PRICE 10/6

# Assembling and Using Your...

Heathkit

DAYSTROM

# AUDIO GENERATOR

## MODEL AG-9U

**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 1. { COLOURED BAND MARKING PREFERRED }

THIS EXAMPLE SHOWS A GRADE 1. RESISTANCE OF 6,800 Ω ± 5%


BLUE ( 6 )
GREY ( 8 )
RED (X $10^2$)
GOLD ( ± 5% )
{ SALMON PINK (GRADE 1.) — THIS MAY BE GENERAL BODY COLOUR

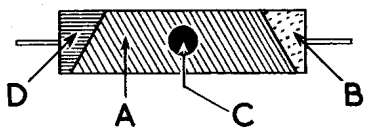



FIG 2. BODY, TIP & SPOT MARKING

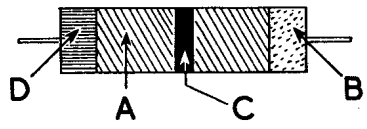
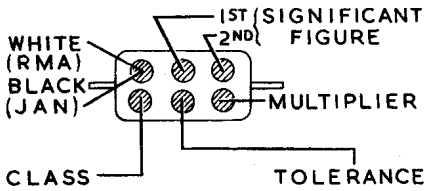


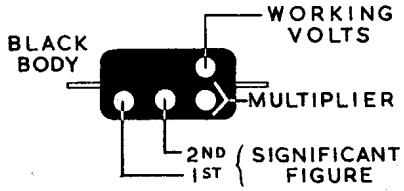

FIG 3. BODY TIP & CENTRAL BAND MARKING

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

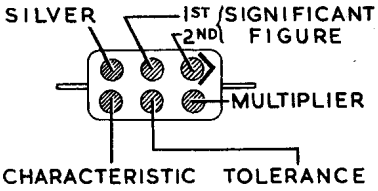
### CURRENT STANDARD CODE




### MOULDED FLAT CAPACITOR COMMERCIAL CODE




### JAN. CODE CAPACITOR




### COLOUR CODE FOR RESISTORS AND CAPACITORS

| Colour | Value in Ohms of pF for Cols. A, B & C. | | | | COL. D. (TOLERANCE RATING) | | | CAPACITORS COL. E. TEMP. COEFFICIENT per $10^6$ per °C. |
|---|---|---|---|---|---|---|---|---|
| | COL. A. 1st Figure | COL. B. 2nd Figure | COL. C. (MULTIPLIER) Resistors ohms | Capacitors pF | Resistors | Ceramic Capacitors Up to 10 pF | Ceramic Capacitors Over 10 pF | |
| 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.).

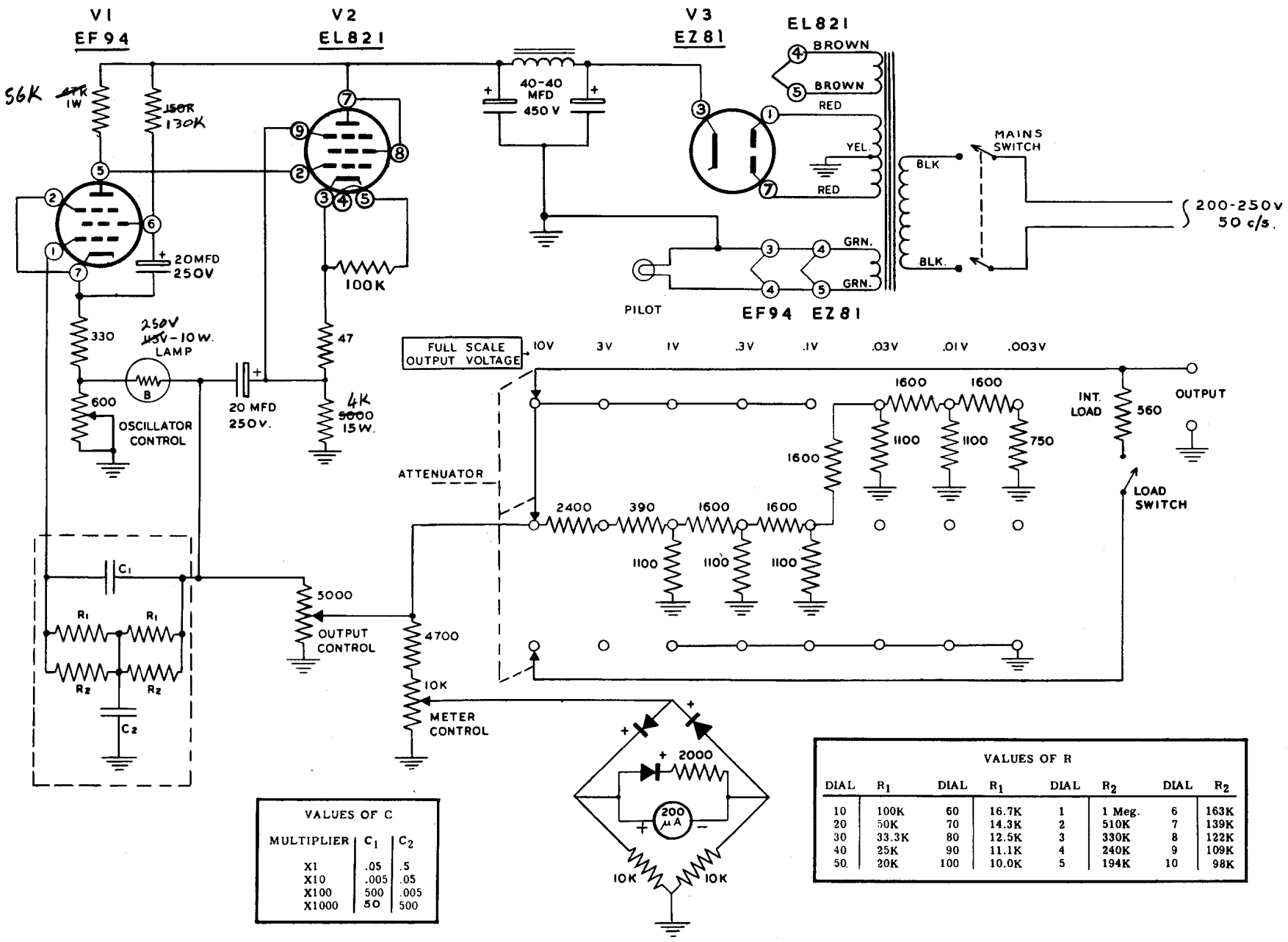
N. B. High-Stability Resistors supplied with this kit are not as a rule colour coded but enamelled in one colour on which the value in Ohms.is printed in figures. Capacitors supplied in this kit usually have their capacity clearly marked in figures. Some Capacitors coded as above also have additional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

# Heathkit 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: | $9\frac{1}{2}$" wide x $6\frac{1}{2}$" high x 5" deep |
| Shipping Weight: | $8\frac{1}{2}$ lbs. |




VALUES OF C

| MULTIPLIER | $C_1$ | $C_2$ |
|---|---|---|
| X1 | .05 | .5 |
| X10 | .005 | .05 |
| X100 | 500 | .005 |
| X1000 | 50 | 500 |

VALUES OF R

| DIAL | $R_1$ | DIAL | $R_1$ | DIAL | $R_2$ | DIAL | $R_2$ |
|---|---|---|---|---|---|---|---|
| 10 | 100K | 60 | 16.7K | 1 | 1 Meg. | 6 | 163K |
| 20 | 50K | 70 | 14.3K | 2 | 510K | 7 | 139K |
| 30 | 33.3K | 80 | 12.5K | 3 | 330K | 8 | 122K |
| 40 | 25K | 90 | 11.1K | 4 | 240K | 9 | 109K |
| 50 | 20K | 100 | 10.0K | 5 | 194K | 10 | 98K |

# HEATHKIT AUDIO GENERATOR MODEL AG-9U.

## 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.

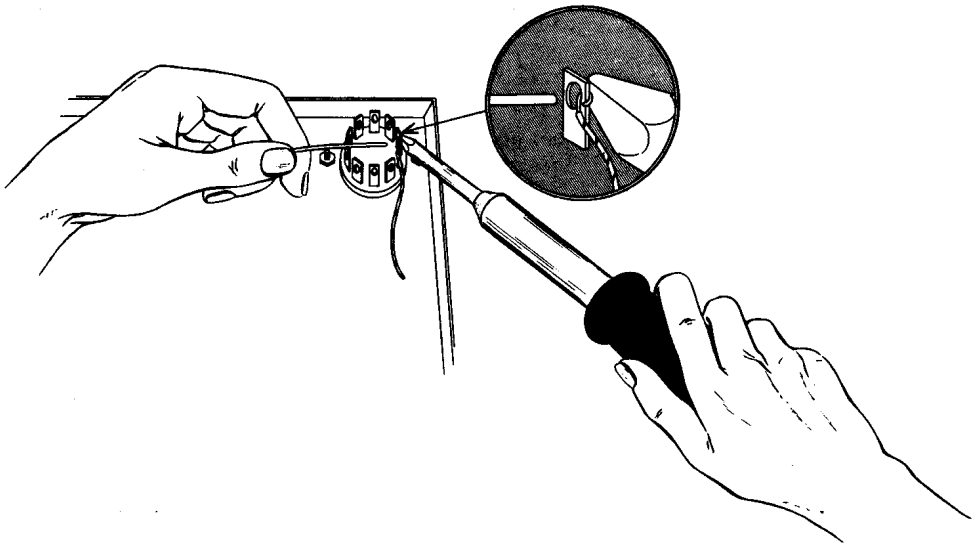
Highest quality resin-cored solder is essential for efficiently securing this kit's wiring and components. The resin core acts as a flux or cleaning agent during the soldering operation.

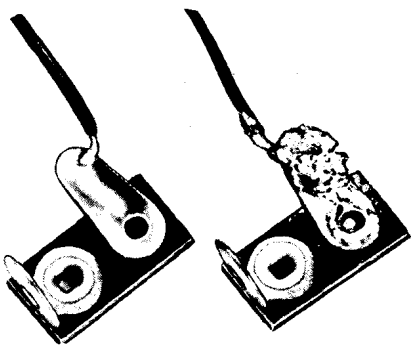
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture. 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

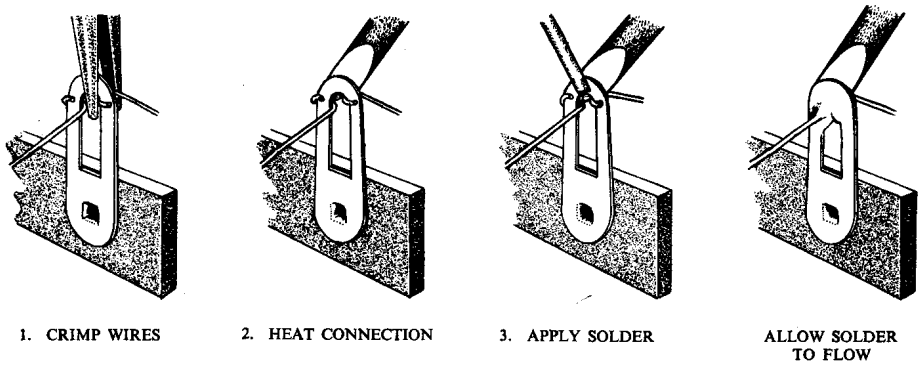
IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number 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.

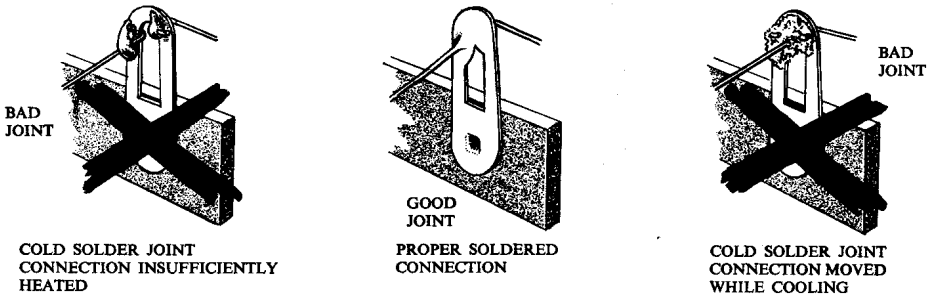
When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.





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.




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.

## INTRODUCTION

The Heathkit model AG-9U Audio Generator is a simple, yet versatile instrument. Whilst being simple in layout and easy to construct, the carefully assembled instrument provides ease of operation in a multitude of test set-ups encountered in audio laboratories. The wide range of repeatable frequencies and the metered low distortion output voltages, cover nearly all values encountered in audio work. The generator is contained in a conveniently small cabinet and will entitle this instrument to a preferred spot in the laboratory.

The excellent performance of which this design is capable, will not be realised in the finished instrument, UNLESS the constructor uses the best workmanship of which he is capable. Poor soldering technique, corrosive fluxes (acid core, so-called non-corrosive pastes), hurried and careless construction and failure to follow procedures outlined in this manual are the most prevalent causes for unsatisfactory operation. Protect your investment in time and money and reap the reward of personal satisfaction that money cannot buy, by doing a first class job of constructing this kit.

## CIRCUIT DESCRIPTION

The circuit of this instrument may be divided into four parts: the power supply, the oscillator, the attenuator and the metering circuit.

The power supply uses the conventional power transformer and a full wave rectifier circuit feeding a ripple filter consisting of two capacitors and a choke.

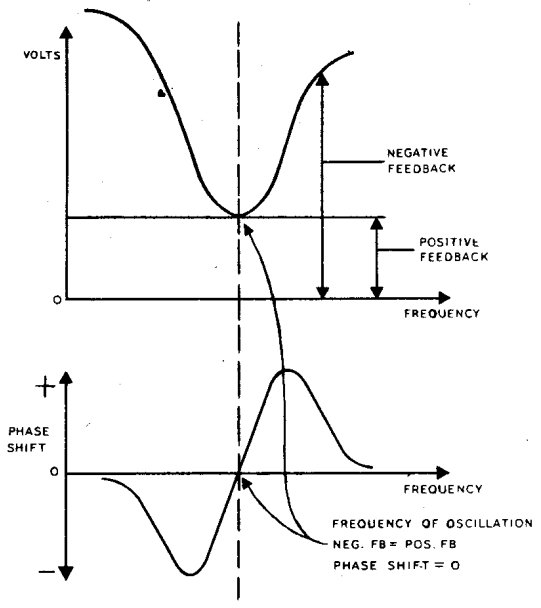
The oscillator uses an EF94 pentode voltage amplifier and an EL821 triode-connected cathode follower. Regenerative feedback from the EL821 to the EF94 cathode is applied through the tungsten filament lamp.

Degenerative feedback is applied from the EL821 through a bridged T network to the grid of the EF94. The resultant oscillation occurs at the frequency where degeneration is minimum and phase shift is zero.

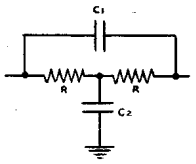
The network is a capacitor shunted bridged T type. Oscillation will occur at a frequency: $F = \frac{1}{2\pi RC}$

where $C = \sqrt{C_1 C_2}$

The amplitude of oscillation is maintained at a nearly constant value by the tungsten lamp. The regenerative feedback is applied through a voltage divider consisting of the lamp and the oscillator control. An increase in output signal increases the lamp current, the lamp temperature and hence the lamp resistance. This reduces the amount of feedback applied to the EF94 cathode and the resultant output. A balanced condition is thus obtained. The oscillator control is used to set the nominal output level.




The bridged T network consists basically of two resistors and two capacitors. From the relationship shown it is evident that a decrease in capacitance by a factor of 10 will increase the frequency by a factor of 10. As the values of $C_1$ and $C_2$ were chosen with a 10:1 ratio, five capacitors can replace four pairs (8 capacitors) in achieving four decade ranges.

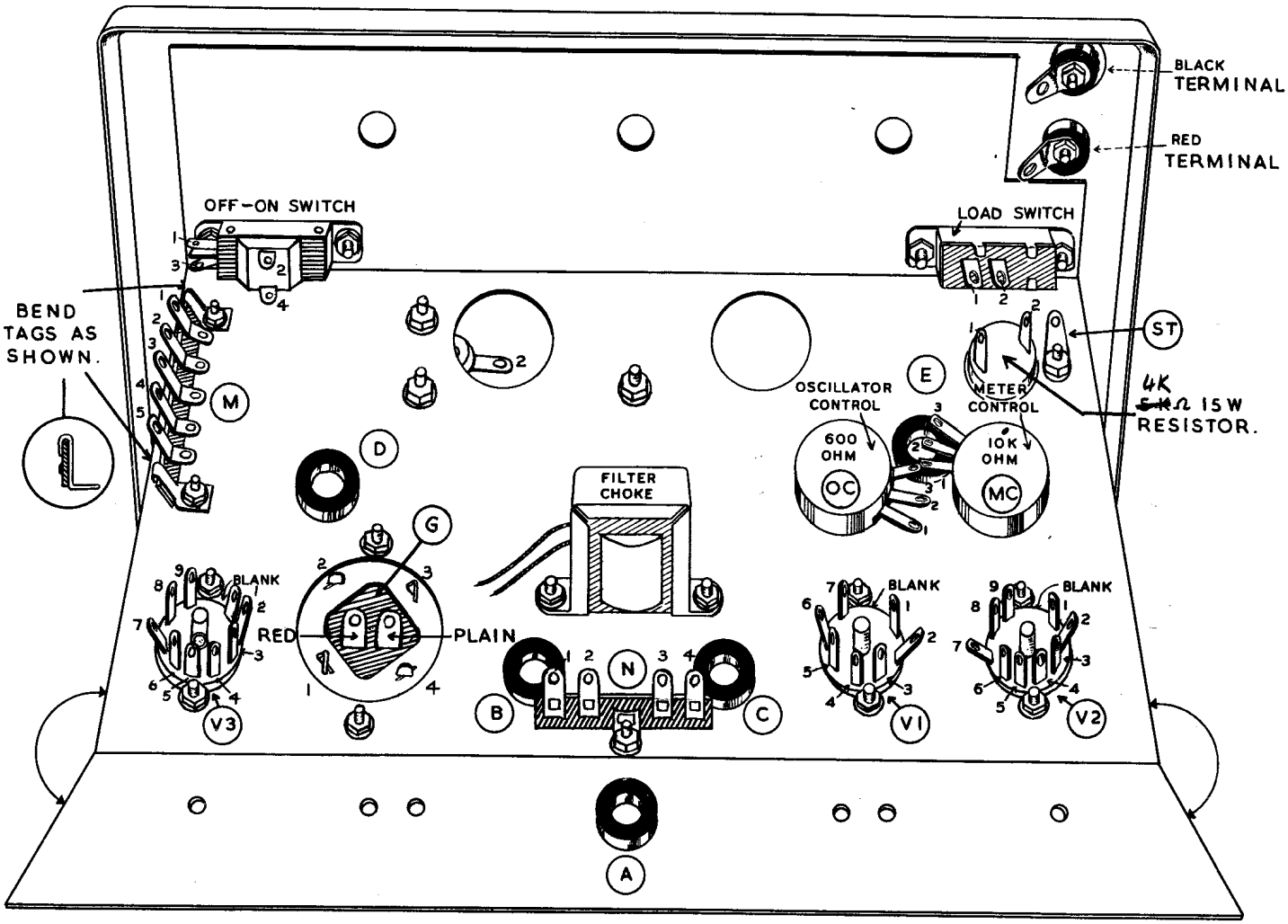



For frequency variations within the ranges provided by the multiplier switch, the value of R is changed. For a multiplier switch setting of X1 a resistance (R) of 100 KΩ will produce a frequency of 10 cycles. As F and R are inversely proportional, 20 cycles or twice the frequency requires half the resistance, or 50 KΩ. Likewise, 30 cycles or three times the frequency requires 1/3 the resistance or 33.3 KΩ. The 0-100 CYCLE switch uses two wafers, each wafer switching four resistors as follows: 100 KΩ, 50 KΩ, 33.3 KΩ, 25 KΩ. 100 K // 25 K = 20 K; 50 K // 25 K = 16.7 K; 33.3 K // 25 K = 14.3 K; 100 K // 33.3 K // 25 K = 12.5 K; 50 K // 33.3 K // 25 K = 11.1K; 100 K // 50 K // 33.3 K // 25 K = 10 K. These resistance values produce frequencies of 10 to 100 cycles in steps of 10 cycles. (// Means "in parallel with".)

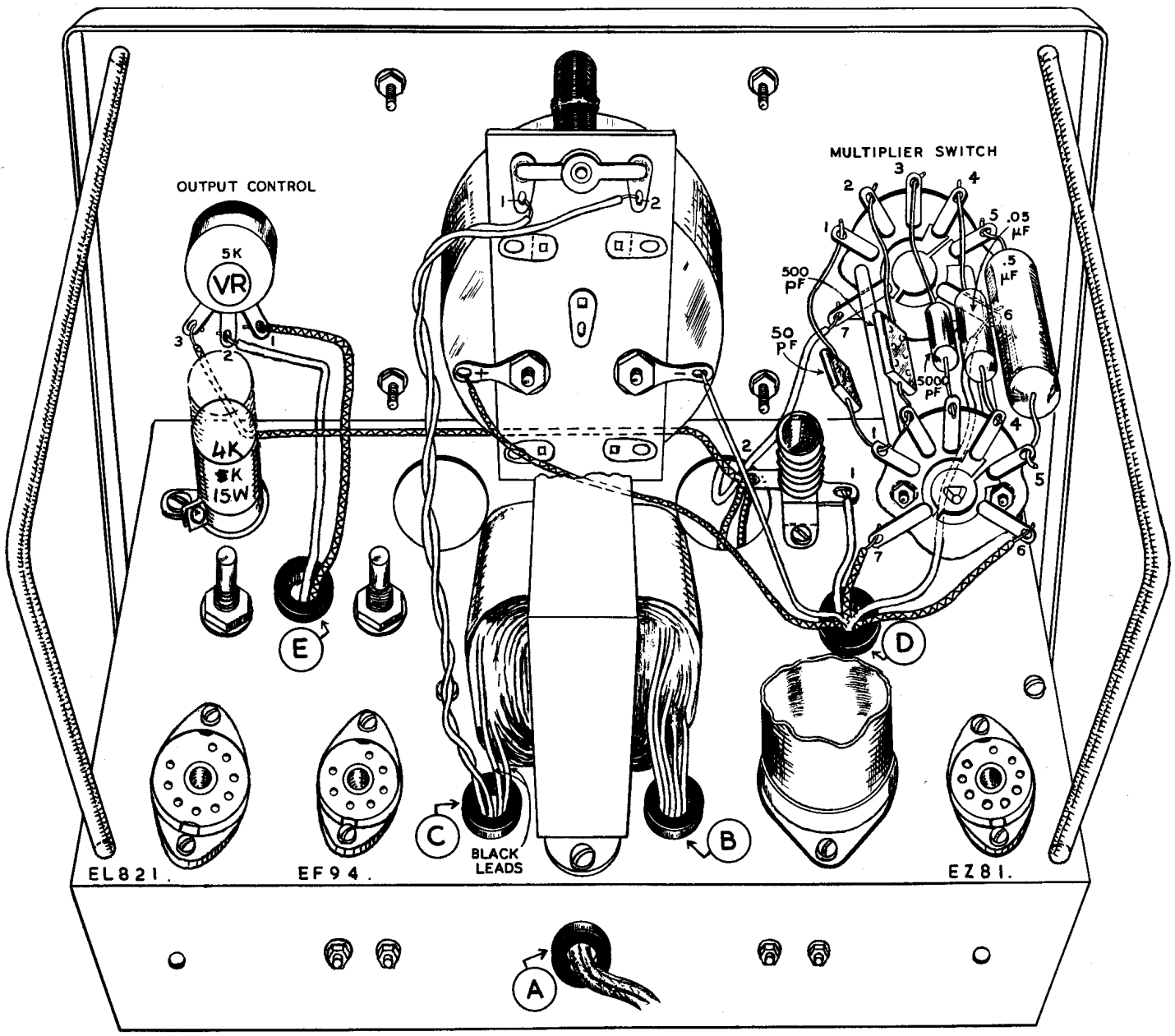
Frequency variations within a 10 cycle range are produced by the 0-10 CYCLE switch. Here the same reasoning and circuitry are used as above, but the actual resistance values are substantially ten times larger. These resistance values are connected in parallel with the first switch and produce one cycle increments.

The attenuator reduces the output voltage from the EL821 cathode-follower through a continuously variable 5 KΩ output control, and then through a step-attenuator. The attenuator system is designed for 600Ω output for the ranges from .003 volt to 1 volt and for high impedance output at the 3 and 10 volt positions. The 600Ω positions may be terminated by an internal load for high impedance work or this load may be disconnected when an external 600Ω load is used. In the 3 and 10 volt positions, the internal load is automatically disconnected. The attenuator operates in steps of 10 dB.

The metering circuit measures the voltage taken from the output control. A portion of this voltage, determined by the meter control, is rectified by a half-bridge using crystal diodes. Non-linearity of the diodes at low signal level is compensated by a third diode across the meter. The meter has three calibrated scales: 0-1 volt, 0-3 volts, and -10 to +2 dB. When the instrument is operated with the proper termination, the meter and attenuator will indicate the output level at the terminals.

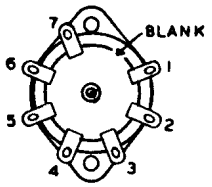



PICTORIAL-1.


OUTPUT CONTROL
5K
VR
4K
8K
15W
MULTIPLIER SWITCH
500 pF
50 pF
5000 pF
.05 μF
.5 μF
E
D
C
B
A
BLACK LEADS
EL821.
EF94.
EZ81.

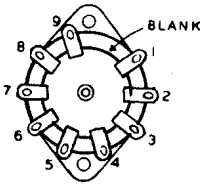
PICTORIAL-2.

( ) Make sure if there is an amendment sheet to this Manual, that you have made the alterations at the appropriate places.




7-PIN V/HOLDER

FIG-4




9-PIN V/HOLDER

FIG-5

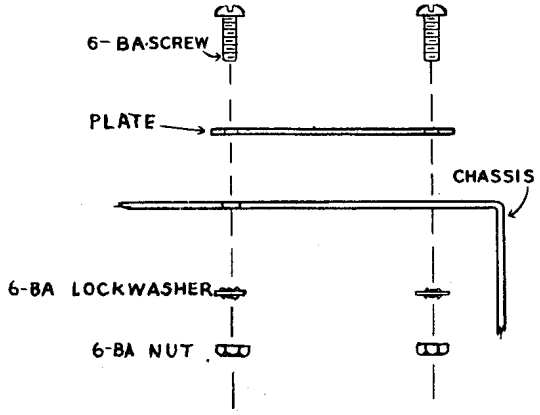



FIG-6.

( ) Mount the 7-pin valveholder, V1, and the two 9-pin valveholders, V2 and V3, on the chassis using 6BA screws (binderhead) lockwashers and nuts. See Figures 4 and 5 for identification. Note the position of the blank spaces in Pictorial 1. Observe that the valveholders mount above the chassis.

( ) Mount the capacitor mounting plate on top of the chassis using 2 - 6BA (binderhead) screws, lockwashers and nuts as shown in Figure 6.

( ) Mount the tungsten lamp socket on top of the chassis, using 2 - 6BA (binderhead) screws, lockwashers and nuts as shown in Pictorial 2.

( ) Install the five 3/8" rubber grommets in positions A, B, C, D and E. See Pictorial 1.

( ) Mount the 5-way tagstrip at location M with 2 - 6BA screws (binderhead) lockwashers and nuts. The earth tags at each end of the tagstrip are not used. To avoid confusion, bend these tags over as shown.

( ) Mount the filter choke below the chassis with 2 - 4BA x $\frac{1}{4}$" screws, lockwashers and nuts.

( ) Mount the power transformer on top of the chassis using 2 - 4BA x 3/8" screws, lockwashers and nuts. Also install the 4-way tagstrip at location N as shown in Figure 7. During the mounting of transformer to chassis feed the 2 BLACK leads through grommet C and the RED, ~~YELLOW~~ + YELLOW, BROWN and GREEN leads through grommet B.

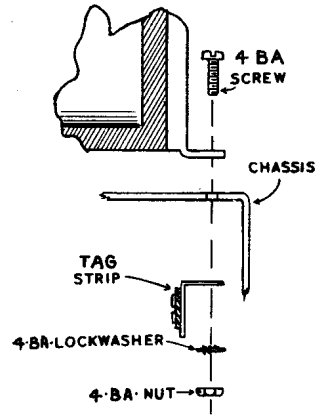
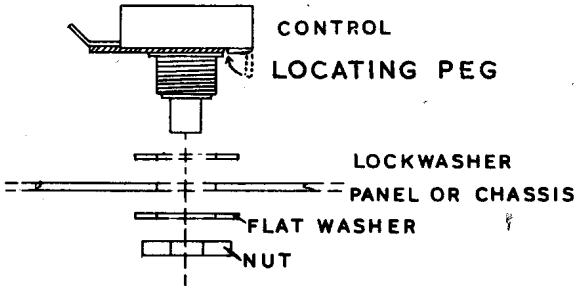



FIG-7.




CONTROL MOUNTING

FIGURE.8.

( ) Mount the 600Ω oscillator control, potentiometer OC. Bend the locating peg as shown. See Pictorial 1 and Figure 8.

( ) Mount the 10 KΩ meter control, potentiometer MC, in the same manner.

( ) Fasten the panel to the chassis by installing the MAINS ON/OFF slide switch. This is the switch having 4 tags. Use 6BA instrument head screws, lockwashers and nuts, with the screw through the panel, the chassis and the switch. Note the tag positions of the switch in Pictorial 1. Do not tighten screws.

( ) Install the LOAD slide switch using 6BA instrument head screws and nuts, in this instance do NOT use lockwashers. Note the tag positions of the switch in Pictorial 1. Check the alignment of the three holes in the panel and chassis, then tighten the screws on the MAINS and LOAD switches.

( ) Install the black and red terminals as shown in Pictorial 1. Use 4BA shakeproof solder tags and before tightening the nuts ensure that the cross-drilled wire holes are horizontal. For terminal assembly see Figure 9.

( ) Mount the [illegible] KΩ output control, potentiometer VR, on the panel. Bend the locating peg as shown. See Pictorial 2 and Figure 8.

( ) Identify the multiplier switch and mount in the same manner. See Pictorial 2.

( ) Mount the 4K KΩ 15 watt resistor to the chassis using a 4BA x $\frac{1}{4}$" screw, 4BA shakeproof solder tag ST and nut as shown in Pictorial 1.

( ) Take the two L brackets and observe that at one end of each bracket the tapped hole has a countersunk entry. This end of the bracket is mounted next to the panel.

( ) Mount each bracket to the panel with a 6BA instrument head screw and to the chassis using a 6BA binder head screw and lockwasher.

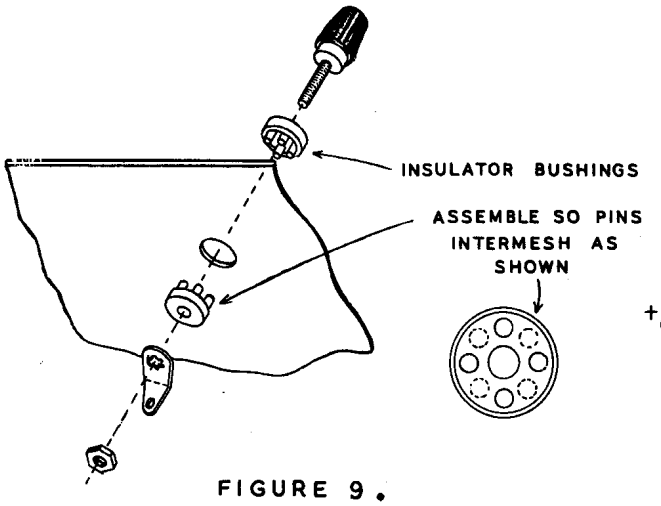



FIGURE 9.

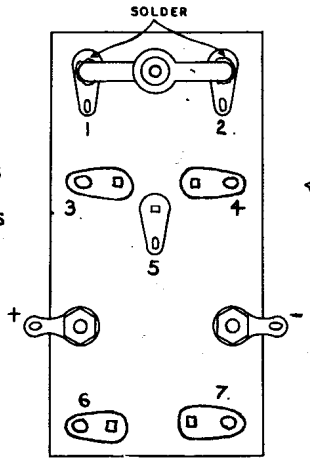



FIG-10.

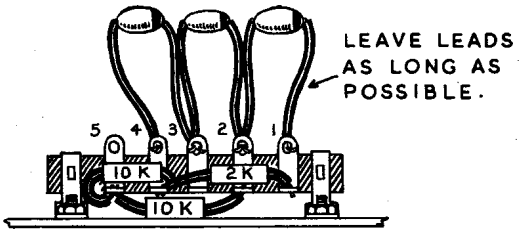



FIGURE-11.

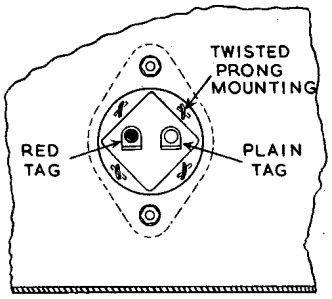



FIGURE-12.

## METER SUB-ASSEMBLY

( ) Remove one nut and the solder tag from each meter stud. NOTE: Hold the inner nut while loosening the outer nut, so that no strain is placed on the plastic meter housing. Run the remaining nut down on the meter stud.

( ) Identify the meter tag board and gently prise the slotted end of tags 1 and 2 approximately 1/8" from the board. See Figure 10.

( ) Install the tag board on the meter studs with the solder tags and nuts that came on the meter. See Pictorial 2.

( ) Solder the pilot lamp socket to tags 1 and 2 as shown in Figure 10.

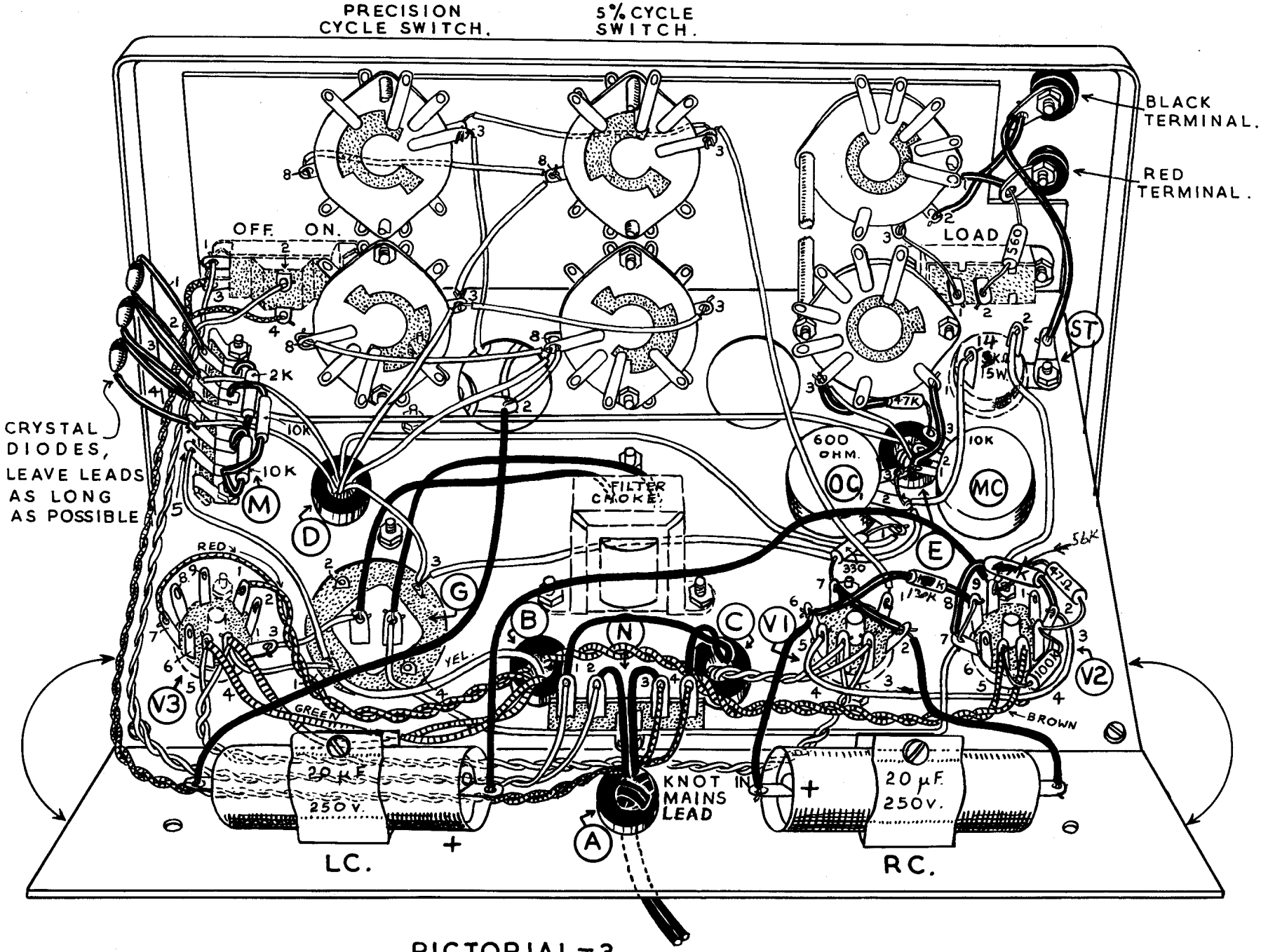
( ) Install the meter on the front panel with the hardware supplied in the meter box.

( ) Slip the 3/8" fibreglass sleeving over the pilot lamp and install the lamp in its socket. Slip the sleeving against the panel.

## 5-WAY TAGSTRIP WIRING

( ) Take a 2 KΩ resistor (RED, BLACK, RED), cut leads to approx. 5/8" and using sleeving connect between the lower tags of M1 (S-1) and M4 (NS). See Figure 11.

( ) Take a 10 KΩ resistor (BROWN, BLACK, ORANGE), cut leads to approx. 5/8" and using sleeving connect between the lower tags of M4 (S-2) and M5 (NS).


PRECISION CYCLE SWITCH.
5% CYCLE SWITCH.
BLACK TERMINAL.
RED TERMINAL.
OFF. ON.
LOAD
ST
2K
10K
10K
CRYSTAL DIODES, LEAVE LEADS AS LONG AS POSSIBLE
M
D
FILTER CHOKE.
600 OHM.
OC
MC
E
56K
330
1.3MK
47Ω
100K
RED
YEL.
GREEN
BROWN
V3
V2
G
B
N
C
VI
20 µF. 250V.
KNOT IN MAINS LEAD
A
LC.
RC.
20 µF. 250v.

PICTORIAL-3.

( ) Take another 10 KΩ resistor (BROWN, BLACK, ORANGE), cut leads to approx. 5/8" and using sleeving connect between the lower tags of M2 (S-1) and M5 (S-2).

( ) Connect a $5\frac{1}{2}$" wire from the upper tag of M4 (NS), route wire through grommet D to the negative(-) meter tag (S-1).

( ) Connect a $7\frac{1}{2}$" wire from the upper tag of M2 (NS), route wire through grommet D to the positive(+) meter tag (S-1).

( ) Connect a crystal diode with the RED cathode lead to the upper tag of M1 (S-1). Connect the other lead to the upper tag of M2 (NS). Leave leads as long as possible. Use 1.3/8" sleeving on each lead.

( ) Connect a second crystal diode with the RED cathode lead to the upper tag of M2 (S-3). Connect the other lead to the upper tag of M3 (NS). Leave leads as long as possible. Use 1.3/8" sleeving on each lead.

( ) Connect a third crystal diode with the RED cathode lead to the upper tag of M3 (NS). Connect the other lead to the upper tag of M4 (S-2). Leave the leads as long as possible. Use 1.3/8" sleeving on each lead.

( ) Install the filter capacitor on top of the chassis by passing the mounting prongs through the slots in the mounting plate, (ensure that the capacitor is correctly positioned) and twist the prongs 1/8 turn with a pair of pliers. See Figure 12 and Pictorial 1. NOTE: After twisting, ensure that none of the prongs are in contact with the chassis.

## CHASSIS WIRING

( ) Connect the YELLOW transformer lead to the twisted mounting prong G1 (NS) on the filter capacitor.

( ) Twist the RED transformer leads and connect one to V3-1 (S-1) and the other to V3-7 (S-1).

( ) Twist the GREEN transformer leads and connect one to V3-4 (NS) and the other to V3-5 (NS).

( ) Twist the BROWN transformer leads and connect one to V2-4 (S-1) and the other to V2-5 (NS).

( ) Connect a wire between V3-4 (NS) and the twisted mounting prong G1 (NS) on the filter capacitor.

( ) Twist two $7\frac{1}{2}$" lengths of wire together and connect one end to V3-4 (S-3) and V3-5 (S-2). At the other end connect one wire to V1-3 (NS) and the other to V1-4 (NS).

( ) Twist two 10" lengths of wire together and connect one end to V1-3 (S-2) and V1-4 (S-2). Pass the other end through grommet C and connect to tag 1 (S-1) and tag 2 (S-1) on the meter tag board.

( ) Connect a wire between V3-3 (S-1) and the RED tag (NS) on the filter capacitor.

( ) Connect one lead from the filter choke to the RED tag (S-2) on the filter capacitor.

( ) Connect the other lead of the filter choke to the PLAIN tag (NS) on the filter capacitor.

( ) Connect a wire between the PLAIN tag (S-2) on the filter capacitor and V2-7 (NS).

( ) Twist two 10" lengths of wire together and connect one end to tag 1 (S-1) on the ON/OFF slide switch and the adjacent end to tag 2 (S-1). At the other end connect one wire to N1 (NS) and the other to N2 (NS).

( ) Twist two $11\frac{1}{2}$" lengths of wire together and connect one end to tag 3 (S-1) on the ON/OFF slide switch and the adjacent end to tag 4 (S-1). At the other end connect one wire to N3 (NS) and the other to N4 (NS).

( ) Twist the BLACK transformer leads and connect one to N1 (S-2) and the other to N4 (S-2).

( ) Connect a wire between the twisted mounting prong G3 (NS) on the filter capacitor and OC2 (NS).

( ) Connect a bare wire link from OC2 (NS) through OC3 (NS) to MC1 (NS).

( ) Connect a wire from tag 1 (S-1) on the tungsten lamp socket, route wire through grommet D to OC1 (NS).

( ) Connect a 330Ω resistor (ORANGE, ORANGE, BROWN) between OC1 (S-2) to V1-7 (NS).

( ) Connect a wire between V1-7 (S-2) and V1-2 (NS).

( ) Connect a wire between V1-5 (S-1) and V2-2 (NS).

( ) Using sleeving connect a ~~150~~ 130 KΩ resistor (BROWN, ~~GREEN~~ ORANGE, YELLOW) between V1-6 (NS) and V2-8 (NS).

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) between V2-3 (NS) and V2-9 (NS).

( ) Connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) between V2-3 (S-2) and V2-5 (S-2).

( ) Using sleeving connect a ~~47~~ 56K KΩ 1 watt resistor (YELLOW, ~~VIOLET~~ BLUE, ORANGE) between V2-2 (S-2) and V2-7 (NS).

( ) Connect a bare wire between V2-7 (S-3) and V2-8 (S-2).

( ) Take the mains lead. Pass it through grommet A in the rear edge of the chassis. Tie a knot for strain relief. Connect one lead to N2 (S-2) and the other lead to N3 (S-2).

( ) Install the two capacitor mounting clamps on rear of chassis flange using 6BA screws, lockwashers and nuts. See Pictorial 3 and Figure 13.

( ) Insert the two 20 μF 250 volt electrolytic capacitors, LC and RC, one in each clamp such that their polarities are positioned as in Pictorial 3.

( ) Insert in each clamp a 4BA x $\frac{1}{2}$" screw, lockwasher and nut and tighten sufficiently to prevent movement of the capacitor. See Figure 13.

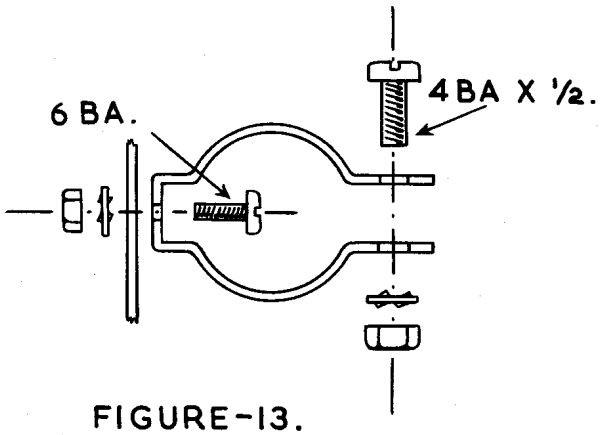


FIGURE-13.

( ) Connect a wire between LC negative (-) (S-1) and tag 2 (NS) on the tungsten lamp socket.

( ) Connect a wire between LC positive (+) (S-1) and V2-9 (NS).

( ) Connect a wire between RC positive (+) (S-1) and V1-6 (S-2).

( ) Connect a wire between RC negative (-) (S-1) and V1-2 (S-2).

( ) Connect a wire between V2-9 (S-3) and tag 2 on the ~~5K~~ 4K 15 watt resistor (S-1).

( ) Connect a wire between OC2 (S-3) and tag 1 on the ~~5K~~ 4K 15 watt resistor (S-1).

( ) Connect a 7$\frac{1}{2}$" wire between tag 2 on the tungsten lamp socket (NS) and VR3 (S-1). Route the wire clear of the 5K 15 watt resistor.

( ) Connect a 4" wire to OC3 (S-2). Pass the wire through grommet E and connect to VR1 (S-1). Route the wire clear of the 5K 15 watt resistor.

( ) Connect a wire between the upper tag of M5 (S-1) and G1 on the filter capacitor (S-4

( ) Connect an 8$\frac{1}{2}$" wire between the upper tag of M3 (S-3) and MC2 (S-1).

## 0-100 CYCLE SWITCH SUB-ASSEMBLY

( ) Identify one of the CYCLE switches and position as shown in Figure 14.

NOTE: The constructor may find it helpful to mount the switch on the base of a small upturned cardboard box. This will make the wiring much easier.

( ) Connect a 50 KΩ precision resistor between tag 9 (S-1) (double tag) on the front section and through tag 9 (S-1) to tag 10 (NS) on the rear section.

( ) Connect a 100 KΩ precision resistor between tag 10 (S-1) on the front section, through tag 10 (S-2) to tag 1 (NS) on the rear section.

( ) Connect a 25 KΩ precision resistor between tag 1 (S-1) on the front section, through tag 1 (S-2) to tag 2 (NS) on the rear section.

( ) Connect a 33.3 KΩ precision resistor between tag 2 (S-1) on the front section, through tag 2 (S-2) to tag 3 (NS) on the rear section.

( ) Connect a 50 KΩ precision resistor between tag 4 (S-1) (double tag) on the rear section, through tag 4 (S-1) to tag 5 (NS) on the front section.

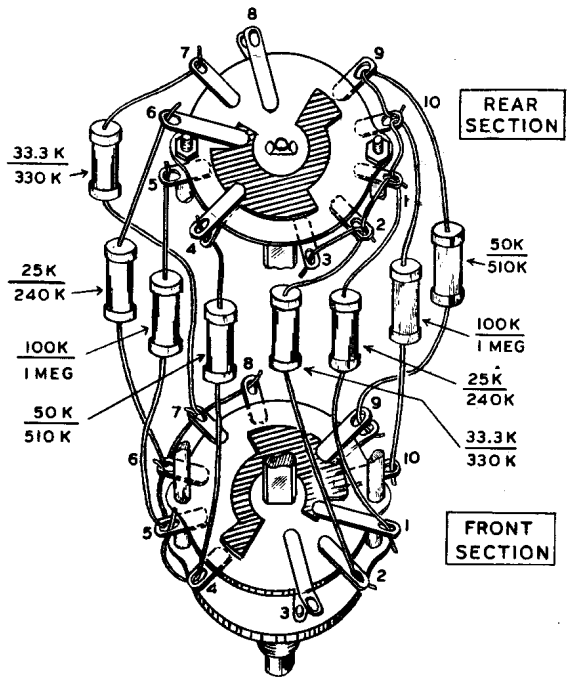



FIGURE-14.

( ) Connect a 100 KΩ precision resistor between tag 5 (S-1) on the rear section, through tag 5 (S-2) to tag 6 (NS) on the front section.

( ) Connect a 25 KΩ precision resistor between tag 6 (S-1) on the rear section, through tag 6 (S-2) to tag 7 (NS) on the front section.

( ) Connect a 33.3 KΩ precision resistor between tag 7 (S-1) on the rear section, through tag 7 (S-2) to tag 8 (NS) on the front section.

( ) Check the switch. Where more than one connection is made to a tag, ensure that the solder flow covers all joints. This also applies where connection is made to a double tag location.

( ) Install the switch through the chassis and panel in the 0-100 position. See Figure 8 for mounting details and Pictorial 3 for orientation.

## 0-10 CYCLE SWITCH SUB-ASSEMBLY

( ) Identify the remaining CYCLE switch and position as shown in Figure 14.

( ) Connect a 510 KΩ 5% resistor between tag 9 (S-1) (double tag) on the front section and through tag 9 (S-1) to tag 10 (NS) on the rear section.

( ) Connect a 1 MΩ 5% resistor between tag 10 (S-1) on the front section, through tag 10 (S-2) to tag 1 (NS) on the rear section.

( ) Connect a 240 KΩ 5% resistor between tag 1 (S-1) on the front section, through tag 1 (S-2) to tag 2 (NS) on the rear section.

( ) Connect a 330 KΩ 5% resistor between tag 2 (S-1) on the front section, through tag 2 (S-2) to tag 3 (NS) on the rear section.

( ) Connect a 510 KΩ 5% resistor between tag 4 (S-1) (double tag) on the rear section, through tag 4 (S-1) to tag 5 (NS) on the front section.

( ) Connect a 1 MΩ 5% resistor between tag 5 (S-1) on the rear section, through tag 5 (S-2) to tag 6 (NS) on the front section.

( ) Connect a 240 KΩ 5% resistor between tag 6 (S-1) on the rear section, through tag 6 (S-2) to tag 7 (NS) on the front section.

( ) Connect a 330 KΩ 5% resistor between tag 7 (S-1) on the rear section, through tag 7 (S-2) to tag 8 (NS) on the front section.

( ) Check the switch. Where more than one connection is made to a tag, ensure that the solder flow covers all joints. This also applies where connection is made to a double tag location.

( ) Install the switch through the chassis and panel in the 0-10 position. See Figure 8 for mounting details and Pictorial 3 for orientation.

## WIRING OF MULTIPLIER SWITCH

( ) Connect a 50 pF capacitor between tag 1 (S-1) on the front and tag 1 (S-1) on the rear of the multiplier switch.

( ) Connect a 500 pF capacitor between tag 2 (S-1) on the front and tag 2 (S-1) on the rear.

( ) Connect a 5000 pF capacitor between tag 3 (S-1) on the front and tag 3 (S-1) on the rear.

( ) Connect a .05 µF capacitor between tag 4 (S-1) on the front and tag 4 (S-1) on the rear.

( ) Connect a .5 µF capacitor between tag 5 (S-1) on the front and tag 5 (S-1) on the rear.

( ) Connect a 5½" wire to tag 6 (S-1) on the front of the multiplier switch. Pass the wire through grommet D and connect to G3 (S-2).

( ) Connect a 4½" wire between tag 7 (S-1) on the front of the multiplier switch and tag 3 (NS) (double tag) on the front of the precision 0-100 cycle switch. Route the wire through the large ventilation hole.

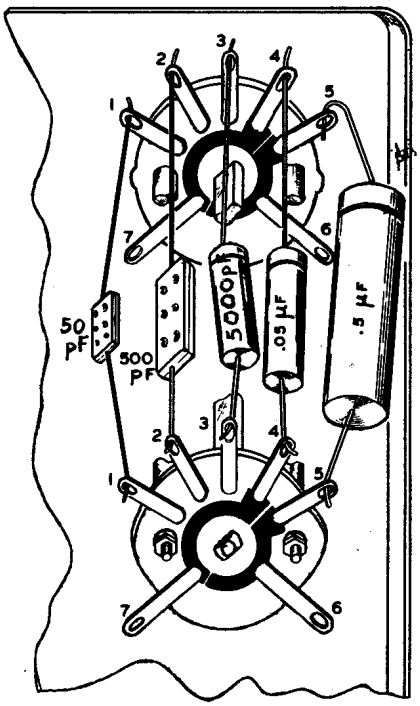



FIG-15.

## UNDER CHASSIS WIRING

( ) Connect a 3½" wire between tag 3 (S-2) (double tag) on the front of the precision cycle switch and tag 3 (NS) (double tag) on the front of the 5% cycle switch.

( ) Connect a 4½" wire between tag 3 (S-2) (double tag) on the front of the 5% cycle switch and V1-1 (S-1).

( ) Connect a 3½" wire between tag 8 (S-2) on the front of the precision cycle switch and tag 8 (NS) on the front of the 5% cycle switch.

( ) Connect a 2½" wire between tag 8 (S-3) on the front of the 5% cycle switch and tag 3 (NS) on the rear of the precision cycle switch.

( ) Connect a 3½" wire between tag 3 (NS) on the rear of the precision cycle switch and tag 3 (S-2) on the rear of the 5% cycle switch.

( ) Connect a 5½" wire from tag 3 (S-4) on the rear of the precision cycle switch, route wire through grommet D to tag 6 (S-1) on the rear of the multiplier switch.

( ) Connect a 3½" wire between tag 8 (S-1) (double tag) on the rear of the precision cycle switch and tag 8 (NS) (double tag) on the rear of the 5% cycle switch.

( ) Connect a 2½" wire from tag 8 (NS) (double tag) on the rear of the 5% cycle switch, route wire through the large ventilation hole to tag 2 (S-3) on the tungsten lamp socket.

( ) Connect a $4\frac{1}{2}$" wire from tag 8 (S-3) (double tag) on the rear of the 5% cycle switch, route wire through grommet D to tag 7 (S-1) on the rear of the multiplier switch.

Route all preceding wires so that they will not interfere with the operation of the switches.

ATTENUATOR SWITCH SUB-ASSEMBLY

( ) Identify the ATTENUATOR switch and position as shown in Figure 16.

( ) Connect a 750Ω 5% resistor (VIOLET, GREEN, BROWN) between tag 2 (NS) and tag 8 (NS) on the front section.

( ) Connect a 1600Ω 5% resistor (BROWN, BLUE, RED) between tag 8 (S-2) and tag 7 (NS) on the front section.

( ) Connect a 1100Ω 5% resistor (BROWN, BROWN, RED) between tag 4 (NS) and tag 7 (NS) on the front section.

( ) Connect a second 1600Ω 5% resistor (BROWN, BLUE, RED) between tag 7 (S-3) and tag 6 (NS) on the front section.

( ) Connect a second 1100Ω 5% resistor (BROWN, BROWN, RED) between tag 6 (NS) and tag 4 (NS) on the front section.

( ) Connect a third 1600Ω 5% resistor (BROWN, BLUE, RED) between tag 6 (S-3) on the front section and tag 7 (NS) on the rear section.

( ) Using sleeving, connect a bare wire between tag 5 (S-1) on the front section and tag 8 (S-1) on the rear section.

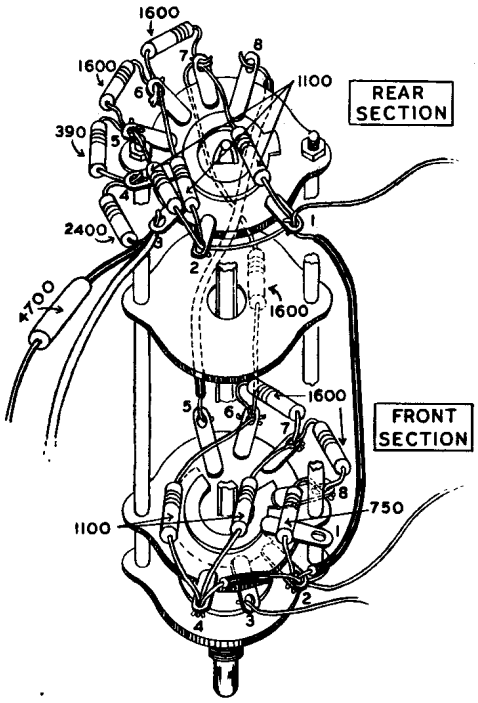



FIGURE-16.

( ) Connect a 3" bare wire to tag 4 (S-3) and after slipping a 1" length of sleeving on, place the lead through tag 2 (NS) on the front section. Leave the excess bare wire for eventual connection to a terminal.

( ) Connect a $1\frac{1}{2}$" bare wire to front section tag 3 (S-1). Leave the other end for eventual connection to the load switch.

( ) Connect a 3" bare wire to tag 2 (S-3) on the front section and after slipping on a 1" length of sleeving, place through tag 1 (NS) on the rear section. Leave the excess length for eventual connection to the controls.

( ) Connect a third 1100Ω 5% resistor (BROWN, BROWN, RED) between tag 1 (NS) and tag 7 (NS) on the rear section.

( ) Connect a fourth 1600Ω 5% resistor (BROWN, BLUE, RED) between tag 7 (S-3) and tag 6 (NS) on the rear section.

( ) Connect a fourth 1100Ω 5% resistor (BROWN, BROWN, RED) between tag 2 (NS) and tag 6 (NS) on the rear section.

( ) Connect a fifth 1600Ω 5% resistor (BROWN, BLUE, RED) between tag 6 (S-3) and tag 5 (NS).

( ) Connect a fifth 1100Ω 5% resistor (BROWN, BROWN, RED) between tag 5 (NS) through tag 2 (S-2) to tag 1 (S-3).

( ) Connect a 390Ω 5% resistor (ORANGE, WHITE, BROWN) between tag 5 (S-3) and tag 4 (NS).

( ) Connect a 2400Ω 5% resistor (RED, YELLOW, RED) between tag 4 (S-2) and tag 3 (NS).

( ) Take a 4700Ω resistor (YELLOW, VIOLET, RED) and cut one lead to approximately 5/8". Use $\frac{1}{2}$" sleeving and connect this end to tag 3 (NS) on the rear section. Leave the other end free.

( ) Connect a 5" wire to tag 3 (S-3) on the rear section, leave the other end free.

( ) Check the switch. Ensure that no resistors foul moving parts. Where more than one connection is made to a tag, ensure that the solder flow covers all joints.

( ) Install the attenuator switch through the chassis and panel. See Figure 8 for mounting details and Pictorial 3 for orientation.

( ) Connect a 560Ω 5% resistor (GREEN, BLUE, BROWN) between tag 2 (S-1) on the load switch and the solder tag of the RED output terminal (NS).

( ) Using sleeving, connect the bare wire from tag 1 on the rear section of the attenuator switch to MC1 (S-2).

( ) Using 1" sleeving, connect the free end of the 4700Ω resistor (YELLOW, VIOLET, RED) (other end previously connected to tag 3 on rear section of attenuator switch) to MC3 (S-1).

( ) Take the 5" wire (other end previously connected to tag 3 on rear section of attenuator switch) pass through grommet E and connect to VR2 (S-1). Route the wire clear of the 5 KΩ 15 watt resistor.

( ) Connect the bare wire from tag 3 on the front section of the attenuator switch to tag 1 (S-1) on the LOAD switch.

( ) Using sleeving, connect the bare wire from tag 2 on the front section of the attenuator switch to the solder tag (NS) on the BLACK terminal.

( ) Using sleeving, connect a bare wire between the solder tag (S-2) on the BLACK terminal and the solder tag ST (S-1). See Pictorial 3.

( ) Using sleeving, connect a bare wire between tag 1 on the front section of the attenuator switch (S-1) and the solder tag on the RED output terminal (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) and inspect each connection carefully for good solder joints.

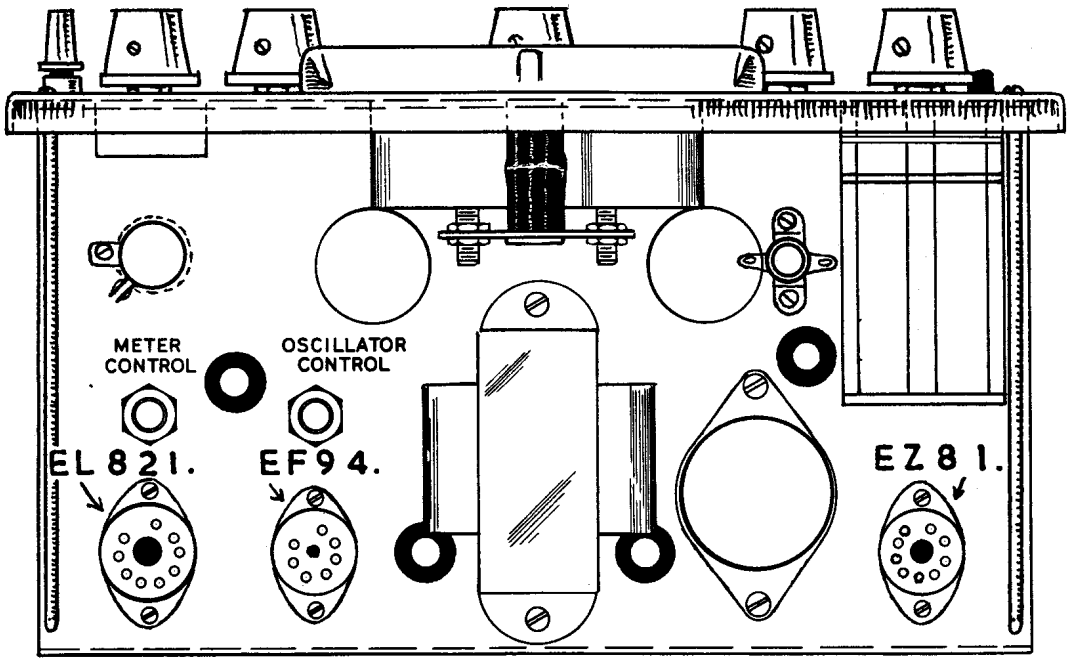



FIG-17.

( ) Fit the five knobs on the shafts of the panel controls and position them correctly.

( ) Install the 10 watt ~~115~~ 250 volt tungsten lamp.

( ) Install the EF94, EL821 and EZ81 valves, see Figure 17.

→ ( ) Prepare the cabinet by installing the handle with 2 - 4BA x $\frac{1}{4}$" screws and lockwashers and by pushing the rubber feet into the four holes in the bottom. Moistening the rubber feet will facilitate installation. See Figure 18.


FIG-18.

## INITIAL TEST AND ADJUSTMENT

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 mains switch on and observe the valves and pilot lamp as they light up. If they do not glow red, turn the mains off and investigate the heater circuit wiring. Set OSCILLATOR and METER controls about centre of rotation. Set the 0-100 CYCLE switch to 10 or more and advance the OUTPUT control. This should show a reading on the meter.

Calibration of the meter. NOTE: If in the following test the OUTPUT control is left in the fully anti-clockwise position, the control will be severely damaged. Proceed as follows: Turn both CYCLE switches to 0. Turn the OUTPUT control to maximum clockwise. Turn the ATTENUATOR to maximum clockwise (10 volt/+20 dB). Connect a wire between the red output terminal and one of the pilot lamp tags on the meter tag board. Use the tag that gives a meter indication. Turn the METER control to produce a meter reading of .63 volts on the 0-1 scale. (The actual voltage will be 10 times this indication, i.e. 6.3 volts.)

If an accurate AC voltmeter of adequate sensitivity (at least 500Ω per volt on the 10 volt range for instance) is available, it should be used in preference to the above procedure. In that case: select a suitable frequency (between 50 and 3000 cycles, depending upon the AC meter used) with the CYCLE and MULTIPLIER switches and connect the meter to the output terminals of the generator. Adjust the METER control to produce equal readings on the two meters.

Adjust the OSCILLATOR control as follows: No connections to the output terminals. OUTPUT control at maximum. CYCLE switches and MULTIPLIER to 10 cycles or more. Turn OSCILLATOR control to give just over full scale reading on the meter. Select various frequencies between 10 cycles and 100 kc and if the output drops below full scale, readjust OSCILLATOR control for full scale. Do not adjust OSCILLATOR control higher than necessary as greater than nominal distortion will result.

This completes the adjustment of the instrument. Feed the mains lead through the hole at the rear of the cabinet. Install the generator in the cabinet and fasten with the two 3/8" sheet metal screws through the rear of the cabinet into the chassis.

## IN CASE OF DIFFICULTY

If upon completion of careful construction, the instrument fails to operate as specified, 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 glowing brighter than normal, discolouring of resistors through overheating, etc.
3. Inspect electrically with a voltmeter. The nominal voltages between valveholder tags and chassis are tabulated below. Nominal voltages were measured with a Heathkit V-7A/UK having an input resistance of 11 megohms. Voltage checks made with instruments of other input characteristics may vary greatly. 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 |
|---|---|---|---|---|---|---|---|---|---|
| EF94 | .6 | ~~2.65~~ 2.8 | H | H | ~~180~~ 155 | ~~135~~ 162 | ~~2.65~~ 3.8 | - | - |
| EL821 | N | ~~180~~ 155 | ~~185~~ 158 | H* | H* | N | ~~380~~ 360 | ~~380~~ 360 | ~~185~~ 156 |
| EZ81 | 320AC | N | ~~385~~ 370 | H | H | N | 320AC | N | N |

N = No connection.
H* = Heater voltage 6.3v AC between pins. CAUTION: These pins are +185 volts with respect to chassis.
H = Heater voltage (one pin 0 volts, other pin 6.3 v AC).
Generator frequency set to 1 kc/s.

Discrepancies of indicated voltages warrant investigation of the particular circuit involved. Wiring errors or faulty components may be found by inspection or resistance measurements.

Consider the characteristics of the circuit by re-reading the circuit description. An understanding of the theory will aid in locating and correcting difficulties.

If intelligent investigation along the lines indicated does not solve your problem, write to Daystrom Limited describing your difficulty in detail, giving all symptoms, voltages and other data that may aid in correcting your trouble. Be sure to state model and name of instrument, AG-9U Audio Generator. You will receive a prompt reply to guide your further efforts.

## APPLICATION

The instrument lends itself to the many applications in audio laboratories where a near-perfect sine wave signal within its amplitude and frequency limits is required. Some of the applications are as follows:

Signal source for bridge measurements.
Signal source for harmonic distortion measurements.
Signal source for external modulation of RF signal generators.
Signal source for testing of audio amplifiers for gain and frequency response.

## OPERATION

The instrument produces a low distortion sine wave signal voltage of variable amplitude and frequency. To select the desired frequency, adjust the 0-100 knob to the first significant figure, adjust the 0-10 knob to the second significant figure and turn the multiplier to the desired value.

Example: For a frequency of 35 cycles, set the 0-100 knob to 30, the 0-10 knob to 5 and the multiplier to X1.

Example: For a frequency of 72 kc, set the 0-100 knob to 70, the 0-10 knob to 2 and the multiplier to X1000.

To select the desired output amplitude into a high impedance load (10 KΩ or more): Set the LOAD switch to INT., the ATTENUATOR to the nearest full scale value above the desired output; adjust the OUTPUT control to give the desired output on the appropriate meter scale.

Example: Desired voltage 7.3 volts. Set ATTENUATOR to 10 volts full scale. Turn OUTPUT to give a .73 volt reading on the 0-1 volt scale.

Example: Desired voltage .025 volts. Set ATTENUATOR to .03 volts full scale. Turn OUTPUT to give a 2.5 volt reading on the 0-3 volt scale.

To select the desired output amplitude into an external 600Ω load (1 volt maximum): Set the LOAD switch to EXT. and proceed as above.

## USING THE dB SCALE

The decibel is the ratio of two power levels and is used in comparative expressions. It may be applied to voltage levels if the impedances are identical. It may be used as a quantitative indication for one power or voltage level if the other level is defined. In this instrument, the dB scale is based on a reference or standard level of 0 dB = 1 milliwatt in 600Ω. If used with a 600Ω external load, the meter reading is expressed in dBm and the reference level is automatically defined.

If the instrument is used with loads differing from 600Ω but substantially less than 10 KΩ, correction factors for the voltage reduction in the attenuator and for the dB level may be calculated.

If the instrument is used with high impedance loads, the relation between two signal levels may be expressed as a number of dB difference.

Example: A device requires a signal of .61 volts on one input jack for a certain output. It requires a signal of .012 volts on another input jack for the same output. How many dB difference between the two input jacks?

.61 volts is -2dB (on meter) $\pm$ 0 dB (on attenuator) = -2
.012 volts is -6 dB (on meter) - 30 dB (on attenuator) = -36
level difference is (-2) - (-36) = 34 dB.

NOTE: Theoretically the input impedances should be equal in the above example. The method described is generally more useful than calculating the power level at each input, using voltage and input impedance and using the formula:

$$dB = 10 \log \frac{P_1}{P_2} = 10 \log \frac{E_1^2/R_1}{E_2^2/R_2}$$

for equal impedance this reduces to:

$$dB = 10 \log \frac{(E_1)2}{(E_2)2} = 20 \log \frac{E_1}{E_2}$$

Although theoretically correct, erroneous impressions may be experienced by using the above approach.

For further information see: Langford-Smith; Radio Designer's Handbook, 7th Ed. Ch. 13.

## ACCURACY

Frequency is primarily determined by the bridged T network and thus the precision of the components in this network. Nominal tolerance for the precision resistors is 1% and for the capacitors 2%. The influence of the 5% resistors is at most, a tenth of the effect of the precision resistors, so their maximum contribution is not more than 1/2%. Allowing for temperature effects, stray capacities and phase shift of the amplifiers at the frequency limits, the maximum frequency error is expected to fall within 5% of the indicated frequency.

Output voltage depends upon a number of factors. Meter calibration is the task of the constructor and it should be borne in mind that most instruments are subject to frequency errors. Moving iron and dynamometer instruments rarely maintain their rated accuracy above 150 cycles. Rectifier instruments begin to drop at about 5 to 10 kc. The output voltage is further affected by the attenuator. Here 5% resistors are used and the resultant accuracy should fall within 5%. The attenuator accuracy also depends upon the load resistance, particularly on the 3 volt range, where a 12 KΩ load makes the output $\frac{1}{2}$ dB less than indicated and a 2000Ω load causes a 3 dB error.

On the 1 volt range and below, a high impedance load will be subjected to twice the indicated voltage (6 dB high) if the internal load is not used.

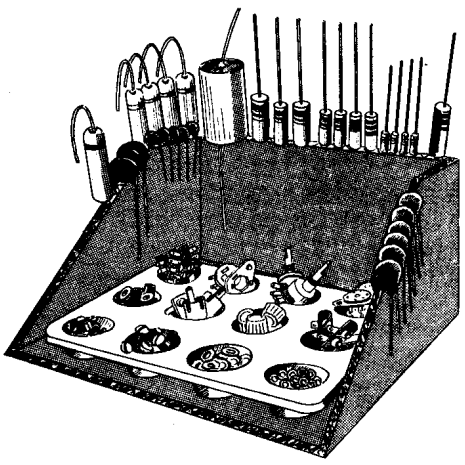
On the 10 volt range, however, loading, whilst lowering the output voltage, will not cause errors because the meter indicates the output voltage directly. Loads of less than 10 KΩ may increase the distortion and very low resistance loads effectively short out the EL821 output and cause oscillation to cease, when the output control is set at maximum.

The meter and its circuit contribute additional inaccuracies at voltages differing from the calibration voltage. The meter movement may deviate as much as 2% of the full scale value due to the discrepancy between the nominal meter curve on which the scale is based and the characteristics of the particular movement in an instrument. The meter rectifiers are non-linear at low voltages but this deviation is effectively compensated for by the third diode. Considering all the factors affecting the accuracy of the output voltage, it is expected to fall within 5% of the indicated value.

## BIBLIOGRAPHY

This manual is written to enable the owner of this instrument to successfully assemble and operate it. It is not an exhaustive treatise on the subject of Audio Generators and their use. Further information may be obtained from the many fine textbooks and excellent magazine articles available from most libraries. A few of these sources are listed below:

Audio Measurements - Crowhurst
High Fidelity Sound Reproduction - Newnes
Electronic Engineering
Wireless World
British Communications and Electronics
Hi-Fi News



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.

## 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.

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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 | 1 | 47Ω |
| H-331C10 | 1 | 330Ω |
| H-472C10 | 1 | 4700Ω |
| H-104C10 | 1 | 100 KΩ |
| ~~H-154C10~~ 4-134C5 | 1 | ~~150 KΩ~~ 130K |
| ~~1-473C10~~ 1-563H51 | 1 | ~~47 KΩ 1 watt~~ 56K 1% 1w |
| **Resistors ± 5%** | | |
| H-391C5 | 1 | 390Ω |
| H-561C5 | 1 | 560Ω |
| H-751C5 | 1 | 750Ω |
| H-112C5 | 5 | 1100Ω |
| H-162C5 | 5 | 1600Ω |
| H-202C5 | 1 | 2000Ω |
| H-242C5 | 1 | 2400Ω |
| H-103C5 | 2 | 10 KΩ |
| H-244C5 | 2 | 240 KΩ |
| H-334C5 | 2 | 330 KΩ |
| H-514C5 | 2 | 510 KΩ |
| H-105C5 | 2 | 1 megohm |
| ~~15-502W5~~ 15-402W5 | 1 | ~~5000Ω~~ 15 watt 4K |
| **Resistors ± 1%** | | |
| 2-97 | 2 | 25 KΩ precision |
| 2-98 | 2 | 33.3 KΩ precision |
| 2-99 | 2 | 50 KΩ precision |
| 2-11 | 2 | 100 KΩ precision |
| **Capacitors** | | |
| 20-517 | 1 | 50 pF mica ± 2% |
| 20-518 | 1 | 500 pF mica " |
| 23-508 | 1 | 5000 pF paper " |
| 23-509 | 1 | .05 µF paper " |
| 23-510 | 1 | .5 µF paper " |
| 25-513 | 2 | 20 µF 250v electrolytic |
| 25-508 | 1 | 40-40 µF electrolytic, 450v |
| **Potentiometers, Switches** | | |
| 10-514 | 1 | 600Ω potentiometer |
| 10-515 | 1 | 5000Ω potentiometer |
| 10-506 | 1 | 10 KΩ potentiometer |
| 60-504 | 1 | SPST slide switch |
| 60-505 | 1 | DP ON/OFF slide switch |
| 63-8 | 1 | 4-position switch MULTIPLIER |
| 63-107 | 1 | 8-position switch ATTENUATOR |
| 63-108 | 2 | 11-position switch CYCLE |
| **Tagstrips, Terminals, Knobs** | | |
| 427-501 | 1 | Terminal, red |
| 427-502 | 1 | Terminal, black |
| 431-502 | 1 | 4-way tagstrip |
| 431-514 | 1 | 5-way tagstrip |
| 431-513 | 1 | Tag board |
| 462-19 | 5 | Knob, with skirt |

| PART No. | PARTS Per Kit | DESCRIPTION |
|---|---|---|
| **Valves, Lamp, Valveholders** | | |
| 411-514 | 1 | Valve, EF94 (6AU6) |
| 411-509 | 1 | Valve, EL821 |
| 411-512 | 1 | Valve, EZ81 |
| 412-505 | 1 | 250 ~~115v~~, 10 watt Tungsten lamp |
| 412-4 | 1 | Pilot lamp, 6v .115 amp |
| 434-516 | 1 | 7-pin valveholder |
| 434-502 | 2 | 9-pin valveholder |
| 434-518 | 1 | Tungsten lamp socket |
| 434-47 | 1 | Pilot lamp socket |
| 438-505 | 1 | 5A FUSED PLUG |
| **Choke, Transformer, Diode, Meter** | | |
| 46-502 | 1 | Filter choke |
| 54-508 | 1 | Power transformer |
| 56-501 | 3 | Crystal diode |
| 407-8A | 1 | Meter |
| **Hardware** | | |
| 250-513 | 5 | 4BA x ¼" screw, binder head |
| 250-9U | 2 | 4BA x 3/8" screw, " " |
| 250-517 | 2 | 4BA x ½" screw, " " |
| 250-525 | 6 | 6BA x 5/16" screw, instrument head, chrome plated |
| 250-501 | 18 | 6BA x ¼" screw, binder head |
| 252-3 | 7 | 4BA hex nut |
| 252-501 | 20 | 6BA hex nut |
| 254-1 | 9 | 4BA lockwasher |
| 254-501 | 20 | 6BA lockwasher |
| 259-504 | 3 | 4BA shakeproof solder tag |
| 250-8 | 2 | 3/8" sheet metal screw |
| **Sheet Metal Parts** | | |
| 90-507 | 1 | Cabinet |
| 200-505 | 1 | Chassis |
| 203-504 | 1 | Panel |
| 204-507 | 2 | Bracket |
| **Wire, Sleeving** | | |
| 89-1 | 1 length | Mains lead |
| 340-501 | 1 length | Bare wire, 22 swg |
| 344-506 | 1 length | Connecting wire |
| 346-501 | 1 length | Sleeving, 1.5 mm |
| 346-6 | 1 length | Sleeving, 3/8" |
| 331-501 | 1 length | Solder, 18 swg |
| **Miscellaneous** | | |
| 73-501 | 5 | 3/8" rubber grommet |
| 211-4U | 1 | Handle |
| 261-502 | 4 | Rubber feet |
| 481-503 | 1 | Insulated mounting plate for electrolytic capacitor |
| 207-505 | 2 | Capacitor mounting clamp |
| 595-508 | 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.

MODEL AG-9U

MODIFICATION entered

To facilitate your construction of this kit with the maximum of ease, will you kindly insert the following alterations in your Instruction Manual NOW. Thank you.

| Page | | |
|---|---|---|
| 2 | Circuit Diagram | Location V1 anode - amend "47 KΩ 1W resistor" to "56 KΩ 1W resistor".<br>Location V1 screen - amend "150 KΩ resistor" to "130 KΩ resistor".<br>Location V1 cathode - amend "115v 10W lamp"to "250v 10W lamp".<br>Location V2 cathode - amend "5000Ω 15W resistor" to "4000Ω 15W resistor". |
| 7 | Pictorial 1 | Amend "5 KΩ 15W resistor" to "4KΩ 15W resistor". |
| 8 | Pictorial 2 | Amend "5 KΩ 15W" to "4 KΩ 15 W". |
| 9 | Step 8 | Amend to read "..... the YELLOW and two BLACK leads through grommet C....." |
| 10 | Step 5 | Amend "5KΩ 15 watt" to "4KΩ 15 watt" |
| 11 | Pictorial 3 | Location V1/V2 - amend "150 KΩ resistor" to "130 KΩ resistor".<br>Location V2 - amend "47 KΩ resistor" to "56 KΩ resistor"<br>Location 5 KΩ 15W resistor - change this resistor to read "4 KΩ 15 W" resistor. |
| 12 | Step 8 | Amend to read "Connect the two YELLOW transformer leads.." |
| 13 | Step 3 | Delete "150 KΩ resistor (BROWN, GREEN, YELLOW)" and insert "130 KΩ resistor (BROWN, ORANGE, YELLOW)". |
| 13 | Step 6 | Delete "47 KΩ" and insert " 56 KΩ". |
| | Steps 16 & 17 | Delete "5KΩ 15W resistor" and insert "4KΩ 15 W resistor". |
| | Step 20 | Amend to read "....on the filter capacitor (S-4)". |
| 17 | Step 10 | Delete "10 watt 115 volt" and insert "10 watt 250 volt". |
| | New step | Immediately before the last step, at the bottom of the page, insert this additional step "( ) Insert the 0.5A fused plug in the voltage selector panel on top of the transformer at the appropriate voltage tapping to suit your mains supply". |
| 18 | IMPORTANT WARNING: | When carrying out the adjustments "Calibration of the meter" and "Adjustment of the Oscillator Control" proceed with extreme care as the meter and oscillator controls are immediately beneath the voltage selector panel on the transformer. The tags on this panel are at mains supply voltage. |
| 18 | Voltage Chart: | Amend as follows:- |

| VALVE | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 | Pin 6 | Pin 7 | Pin 8 | Pin 9 |
|---|---|---|---|---|---|---|---|---|---|
| EF94 | .6 | 3.8 | H | H | 155 | 162 | 3.8 | - | - |
| EL821 | N | 155 | 158 | H | H | N | 360 | 360 | 156 |
| EZ81 | 320 AC | N | 370 | H | H | N | 320 AC | N | N |

| | | |
|---|---|---|
| 22 | PARTS LIST: | Delete "1-473C10 1 off 47KΩ 1 watt"<br>Insert "1-563HS1 1 off 56 KΩ ± 1% 1 watt".<br>Delete "H-154C10 1 off 150 KΩ resistor"<br>Insert "H-134C5 1 off 130 KΩ resistor".<br>Delete "15-502W5 1 off 5000Ω 15 watt".<br>Insert "15-402W5 1 off 4000Ω 15 watt".<br>Amend Part No.412-505 to read 250v. 10W. Tungsten Lamp.<br>Add New Part "438-505 1 off Fused Plug 0.5A". |