) Dress the line cord through rubber grommet at rear of chassis and knot about three inches from free end to provide strain relief.
( ) Connect one line cord wire to H1 (S).
( ) Connect the other line cord wire to H2 (S).
( ) Install a red banana plug on one end of a red test lead. Solder an alligator clip to the remaining end.
( ) Connect a black banana plug to one end of a black test lead. Solder an alligator clip to the remaining end.
( ) Install 1626 tube in socket F.
( ) Install pointer knob on power factor control. With control in maximum counter-clockwise position, the pointer should read PAPER AND MICA
( ) Install a pointer knob on the test switch so that it indicates NORMAL
( ) Install pointer knob on selector switch so that at maximum counter-clockwise position the reading is AC OFF

PREPARATION OF TEST LEADS



CABINET PREPARATION

Install the four rubber feet in the openings provided in the bottom of cabinet. The rounded portion of the foot should be inserted in cabinet opening and carefully worked in with a small screwdriver. The flat portion is the actual resting or contact surface. Install the handle on top of cabinet using two handle screws furnished. No lockwashers are needed for this installation.



CALIBRATION

Plug the a-c line cord into a 117 volt a-c supply source. Turn the instrument on and allow a few minutes warm up time. Set the selector switch to the Rx100 position. Connect the red test lead to the center panel terminal and the black test lead to the left panel terminal. Clip the 200K precision calibrating resistor supplied with the kit to the test lead alligator clips. Fasten the pointer indicator knob to the main control shaft using just enough tension on the knob setscrew to hold the knob on the shaft. Because the dial calibrating point of 2000 is found near the top panel edge thereby placing the pointer indicator knob in a vertical position, it is possible that the center panel binding post may interfere with proper adjustment of the knob setscrew. The correct setting of the indicator knob would be at 2000 when the electron beam indicator is at null or in balance with the calibrating resistor. A preliminary check will determine whether the indicator knob is to be moved to the left or right on the control shaft and this can easily be accomplished by forcing the knob slightly against either the left or right rotation stop of the main control and permitting a slight amount of slippage between the knob and control shaft to take place. By repeating the null checking and knob slipping procedure, it will be possible to arrive at the desired calibration point and then, of course, the setscrew should be firmly tightened. After tightening, recheck to determine whether or not any slippage has taken place during the tightening process.

INITIAL TEST

Turn the instrument on and set the selector switch to the lowest capacity range. Remove test leads from panel terminals and rotate the main control to the left or counter-clockwise position. Near the end of control rotation, a null indication will be obtained. A null indication represents the widest possible opening of the eye or maximum shadow angle and indicates that the circuit is in balance. The panel reading at this null indication is usually a small value in the order of 5 to 30 mmfd. This value represents the inherent minimum capacity of the instrument. Factors involved in the inherent minimum capacity are the general construction technique, wiring dress, parts placement and distributed capacity in the transformer windings.

Because of variation in individual construction technique, there is a definite possibility that the inherent minimum capacity can be further reduced through the following experiments. Experiment with the circuit connection of the .05 AC line bypass condenser by changing the connection from H3 to H1 and leaving it in whichever position permits the lowest possible inherent minimum capacity. In some instances, the inherent minimum capacity can be further reduced by reversing the red and red-yellow transformer leads. In these experiments, the reduction or change in inherent minimum capacity should be observed on the electron ray beam indicator When making critical and accurate capacity measurements on the lowest range, consideration should be given the inherent minimum capacity and this value should be subtracted from the indicated value. Of course, on higher capacity readings, the effect of the inherent minimum capacity is minimized and need not be considered.

The completed instrument can now be installed in the cabinet by dressing the a-c line cord through the rear cabinet opening and fitting the chassis and panel to the cabinet. When properly aligned, the panel will fit smoothly and evenly on the cabinet flange. Insert the two No. 6 sheet metal screws in the rear of the cabinet and engage the corresponding holes in the rear of the chassis. While tightening these screws make sure that the panel is still properly fitted to the cabinet flange to prevent possible bending of the panel in event an obstruction is encountered.

OPERATION OF THE HEATHKIT C-3 CONDENSER CHECKER

The operation of this instrument is basically simple and through continued use the serviceman will perform the various test functions automatically. In all test procedures, the center binding post is considered positive and is common to all tests. The black test lead should be connected to the right binding post for capacity measurements and transferred to the left binding post for resistance measurements. For service convenience, liberal length test leads are supplied. For making accurate measurements of small capacities or low value resistors, the test leads should be removed entirely and the component under test connected directly to the instrument binding posts.

Resistance measurements are read directly on the outer calibrated scale when the selector switch is set at the R position. With the switch set at Rx100, it is merely necessary to add two zeros to the resistance measurement obtained. Resistance measurements are made by connecting the left and center binding posts or test leads to the component under test and rotating the main control for a balance or null indication. The total range of resistance measurements is from 100 ohms to 5 megohms.

To measure capacity, it is merely necessary to transfer the black test lead to the capacity binding post terminal. You will note that the dial is calibrated in three capacity ranges plus an extended range for checking extremely high capacity values. The ranges are in logical sequence working from the inner edge of the calibrated scale toward the outer or resistance scale as the selector switch is progressively advanced through succeeding ranges. The calibration for the extended capacity range will be found on the extreme inner portion of the dial calibration. This calibration was deliberately placed in this manner to minimize confusion on the three capacity ranges most commonly used.

For applications requiring the testing of paper or mica condensers, the power factor control should be rotated to its maximum counterclockwise position until a click of the switch is heard and the pointer knob is at the paper-mica position. The test leads should be connected to the center and right or capacity binding post. The test lead alligator clips should be clipped to the condenser under test and with proper setting of the capacity range switch, it will be possible to obtain a null indication by rotating the indicator knob. The capacity can then be read directly on the calibrated scale. If the condenser being measured is connected in a circuit, it will be necessary to disconnect at least one side of the condenser from the circuit so that associated wiring will not adversely affect the information supplied by the condenser checker. To measure extremely small capacity values, it would be desirable to remove the condenser from the circuit entirely and connect it directly to the instrument binding posts, removing the test leads entirely. The value of the inherent minimum capacity for your particular instrument should be subtracted from the reading obtained.

After the capacity value has been determined, a leakage test for quality can be quickly made. Set the selector switch to one of the five polarizing voltages available. The working or rated voltage of a condenser is usually printed on the condenser itself. Rotate the leakage switch to the leakage position and observe action of the electron beam indicator tube. A sudden closing and then return to normal shadow angle would indicate a satisfactory condenser. A partially closed eye or a fluttering condition would indicate a leaky condenser. If the eye closes entirely or overlaps, the condenser is shorted. The spring return test switch will automatically discharge the condenser under test so as to completely eliminate d-c shock hazard to the serviceman.

Electrolytic condensers frequently have a certain amount of internal resistance in series with the capacity. To balance the bridge circuit, it is necessary to balance such resistance with resistance in series with the standard condenser (power factor control). As electrolytic condensers are found only in the higher capacity values, the control only functions on the high and extended ranges.

When checking the capacity or quality of electrolytic condensers, it is essential that polarity be observed. The positive terminal of the condenser should be connected to the red test lead or center binding post and the negative condenser terminal to the black test lead or outer condenser binding post.

The power factor is a measure of the energy loss in an imperfect condenser. In filter applications, a higher power factor decreases the effective capacity so that the effective capacity at 20% power factor is 98% of the measured capacity. At 30% power factor, the effective capacity is decreased to 95%. While at 50% power factor, the effective capacity is decreased to 87% of the measured capacity.

When measuring the capacity of electrolytic condensers, the main control as well as the power factor control should both be adjusted for null indication. When both controls are set to the point of balance or null, the capacity reading can be made directly on the calibrated scale and the power factor reading can be taken from the power factor control which is calibrated percentagewise.

The tolerance of many types of condensers is quite wide. While small ceramic and mica condensers used in tuned circuits sometimes have a tolerance of plus or minus 2%, condensers for blocking or bypass applications seldom are rated closer than plus or minus 20%. Frequently tolerances of minus 50% to plus 100% are encountered for bypass and filter condensers. Many of the ceramic bypass condensers are specified with a guaranteed minimum capacity.

A significant point of condenser checker operation which would be well worth remembering is that a condenser which will not balance on any of the ranges but allows the eye to open on the low end of the low range is an open condenser. A condenser which allows the eye to open on the high end of the high ranges is a shorted condenser.

CIRCUIT DESCRIPTION

The circuit of the Heathkit Model C-3 Condenser Checker is fundamentally an a-c powered bridge circuit formed for both resistive and capacitive measurements. The main control varies the resistance in two arms and third arm (in resistive measurements) consists of either of two resistors one of which is one hundred times larger than the other. Thus the coverage of resistance range measurements is obtained. The fourth arm is the unknown resistance.

For capacitive measurements, the main control varies the resistance in two arms, the third arm consists of any one of three known condensers and the fourth arm is the unknown condenser. The high capacity end of the dial is extended by means of an added resistance placed on one side of the main control resistance.

Electrolytic condensers frequently have a certain amount of internal resistance in series with the capacity. To balance the bridge, it is necessary to balance such resistance with resistance in series with the standard condenser (power factor control). As electrolytic condensers are only found in the higher capacity values, the control only functions on the high and extended ranges.

The leakage test places the correct test voltage on the condenser and leakage is indicated by the degree of angle closing in the electron beam indicator tube.

The a-c power to the bridge is supplied by a winding on the secondary of the power transformer. Indication of balance or null is by means of a magic eye or electron beam indicator tube. At balance, the eye is open to its maximum point.

For safety of operation, the entire instrument is transformer operated and d-c operating voltages are obtained from a half wave rectifier circuit. The spring return panel leakage switch completely eliminates shock hazard to the operator.

IN CASE OF DIFFICULTY

1. Carefully recheck the instrument wiring. The most frequent cause of difficulty can be traced to wiring errors or reversed connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.
2. Check all operating voltages both a-c and d-c. The readings listed below were made with a Heathkit VTVM. It would be reasonable to expect some deviation from these values and factors involved would be the type of measuring instrument used, the tolerance of components and variations in a-c line voltage.

TRANSFORMER A-C VOLTAGES	
Yellow-to-yellow	12 volts
Green-to-green-yellow	55 volts
Red-to-red-yellow	500 volts

D-C OPERATING VOLTAGES	
From chassis to pin 8 of 1626 tube	+150 volts
From chassis to pin 1 of 1626 tube	-410 volts
From chassis to pin 3 of 1629 tube	+80 volts

3. Carefully recheck the wiring of the selector switch. Check the panel binding posts for possible shorting through incorrectly mounted shoulder and fiber washers.

4. If you are unable to locate the difficulty in your instrument, may we suggest that you write to the Heath Company and furnish all possible information which may assist us in diagnosing the difficulty being experienced. Clearly identify the kit involved by name and model number, giving the purchase date and, if possible, the invoice number; describe in detail the difficulty that you have encountered, state what you have attempted to do to correct the trouble, what results have been achieved, and include any information or clues that you feel could possibly be of value to the consultant who handles your problem. A chart of operating voltages would be very helpful.

REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.

B. Identify the type and model number of kit in which it is used.

C. Mention the order number and date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SERVICE

In event continued operational difficulties of the completed instrument are experienced, the Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance from your instrument. The facilities of our Service Department are at your disposal and your instrument may be returned for inspection and repair for a service charge of $4.00, plus the price of any additional parts or material that may be required. It is necessary that you provide full and complete information concerning your problem when returning your instrument for Factory Repair Service.

Local Service by Authorized Heathkit Dealers is also available and often will be your fastest, most efficient method of obtaining service for your Heathkits. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you would pay if you elected to return your kit to the Heath Company.

Heathkit dealers will honor the regular 90 day Heathkit Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company. It will be necessary that you verify the purchase date of your kit by presenting your copy of the Heath Company invoice to the authorized dealer involved.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if your local dealer assists you in locating a defective part (or parts) in your Heathkit, or installs a replacement part for you, he may charge you for this service.

Heathkits purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized Heathkit dealer in order to be eligible for parts replacement under the terms of the Warranty.

THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding modifications of Heathkits for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic outlet stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder, according to information which will be much more readily available from some local source.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A TAG TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

SPECIFICATIONS

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

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

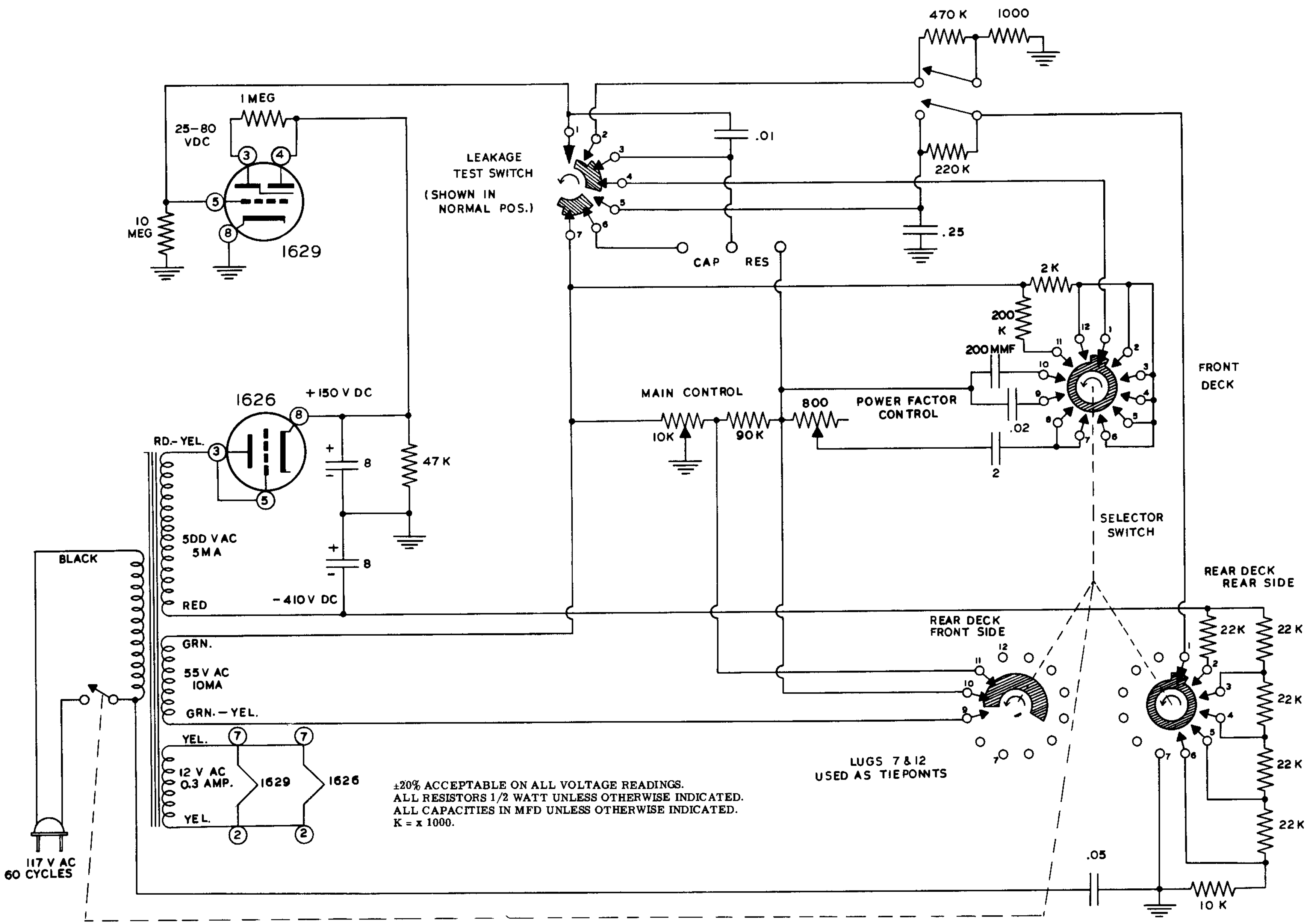
NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

C3 PARTS LIST

Part No.	Parts Per Kit	Description
Resistors		
1-9	1	1000 ohms
1-20	1	10K ohms
1-22	5	22K ohms
1-29	1	220K ohms
1-33	1	470K ohms
1-35	1	1 megohm
1-40	1	10 megohm
1-7A	1	47K ohm 1 watt
2-41	1	90K ohm precision
2-54	2	200K ohm precision
2-16A	1	2K ohm precision
Condensers		
20-2	1	200 MMF precision
23-3	1	.01 MFD
23-19	1	.02 MFD precision
23-10	1	.05 MFD
23-24	1	.25 MFD
23-16	1	2 MFD precision
25-2	2	8 MFD-475V. electrolytic
Controls—Switches		
11-6	1	10K ohm W.W. control
19-13	1	800 ohm W.W. control w. DPST sw.
63-45	1	2 pos. spring return switch
63-46	1	12 pos. switch
Transformer-Tubes		
54-7	1	power transformer
411-29	1	1626 tube
411-30	1	1629 tube
Sheet metal parts		
90-14	1	Cabinet
200-M35	1	Chassis
203-39F7	1	Panel
204-M34	1	Bracket
211-4	1	Handle

Part No.	Parts Per Kit	Description
Knobs-Sockets		
100-M65	1	Indicator Knob
434-2	1	Octal saddle socket
434-4	1	Octal ring socket
462-19	3	Pointer knobs
Grommets-Feet-Terminal Strips		
73-1	5	3/8 grommets
261-1	4	rubber feet
431-1	1	1-lug terminal strip
431-2	1	2-lug terminal strip
431-3	1	3-lug terminal strip
431-5	1	4-lug terminal strip
Clips-Binding Posts-Plugs		
260-1	2	alligator clips
100-M16B	3	binding post caps
427-2	3	binding post bases
438-13	2	Banana plug assembly less insulator
70-5	1	Banana plug insulator, black
70-6	1	Bana plug insulator, red
Wire		
89-1	1	line cord
340-2	1	#20 bare wire
341-1	1	length black test wire
341-2	1	length red test wire
344-1	1	length hookup wire
Hardware		
208-2	2	mounting clip
250-8	2	#6 sheet metal screws
250-9	11	6-32 screws
250-83	2	#10 handle screws
252-3	14	6-32 nuts
252-7	4	control nuts
253-1	3	#6 fibre flat washers
253-2	3	#6 fibre shoulder washers
253-10	4	control nickel washers
254-1	7	#6 lockwashers
254-4	4	control lockwasher
259-1	7	#6 solder lugs
595-44	1	Instruction manual



±20% ACCEPTABLE ON ALL VOLTAGE READINGS.
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE INDICATED.
ALL CAPACITIES IN MFD UNLESS OTHERWISE INDICATED.
K = x 1000.

HEATHKIT CONDENSER CHECKER
Model C-3

HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of rosin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

WIRING

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

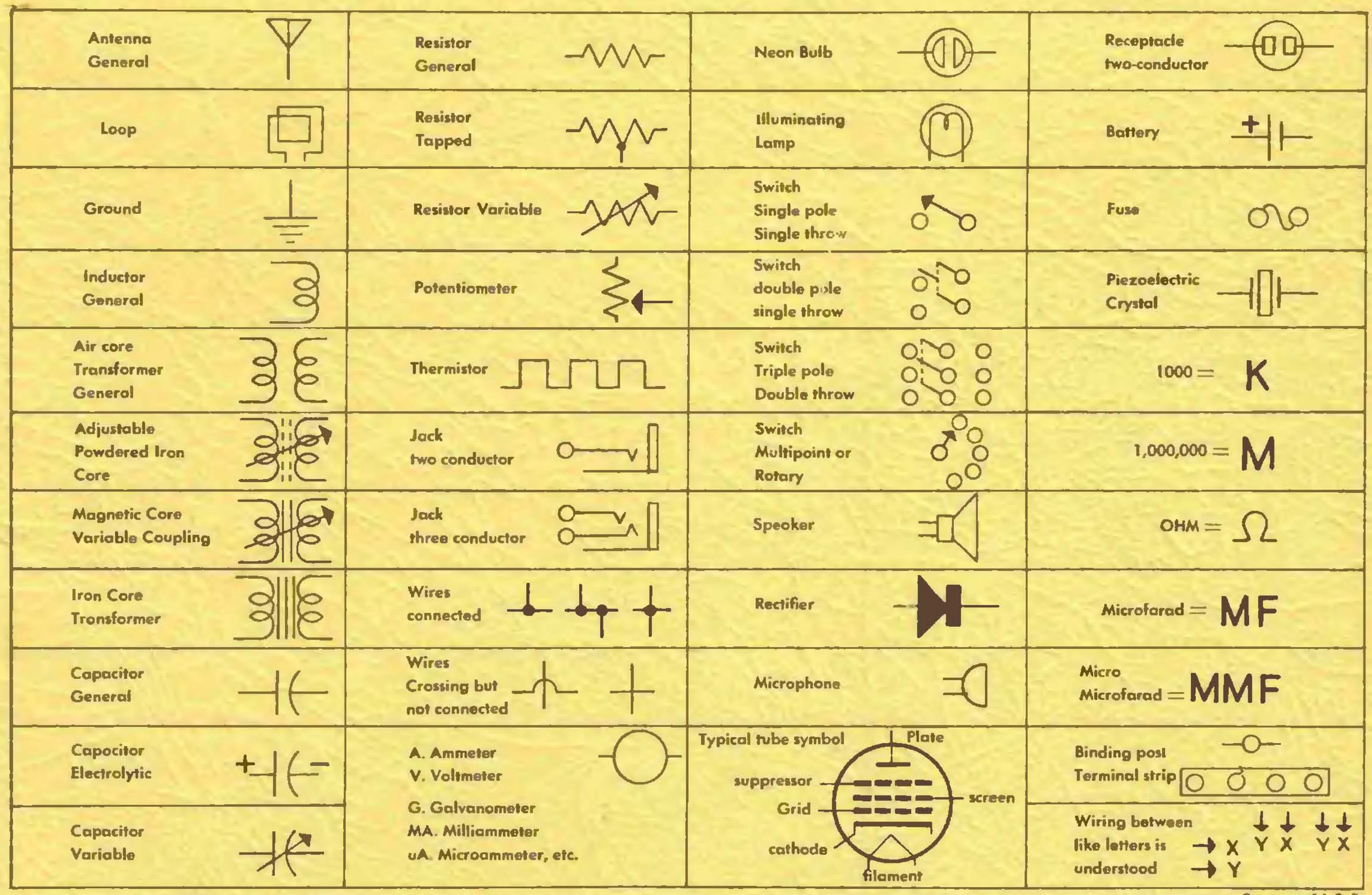
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.

In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and tube sockets. This is particularly important in instruments such as the VTVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality rosin core radio type solder.



Courtesy of I. R. E.

HEATH COMPANY

A Subsidiary of Daystrom Inc.

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

BENTON HARBOR, MICHIGAN

10/6/58

Litho in U. S. A.

Notes on the Heathkit C-3
by
Kenneth G. Gordon W7EKB

1) For the leakage tests, the voltages at the various switch-positions (labeled 25, 150, 250, 350, 450 VDC.) are not very exact, even if the resistors are still within tolerance. The current through the voltage-divider string SHOULD be about 4.5 mA. (.004545 A). If that is so, and if all the resistors are within tolerance, then the calculated voltages will be about 45, 145, 245, 345, and 445 VDC. However, those resistors were always *WAY* out of tolerance, sometimes by several hundred percent in those units I checked. Obviously, the position labeled “25” volts, should have been labeled “50” volts instead.

2) The 47 K resistor shown on the schematic, which is actually across the 1629 eye-tube, was found to be over 110 K in the units I have checked. This resistor sets a) the voltage across the 1629, and b) the total current in the string. At 4.5 mA, there should be about 210 VDC across the 1629 at “idle”. Before I started the restoration, one of my units had 330 VDC on the eye tube! This resistor dissipates about 1 watt, so a 2 watt resistor should be OK here.

3) The filter capacitor closest to the diode only has the voltage across the 1629 on it, which varies, when you are testing leakage, from a low of about 100 volts, to a high of about 430 volts (momentarily), so a capacitor with a working-voltage of 475 VDC, or higher, is not needed here. The other filter capacitor, however, has whatever voltage is left after the 1629’s requirements are met. The 1629 will operate properly with voltages as low as 100 VDC. (Don’t go over 250 VDC though. Doing so for very long will severely shorten the life of the eye tube.)

4) Calculating the true resistor values that would give the “correct” voltages for the leakage test resulted in: 11 K, 22K, 22K, 22K, and 22K. I adjusted the true value of the “47 K” resistor at the “top” of the voltage-divider so that the actual current drawn by the string was 4.5 mA, and the voltages were accurate or slightly high at no load. If you want the leakage test voltages to be reasonably accurate, make sure that the current through the voltage-divider string is 4.5 mA., and your resistors are close to what I have listed.

5) The last 22 K resistor between the voltage-divider string and the 450 VDC switch position connection is only a current limiter, so its true resistance value is not too important.

6) Replace all the capacitors, except the filters and the micas, with metalized film capacitors. The increase in accuracy and repeatability of the instrument will be amazing! The micas were usually OK, but you may want to test yours anyway, and replace those that are out of tolerance.

7) All resistors in the voltage divider string should be replaced with 2-watt wire-wound units from Mouser of the values calculated above. The power dropped by each 22 K resistor in the voltage-divider string will be around 0.45 watt at no load if the current is “set” to 4.5 mA., but can rise much higher when you are testing bad capacitors for leakage. This is undoubtedly why the ½ watt 22 K ohm resistors were “cooked” in my units. If the unit is left on, those resistors are dissipating nearly ½

watt continuously, which isn't good either.

8) Make sure the two resistors associated with the 1629 are within tolerance. If either one is much lower in resistance than specified, the eye will not open fully, or could overlap when closed. You may have to experiment with the value of the resistor between pins 3 and 4 in order to get the eye to just close when nothing is being measured. My unit required a resistor of around 6 megohms rather than the 1 megohm shown. The "+60 volts" specified on the schematic at pin 3 varies wildly, depending on where the "Main Control" is set during measurements, so it is not to be taken literally.

9) As mentioned above, the maximum voltage that the 1629 should be subjected to is 250 VDC, and less is better. Cathode current should not be more than about 4 mA. That will be OK, as long as the grid resistor is close to 1 megohm or larger and the plate voltage is below 250 VDC.

10) I replaced the line cord on my units with a three-wire grounded type, and added a chassis mounted fuse holder. The repeatability of the instruments was greatly improved, since that, according to the manual, can depend a lot on which way the plug is inserted in the wall socket. With a three-prong plug, it always goes in the same way. The fuse, a 1 amp fast-blow is adequate, saves the power transformer if the diode or filter caps short out.

11) I shunted each power-supply filter cap with a 100 K ohm, 2-watt resistor. This leveled out the power supply variations very noticeably, and made the leakage and other tests much more stable. This should make the filter caps last a lot longer too.

12)If you have to replace your power transformer as I did, you will have to add a resistor between the 47 K resistor and the rectifier to absorb any voltage above that for which the circuit was designed, unless your transformer puts out 460 to 500 VAC. Measure the voltage at the top and bottom of the filter capacitor string, subtract 660 VDC from that, and find a 2 watt resistor of the proper value, i.e. (R = (E – 660)/.0045). Move the ungrounded end of the 47 K 2 watt resistor and the 1629 plate lead from pin 8 of the 1626 socket to an unused pin on that socket. Then connect your new resistor between pin 8 and the junction of the 47 K resistor and the 1629 plate lead. You can also adjust the value of this new resistor to set your leakage test voltages to their exactly correct values if desired.

13) IMPORTANT: If you are testing high value capacitors, i.e. 470 µfd @ 450 VDC for instance, you MUST park the "Main Control" pointer at the far left stop (counter-clockwise) when doing leakage testing. When the "Leakage" knob is released after testing, the capacitor under test is connected to one end of the "Main Control". If the knob is over to the RIGHT, that point is connected to ground, and when you release the knob, the full charge of the capacitor is dumped to ground through one end of the "Main Control" resistance. This can burn out the "Main Control" by essentially blowing one end of it off. If this occurs, the "Main Control" pot must be replaced.