Assembling and Using Your...

Heathkit DAYSTROM

VALVE MILLIVOLTMETER

MODEL AV-3U

DAYSTROM LIMITED

A Subsidiary of the Daystrom Group, Manufacturers of the world's finest Electronic Equipment in Kit Form.

GLOUCESTER, ENGLAND

COLOUR CODE FOR FIXED RESISTORS - (B.S.1852-1952)
COLOUR BAND MARKING

FIG I. (COLOURED BAND MARKING PREFERRED)

THIS EXAMPLE SHOWS A GRADE I. RESISTANCE OF 6,800 Ω ± 5%

BLUE (6)
GREY (8)
RED (X10²)
GOLD (± 5%)
SALMON PINK (GRADE I.)
THIS MAY BE GENERAL BODY COLOUR

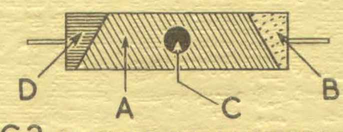


FIG 2. BODY, TIP & SPOT MARKING

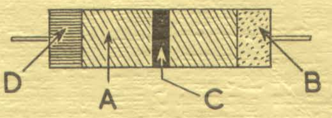
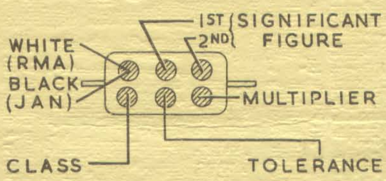


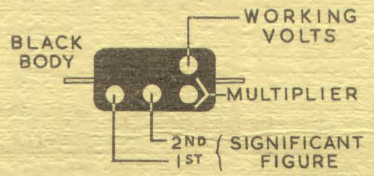
FIG 3. BODY TIP & CENTRAL BAND MARKING

AMERICAN "RMA", "JAN" & COMMERCIAL CODING FOR MOULDED MICA CAPACITORS

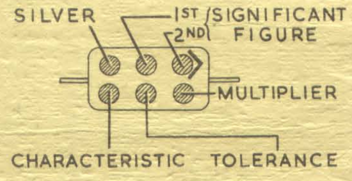
CURRENT STANDARD CODE



MOULDED FLAT CAPACITOR COMMERCIAL CODE



JAN. CODE CAPACITOR



COLOUR CODE FOR RESISTORS AND CAPACITORS

Colour	Value in Ohms or pF for Cols. A, B & C. COL. A. 1st Figure	COL. B. 2nd Figure	COL. C. (MULTIPLIER) Resistors ohms	Capacitors pF	COL. D. (TOLERANCE RATING) Resistors	Ceramic Capacitors Up to 10 pF	Over 10 pF	CAPACITORS COL. E. TEMP. COEFFICIENT per 10^6 per °C.
BLACK	-	0	1	1	-	2 pF	± 20%	0
BROWN	1	1	10	10	± 1%	0.1 pF	± 1%	-30
RED	2	2	100	100	± 2%	-	± 2%	-80
ORANGE	3	3	1,000	1,000		-	± 2.5%	-150
YELLOW	4	4	10,000	10,000		-	-	-220
GREEN	5	5	100,000	-		0.5 pF	± 5%	-330
BLUE	6	6	1,000,000	-		-	-	-470
VIOLET	7	7	10,000,000	-		-	-	-750
GREY	8	8	100,000,000	.01		0.25 pF	-	+30
WHITE	9	9	1,000,000,000	.1		1 pF	± 10%	+100
SILVER			.01	-	± 10%	-	-	
GOLD			.1	-	± 5%	-	-	
SALMON PINK			-	-	-	-	-	
NO "D" COLOUR				-	-	-	-	

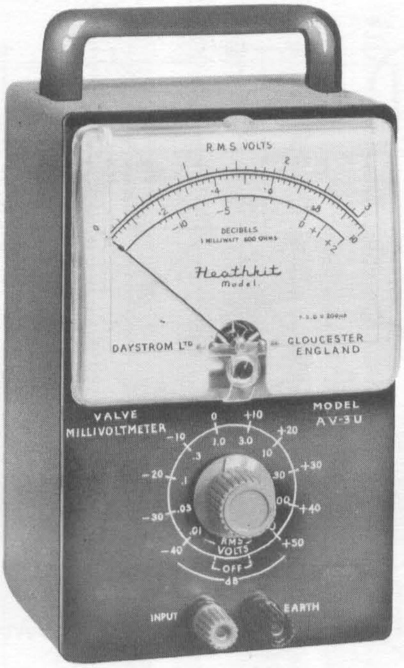
The Colour coding should be read from left to right, in order, starting from the end and finishing near the middle.

Standard ± tolerances for resistors are:- Wire-wound: 1%, 2%, 5%, 10%. Composition, Grade 1: 1%, 2%, 5%. Grade 2: 5%, 10%, 20%. (20% is indicated by 4th (or 'D') colour). Grade 1: ("high-stability") composition resistors are distinguished by a salmon-pink fifth ring or body colour. (Reference: B.S. 1852: 1952 B.S.I.).

N. B. High-Stability Resistors supplied with this kit are not as a rule colour coded but enamelled in one colour on which the value in Ohms is printed in figures. Capacitors supplied in this kit usually have their capacity clearly marked in figures. Some Capacitors coded as above also have additional "voltage rating" coding.

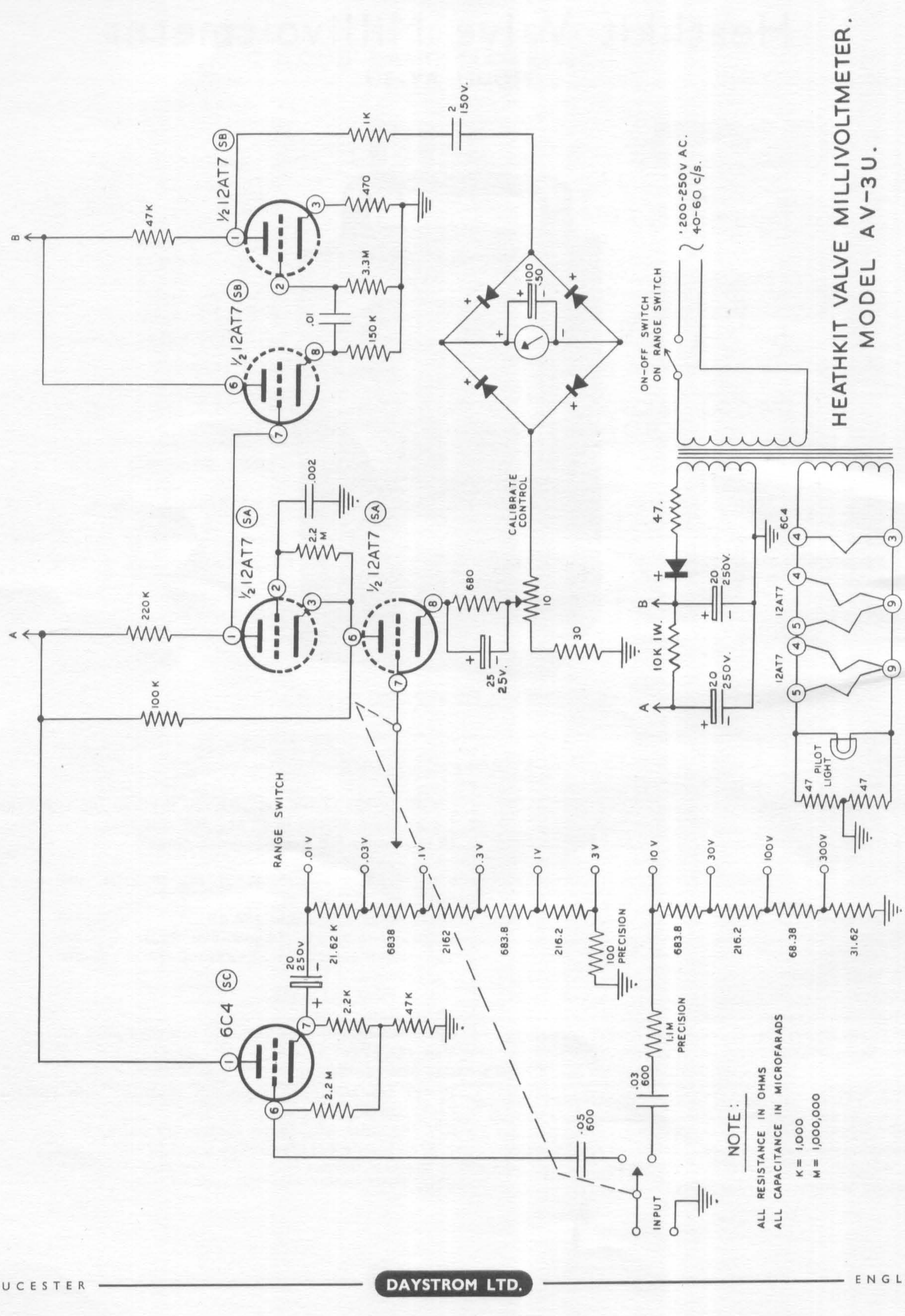
Heathkit Valve Millivoltmeter

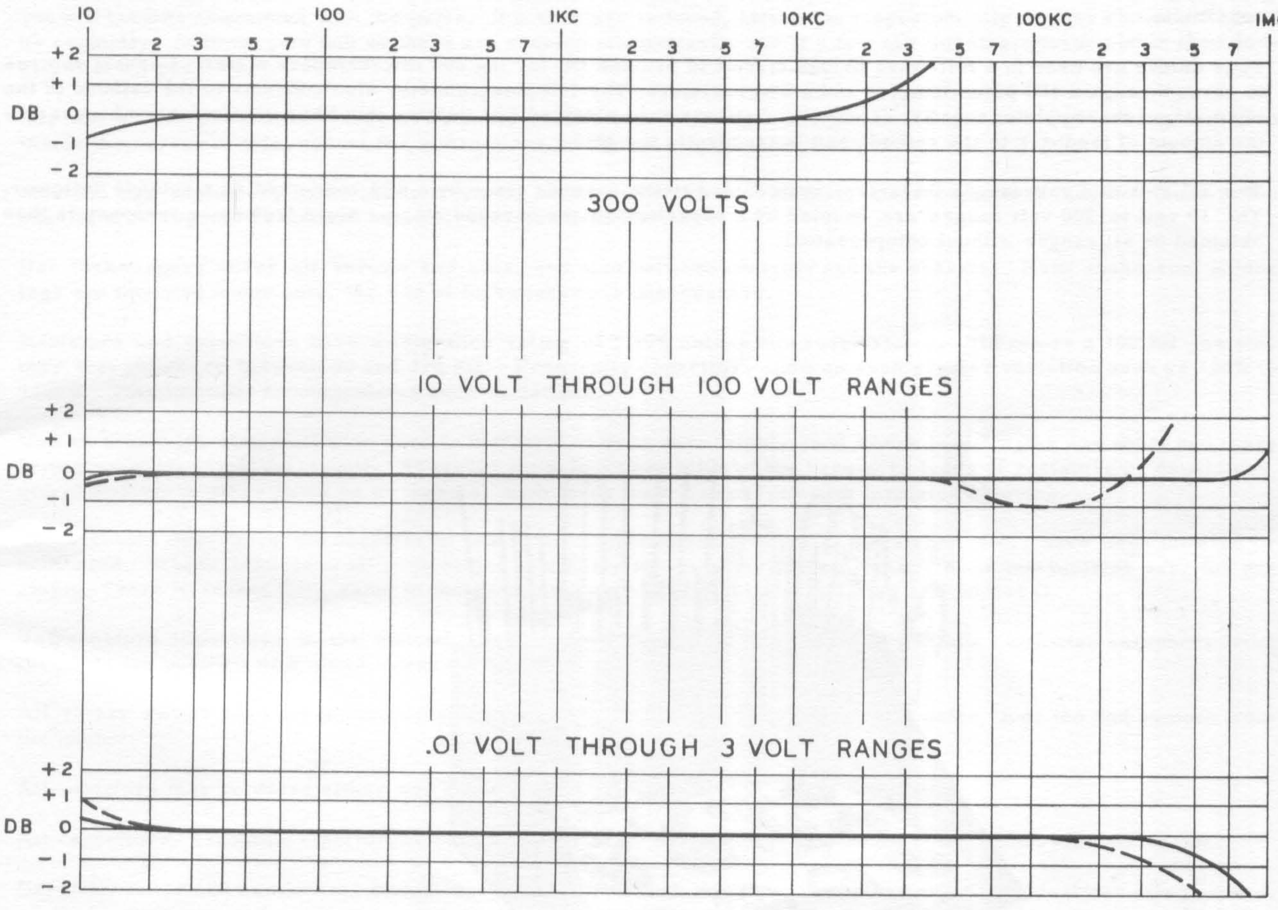
MODEL AV-3U



SPECIFICATIONS

Frequency Response:	± 1 dB 10 cps to 400 kc, .01 volt through 100 volt ranges. ± 2 dB from 10 cps to 40 kc, 300 volt range.
Sensitivity:	10 millivolts full scale (lowest range).
Range:	
Volts:	0.01, 0.03, 0.1, 0.3, 1, 3, 10, 30, 100, 300 volts RMS, full scale.
Decibels:	Total range - 52 dB to +52 dB. Scale -12 to +2 dB. (1 mW-600 ohm). Ten switch selected ranges from -40 to +50 dB.
Input Impedance:	1 megohm at 1 kc.
Accuracy:	Within 5% of full scale.
Multipliers:	1% precision type.
Meter:	$4\frac{1}{2}$" streamlined case with 200 microampere movement.
Valve Complement:	Two 12AT7 (or ECC81). One 6C4 (or EC90).
Power supply:	Power transformer, selenium rectifier with resistance-capacitance filter.
Power Requirements:	200-250 volts AC, 40-60 cycles, 10 watts.
Dimensions:	7.3/8" high x 4.11/16" wide x 4.1/8" deep.
Net Weight:	$3\frac{1}{2}$ lbs.
Shipping Weight:	5 lbs.


HEATHKIT VALVE MILLIVOLTMETER.
MODEL AV-3U.
6C4 (SC)
½ 12AT7 (SA)
½ 12AT7 (SB)
RANGE SWITCH
.01 V
.03V
.1V
.3V
1V
3V
10 V
30V
100V
300V
21.62 K
6838
2162
683.8
216.2
100 PRECISION
683.8
216.2
68.38
31.62
1.1M PRECISION
.03 600
.05 600
INPUT
20 250V
2.2K
47K
2.2 M
220K
100K
47K
2.2 M
.002
680
25 25V.
CALIBRATE CONTROL
10
30
.01
150 K
3.3M
470
1K
2 150V.
100 .50
ON-OFF SWITCH ON RANGE SWITCH
200-250V AC. 40-60 c/s.
47.
10K 1W.
20 250V.
20 250V.
12AT7
12AT7
6C4
PILOT LIGHT
47
47
NOTE:
ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN MICROFARADS
K = 1,000
M = 1,000,000



These curves represent measurements made on several AV-3U Millivoltmeters built by different persons. They represent the performance which may be expected. The best and poorest responses are shown for the ranges indicated. Frequency response should fall between these limits. Lead dress and component position will affect frequency response. The meters on which these measurements were made were calibrated at 1 kc on the 1 volt range.

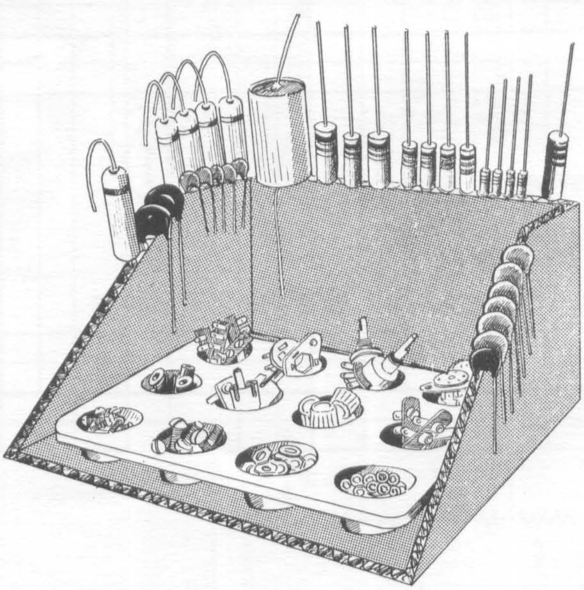
When comparing an instrument of this kind with another instrument, consider that the instruments may deviate in opposite directions. Thus, two instruments, both within 1 dB, may show a difference of 2 dB. Critical comparison should be made only against an accurate laboratory standard AC voltmeter.

CIRCUIT DESCRIPTION

The Heathkit Millivoltmeter, Model AV-3U is a stable meter designed to measure AC voltages over a wide range of frequencies. A 12AT7 is connected in a cascode type circuit which provides very high gain with relatively low noise. The output of the cascode stage is coupled to the meter stage by a cathode follower. This increases the high frequency response of the amplifier as a whole as well as providing higher gain from the cascode stage, since it is not being loaded. This also adds to the stability of the circuit. The high gain makes possible a 10 millivolt full scale sensitivity.

Four diodes are used in a full-wave bridge circuit to provide DC for the 200 microampere meter. Current returns to earth through a 10Ω potentiometer and a 30Ω resistor. The 10Ω potentiometer also connects to the cathode of the input stage, thus applying negative feedback. Calibration is obtained by adjusting this 10Ω potentiometer which varies the amount of feedback to the cathode and consequently the gain.

The .01 volt to 3 volt ranges inclusive, are coupled to the cascode stage by a 6C4 connected as a cathode follower. The 10 volt to 300 volt ranges are coupled by a capacitor to the cascode stage. Good frequency response is thus obtained on all ranges without compensation.



This illustration shows how resistors and capacitors may be placed in the cut edge of a corrugated cardboard carton until they are needed. Their values can be written on the cardboard next to each component.

PRELIMINARY NOTES AND INSTRUCTIONS

The Step-by-Step instructions given in this manual should be followed implicitly to ensure a minimum of difficulty during construction and a completely satisfactory result, including many years of accurate, trouble-free service from the finished instrument.

UNPACK THE KIT CAREFULLY, EXAMINE EACH PART AND CHECK IT AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. If a shortage is found, attach the inspection slip to your claim and notify us promptly. Screws, nuts and washers are counted mechanically and if a few are missing, please obtain them locally if at all possible.

Lay out all the parts so that they are readily available in convenient categories. Refer to the general information inside the covers of this manual for instructions on how to identify components.

Moulded egg containers make handy trays for holding small parts. Resistors and capacitors may be placed in the edge of a corrugated cardboard box until they are needed.

Use lockwashers under all screws and nuts, and also between controls and the chassis. When shakeproof solder tags are mounted under nuts, the use of lockwashers is unnecessary.

Resistors and capacitors have a tolerance rating of $\pm$ 10% unless otherwise stated. Therefore a 100 KΩ resistor may test anywhere between 90 and 110 KΩ. Frequently capacitors show an even greater variation such as -50% to +100%. This Heathkit accommodates such variations.

Unless otherwise stated all wire used is insulated. Bare wire is only used where lead lengths are short and there is no possibility of a short circuit. Wherever there is a possibility of the bare wire leads of resistors or capacitors, etc., shorting to other parts or to chassis, such leads must be covered with insulated sleeving.

To facilitate describing the location of parts, all valveholders, controls, tag strips, etc., have been lettered or numbered. Where necessary all such coding is clearly shown in the illustrations. When instructions say, for example, "wire to socket G3", refer to the proper figure and connect a wire to tag 3 of socket G.

Valveholders illustrated in the manual are always shown with their tags numbered in a clockwise sequence, from the blank tag position or keyway, when viewed from underneath.

All rotary switch tags are numbered clockwise when viewed from the rear of the wafer, i.e. the end remote from the knob.

All resistors may be wired either way round.

All capacitors, excepting electrolytic capacitors, may be wired either way round unless otherwise stated.

Carefully letter and number tag strips, valveholders, transformers, etc. A wax pencil is ideal for this purpose.

When mounting resistors and capacitors make sure that the value can be read when in position.

Observe polarity on all electrolytic capacitors, i.e. RED = POSITIVE.

A circuit description is included in this manual so that those with some knowledge of electronics will be able to obtain a clearer picture of the actual functioning of this instrument. It is not expected that those with little experience will understand the description completely, but it should be of help in the event that they desire to become more familiar with the circuit operation and thus learn more from building the kit than just the placing of parts and the wiring.

Read this manual right through before starting actual construction. In this way, you will become familiar with the general step-by step procedure used. Study the pictorials and diagrams to get acquainted with the circuit layout and location of parts. When actually assembling and wiring, READ THROUGH THE WHOLE OF EACH STEP so that no point will be missed.

A tick (✓) should be made in the space provided at the beginning of each instruction immediately it has been completed. This is most important as it will avoid omissions or errors, especially whenever work is interrupted in the course of construction. Some Kit-builders have found it helpful in addition to mark each lead in the pictorial in coloured pencil as it is completed.

Successful instrument construction requires close observance of the step-by-step procedure outlined in this manual. For your convenience, some illustrations may appear in large size folded sheets. It is suggested that these sheets be fastened to the wall over your work area for reference purposes during instrument construction.

The Company reserves the right to make such circuit modification and/or component substitutions as may be found desirable, indication being by "Advice of Change" included in the kit.

NOTE: Daystrom Ltd. will not accept any responsibility or liability for any damage or personal injury sustained during the building, testing, or operation of this instrument.

> ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT ONLY "60/40" RESIN CORE RADIO SOLDER BE PURCHASED.

PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

Correct soldering technique is extremely important. Good soldered joints are essential if the performance engineered into the kit is to be fully realised. If you are a beginner with no experience in soldering, half an hour's practice with odd lengths of wire and a valveholder, etc., will be invaluable.

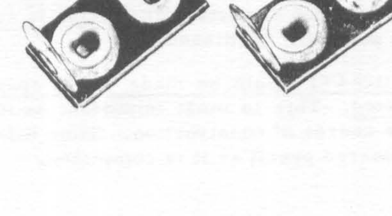
Highest quality resin-cored solder is essential for efficiently securing this kit's wiring and components. The resin core acts as a flux or cleaning agent during the soldering operation.

NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture. The resulting compounds are not only corrosive but actually destroy the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will cause erratic or degraded performance of the instrument.

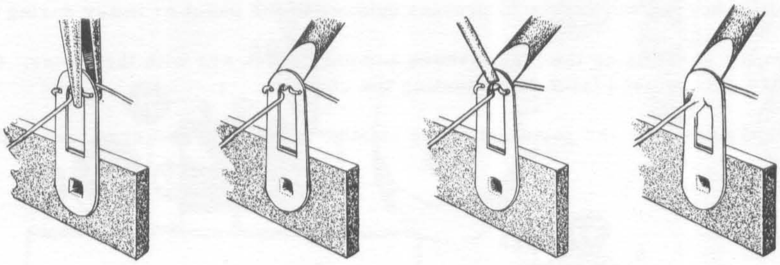
IMPORTANT

IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect one lead of a 47 KΩ resistor to tag 1 (S-2)", it will be understood that there should be two leads connected to the terminal at the time it is soldered. This additional check will help to avoid errors.

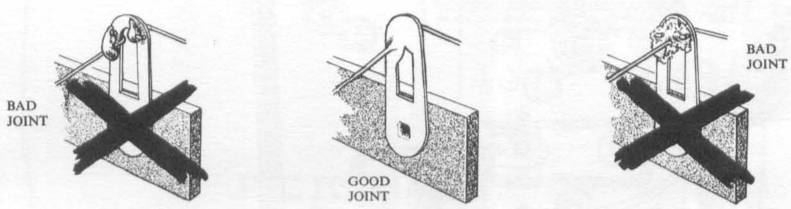
When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.



If the tags are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good mechanical joint is made without relying on solder for physical strength.



1. CRIMP WIRES 2. HEAT CONNECTION 3. APPLY SOLDER ALLOW SOLDER TO FLOW



COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED | PROPER SOLDERED CONNECTION | COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING

Typical good and bad soldered joints are shown above.

A poor soldered joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface caused by movement of the joint before it solidifies is another evidence of a "cold" connection and possible "dry" joint. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance.

To make a good soldered joint, the clean tip of the hot soldering iron should be placed against the joint to be soldered so that the flat tag is heated sufficiently to melt the solder. Resin core solder is then placed against both the tag and the tip of the iron and should immediately flow over the joint. See illustrations. Use only enough solder to cover the wires at the junction; it is not necessary to fill the entire hole in the tag with solder. Don't allow excess solder to flow into valveholder contacts, ruining the sockets, or to creep into switch sockets and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.

A clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 25 to 50 watt iron, or the equivalent in a soldering gun, is very satisfactory. Keep the iron hot and its tip and the connections to be soldered bright and clean. Always place the solder on the heated "work" and then place the bit on top of the solder until it flows readily and "wets" the joint being made. Don't take the solder on to the bit and then try to bring it to the work directly from the soldering iron. Whenever possible a joint should be secured mechanically by squeezing tight with pliers prior to soldering it. The hot soldering bit should frequently be scraped clean with a knife, steel wool or a file, or wiped clean quickly by means of a rag or steel wool.

Don't apply too much solder to the soldered joint. Don't apply the solder to the iron only, expecting that it will roll down onto the connection. Try to follow the instructions and illustrations as closely as possible.

Don't bend a lead more than once around a connecting point before soldering, so that if it should have to come off due to a mistake or for maintenance it will be much easier to remove.

Follow these instructions and use reasonable care during assembly of the kit. This will ensure the deserved satisfaction of having the instrument operate perfectly the first time it is switched on.

METER SUB-ASSEMBLY

( ) If there is an amendment sheet to this manual, ensure that you have made the alterations at the appropriate places.

( ) Place a soft cloth pad on your workspace to prevent damage to the panel or meter during this assembly.

( ) Mount the meter on the panel using the lockwashers and nuts which are with the meter. Do not tighten the nuts at M1 and M4. They will be used later for mounting the chassis.

( ) Mount the pilot light socket on the terminal board at MS. Solder the socket to terminals 1 and 2 as shown in Figure 4.

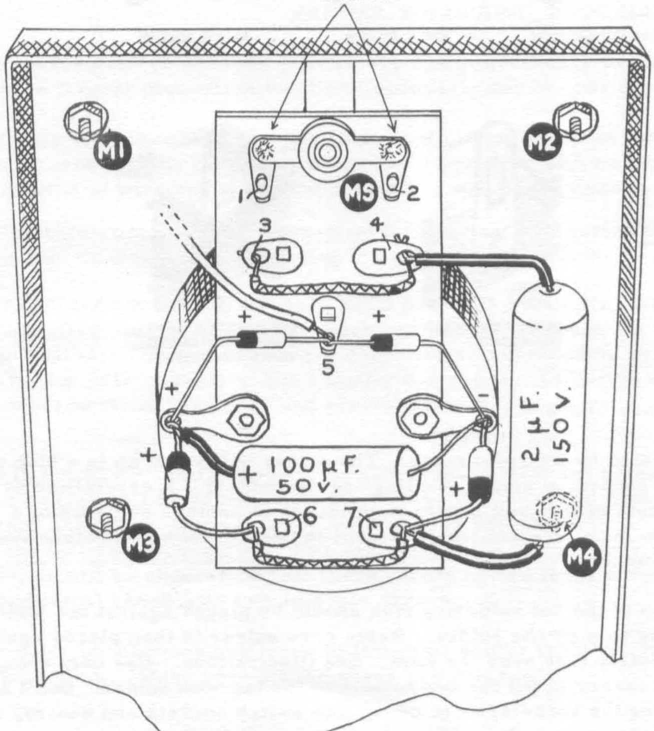


FIGURE-4.

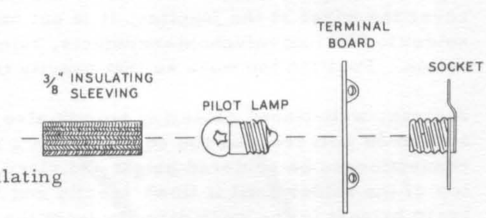


FIGURE-5.

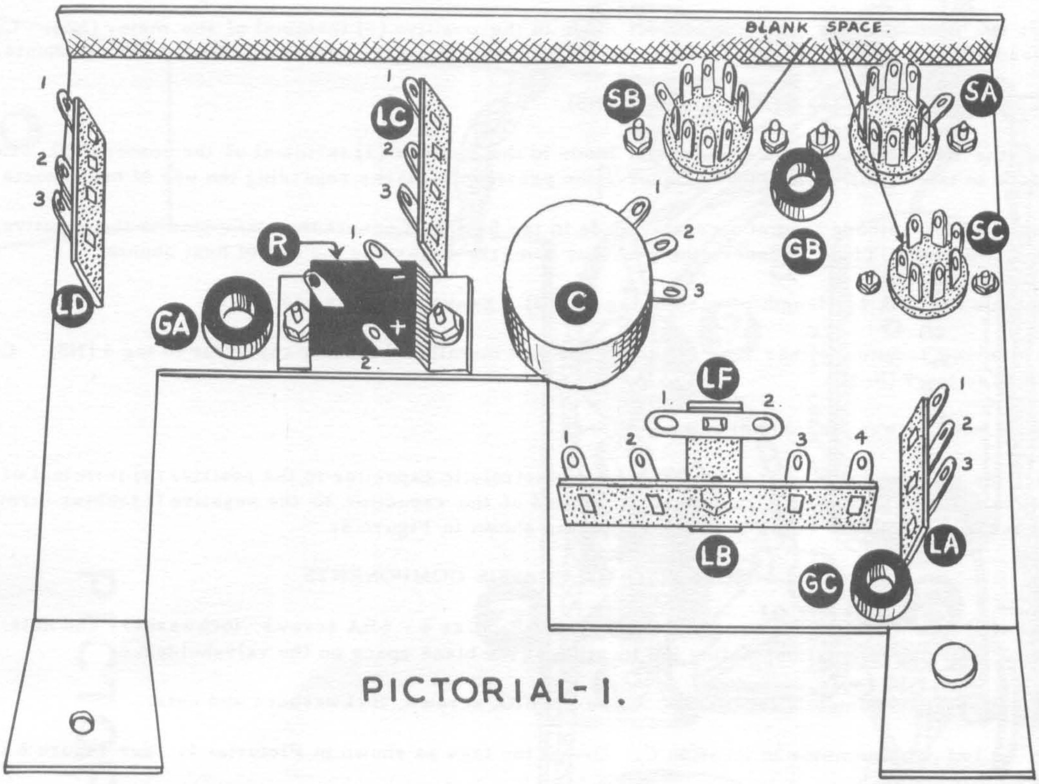
( ) Install the pilot lamp in its socket. Slip the 3/8" diameter insulating sleeving over the pilot lamp. See Figure 5.

( ) Remove one nut and the solder tag from each meter stud. NOTE: Hold the inner nut while loosening the outer nut to prevent strain being placed on the plastic meter housing.

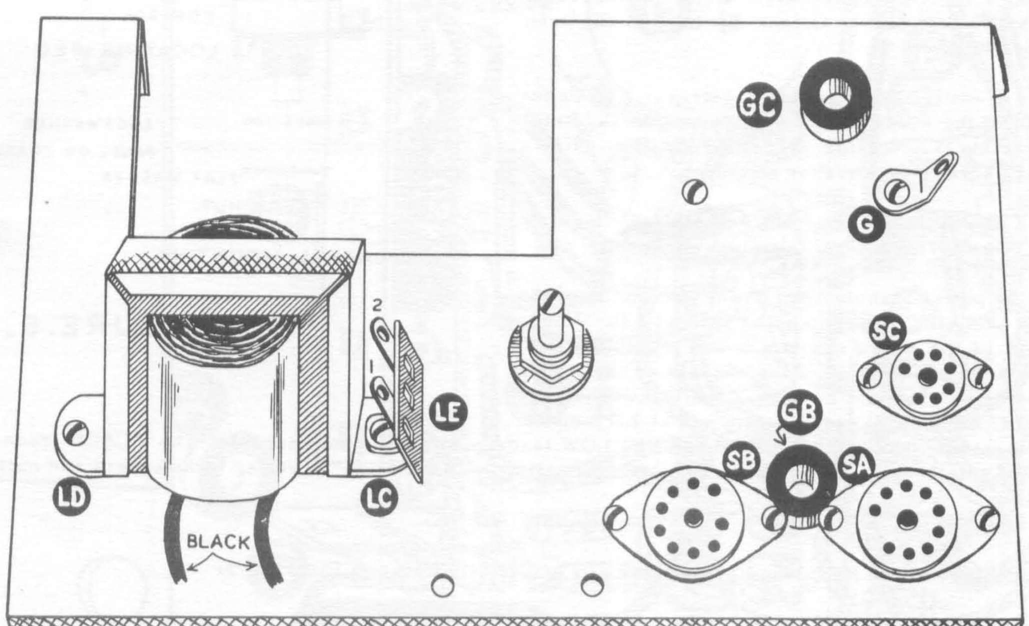
( ) Mount the tag board on the meter studs using the solder tags and nuts that came with the meter.

( ) Slip the sleeving on the pilot lamp against the panel. See Figure 5.

( ) Connect the RED cathode lead of a crystal diode to tag 7 (NS). Connect the other lead to the negative (-) meter tag (NS). CAUTION: When soldering, hold the diode leads with a pair of long nosed pliers or clips between the joint and the diode to act as a heat shunt. The application of excessive heat may ruin the diode elements.



PICTORIAL-1.



PICTORIAL-2.

(√) Connect the RED cathode lead of a crystal diode to the positive (+) terminal of the meter (NS). Connect the other lead to tag 6 (NS). CAUTION: Observe the previous remarks regarding the use of heat shunts.

(√) Connect a wire between tag 6 (S-2) and tag 7 (NS).

(√) Connect the RED cathode lead of a crystal diode to the positive (+) terminal of the meter (NS). Connect the other lead to tag 5 (NS). CAUTION: Observe the previous remarks regarding the use of heat shunts.

(√) Connect the RED cathode lead of a crystal diode to tag 5 (NS). Connect the other lead to the negative (-) meter terminal (NS). CAUTION: Observe the previous remarks regarding the use of heat shunts.

(√) Connect one end of a 4¾" length of wire to tag 5 (S-3). Leave the other end free.

(√) Using sleeving, connect either lead of a 2 μF 150 volt metallised tubular capacitor to tag 4 (NS). Connect the other lead to tag 7 (S-3).

(√) Connect a wire between tag 3 (NS) and tag 4 (S-2).

(√) Connect the positive (+) lead of a 100 μF 50 volt electrolytic capacitor to the positive (+) terminal of the meter (S-3) (use sleeving). Connect the negative (-) lead of the capacitor to the negative (-) meter terminal (S-3). The capacitor should lie below the meter studs as shown in Figure 4.

MOUNTING OF CHASSIS COMPONENTS

(√) Mount two 9-pin valveholders in locations SA and SB. Use 4 - 6BA screws, lockwashers and nuts. Refer to Pictorial 1 for pin orientation, noting the location of the blank space on the valveholder.

(√) Mount a 7-pin valveholder in location SC. Use 2 - 6BA screws, lockwashers and nuts.

(√) Mount the 10Ω potentiometer in location C. Orient the tags as shown in Pictorial 1. See Figure 6 for correct mounting procedure.

(√) Insert three 3/8" rubber grommets at GA, GB and GC.

(√) Mount the selenium rectifier at R. Use 2 - 6BA screws, lockwashers and nuts. Orient the tags as shown in Pictorial 1.

(√) Mount a 3-way (centre tag earth) tagstrip at LA. Under the head of the screw mount a solder tag at GA. Refer to Pictorials 1 and 2 for proper orientation. Use a 4BA x ¼" screw, lockwasher and nut.

(√) Mount a 4-way tagstrip at LB and a 1-way tagstrip at LF. Use a 4BA x ¼" screw, lockwasher and nut.

(√) Mount the power transformer on the other side of the chassis using the mounting holes LC and LD. Under the head of the screw mount a 2-way tagstrip at LE. This is on the same side of the chassis as the transformer. See Pictorial 2. Under the lockwasher and nut at LC mount a 3-way tagstrip and at LD mount a 3-way tagstrip. Note that the RED and YELLOW leads go through grommet GA. The BLACK leads remain on the same side of the chassis as the transformer. Use 2 - 4BA x 3/8" screws, lockwashers and nuts.

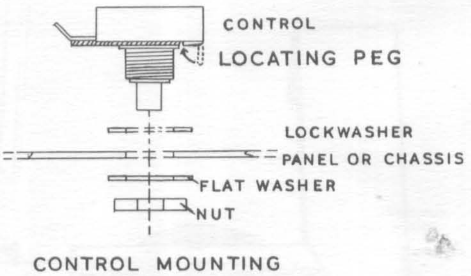


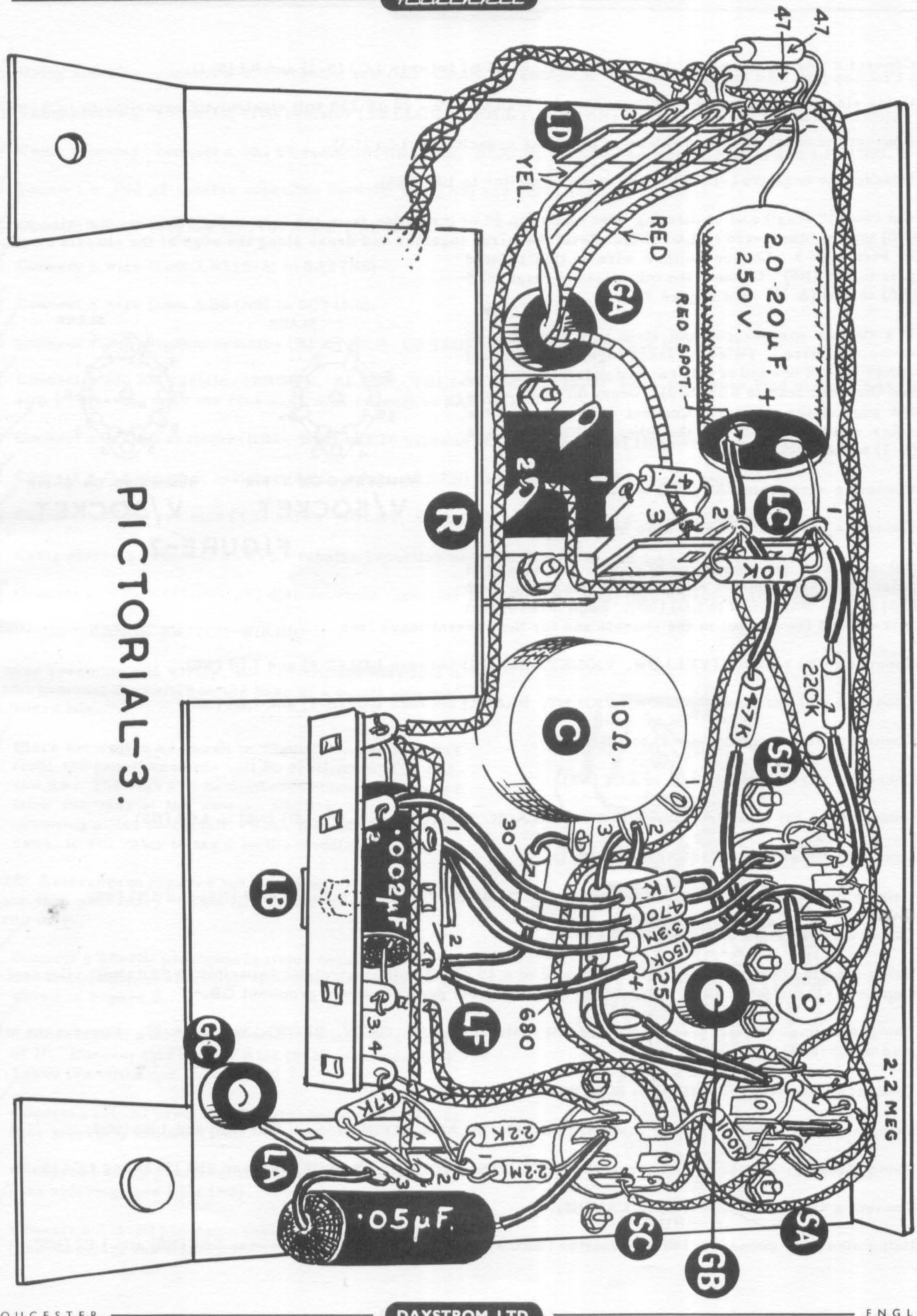
FIGURE.6.

CHASSIS WIRING

(√) Connect either of the RED transformer leads to LC3 (NS). Refer to Pictorial 3.

(√) Connect the other RED transformer lead to LD1 (NS).

(√) Connect either of the YELLOW transformer leads to LD2 (NS). Connect the other YELLOW lead to LD3 (NS).


47
47
LD
YEL.
RED
20-20μF. +
250V.
RED SPOT.
GA
R
47
LC
10K
220K
47K
SB
C
10Ω.
.002μF
LB
1K
470
3.3M
150K
25
680
LF
GC
47K
2.2K
2.2M
LA
.05μF.
SC
GB
SA
2.2 MEG
100K

PICTORIAL-3.

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) between LC3 (S-2) and R1 (S-1).

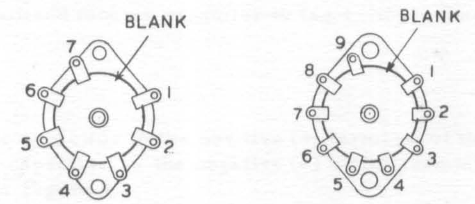
( ) Using sleeving, connect the RED positive (+) lead of a 20 - 20 μF 250 volt electrolytic capacitor to LC2 (NS).

( ) Connect the other positive (+) lead of the same capacitor to LC1 (NS).

( ) Connect the negative (-) lead of the same capacitor to LD1 (NS).

( ) Cut two $8\frac{1}{2}$" lengths of connecting wire and strip $\frac{1}{4}$" of insulation from the four ends. Connect one wire to LD2 (NS) and the other wire to LD3 (NS). Twist the wires together and dress along the edge of the chassis as shown in Pictorial 3. Connect either wire of this twisted pair to SB9 (NS). Connect the other lead through SB5 (NS) to SB4 (S-1). See Figure 7.

( ) In a similar manner cut and strip two 3" lengths of connecting wire. Twist the leads together. Connect either lead of one end of this twisted pair to SB9 (S-2) and the other lead to SB5 (S-2). Dress this pair along the edge of the chassis. Connect either lead of the other end to SA9 (NS) and the other lead through SA4 (S-1) to SA5 (NS).



NUMBERING ON 7-PIN V/SOCKET

NUMBERING ON 9-PIN V/SOCKET.

FIGURE-7.

( ) Connect a wire from SA9 (S-2) to SC3 (S-1).

( ) Connect a wire from SA5 (S-2) to SC4 (S-1).

( ) Cut and strip two 4" lengths of connecting wire and twist together. Connect either lead of one end to LD2 (NS) and the other lead to LD3 (NS). Bend this twisted pair around the cut-out in the chassis and for the present leave free.

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) between LD2 (S-4) and LD1 (NS).

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) between LD3 (S-4) and LD1 (NS).

( ) Connect a wire from LD1 (S-5) to LB1 (NS).

( ) Connect a wire from R2 (S-1) to LC2 (NS).

( ) Connect a 10 KΩ 1 watt resistor (BROWN, BLACK, ORANGE) between LC1 (NS) to LC2 (NS).

( ) Connect a wire from LC2 (NS) to SB6 (S-1).

( ) Using sleeving, connect a 220 KΩ resistor (RED, RED, YELLOW) between LC1 (NS) and SB7 (NS).

( ) Connect a wire from SB7 (S-2) to SA1 (S-1).

( ) Using sleeving, connect the positive (+) lead of a 25 μF 25 volt electrolytic capacitor to SA8 (NS). Connect the negative (-) lead to C2 (NS). Make sure this capacitor does not cover grommet GB.

( ) Using sleeving, connect one lead of a 680Ω resistor (BLUE, GREY, BROWN) to SA8 (S-2). Connect the other lead to C2 (S-2).

( ) Connect a wire from LC1 (S-4) to SC1 (NS).

( ) Using sleeving, connect a 1 KΩ resistor (BROWN, BLACK, RED) between SB1 (NS) and LB2 (NS).

( ) Using sleeving, connect a 47 KΩ resistor (YELLOW, VIOLET, ORANGE) between SB1 (S-2) and LC2 (S-5).

( ) Connect a wire from LB1 (NS) to LA2 (NS).

( ) Using sleeving, connect a 150 KΩ resistor (BROWN, GREEN, YELLOW) between SB8 (NS) and LF2 (NS).

(✓) Using sleeving, connect a 3.3 megohm resistor (ORANGE, ORANGE, GREEN) between SB2 (NS) and LF1 (NS).

(✓) Using sleeving, connect a 470Ω resistor (YELLOW, VIOLET, BROWN) between SB3 (S-1) and LF1 (NS).

(✓) Using sleeving, connect a 30Ω 5% resistor (ORANGE, BLACK, BLACK) between C3 (S-1) and LF2 (NS).

(✓) Connect a .002 μF tubular capacitor between LB1 (NS) and LB3 (NS).

(✓) Connect a wire between LF1 (S-3) and LB1 (S-4).

(✓) Connect a wire from LB3 (S-2) to SA2 (NS).

(✓) Connect a wire from LB4 (NS) to SC7 (NS).

(✓) Connect a 2.2 megohm resistor (RED, RED GREEN) between SA6 (NS) and SA2 (S-2).

(✓) Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) to SC1 (S-2), pass the other lead through SA6 (S-2), slip ½" sleeving over the free end, then connect to SA3 (S-1).

(✓) Connect a 2.2 KΩ resistor (RED, RED, RED) between SC7 (S-2) and LA1 (NS).

(✓) Connect a 2.2 megohm resistor (RED, RED, GREEN) between SC6 (NS) and LA1 (NS).

(✓) Connect a 47 KΩ resistor (YELLOW, VIOLET, ORANGE) between LA1 (S-3) and LA2 (NS).

(✓) Using sleeving, connect a .05 μF tubular capacitor between SC6 (S-2) and LA3 (NS).

(✓) Connect a .01 μF (10,000 pF) disc ceramic capacitor between SB2 (S-2) (use sleeving) and SB8 (S-2).

RANGE SWITCH WIRING

To ease assembly and wiring the constructor may find it helpful to mount the switch on the base of a small upturned cardboard box.

(✓) Place the switch as shown in Figure 8. The sections from the panel outwards will be designated RF, RM, and RR. The tags will be numbered clockwise, viewed from the rear of the switch, starting just above the mounting pillar on the left. When the notation RM4 is used, it will refer to tag 4 on the middle section.

NOTE: Reference to Figure 8 shows component lead lengths longer than necessary. This has been drawn as such for clarity only.

(✓) Connect a 68.38Ω precision resistor between RM1 (NS) and RM2 (NS) (use sleeving). Position the resistor as shown in Figure 8.

(✓) Cut one lead of a 31.62Ω precision resistor to a length of 1". Connect this lead to RM1 (S-2) (use sleeving). Leave the other end free.

(✓) Connect a 216.2Ω precision resistor between RM2 (S-2) (use sleeving) and RM3 (NS).

(✓) Connect a 683.8Ω precision resistor between RM3 (S-2) (use sleeving) and RM4 (NS).

(✓) Connect a 216.2Ω precision resistor between RM5 (NS) (use sleeving) and RM6 (NS).

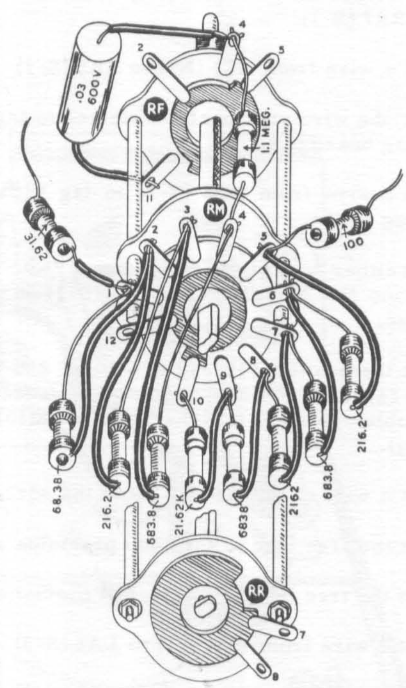


FIGURE-8.

( ) Cut one lead of a 100Ω precision resistor to a length of ½". Connect this lead to RM5 (S-2). Leave the other end free.

( ) Connect a 683.8Ω precision resistor between RM6 (S-2) (use sleeving) and RM7 (NS).

( ) Connect a 2162Ω precision resistor between RM7 (S-2) (use sleeving) and RM8 (NS).

( ) Connect a 6838Ω precision resistor between RM8 (S-2) (use sleeving) and RM9 (NS).

( ) Connect a 21.62 KΩ precision resistor between RM9 (S-2) (use sleeving) and RM10 (NS).

( ) Connect a 1.1 megohm precision resistor between RF4 (NS) and RM4 (S-2).

( ) Take the .03 μF tubular capacitor and cut each lead to approximately 1". Using sleeving, connect this capacitor between RF11 (S-1) and RF4 (S-2). This capacitor should lie close to the panel when the switch is mounted on the panel.

FINAL ASSEMBLY AND WIRING

( ) Mount a RED terminal on the panel at BR, see Pictorial 4. Refer to Figure 9 for mounting procedure. Use a 4BA shakeproof solder tag and before tightening the nut ensure that the cross-drilled wire hole is horizontal.

( ) Mount the chassis on the panel. At the top, the chassis is held by meter mounting screw M1. The bottom of the chassis is held by BLACK terminal BB, which is mounted at this time. Use a 4BA shakeproof solder tag and before tightening the nut ensure that the cross-drilled wire hole is horizontal.

( ) Mount the RANGE switch on the panel. Refer to Figure 6 for mounting procedure and Pictorial 4 for switch orientation.

( ) Twist the two BLACK transformer leads together and connect either lead to LE2 (NS). Connect the other lead to RR7 (S-1).

( ) Connect a wire from LE1 (NS) to RR8 (S-1).

( ) Connect the wire previously connected to tag 5 on the meter tag board to C1 (S-1).

( ) Connect a wire from LB2 (S-2) to tag 3 (S-2) on the meter tag board.

( ) Connect either lead of the twisted pair from LD to tag 1 (S-1) and the other lead to tag 2 (S-1) on the meter tag board.

( ) Connect the positive (+) lead of a 20 μF 250 volt electrolytic capacitor to LB4 (S-2). Make this lead as short as possible. Connect the other lead to RM10 (S-2) (use sleeving).

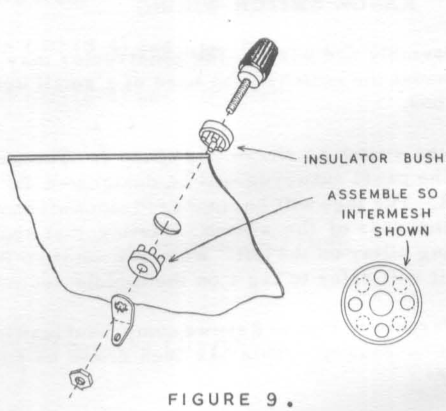


FIGURE 9.

( ) Connect a wire to RF5 (S-1), route the wire through grommet GC and connect to LA3 (S-2).

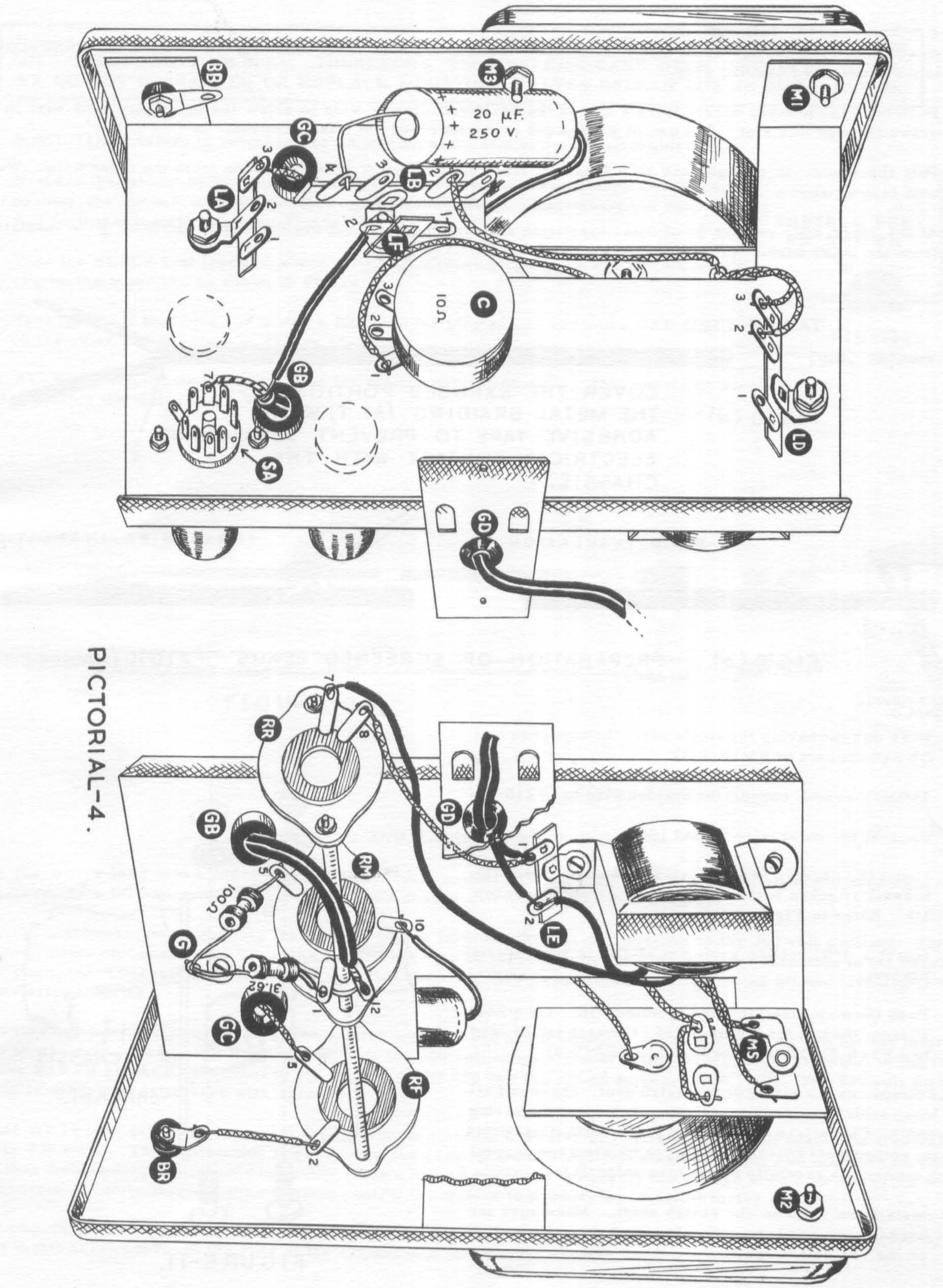
( ) Connect the free lead of the 100Ω precision resistor from RM5 to solder tag G (NS).

( ) Connect the free lead of the 31.62Ω precision resistor from RM1 to solder tag G (S-2).

( ) Connect a wire from BB (S-1) to LA2 (S-3).

( ) Connect a wire from BR (S-1) to RF2 (S-1). Make sure this lead does not touch the lead of the .03 μF capacitor connected to RF4.

( ) Take the screened wire and cut to a length of 5½".


BB
M3
20 μF.
250 V.
M1
GC
LA
LB
LF
C
10Ω
GB
SA
LD
GD
RR
RM
G
100Ω
31.6Ω
RF
BR
LE
MS
M2

PICTORIAL-4.

Refer to Figures 10A, 10B and 10C.

( ) At one end, strip off 1½" of the outer insulation. A sharp knife or razor blade should be used, but avoid cutting into the screened braided wire.

(✓) Push back the braided wire. Make a slot in the braid sufficiently wide to allow the inner insulated wire to be drawn through this slot. The use of a large pin or scriber will aid this operation.

(✓) Pull the braid out straight and fit a length of sleeving. Strip off ¼" of insulation from the inner wire. Wrap with tape as shown.

(✓) At the other end, remove ½" of outer insulation and also the screened braided wire. Strip off ¼" of insulation from the inner wire. Wrap with tape as shown.

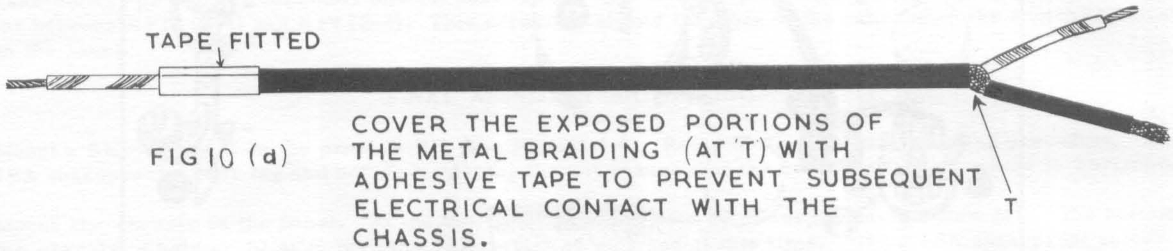


FIG 10 (d)

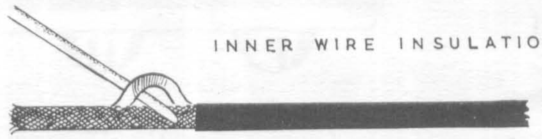


FIG 10 (b) PREPARATION OF SCREENED LEADS FIG-10 (c)

(✓) Pass this end having the single wire, through grommet GB and connect to RM12 (S-1).

(✓) At the other end, connect the braided wire to LF2 (S-3).

(✓) Connect the inner wire to SA7 (S-1).

(✓) Mount the chassis bracket using 4BA hardware. The bracket attaches to the panel by meter mounting screw M4. Refer to Figure 11.

(✓) Insert a 3/8" rubber grommet at GD in the chassis bracket.

( ) Pass the mains lead through grommet GD. Tie a knot 2" from the end for strain relief. Connect either lead to LE1 (S-2) and the other lead to LE2 (S-2).

This completes the wiring of the instrument. Shake out all the loose solder bits and wire clippings. Inspect the wiring carefully. Check lead dress (bare leads contacting metal parts, components touching moving parts etc.) and inspect each connection carefully for proper soldering.

( ) Install the knob on the switch shaft. Make sure the knob is positioned properly. Figure 8 shows the switch on the .01 volt range.

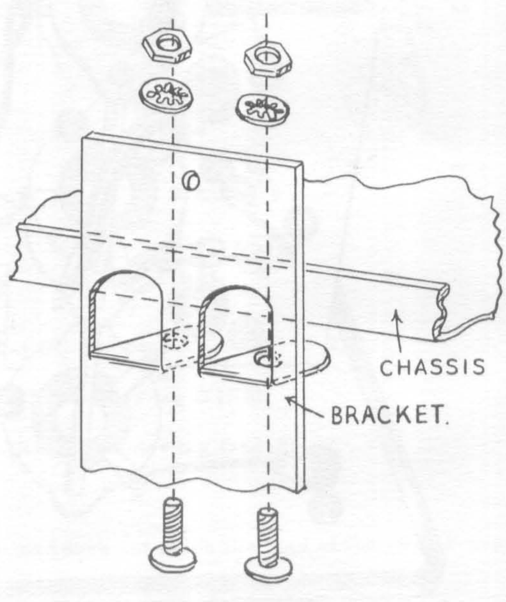


FIGURE-11.

IMPORTANT WARNING: MINIATURE VALVES CAN BE EASILY DAMAGED WHEN PLUGGING THEM INTO THEIR VALVEHOLDERS. THEREFORE, USE EXTREME CARE WHEN INSTALLING THEM. WE DO NOT GUARANTEE OR REPLACE MINIATURE VALVES BROKEN DURING INSTALLATION.

( ) Install 12AT7 valves in valveholders SA and SB and a 6C4 valve in valveholder SC.

( ) Prepare the cabinet by installing the handle with 2 - 4BA screws and lockwashers, and pushing the rubber feet into the four holes in the bottom. Moistening the rubber feet will facilitate installation, see Figure 12.

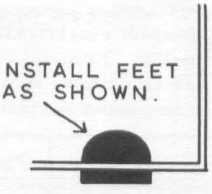


FIG-12.

( ) Take the BLACK test lead and fasten a BLACK wander plug on one end and a crocodile clip on the other end as shown in Figure 13.

( ) Take the RED test lead and fasten a RED wander plug on one end and a RED test prod on the other end as shown in Figure 13.

The AV-3U Millivoltmeter is now ready for testing and calibration. This should be done before placing the meter in the case.

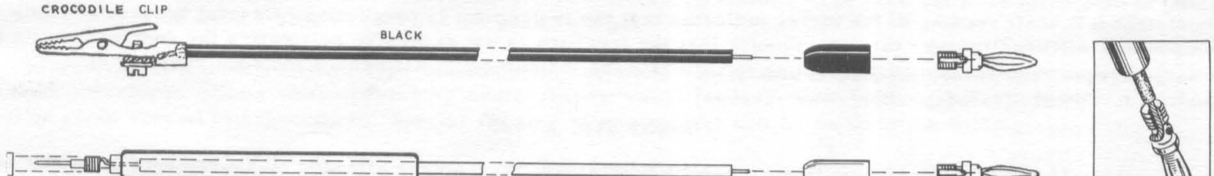


FIGURE-13.

TESTING AND CALIBRATING THE AV-3U

Plug the mains lead into a 200-250 volt, 40-60 cycle outlet. Do not plug into an outlet of higher voltage or lower frequency, or a DC outlet, as an incorrect power source will damage the transformer.

Turn the instrument on by rotating the RANGE switch from the "mains off" position to the 300 volt position. There are two "mains off" positions. Thus, the instrument may be turned off by rotation in either direction to the nearest "off" position. Observe the valves and the pilot lamp. If they do not light, turn the mains off and investigate the heater circuit wiring.

Upon turning on the instrument the meter pointer should move about slightly. Allow a minute or two for the instrument to warm up. Rotate the RANGE switch to the 300 volt range. Connect the INPUT (RED) terminal to the line and the EARTH (BLACK) terminal to the neutral of the 230 volt AC mains supply. CAUTION: The 230 volt mains supply is dangerous. Proceed with care.

Adjust the 10 ohm calibrate control C until the meter needle indicates 2.3 volts on the 3 volt scale (the true value will be 230 volts). This calibration is derived on the assumption of a 230 volt nominal supply and it should be realised that the accuracy will depend upon this. For a higher degree of accuracy, the voltage should be measured with an accurate AC voltmeter and the calibrate control C adjusted to produce an identical meter reading.

This completes the adjustment of the instrument. Install the instrument in the cabinet and fasten with the two 3/8" sheet metal screws through the rear of the cabinet into the chassis bracket.

IN CASE OF DIFFICULTY

If, upon completion of careful construction, the instrument fails to operate, proceed as follows:

1. Check the wiring carefully step-by-step. Often having a friend check for you will locate an error consistently overlooked.
2. Inspect visually for malfunctioning, such as valves not lighting, discolouring of resistors through overheating, etc.
3. Inspect electrically with a voltmeter. The nominal voltages between valveholder pins and chassis are tabulated below. Nominal voltages were measured with a Heathkit V-7A/UK having an 11 megohm input impedance. Lower resistance meters may give lower readings in some instances. Normal deviations due to mains voltage and component variations may reach ± 20%.

VALVE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
12AT7 (SA)	89	38	52	3.15AC	3.15AC	52	0	0-1	3.15AC
12AT7 (SB)	80	0	0-1	3.15AC	3.15AC	163	89	90	3.15AC
6C4 (SC)	138	N	3.15AC	3.15AC	138	26	70	-	-

N = No connection.

When discrepancies occur, investigate the circuit involved. Wiring errors or faulty components may be found upon inspection.

Consistent full scale reading of the meter indicates that the instrument is oscillating. Careful redress of leads and components will usually clear this up. Ensure that the feedback is not excessive by rotating the control C to its full anti-clockwise position before attempting to calibrate the instrument. Also check the 2 μF coupling capacitor for excessive leakage.

USING THE AV-3U

The Heathkit Model AV-3U Millivoltmeter has 10 separate voltage ranges allowing measurements up to 300 volts RMS. The voltage markings on the RANGE switch refer to full scale voltage readings. Frequency response is ± 1 dB from 10 cps to 400 kc, .01 volt through 100 volt ranges; and ± 2 dB from 10 cps to 40 kc, 300 volt range.

When the instrument is set to the lower ranges, the meter may show a residual indication. This is caused by the extreme sensitivity of the circuit. To check for zero indication, the instrument mains lead should be reversed in the AC outlet until a minimum reading is obtained. Zero reading should be evident when the input terminals are shorted together. Any residual indication will have no effect on the accuracy of these ranges when readings are made, due to the low impedance of the circuits being tested.

The meter scale is calibrated 0-3 and 0-1 for voltage measurements. When making measurements on the .03, .3, 3, 30 or 300 volt ranges, read the 0-3 meter scale and adjust the decimal for the correct voltage.

Example: Using the .03 range, the meter reads 2. For correct voltage, move the decimal point two places to the left, i.e., .02 volts.

When taking measurements on the .01, .1, 1, 10 or 100 volt ranges, read the 0-1 meter scale and adjust the decimal for the correct voltage.

Example: Using the .1 volt range, the meter reads .64. For correct voltage, move the decimal one place to the left, i.e., .064 volts.

Due to the high sensitivity of the instrument, the input terminals should not be touched when the meter is set for the lower ranges. Stray electric fields, picked up by the human body will deflect the pointer beyond full scale. Repeated hammering may bend the pointer.

Although the pointer may bend by overloading, the electronic circuit is self-limiting. Because of this self-limiting, the maximum current through the meter movement under extreme overload conditions is yet within the safety factor of the meter coil windings. Although the meter may not burn out from severe overloading, other circuit components can be damaged by prolonged overloads.

Using the Decibel Scale: Because the human ear does not respond to the volume of sound in proportion to the signal strength, a unit of measure called the "Bel" was adopted. The "Bel" is more nearly equivalent to human ratios. Normally the reading is given in 1/10 of a "Bel" or "decibel". Different signal levels are adopted by various manufacturers as standard or "0" decibels. The trend within the last few years has been toward the use of 1 milliwatt into a 600Ω load as "0" dB. This reference has been given a special designation of "dBm". This Heathkit is calibrated to read in "dBm" when connected across a 600Ω load.

When using the AV-3U for dB measurement, adjust the RANGE switch until there is a reading on the decibel scale. The meter reading is then either added to or subtracted from the range indication.

Example: Range +20 dB, meter indicates -5 dB, actual value is +15 dB.
Range -10 dB, meter indicates -4 dB, actual value is -14 dB.

Since the decibel is a power ratio or voltage ratio, it may be used as such without specifying the reference level. Thus, for instance, a fidelity curve may be determined on an amplifier by feeding in a signal of variable frequency but constant amplitude. At a reference frequency of, say, 400 cycles, make an initial reading on the AC voltmeter, connected to the output. A suitable load, such as a speaker, should be connect3d to the amplifier output during the test. As the input frequency is varied at constant amplitude, the output level variation may be noted in dB above and below the specified reference level.

When making comparative measurements, the circuit impedance must be considered. Such is the case when measuring the overall gain of an amplifier. If the input impedance is the same as the output impedance, the dB gain can be measured directly with the AV-3U. In the case where the input and output impedance differ, it is necessary to correct each reading mathematically to a common reference level.

Complex Waveforms: This instrument, like most AC voltmeters, is calibrated to read the Root Mean Square (RMS) value of a pure sine wave. This is 70.7% of the peak voltage.

As characteristic of most rectifier type instruments, the meter deflection is proportional to the average value of the input waveform. Thus when measuring oddly shaped waves (square, saw-toothed, pulse), the meter reading must be given special interpretation. Special reading on this subject will be found in the Bibliography.

AV-3U APPLICATIONS

AC voltages at any point in practically any type of circuit can be measured with the AV-3U. Heater voltage, mains voltage, noise, output and gain measurements can be made quickly and accurately by connecting the test leads across the point where information is desired. Voltage gain is measured stage by stage or overall by measuring input voltage versus output voltage, dividing the output by the input voltage. Checks at the secondary of an output transformer for voltage gain are not feasible however, since the last stage in a power amplifier provides power gain at low impedance, rather than voltage gain.

Ripple on the output of power supplies can be measured by connecting the AV-3U across the supply.

NOTE: The built-in DC blocking capacitors are rated at 600 volts DC working.

Amplifier noise measurements are made by running the amplifier to full output power at a reference frequency such as 400 or 1000 cycles and then turning off the signal source, leaving it connected to the amplifier input. The reading in volts or dB should be noted at full output and read again after the signal source has been turned off. The difference between the two readings is the noise output level in volts or dB below the specified output.

BIBLIOGRAPHY

Added information on the construction and use of AC meters will be found in the many fine text books, electronic and radio magazines available from most libraries. Particular reference can be made to:-

Instruments & Measurements - Golding
Radio Designers Handbook - Langford-Smith
Electronic Engineering
Wireless World

REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally, however, improper instrument operation can be traced to a faulty valve or component. Should inspection reveal the necessity for replacement, write to Daystrom Ltd. and please 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 the 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.

Daystrom Ltd. will promptly supply the necessary replacements. 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 valves are to be returned, pack them carefully to prevent breakage in shipment, as broken valves 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

If the completed instrument should fail to function properly and attempts to find and cure the trouble prove ineffective, the facilities of Daystrom's Service Dept. are at your disposal. Your instrument may be returned carriage paid to Daystrom Ltd., Gloucester, and the Company will advise you of the service charge where not covered within the terms of the guarantee (i.e. a faulty component supplied by us). THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THIS MANUAL. 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.

Daystrom Ltd. is willing to offer its full co-operation to assist you in obtaining the specified performance level of your instrument. Factory repair service is available or you may contact the Engineering Consultation Department by mail. For information regarding possible modification of existing kits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. Although Daystrom Ltd. sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit and layout 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 LABEL TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper, wood wool or plastic cushioning material on all sides. DO NOT DESPATCH IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

PRICES: All prices are subject to change without notice.

MODIFICATIONS TO SPECIFICATIONS: Daystrom Ltd. 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.

* * * * * * * * * * * * * * * *

The Heathkit builder is again strongly urged to follow step-by-step the instructions given in this Manual to ensure successful results. Daystrom Ltd. assumes no responsibility for any damages or injuries sustained in the assembly or handling of any of the parts of this kit or the completed instrument.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors ± 10%		
H-470C10	3	47Ω
H-471C10	1	470Ω
H-681C10	1	680Ω
H-102C10	1	1 KΩ
H-222C10	1	2.2 KΩ
H-473C10	2	47 KΩ
H-104C10	1	100 KΩ
H-154C10	1	150 KΩ
H-224C10	1	220 KΩ
H-225C10	2	2.2 MΩ
H-335C10	1	3.3 MΩ
1-103C10	1	10 KΩ 1 watt
Resistors ± 5%		
H-300C5	1	30Ω
Resistors ± 1%		
2-22	1	31.62Ω precision
2-23	1	68.38Ω precision
2-4	1	100Ω precision
2-25	2	216.2Ω precision
2-28	2	683.8Ω precision
2-31	1	2162Ω precision
2-33	1	6838Ω precision
2-39	1	21.62 KΩ precision
2-116	1	1.1 MΩ precision
Capacitors		
23-513	1	.002 μF tubular
21-511	1	.01 μF disc
23-514	1	.03 μF tubular
23-515	1	.05 μF tubular
23-512	1	2 μF tubular
25-501	1	25 μF 25v electrolytic
25-515	1	20 μF 250v electrolytic
25-514	1	20-20 μF 250v electrolytic
25-28	1	100 μF 50v electrolytic
Valves, Lamp, Sockets		
411-4	1	6C4 (EC90) valve
411-24	2	12AT7 (ECC81) valve
412-4	1	6.3 volt .115 amp pilot lamp
434-516	1	7-pin valveholder
434-502	2	9-pin valveholder
434-47	1	Pilot lamp socket
Terminals, Knobs, Tagstrips		
427-501	1	Terminal, red
427-502	1	Terminal, black
431-513	1	Tag board
431-1	1	1-way tagstrip
431-2	1	2-way tagstrip
431-508	2	3-way tagstrip
431-10	1	3-way tagstrip (centre tag earth)
431-502	1	4-way tagstrip
70-5	1	Wander plug, black

PART No.	PARTS Per Kit	DESCRIPTION
Terminals, Knobs, Tagstrips cont'd.		
70-6	1	Wander plug, red
439-1	1	Test prod, red
462-19	1	Knob, skirted
Transformer, Diode, Meter		
54-509	1	Power transformer
56-501	4	Crystal diode
57-503	1	Selenium rectifier
407-8A	1	Meter
Sheet Metal Parts		
200-510	1	Chassis
204-509	1	Chassis bracket
203-509	1	Panel
90-17	1	Cabinet
Hardware		
250-513	6	4BA x $\frac{1}{4}$" screw, binder head
250-9U	2	4BA x 3/8" screw, binder head
250-501	8	6BA x $\frac{1}{4}$" screw, binder head
252-3	6	4BA hex nut
252-501	8	6BA hex nut
254-1	8	4BA lockwasher
254-501	8	6BA lockwasher
259-504	3	4BA shakeproof solder tag
250-8	2	3/8" sheet metal screw
Controls, Switches		
11-26	1	10Ω potentiometer
63-129	1	12-position RANGE switch
Wire, Sleeving, Solder		
89-1	1	Mains lead
344-506	1 length	Connecting wire
341-2	1 length	Test lead, red
341-1	1 length	Test lead, black
343-501	1 length	Screened and insulated wire
346-501	1 length	Sleeving, 1.5 m.m.
346-6	1 length	Sleeving, 3/8"
331-501	1 length	Solder, 18 swg.
Miscellaneous		
73-501	4	Rubber grommet, 3/8"
211-4U	1	Handle
260-1	1	Crocodile clip
261-1	4	Rubber feet
595-513	1	Instruction manual

G U A R A N T E E

Daystrom Limited guarantee subject to the following terms to repair or replace free of charge any defective parts of this Heathkit (with the exception of cathode ray tubes and valves referred to hereunder) which fail owing to faulty workmanship or material provided the defective parts are returned to Daystrom Limited within 12 months from date of purchase:-

1. This guarantee is given to and for the benefit of the original buyer only, and is and shall be in lieu of, and there is hereby expressly excluded, all other guarantees conditions or warranties, whether express or implied, statutory or otherwise, as to quality or fitness for any purpose of the equipment, and in no event shall Daystrom Limited be liable for any loss of anticipated profits, damages, consequential or otherwise, injury, loss of time or other losses whatsoever incurred or sustained by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof.

2. No replacement will be made of parts damaged by the buyer in the course of handling, assembling, testing or operating Heathkit equipment.

3. The purchaser shall comply with the Replacements Procedure laid down in the relevant Heathkit Manual.

4. Daystrom Limited will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used and in such event this guarantee shall be completely void.

Note: The Cathode Ray Tubes and Valves forming part of the equipment are guaranteed by the respective manufacturers. It should be noted that their guarantee is given only in respect of faulty workmanship and/or material and does not cover misuse or consequential damage.

Heathkit Audio Generator

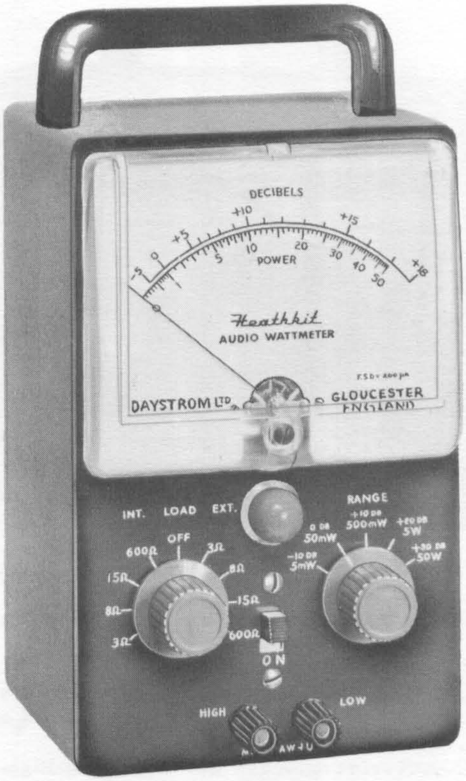
MODEL AG-9U

SPECIFICATIONS

Frequency Range:..................................	10 cycles - 100 kc/s
Frequency Selection:................................	Switch-selected, 2 significant figures and multiplier
Frequency Accuracy:................................	± 5%
Output Voltage Ranges:..............................	0-10 volts into High-Z (10 KΩ min.) 0-3 volts into High-Z (10 KΩ min.) 0-1 volts) 0-.3 volts) 0-.1 volts) Into external load of approximately 600Ω 0-.03 volts) or with internal load into external High-Z 0-.01 volts) 0-.003 volts)
Source Impedance:..................................	0-10 volt range - varies between 0 and 1000Ω 0-3 volt range - varies between 800 and 1000Ω 0-1 volt range and below - 600Ω (External load) 290Ω (Internal load)
dB Ranges:..	-60 dB to +22 dB (-10 to +2 on meter, -50 to +20 on attenuator in 10 dB steps).
dBm Ranges (600Ω Ext. Load):......................	-60 dBm to +2 dBm (0 dBm = 1 mW-600Ω)
Output Indications:................................	Voltage and dB scales on meter
Output Meter Accuracy:.............................	± 5% of full scale when properly terminated
Distortion:..	Less than 0.1% from 20-20,000 cycles
Valve Complement:..................................	EF94, EL821 and EZ81
Power Requirements:................................	200-250 volts, 40-60 cycles, AC, 40 watts
Dimensions:..	9½" wide x 6½" high x 5" deep
Shipping Weight:...................................	8½ lbs.

HEATHKIT AUDIO WATTMETER

MODEL AW-1U



SPECIFICATIONS

Frequency Response:	$\pm$ 1 dB, 10 cycles to 250 kc.
Power Range:	0-5 milliwatts, 50 milliwatts, 500 milliwatts, 5 watts, 50 watts full scale.
dB Ranges:	Total range, -15 dB to +48 dB, scale -5 to +18 dB (1 mW-600Ω). Five switch selected ranges from -10 dB to +30 dB.
Load Resistors:	3Ω, 8Ω, 15Ω and 600Ω non-inductive, switch selected.
Audio Input Power Ratings:	Up to 25 watts maximum continuous duty, 50 watts maximum intermittent, duty cycle 3 minutes. Ventilated cabinet allows efficient cooling.
Multipliers:	1% precision type.
Meter:	4$\frac{1}{2}$" streamlined case with 200 microampere movement.
Meter Rectifier:	Crystal diode bridge for wide range frequency response.
Valve:	12AU7 - voltage amplifier and current amplifier for meter.
Power Supply:	Power transformer and selenium rectifier.
Power Requirements:	200-250 volts AC, 40-60 cycles, 6 watts.
Dimensions:	7.3/8" high x 4.11/16" wide x 4.1/8" deep.
Net Weight:	3$\frac{3}{4}$ lbs.
Shipping Weight:	6 lbs.

HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual thoroughly to familiarise yourself with the general procedure. Note the relative location of pictorial inserts in respect of the progress of the assembly procedure outlined.
This information is offered primarily for the convenience of the novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronic 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 specialised equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 25-50 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 resin 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 the valve holders are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer colour coded wires will be available at the proper chassis opening. Make it a standard practice to use lockwashers under all 4BA and 2BA nuts. The only exception being in the use of soldering tags - the necessary locking feature is already incorporated in the design of the soldering tags. 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 terminals that require the use of fibre insulating washers, it is good practice to slip the shouldered washer over the terminal stud before installing the mounting stud in the panel hole provided. Next, install a flat fibre washer and a soldering tag under the mounting nut. Be sure that the shouldered washer is properly centred in the panel to prevent possible shorting of the terminal.

WIRING

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

SOLDERING

Much of the performance of the kit instrument, particularly in respect of accuracy and stability, depend upon the degree of workmanship used in making soldered connections. Properly 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 so that the solder flows thoroughly and 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 valve holders. This is particularly important in instruments such as the VVM, 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 resin core type solder.

AERIAL	CAPACITOR (VARIABLE)	SWITCH — SINGLE POLE (S.P.) SINGLE THROW (S.T.)	BATTERY +
LOOP	RESISTOR	SWITCH — DOUBLE POLE (D.P.) DOUBLE THROW (D.T.)	FUSE OR
DIPOLE	RESISTOR (TAPPED)	SWITCH — TRIPLE POLE (T.P.) DOUBLE THROW (D.T.)	CRYSTAL
EARTH	RESISTOR (VARIABLE)	LOUDSPEAKER	TERMINAL & TERMINAL STRIP
INDUCTOR (COIL OR R.F. CHOKE)	POTENTIOMETER	RECTIFIER	WIRING BETWEEN LIKE LETTERS IS UNDERSTOOD →X →Y XY XY
R.F. COIL WITH ADJUSTABLE IRON DUST CORE	JACK (TWO CONDUCTOR)	MICROPHONE	MICRO (X 1/1,000,000) = μ
L.F. CHOKE (IRON CORED) WITH TAPPINGS	JACK (THREE CONDUCTOR)	TYPICAL TUBE SYMBOL: ANODE, SUPPRESSOR GRID, SCREEN GRID, CONTROL GRID, CATHODE, HEATER FILAMENT	MILLI (X 1/1000) = m
R F TRANSFORMER (AIR CORE)	WIRES CONNECTED		KILO (X .1000) = K
TRANSFORMER (R.F. OR I.F.) ADJUSTABLE IRON DUST CORE	WIRES CROSSING BUT NOT CONNECTED	TRANSISTOR (P.N.P. TYPE)	MEGA (X 1,000,000) = M
TRANSFORMER (MAINS OR L.F.) IRON CORE	A-AMMETER V-VOLTMETER mA-MILLIAMMETER μA-MICROAMMETER ETC. (A)	TRANSISTOR (N.P.N. TYPE)	OMEGA (OHMS) = Ω
CAPACITOR	NEON LAMP STABILISER VALVE	SOCKET OUTLET — CO AXIAL	MICROFARAD = μF
CAPACITOR (ELECTROLYTIC) + −	LAMP PILOT OR ILLUMINATING	TWO PIN SOCKET AND TWO PIN PLUG	PICOFARAD = pF MICRO.MICRO FARAD = μμF

TEST 1

HANDLE WITH CARE

DAYSTROM LIMITED

A Member of the Daystrom Group

THE WORLDS LARGEST MANUFACTURERS
OF ELECTRONIC KITS

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