Assembling and Using Your...

Heathkit
DAYSTROM

AUDIO WATTMETER

MODEL AW-1U

DAYSTROM LIMITED
A Member of the Schlumberger Group including the Heath Company.
Manufacturers of the world's finest Electronic Equipment in Kit Form.
GLOUCESTER, ENGLAND

ADVICE OF CHANGE

Colour Coding of Mains Cables.

H.M. Government have decided to make regulations requiring the core colours of three-core flexible cables to comply with the following international coding recently agreed by most of the countries in Europe:

Green and Yellow striped core	EARTH
Brown core	LIVE
Light blue core	NEUTRAL

Under the old system the colour code was Green -EARTH; Red - LIVE; Black - NEUTRAL.

When connecting the mains cable in your kit, please amend the appropriate step/s in your manual as follows:-

Amend Green to read Green and Yellow stripe.

Amend Red to read Brown.

Amend Black to read Light blue.

A.O.C. 8-10-69/Gen.

lead is always the lead attached to the aluminium case.

GENERAL ADVICE OF CHANGE

Some of the components supplied with this kit may differ slightly from the descriptions and pictorials given in the manual.

Resistors

These may be colour coded instead of value marked. For identification, use the chart found on the inside cover of the Manual.

Capacitors (Polyester)

These may be colour coded instead of value marked. The value colour code is the first three colour bands, starting with the end furthest from the leads. Where the first two colours are the same, this is denoted by a very wide first colour band. The remaining colours are used to denote tolerance and voltage working. The following values are in common use:-

.01 µF	=	10,000 pF	=	Brown, Black, Orange
.022 µF	=	22,000 pF	=	Red, Red, Orange
.1 µF	=	100,000 pF	=	Brown, Black, Yellow
.22 µF	=	220,000 pF	=	Red, Red, Yellow
.47 µF	=	470,000 pF	=	Yellow, Violet, Yellow.

Capacitors, (Electrolytic) Polarity Identification

The positive (+) lead of electrolytic capacitors is the end with a Red, White or Black insulator and on the larger types also with a + sign. The negative lead is always the lead attached to the aluminum case.

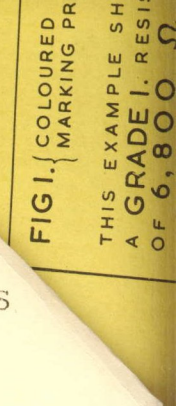
The capacity values supplied may be slightly higher or lower than that specified in the parts. For example 2.5µF may be supplied in lieu of 2µF and 640µF may be supplied in lieu of 650µF. Also the voltage working may be slightly higher than that specified.

Diodes and Transistors

Transistors and diodes may be supplied with an improved or alternative type to that stated in the manual and will perform satisfactorily.

For example:-

Part No. 56-510	IN191 / OA79 Diode. Now replaced by AA119 Diode. The positive (+) end is marked with a coloured ring.
Part No. 417-522	2N408 Transistor. AC128 transistors may be supplied in lieu.



RESISTOR CODING 686/18/ALL MODELS

Any insulated wire wound resistors in this kit may be value coded as shown below.

Resistor

Resistor Value	Code
0.1 Ω	R10
0.24 Ω	R24
1 Ω	1RO
10 Ω	10R
1 KΩ	1KO
1.5 KΩ	1K5

Tolerance

Tolerance	Code
± 0.1 %	B
± 0.25 %	C
± 0.5 %	D
± 1%	F
± 2%	G
± 5%	J
± 10%	K
± 20%	M
± 30%	N
± .05 Ω	± .05 Ω

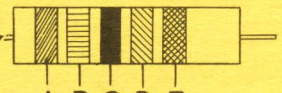
Examples

Value		Code	
0.24 Ω	± .05 Ω	R24	± 05 Ω
10 Ω	± 5%	10R	J
90 Ω	± 10%	90R	K

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 10²)
GOLD (± 5%)
{ SALMON PINK (GRADE 1.) — THIS MAY BE GENERAL BODY COLOUR

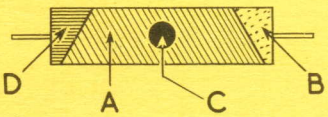


FIG 2. BODY, TIP & SPOT MARKING

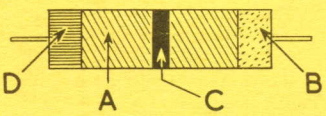
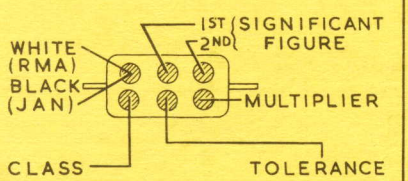


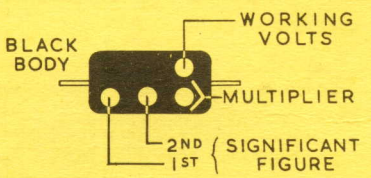
FIG 3. BODY TIP & CENTRAL BAND MARKING

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

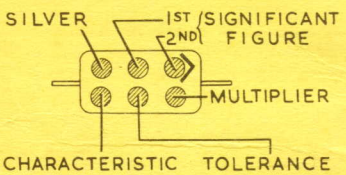
CURRENT STANDARD CODE



MOULDED FLAT CAPACITOR COMMERCIAL CODE



JAN. CODE CAPACITOR



COLOUR CODE FOR RESISTORS AND CAPACITORS

Colour	Value in Ohms or 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	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	-	-	-	-	-	-	-	

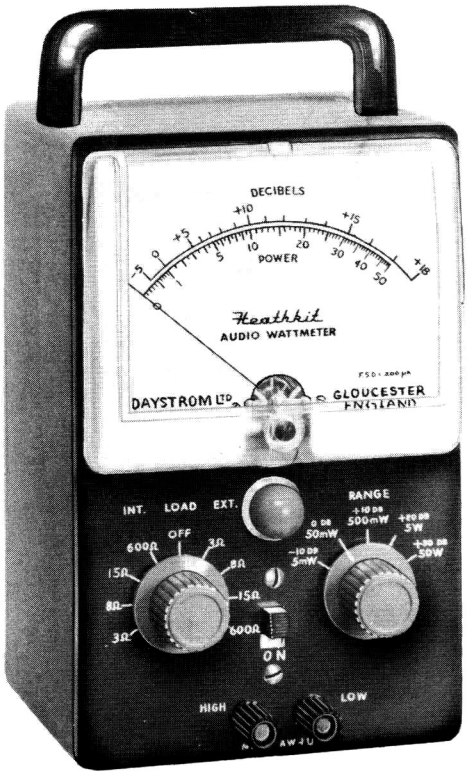
The Colour coding should be read from left to right, in order, starting from the end and finishing near the middle.

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.

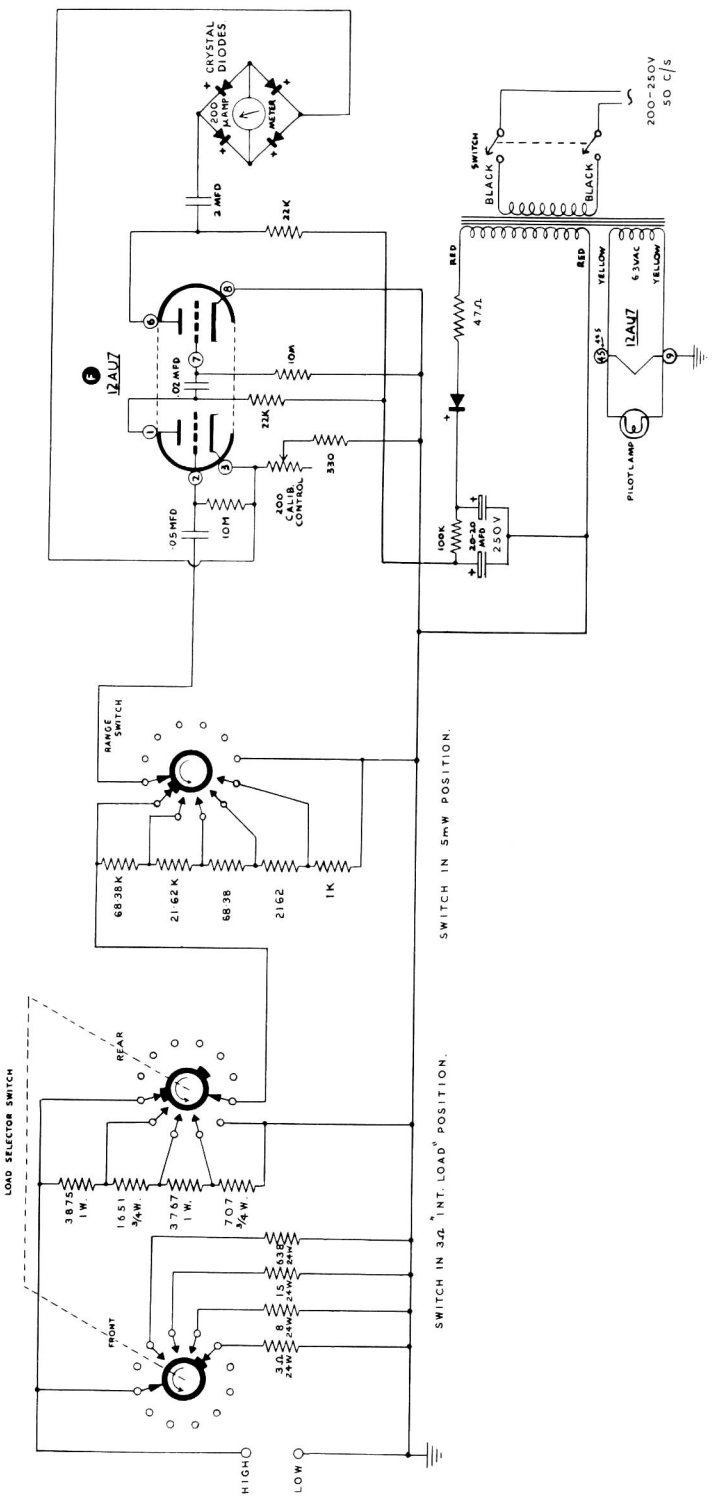
HEATHKIT AUDIO WATTMETER

MODEL AW-1U

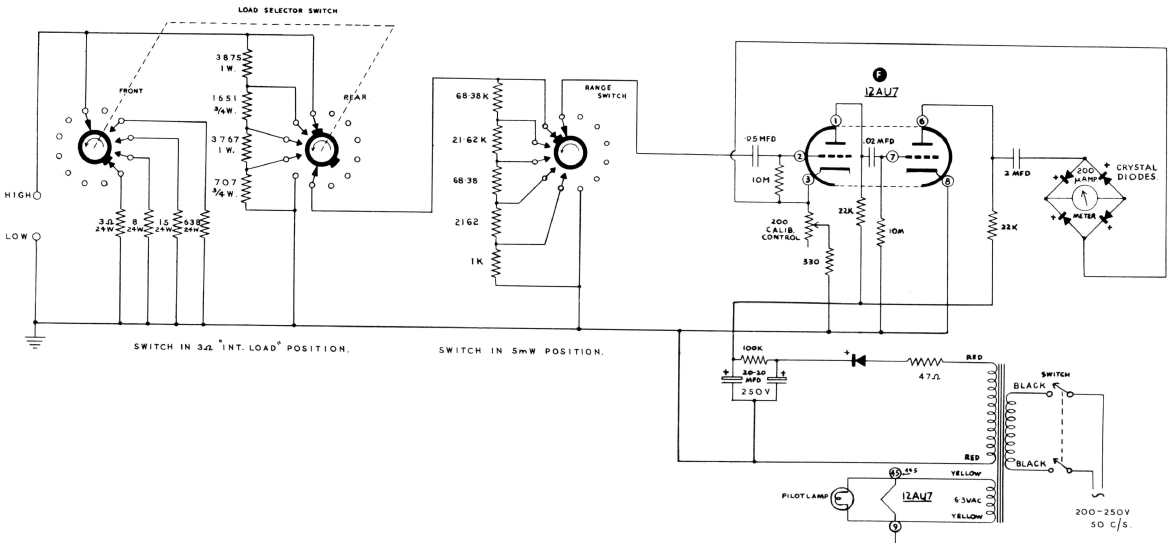


SPECIFICATIONS

Frequency Response:	± 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:	4½" 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:	3¾ lbs.
Shipping Weight:	6 lbs.



HEATHKIT AUDIO WATTMETER MODEL AW-1U



HEATHKIT AUDIO WATTMETER MODEL AW-1U

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 ± 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.

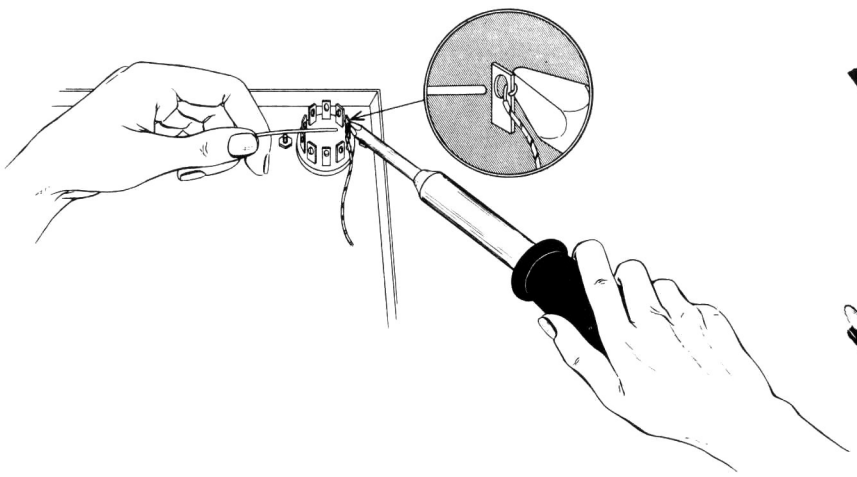
Highest quality resin-cored solder is essential for efficiently securing this kit's wiring and components. The resin core acts as a flux or cleaning agent during the soldering operation.

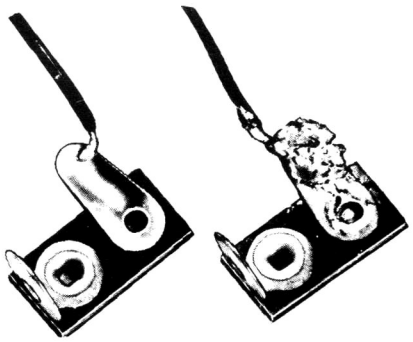
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture.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

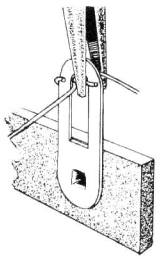
IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number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

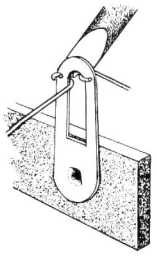




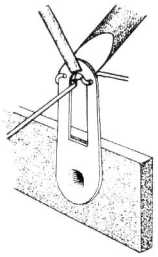
If the tags are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good mechanical joint is made without relying on solder for physical strength.



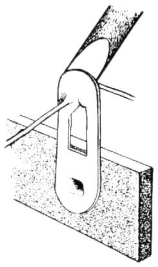
1. CRIMP WIRES



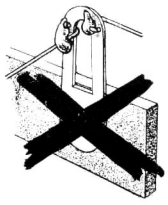
2. HEAT CONNECTION



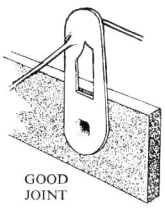
3. APPLY SOLDER



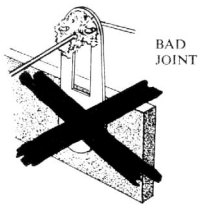
ALLOW SOLDER TO FLOW



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.

INTRODUCTION

The Heathkit model AW-1U Audio Wattmeter is an excellent instrument and care used in construction will be well repaid. The construction is open and easily accomplished but should not be rushed, as poor workmanship can easily result in poor operation.

CIRCUIT DESCRIPTION

The basic circuit consists of two stages of amplification feeding a bridge rectifier circuit. The meter-bridge circuit returns to the cathode of the voltage amplifier to provide negative feedback.

Essentially, the valve and meter make up a standard AC VVM. However, the input arrangement is such that the voltage across the load resistor is divided in a network of precision resistors to give a voltage that is correct in relation to the power dissipated in the high wattage load resistors. Since the power dissipated is related to the voltage out of the input network, the meter scale can be calibrated directly in watts.

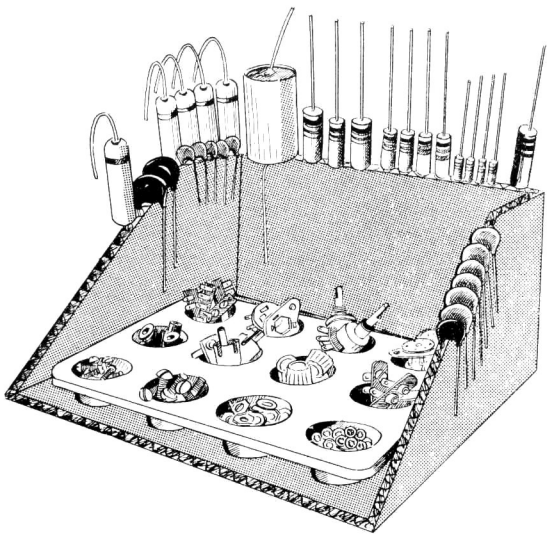
External or internal load resistors of 3, 8, 15 and 600 ohms are selected by rotating the load selector switch to the desired position. The voltage correcting resistors are automatically connected in the correct sequence at the same time. The output of this network is fed to the input of the VVM decade or range switch. This voltage divider provides five separate meter ranges. The precision resistors used here make it possible for one calibration to serve for all ranges. All or part of the voltage developed across the divider is applied to the grid of the first amplifier stage.

The first stage of amplification uses one section of the 12AU7 valve as a voltage amplifier. Voltage from this stage is coupled through a capacitor to the other section of the valve, which is a current amplifier to feed the meter circuit. Within the bridge circuit, the crystal diodes rectify the output current, providing a unidirectional current flow through the meter movement.

Feedback from the anode of the last stage is applied to the cathode of the input stage. By varying the calibration control, which is in the earth return of this cathode, the feedback is changed, thus controlling the overall gain of the amplifier. The use of feedback in this manner provides a high degree of stability in the instrument, and greatly extends its frequency response.

The power supply is transformer operated with a simple half-wave rectifier and resistance-capacitance filter system.

We strongly urge that you follow the wiring and parts layout shown in this manual. The position of wires and parts is quite critical in this instrument and changes may seriously affect the characteristics of the circuit.



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.

STEP-BY-STEP ASSEMBLY

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

(✓) Place the chassis so that it corresponds to the position shown in Figure 4. Using 2 - 6BA screws, lockwashers and nuts, mount the 9-pin valveholder at location F. Note the location of the blank space on the valveholder.

(✓) Mount a 3-way tagstrip at G, using a 4BA screw, lockwasher and nut.

(✓) Mount a 4-way tagstrip at location E as shown. Use a 4BA screw, lockwasher and nut. Do not secure too tightly, as this same screw will be used to mount the chassis bracket later on.

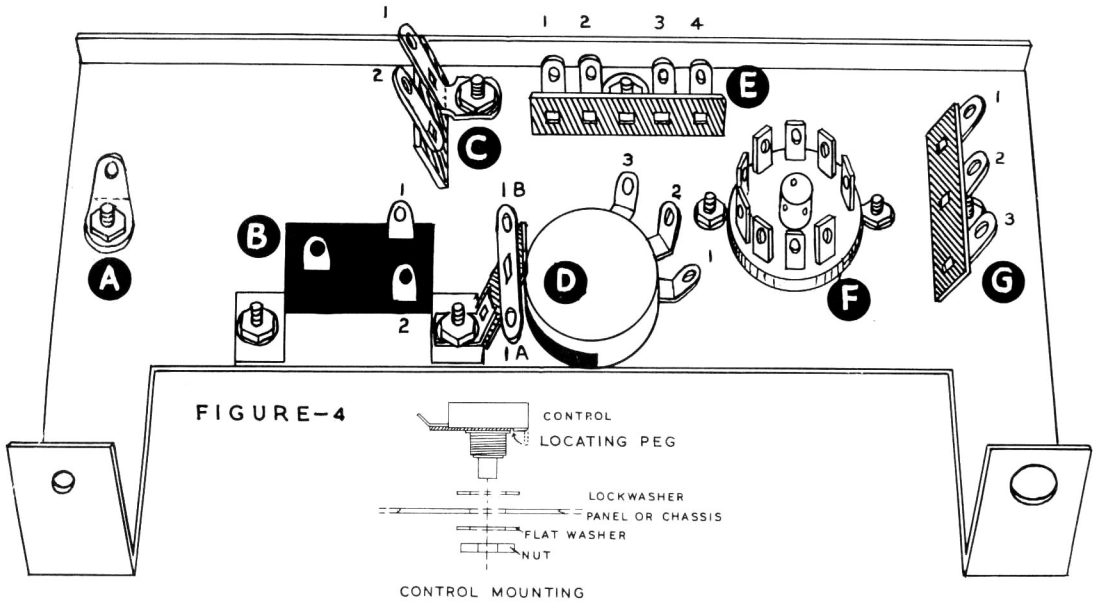


FIGURE-4

CONTROL MOUNTING

FIGURE.6.

(✓) Install the 200Ω potentiometer at D with the tags pointing in the direction as shown in Figure 4. Bend the locating peg and install as shown in Figure 6.

(✓) Mount the selenium rectifier at B and orient tags as shown in Figure 4. Also mount a 1-way tagstrip at Y. Use 2 - 6BA screws, lockwashers and nuts.

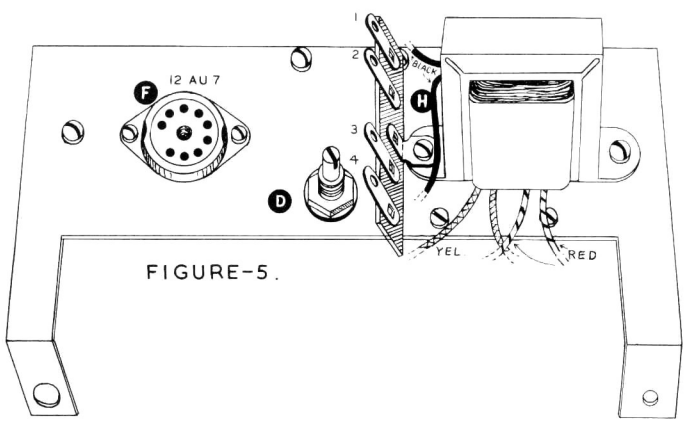


FIGURE-5.

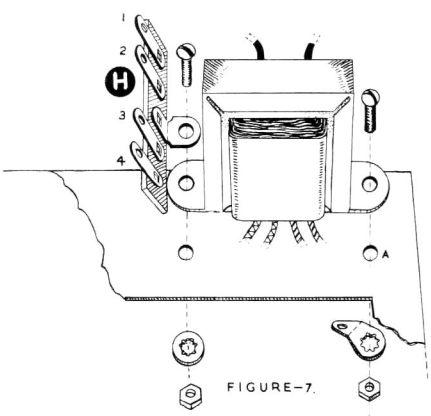
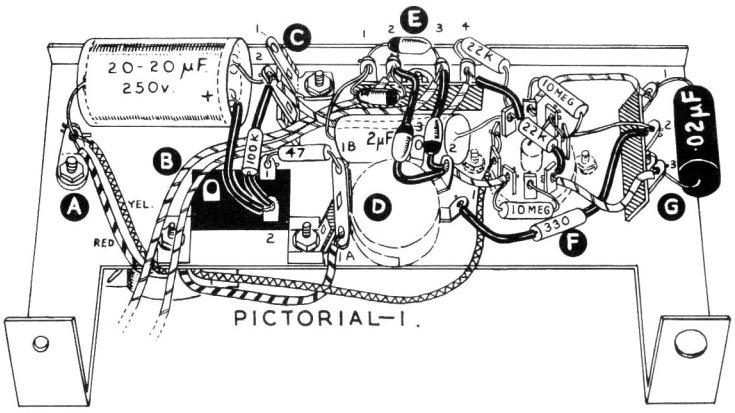


FIGURE-7.

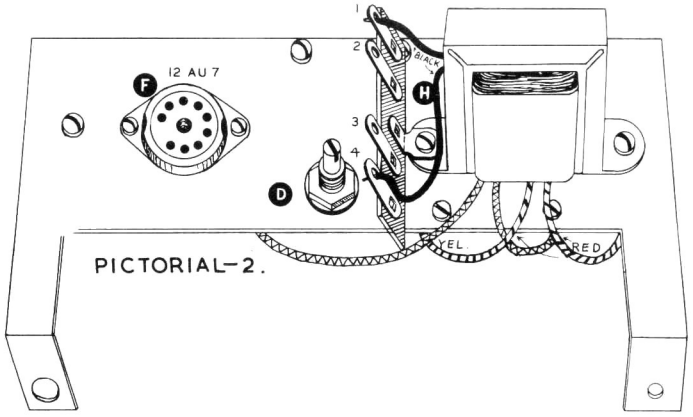
( ) Mount the power transformer on top of the chassis and orient the leads as shown in Figure 5. Refer also to Figures 4 and 7, and mount a 4-way tagstrip on top of chassis at H and a 4BA shakeproof solder tag below the chassis at A. Use 4BA screws, lockwashers and nuts.

( ) Mount the off-set 2-way tagstrip at C temporarily, using a 4BA screw, lockwasher and nut.

When connecting the transformer leads, before cutting, run each lead to its connecting point and leave sufficient wire to make the connection. Pictorials 1 and 2 show chassis wiring.

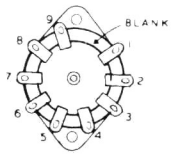


PICTORIAL-1.



PICTORIAL-2.

( ) Cut one YELLOW lead of the power transformer to a length sufficient to reach tags 4 and 5 of valveholder F. Strip off about $\frac{1}{2}$" of insulation and remove the varnish insulation by scraping the exposed wire end. Tin the wire and pass it through F4 (NS) and F5 (S-1). Refer to Figure 8 for valveholder pin numbering.



9-PIN
V/HOLDER
FIG-8

( ) In a similar manner, connect the other YELLOW wire to solder tag A (NS).

( ) Cut, strip and tin one RED wire of the power transformer to a length sufficient to reach the tagstrip Y1A (S-1).

( ) In a similar manner, connect the other RED wire to solder tag A (NS).

( ) Connect a 47Ω resistor (YELLOW, VIOLET, BLACK) between Y1B (S-1) and selenium rectifier B1 (S-1).

( ) On top of the chassis, connect one of the BLACK leads of the transformer to tagstrip H4 (NS).

( ) Connect the other BLACK wire to tagstrip H1 (NS).

( ) Using sleeving, connect a 100 KΩ resistor (BROWN, BLACK, YELLOW) from rectifier B2 (NS) to tagstrip C2 (NS).

( ) Mount the 20-20 µF 250 volt capacitor as shown with the single lead pointing towards solder tag A. Connect this, the negative lead, to solder tag A (S-3).

( ) Using sleeving, connect the positive (RED tag) lead of the filter capacitor to rectifier B2 (S-2).

( ) Using sleeving, connect the other positive (PLAIN tag) lead to tagstrip C2 (NS).

( ) Pass a length of bare wire through tagstrip G2 (NS), valveholder F9 (NS) and F8 (NS).

( ) Connect a bare wire from the centre screen of valveholder F (S-1) to F8 (S-2).

( ) Connect a wire between potentiometer D2 (NS) and valveholder F3 (NS).

( ) Connect a 10 megohm resistor (BROWN, BLACK, BLUE) from valveholder F2 (NS) to F3 (S-[illegible]).

( ) Connect a 10 megohm resistor (BROWN, BLACK, BLUE) from valveholder F7 (NS) to F9 (S-[illegible]).

( ) Connect a wire from tagstrip C2 (S-3) to tagstrip E4 (NS).

( ) Mount the 2 uF capacitor, position as shown between potentiometer D and tagstrip E. Connect one wire to tagstrip E1 (NS) and the other wire to valveholder F6 (NS).

( ) Connect a 22 KΩ resistor (RED, RED, ORANGE) from tagstrip E4 (NS) to valveholder F6 (S-2).

( ) Using sleeving, connect a 22 KΩ resistor (RED, RED, ORANGE) from tagstrip E4 (S-3) to valveholder F1 (NS).

( ) Using sleeving, connect a 330Ω resistor (ORANGE, ORANGE, BROWN) from control D1 (S-1) to tagstrip G2 (NS).

( ) Mount a .02 µF capacitor between tagstrip G1 (NS) and G3 (NS).

( ) Connect a wire between tagstrip G3 (S-2) and valveholder F1 (S-2).

( ) Connect a wire between tagstrip G1 (S-2) and valveholder F7 (S-2).

( ) Cut a piece of wire to a length of 5". Strip ¼" of insulation from both ends and connect one end to tagstrip E2 (NS). Leave the other end free.

( ) In similar manner, cut a piece of wire to a length of 7" and connect one end to tagstrip E3 (NS). Leave the other end free.

( ) Connect a crystal diode with the RED cathode lead to tagstrip E2 (NS) and the other lead to E1 (NS).

( ) Connect a crystal diode with the RED cathode lead to tagstrip E1 (S-3) and the other lead to E3 (NS). CAUTION: 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 whilst soldering. The application of excessive heat may ruin the diode elements.

( ) Using sleeving, connect a crystal diode with the RED cathode lead to tagstrip E2 (S-3) and the other lead to potentiometer D2 (NS). CAUTION: Observe the previous remarks regarding the use of heat shunts.

( ) Using sleeving, connect a crystal diode with the RED cathode lead to potentiometer D2 (S-3) and the other lead to tagstrip E3 (S-3). CAUTION: Observe previous remarks regarding the use of heat shunts.

MOUNTING OF PANEL COMPONENTS

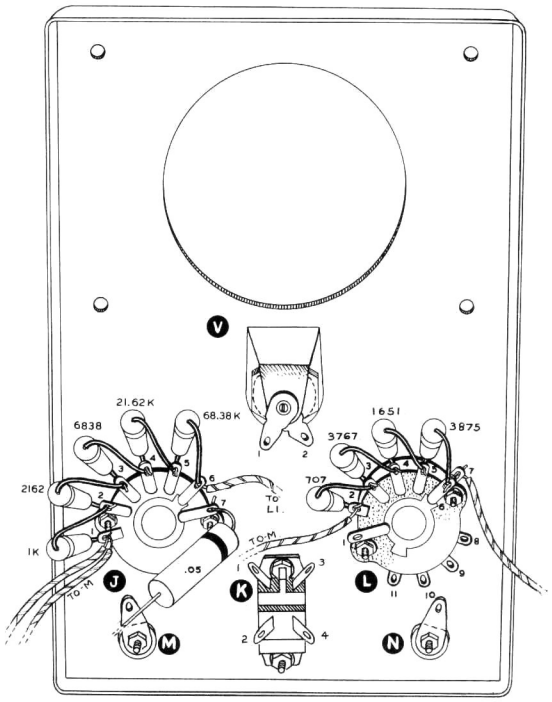


FIGURE-9.

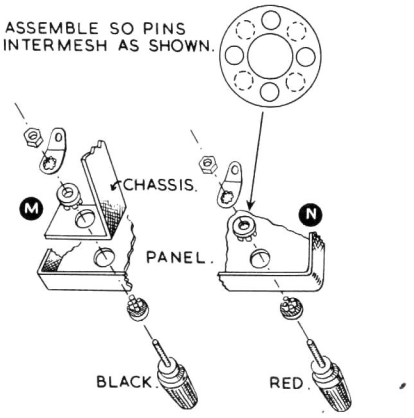


FIGURE-10.

Refer to Figure 9 for positioning of switches, terminals, etc. on the panel. Orient all contacts and tags in the same relative position as shown.

- Mount the on-off MAINS slide switch at location K using 2 - 6BA instrument head screws, lockwashers and nuts. Ensure that the switch tags are located as shown.
- Install a RED terminal at location N. Use a 4BA shakeproof solder tag and before tightening the nut ensure that the cross-drilled wire hole is horizontal. Refer to Figure 10.
- Temporarily install a BLACK terminal at location M, using a 4BA shakeproof solder tag. Do not tighten, for this terminal will be used to mount the chassis later.
- Refer to Figure 11 and mount the pilot light assembly at position V.

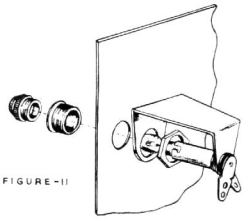


FIGURE-11

PILOT LIGHT ASSEMBLY

WIRING OF RANGE AND LOAD SELECTOR SWITCHES

The RANGE and LOAD SELECTOR switches are wired before they are installed on the panel. Follow the switch tag numbering carefully and double check each resistor for position and value before soldering it in place. Switch tags are numbered in clockwise sequence, as shown in Figures 12 and 13. The number 1 tag of the RANGE switch is the short dummy tag at the left of the wafer mounting post. Number seven tag is the long contact next to the other mounting post. On the LOAD SELECTOR switch, the number one tag is the long tag to the right of the wafer mounting post at the rear section.

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

NOTE: When soldering the precision resistors in place, hold the leads with a clamp or pliers to keep the components from becoming excessively warm. Excess heat may cause the resistors to change value.

( ) Identify the RANGE switch and position as shown in Figure 12.

( ) Cut a piece of wire to a length of 2". Strip both ends and connect one end to J1 (NS). Leave the other end free.

( ) In a similar manner, cut a piece of wire to a length of 3". Connect one end to J1 (NS). Leave the other end free.

( ) Connect a 1 KΩ precision resistor from J1 (S-3) to J2 (NS). (Use sleeving.)

( ) Connect a 2162Ω precision resistor from J2 (S-2) to J3 (NS). (Use sleeving.)

( ) Connect a 6838Ω precision resistor from J3 (S-2) to J4 (NS). (Use sleeving.)

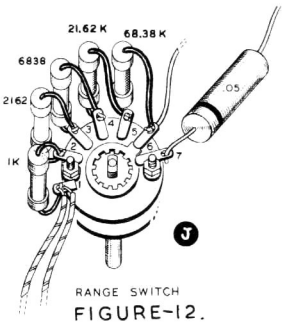
( ) Connect a 21.62 KΩ precision resistor from J4 (S-2) to J5 (NS). (Use sleeving.)

( ) Connect a 68.38 KΩ precision resistor from J5 (S-2) to J6 (NS). (Use sleeving.)

( ) Cut a piece of wire to a length of $1\frac{3}{4}$". Connect one end to J6 (S-2). Leave the other end free.

( ) Cut the lead at one end of a .05 μF capacitor to a length of 5/8". Connect this end to J7 (S-1). Leave the other end free.

( ) Mount the RANGE switch at location J, orienting it as shown. Observe Figure 6 for mounting details.



RANGE SWITCH
FIGURE-12.

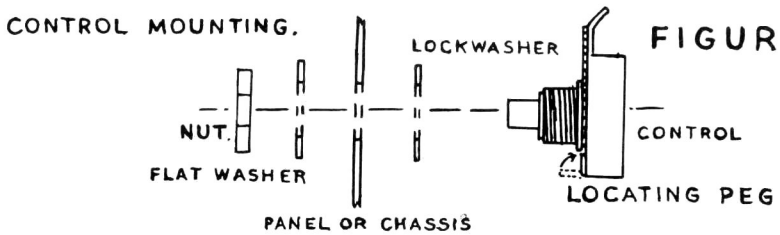


FIGURE.6.

( ) Identify the LOAD SELECTOR switch and position as shown in Figure 13.

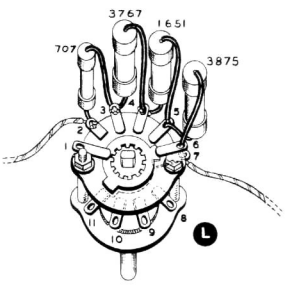
( ) Cut a piece of wire to a length of 3". Strip both ends and connect one end to L2 (NS).

( ) Connect a 707Ω precision resistor from L2 (S-2) to L3 (NS). (Use sleeving.)

( ) Connect a 3767Ω precision resistor from L3 (S-2) to L4 (NS). (Use sleeving.)

( ) Connect a 1651Ω precision resistor from L4 (S-2) to L5 (NS). (Use sleeving.)

( ) Connect a 3875Ω precision resistor from L5 (S-2) to L6 (NS) (use sleeving) and L7 (NS) directly underneath.

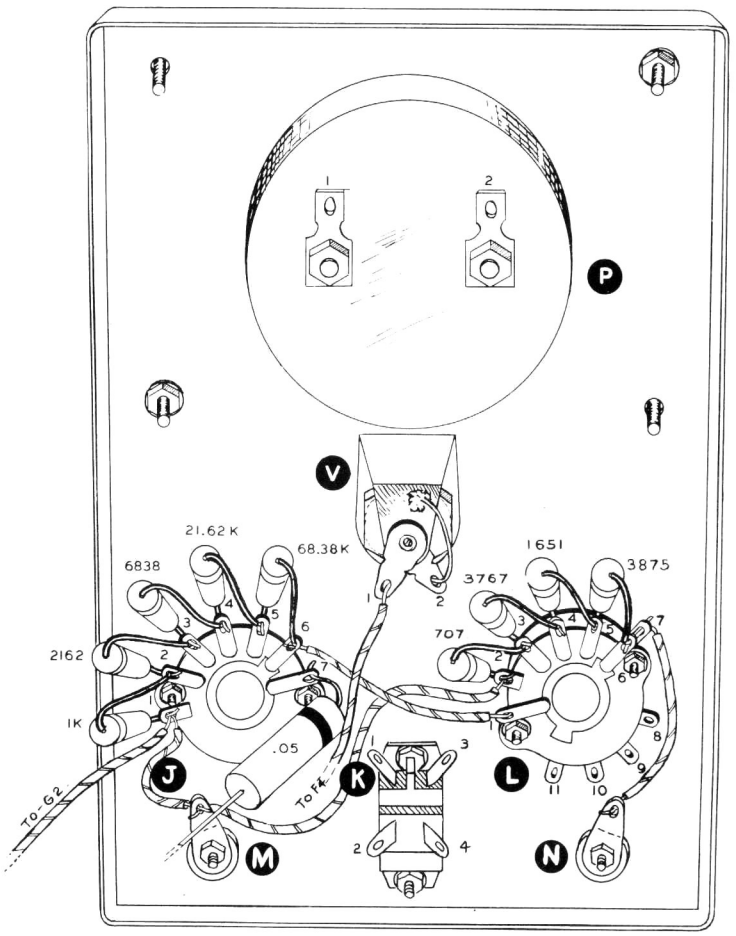


SELECTOR SWITCH
FIGURE-13.

( ) Cut a piece of wire to a length of 3". Connect one end to L6 (S-2) and L7 (S-2). Leave the other end free.

( ) Mount the LOAD SELECTOR switch at location L. Observe Figure 6 for mounting details.

WIRING OF PANEL



PICTORIAL-3.

( ) Connect the wire from RANGE switch J6 to LOAD SELECTOR switch L1 (S-1).

( ) Connect the wire from LOAD SELECTOR switch L6 and L7 to RED terminal N (S-1).

( ) Connect the 2" wire from RANGE switch J1 to BLACK terminal M (NS).

( ) Connect the wire from LOAD SELECTOR switch L2 to BLACK terminal M (NS).

( ) Connect a bare wire from pilot light socket V2 (S-1) to the socket mounting frame (S-1).

( ) Cut a piece of wire to a length of 3". Strip both ends and connect one end to pilot light socket V1 (S-1). Leave the other end free.

( ) Mount the meter movement on the panel at location P. Fasten in place with lockwashers and nuts at the two points shown in Pictorial 3. Do not secure the other two bolts yet, as they will be used to mount the chassis and chassis bracket.

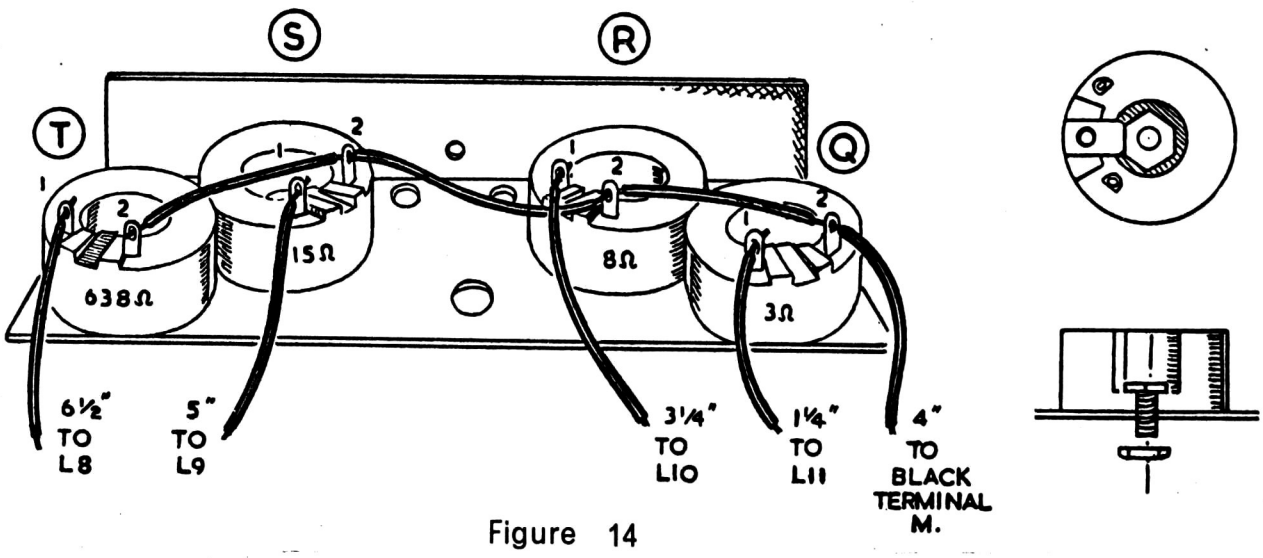


Figure 14

- Mount the 3Ω 24 watt resistor at location Q as shown in Figure 14 using the hardware supplied.
- Mount the 8Ω 24 watt resistor at location R.
- Mount the 15Ω 24 watt resistor at S and carefully bend the tags outwards at right angles.
- Mount the 638Ω 24 watt resistor at T.
- Connect a wire from T2 (S-1) to S2 (NS).
- Connect a wire from S2 (S-2) to R2 (NS).
- Connect a wire from R2 (S-2) to Q2 (NS).
- Cut a piece of wire to a length of 6½", strip both ends and connect one end to T1 (S-1).
- In a similar manner connect one end of a 5" length of wire to S1 (S-1).
- In a similar manner connect one end of a 3¼" length of wire to R1 (S-1).
- In a similar manner connect one end of a 1¼" length of wire to Q1 (S-1).
- In a similar manner connect one end of a 4" length of wire to Q2 (S-2).
- Route all wires clear of the resistors.

PANEL TO CHASSIS ASSEMBLY AND WIRING

Refer to Figure 15.

- Install the chassis on the panel. The small hole at the power transformer end of the chassis slips over the upper left hand meter bolt and is secured with a 4BA lockwasher and nut. The lower end is held in place by the BLACK terminal M. Dismount the terminal, slide the chassis hole over hole M and re-mount the assembly. Make sure that the insulator bushes are properly centred and the pins inter-meshed, also that the cross-drilled wire hole is horizontal.
- Connect the wire from pilot light socket V1 to valveholder F4 (S-2).
- Cut the lead of the .05 µF capacitor to a length sufficient to reach valveholder F2. Using sleeving, connect to F2 (S-2).
- Connect the wire from RANGE switch J1 to tagstrip G2 (NS).
- Connect the wire from tagstrip E2 to meter tag P1 (S-1).
- Connect the wire from tagstrip E3 to meter tag P2 (S-1).

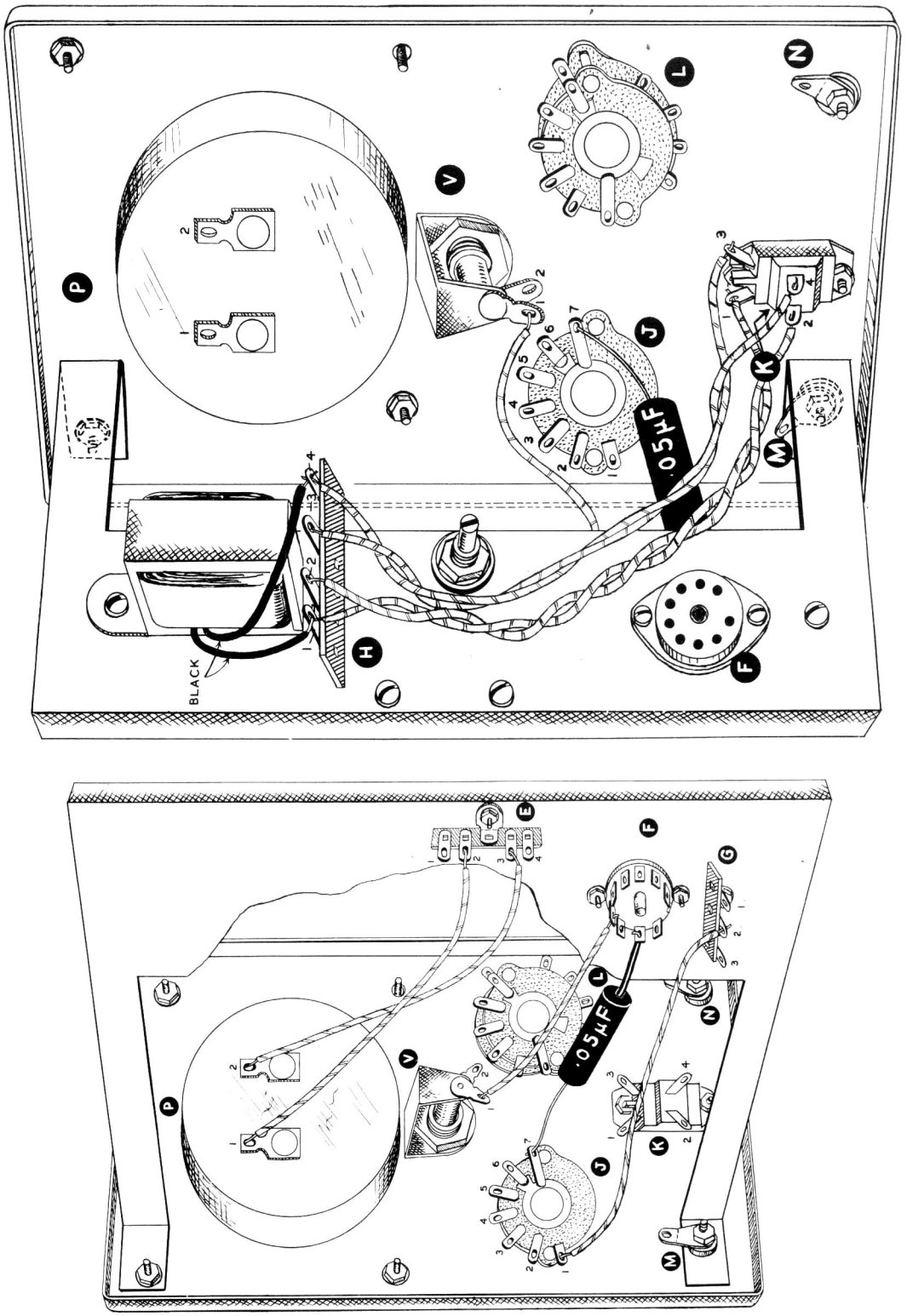
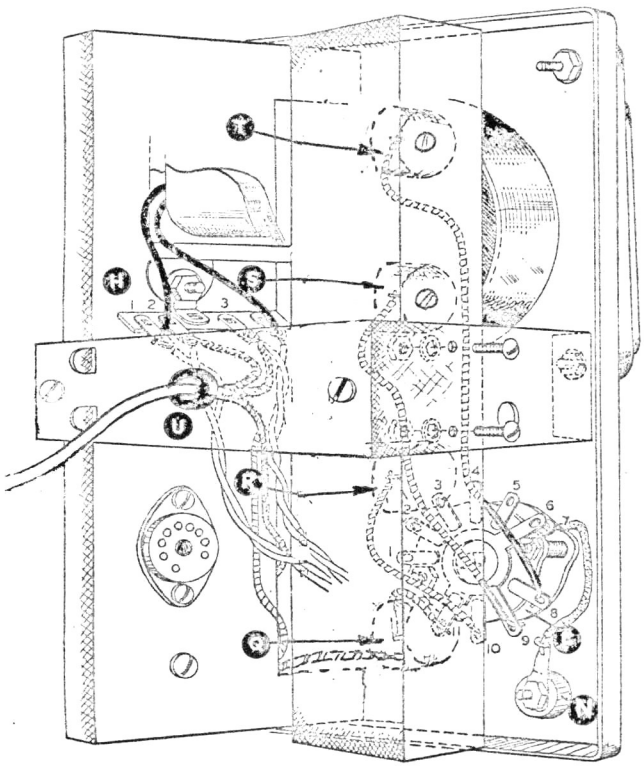
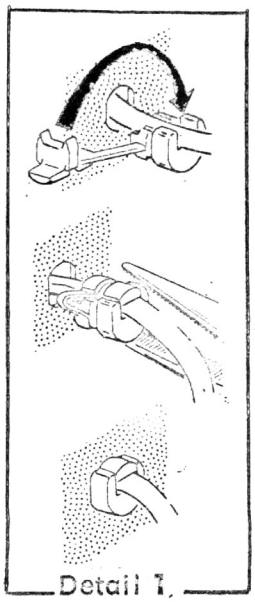


FIGURE-15.



FIGURE—16.



(✓) Cut two wires to a length of 5¼". Strip all ends and twist the wires together. Connect one wire to tagstrip H1 (S-2) and the adjacent wire to H2 (NS) on top of the chassis.

(✓) At the opposite end of the twisted pair, connect one wire to slide switch K1 (S-1) and the adjacent wire to K2 (S-1). Dress the twisted pair against the chassis.

(✓) Cut two wires to a length of 5¼". Strip all ends and twist the wires together. Connect one wire to tagstrip H3 (NS) and the adjacent wire to H4 (S-2).

(✓) At the opposite end of the twisted pair, connect one wire to slide switch K3 (S-1) and the adjacent wire to K4 (S-1). Dress the twisted pair against the chassis.

(✓) Mount the chassis bracket to the chassis and front panel. The single hole end of the bracket fastens to the lower right meter bolt with a 4BA lockwasher and nut. At the opposite end, remove the screws holding the tagstrips E and C in place and secure the bracket with two 4BA screws, lockwashers and nuts. Refer to Figure 16.

(✓) Pass the mains lead through hole U. Connect the Black wire to tagstrip H2(S-2), the Red wire to H3(S-2) and the Green wire tagstrip G2(S-3).

(✓) Position the strain relief bush on the mains lead and install in the chassis as shown in Detail 1.

(✓) Mount the resistor bracket to the chassis bracket using 2 - 4BA sorews, lockwashers and nuts. Refer to Figure 16. Ensure that the precision resistors on LOAD switch L are clear of the 24 watt resistor R.

(✓) Connect the wire from 3Ω resistor Q1 to LOAD SELECTOR switch L11 (S-1).

(✓) Connect the wire from 3Ω resistor Q2 to the BLACK terminal M (S-3).

(✓) Connect the wire from 8Ω resistor R1 to LOAD SELECTOR switch L10(S-1).

(✓) Connect the wire from 15Ω resistor S1 to LOAD SELECTOR switch L9 (S-1).

(✓) Connect the wire from 638Ω resistor T1 to LOAD SELECTOR switch L8 (S-1).

IMPORTANT NOTICE: MINIATURE VALVES CAN EASILY BE DAMAGED WHEN INSTALLING THEM IN THEIR VALVEHOLDERS. THEREFORE, USE EXTREME CARE WHEN INSTALLING THE 12AU7 VALVE. WE DO NOT GUARANTEE OR REPLACE MINIATURE VALVES BROKEN DURING INSTALLATION.

(✓) Install the 12AU7 valve in valveholder F.

(✓) Turn both switches to their fully anti-clockwise position.

(✓) Install a knob on each switch shaft with the pointer at "3 ohm INT" for the LOAD switch and "5 mW/-10 dB" on the RANGE switch. Tighten the grub screws.

(✓) Install the handle on top of the cabinet with No. 10 x ½" S.M. screws. Mount the four rubber feet on the bottom of the cabinet by pushing them through the holes provided. Moistening the rubber feet will facilitate installation.

(✓) Install the pilot lamp in the pilot light assembly socket V.

This completes the construction of the AW-1U Audio Wattmeter.

TEST AND CALIBRATION

Check over the wiring carefully. We suggest tracing over each wire on the pictorial with a coloured pencil as it is checked on the instrument. Inspect each solder connection to be sure that the solder has flowed smoothly. Remove all wire and insulation clippings, solder splashes, etc., to eliminate any possibility of short circuits.

Inspect the meter to see that the mechanical zero is correct. If not, place the instrument in its normal operating position. (This usually is with the bottom on a level surface.) Turn the plastic screw on the meter face with a screwdriver, whilst GENTLY tapping the meter face with one finger, until the meter needle coincides with the zero line at the extreme left hand side of the scale.

Plug the instrument into a 200-250 volt 40-60 cycle AC ONLY outlet. The instrument will not operate and serious damage will result if plugged into a DC outlet.

Turn the MAINS switch on and allow a minute for warm up. Observe the valve and pilot light. If everything is operating properly, the pilot lamp will light and the valve heaters will glow red. Also, the meter needle will move upscale once or twice due to charging effects of the 2 μF meter coupling capacitor. If no light or meter action is evident, turn the instrument off and carefully recheck the wiring. Also check the switch, making sure that the moving element is free to travel the full length of the switch slot. If the instrument still fails to operate, the power should be turned off and the steps outlined under IN CASE OF DIFFICULTY followed.

To calibrate the wattmeter, set the LOAD switch to the 15Ω INT. position. Rotate the RANGE switch to the 5 W position. Connect a wire from the HIGH (Red) terminal to the pilot light tag V1 and adjust the calibrate control D so that the meter indicates 26.5 watts on the 0-50 scale (the true value will be 2.65 watts). This calibration is derived on the basis of a 6.3 volt heater supply and it should be realised that the accuracy will depend upon this.

If a higher degree of accuracy is desired, the voltage should be measured with an accurate AC voltmeter. The power dissipated in the instrument can be calculated by using the formula:

$$W = \frac{V^2}{R}$$

where V equals the R.M.S. voltage and R equals the input resistance, in this case 15Ω. Calibration will be completed by adjusting the calibrate control until the needle indicates the correct wattage.

When calibration is complete, slip the instrument into the cabinet and secure with two 3/8" sheet metal screws through the holes provided in the back.

USING THE AUDIO WATTMETER

The Model AW-1U has five separate power and dB ranges allowing measurements up to 50 watts and +48 dB. The markings on the switch refer to full scale power readings.

To test an audio amplifier, the output of the equipment under test should be connected to the input of the wattmeter. Rotate the LOAD SELECTOR switch so that it indicates the resistance equivalent to the output impedance of the amplifier.

Example: The amplifier has a 15Ω output. Connect the earth side of the amplifier to the BLACK or LOW terminal of the meter. The 'live' side of the output transformer secondary winding is connected to the RED or HIGH terminal. Set the LOAD SELECTOR switch to the 15Ω INT. load position and the RANGE switch to 50 W. DO NOT USE AN EXTERNAL LOAD RESISTOR OF ANY TYPE. PROPER LOADING IS MAINTAINED WITHIN THE INSTRUMENT. Amplifier power output will be indicated directly on the meter. Rotate the RANGE switch to the left as necessary to give a satisfactory meter deflection.

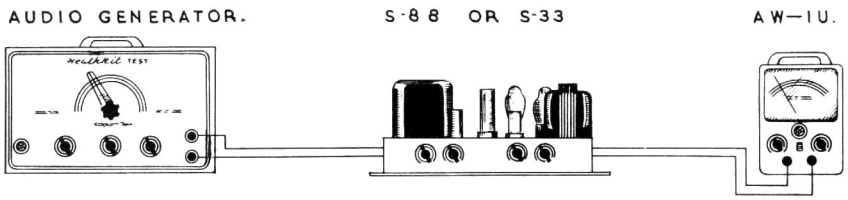


FIGURE.17.

Indication of power output is obtained by connecting the output of a sine wave audio oscillator to the amplifier input. The power output will be indicated directly on the wattmeter scale. If necessary, turn the RANGE switch to the left until adequate deflection of the meter needle is obtained. (For best results, the RANGE switch should always be set to give an approximate centre scale reading. This will maintain a higher degree of accuracy, since the readings will be close to the calibration point.)

CAUTION: The load resistors are rated at 24 watts continuous dissipation. Powers above this up to 50 watts can be handled safely only if the power is applied intermittently. Do not use at power levels higher than 25 watts for periods exceeding three minutes.

Maximum amplifier power output is obtained when the meter needle fails to deflect further when the amplifier input is increased. For best indication, an oscilloscope should be connected across the wattmeter terminals, for the scope will show distortion and overload. Output of an amplifier will sometimes increase beyond the overload point, but the additional power consists mainly of distortion products.

Noise measurements can be made by noting dB at full output. Then turn off the power supply in the audio generator, leaving it connected to the amplifier input. Rotate the RANGE switch to the left until a reading is obtained, if any. Again, note the dB reading. Subtract the noise reading from the full power reading, which will give the noise in dB below full power output.

Frequency response and power curve measurements are easily accomplished using the Heathkit Audio Wattmeter. Again, the audio generator should be connected to the amplifier input. If possible, the output of the audio generator should be metered to ensure constant output level, i.e. Heathkit Audio Generator Model AG-9U. The output of the amplifier is connected to the wattmeter as before. Set the audio oscillator and amplifier to the desired output and take the response, keeping the output of the generator at the same level. The curve can be plotted in dB or watts as indicated on the wattmeter.

If desired, the Audio Wattmeter can be used with an external load such as a speaker, a low impedance line or an external resistance. When this is done, the instrument is bridged across the output leads at the external load or at the amplifier output, with the LOAD SELECTOR switch set to EXT. load and to the proper impedance. Readings obtained will then be exactly the same as if the internal load resistance were used. The switch must be set to the proper impedance, however, for the same compensating resistors are used with the external load. Proper indication of power cannot be obtained at impedances other than 3, 8, 15 and 600Ω.

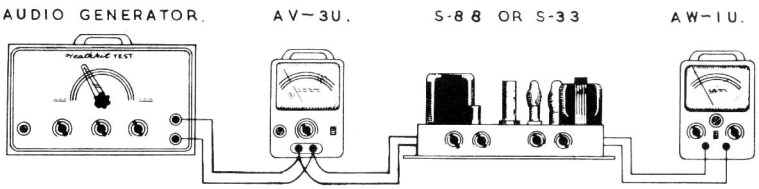


FIGURE.18.

The instrument can be left bridged across a line without indicating, if necessary, by placing the LOAD SELECTOR switch in the OFF position. This disconnects the meter amplifier from the circuit, leaving only the compensating resistors connected across the load circuit.

CAUTION: The LOAD SELECTOR switch should never be rotated when energy is applied to the wattmeter input. If it becomes necessary to change impedance setting, the input to the amplifier under test should be reduced to zero, or the amplifier turned off. Damage to the meter movement/needle due to violent hammering against the stops will be avoided if this precaution is observed.

Highly accurate monitoring of output level for recording purposes etc. can be accomplished by connecting the wattmeter across the amplifier output leads and setting the LOAD SELECTOR switch to the proper impedance under EXT. load. The circuitry is such that the instrument makes an excellent dB meter.

READING THE POWER SCALES

The meter power scale is marked from 0 to 50 watts for power measurements. When making measurements on the 5 mW (milliwatt), 50 mW or 5W scales, read the scale and adjust the decimal for the correct wattage.

Example: Using the 500 mW range, the meter indicates 10. For correct power, move the decimal point two places to the left, or .1 watts (100 mW).

On the 50 W range, the meter reads direct. For each anti-clockwise position of the RANGE switch, move the decimal point one place to the left.

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" (dB).

Different signal levels are adopted by various manufacturers as a standard or "0" decibels. The trend within the last few years has been toward the use of a 1 milliwatt into a 600Ω load as "0" dB. This reference has been given a special designation of "dBm". The Heathkit Audio Wattmeter is calibrated to read in "dBm" when used as a 600Ω load.

When using the AW-1U for dB measurements, 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 +25 dB.
RANGE -10 dB, meter indicates +15 dB, actual value is +5 dB.

Since the decibel is a power 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. As the input frequency is varied at constant amplitude, the output level variation may be noted directly in dB above and below the specified reference level.

COMPLEX WAVE FORMS

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 wave form. Thus when measuring odd shaped waves, (square, saw-tooth, pulse) the meter reading must be given special interpretation. Special reading on the subject will be found in the bibliography.

ACCURACY

The accuracy of the meter movement is within 2% of full scale. The precision resistors used in the divider circuits are within 1%. Some slight error may be introduced by the circuit itself. Final accuracy of the instrument should be within 5% of full scale at the calibrating frequency.

The frequency response of the instrument is ±1 dB from 10 cps to 250 kc.

In actual practice, inaccuracies do not usually fall in the same direction, consequently some tend to cancel out others. Therefore, it should be expected that the accuracy of the AW-1U will fall well within 5% of full scale.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Most cases of trouble result from bad soldered connections or wiring mistakes. Often having a friend check the wiring will reveal a mistake consistently overlooked.
2. Check the valve. A visual inspection of the heaters will show whether or not both sections of the valve are lit. If the heaters glow red, but the instrument will not operate, the valve should be tested on a valve tester.
3. Check the wiring for short circuits. Special attention should be given to the valveholder pins, the tagstrips, the switches and the rectifier. Excess amounts of solder at these points can cause shorts between contacts or from a contact to earth.
4. Check the continuity of the test leads being used, the circuit components and the precision resistors. The crystal diodes can be checked with an ohmmeter by removing one end of the diode from the circuit. The resistance reading should be noted and the ohmmeter connections to the diode reversed. Again note the reading. The ratio between the readings should be at least 100 to 1.
5. If completely dead, check the MAINS switch to make sure that the moving element can operate freely the full length of the switch. The mains lead and power transformer should be measured for open circuits.
6. If pointer swings to full scale on all ranges, the instrument may be oscillating. Careful redress of wiring will usually eliminate this.
7. If pointer swings against the back stop, the crystal diodes have been reversed. Correct by changing the meter connections or reversing the diodes.
8. The 2 µF metallised capacitor is specially selected for the application. DO NOT USE ordinary paper tubulars, since they may lead to instability or inaccuracy.
9. Check the operating voltages against the chart below. If a wide deviation is found, the transformer and filter circuits should be rechecked. Other discrepancies can usually be eliminated by carefully inspecting all components and connections associated with the point where the discrepancy is found.

VOLTAGE CHART

All voltages were measured with a Heathkit V-7A/UK having an input resistance of 11 megohms. All readings are DC voltages measured with respect to chassis, unless otherwise specified. Variations up to 20% are normal and would not necessarily indicate a fault.

VALVE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
12AU7	20 V	0 to -.4	0 to .4V	6.3V AC	6.3V AC	18 V	0 to -.5	0	0
RECTIFIER TAG			TO FILTER		TO POWER TRANSFORMER				
RECTIFIER VOLTAGE			200 V		155 V AC				

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		
H-470C10	1	47Ω
H-331C10	1	330Ω
H-223C10	2	22 KΩ
H-104C10	1	100 KΩ
H-106C10	2	10 megohm
2-31	1	2.162 KΩ precision ± 1%
2-33	1	6.838 KΩ precision ± 1%
2-39	1	21.62 KΩ precision ± 1%
2-40	1	68.38 KΩ precision ± 1%
H-102HS1	1	1 KΩ precision ± 1%
2-501	1	707Ω precision ± 1%
2-502	1	1651Ω precision ± 1%
2-503	1	3767Ω precision ± 1%
2-504	1	3875Ω precision ± 1%
3-507	1	3Ω 24W non-inductive ± 1%
3-508	1	8Ω 24W non-inductive ± 1%
3-509	1	15Ω 24W non-inductive ± 1%
3-510	1	638Ω 24W non-inductive ± 1%
Capacitors		
23-511	1	.02 µF paper
23-501	1	.05 µF paper
23-507	1	2 µF metallised
25-514	1	20 + 20 µF 250 volt electrolytic
Controls - Switches		
11-504	1	200Ω W.W. potentiometer
60-505	1	DP ON/OFF slide switch
63-66	1	1-pole 5-position RANGE switch
63-73	1	9-position LOAD selector switch
Sockets - Terminals - Grommets - Feet - Knobs - Tagstrips		
434-502	1	9-pin valveholder
434-508	1	Pilot lamp socket
427-501	1	Terminal, red
427-502	1	Terminal, black
75-30	1	Strain relief bush
431-1	1	1-way tagstrip
431-14	1	2-way tagstrip
431-10	1	3-way tagstrip

PART No.	PARTS Per Kit	DESCRIPTION
Sockets - Terminals - Grommets - Feet - Knobs - Tagstrips		
431-502	2	4-way tagstrip
261-1	4	Rubber feet
462-G539	2	Knob
211-15	1	Handle
Valve - Transformer - Rectifier - Meter		
411-25	1	12AU7 (ECC82) valve
54-504	1	Power transformer
57-503	1	Selenium rectifier
56-501	4	Crystal diode
407-22	1	Meter
412-501	1	Pilot lamp 6.3 volt .15 amp
Hardware		
250-513	12	4BA x ¼" screw, binder head
250-531	2	6BA x ¼" screw, instrument head, chrome plated
250-501	4	6BA x ¼" screw, binder head
250-8	2	3/8" sheet metal screw
252-3	8	4BA hex nut
252-501	6	6BA hex nut
254-1	12	4BA lockwasher
254-501	6	6BA lockwasher
259-504	3	4BA shakeproof solder tag
250-83	2	No. 10 x ½" sheet metal screw
Sheet Metal Parts		
90-G551	1	Cabinet
200-506	1	Chassis
203-G601	1	Panel
204-538	1	Resistor bracket
204-509	1	Chassis bracket
Wire - Solder		
89-G504	1	Mains lead
340-501	1 length	Bare wire, 22 swg.
344-506	1 length	Connecting wire
346-501	1 length	Sleeving, 1.5 m.m.
331-501	1 length	Solder, 18 swg.
595-G620	1	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

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.

GUARANTEE

Daystrom Limited guarantee subject to the following terms to repair or replace free of charge any defective parts (with the exception of cathode ray tubes and valves referred to hereunder) of any Heathkit model which fails 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 Heathkit models 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: Any Cathode Ray Tubes and Valves which form 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.

A selection of typical symbols found in circuit diagrams

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, CONTROL GRID, SCREEN 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.	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

DAYSTROM LIMITED

A Member of the Schlumberger Group including the Heath Company

MANUFACTURERS OF THE LARGEST SELLING ELECTRONIC KITS IN THE WORLD

GLOUCESTER, ENGLAND

rmc 2261 8/68

Printed in England

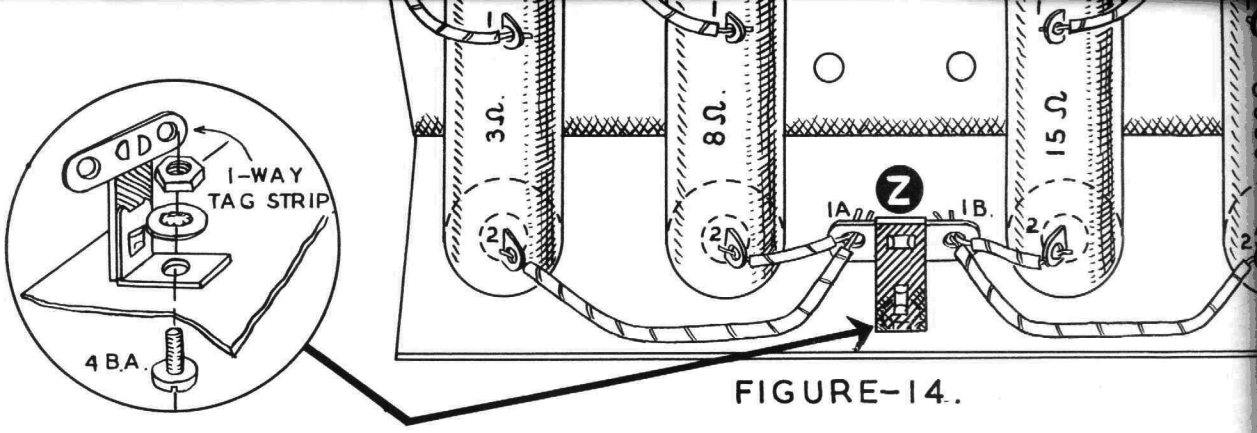
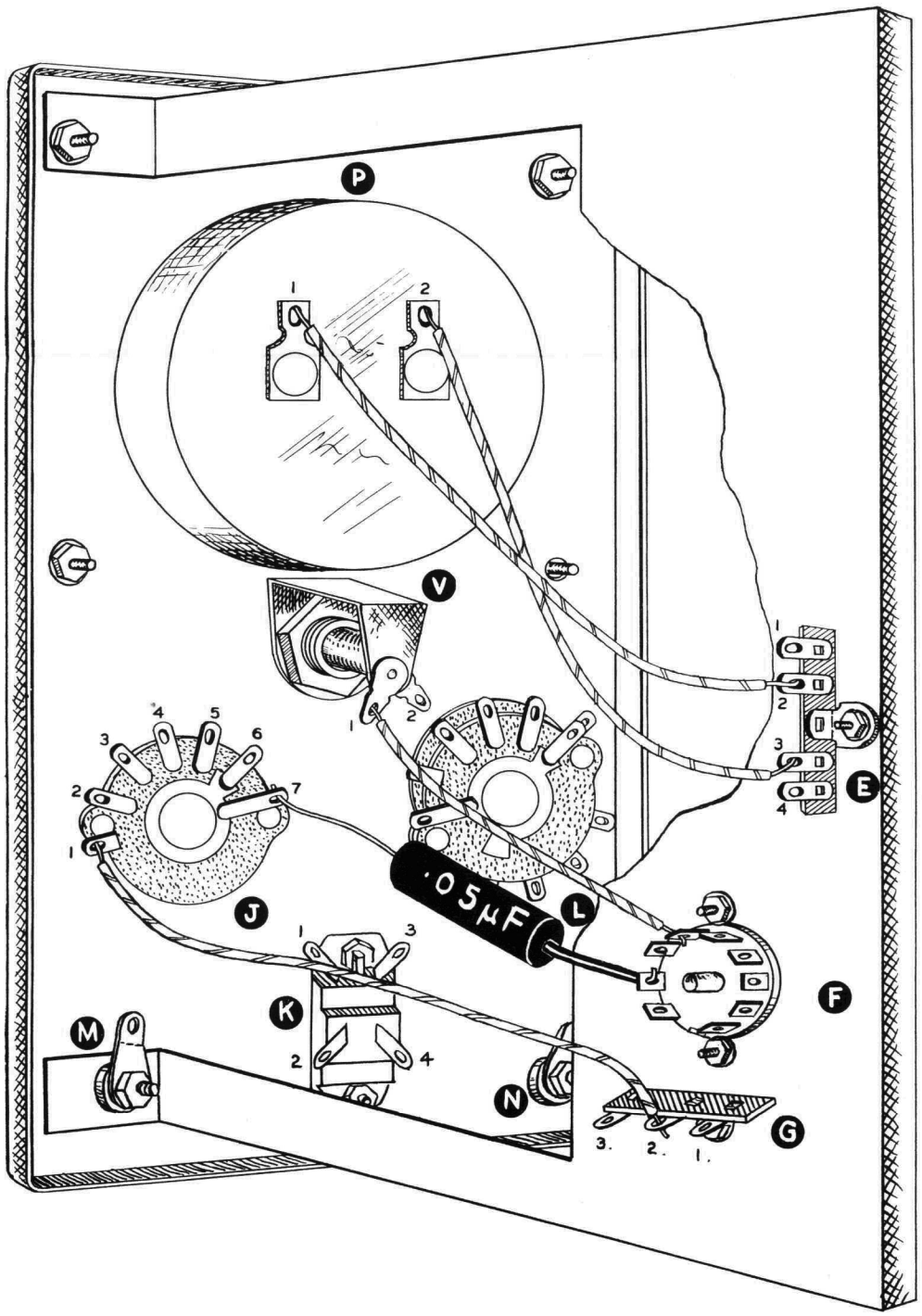
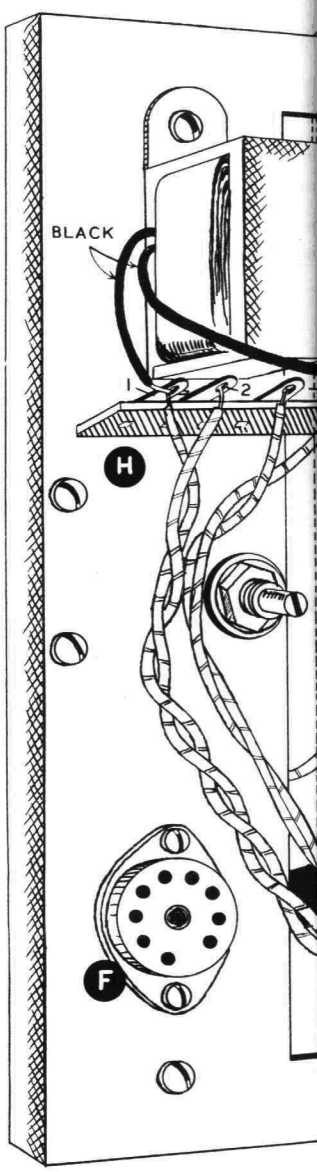


FIGURE-14.





FIG

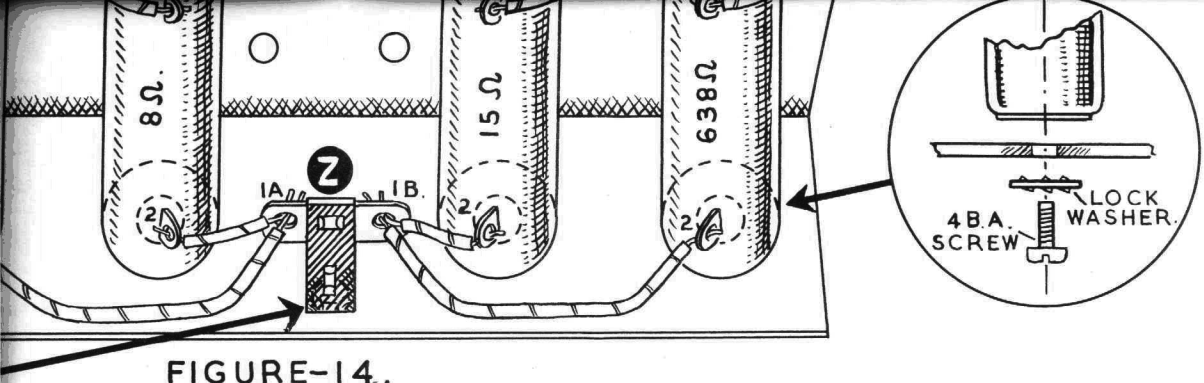


FIGURE-14.

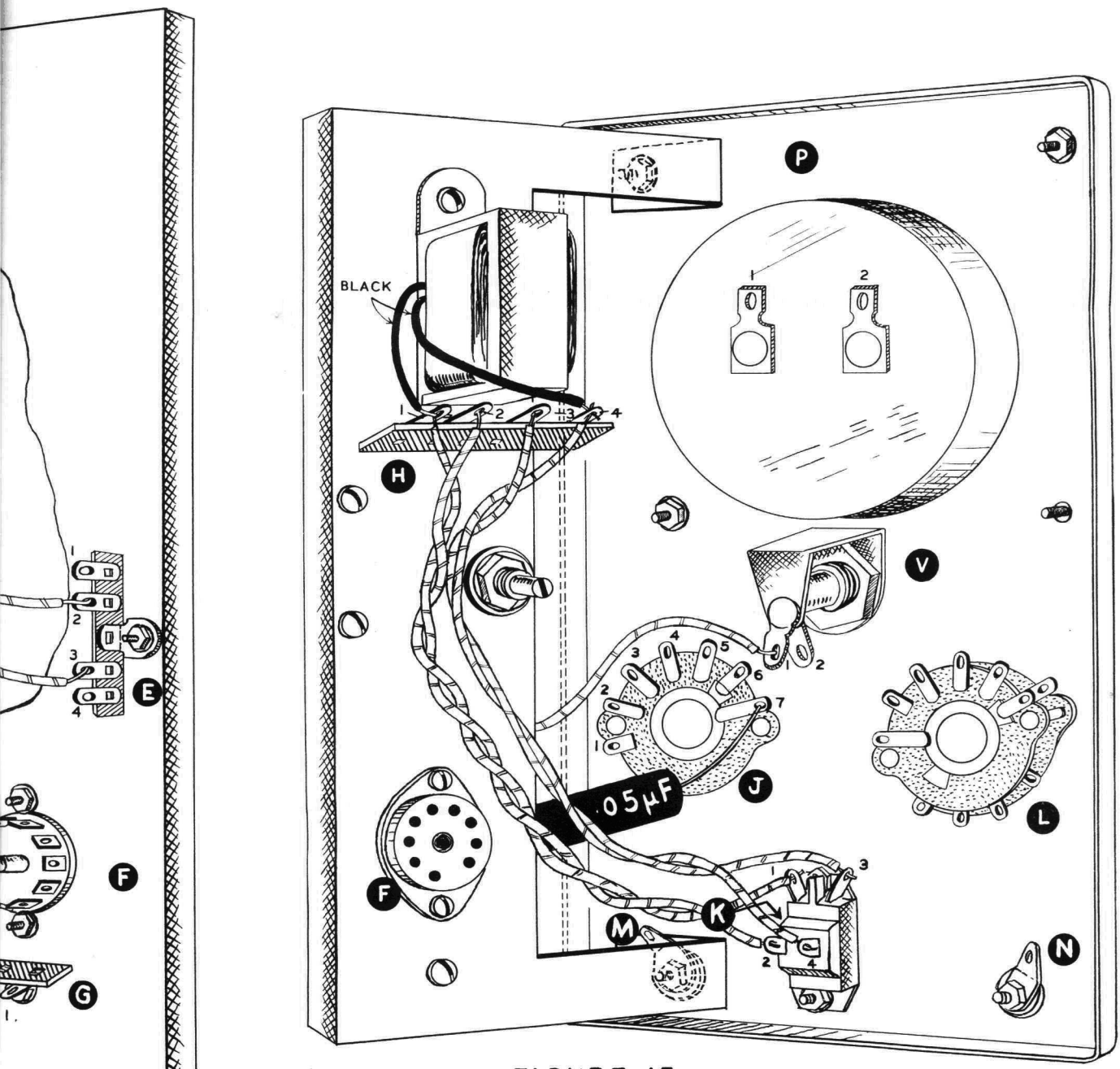
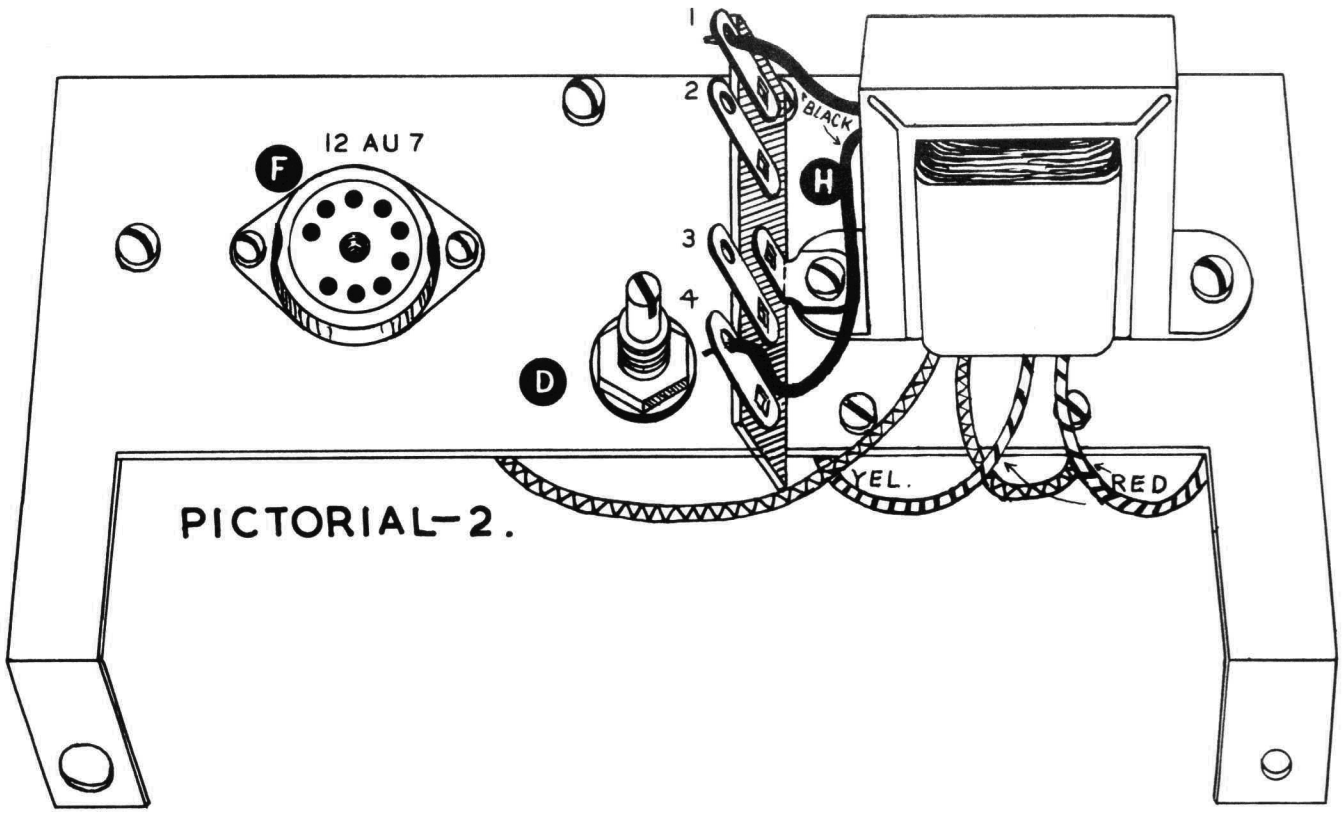


FIGURE-15.



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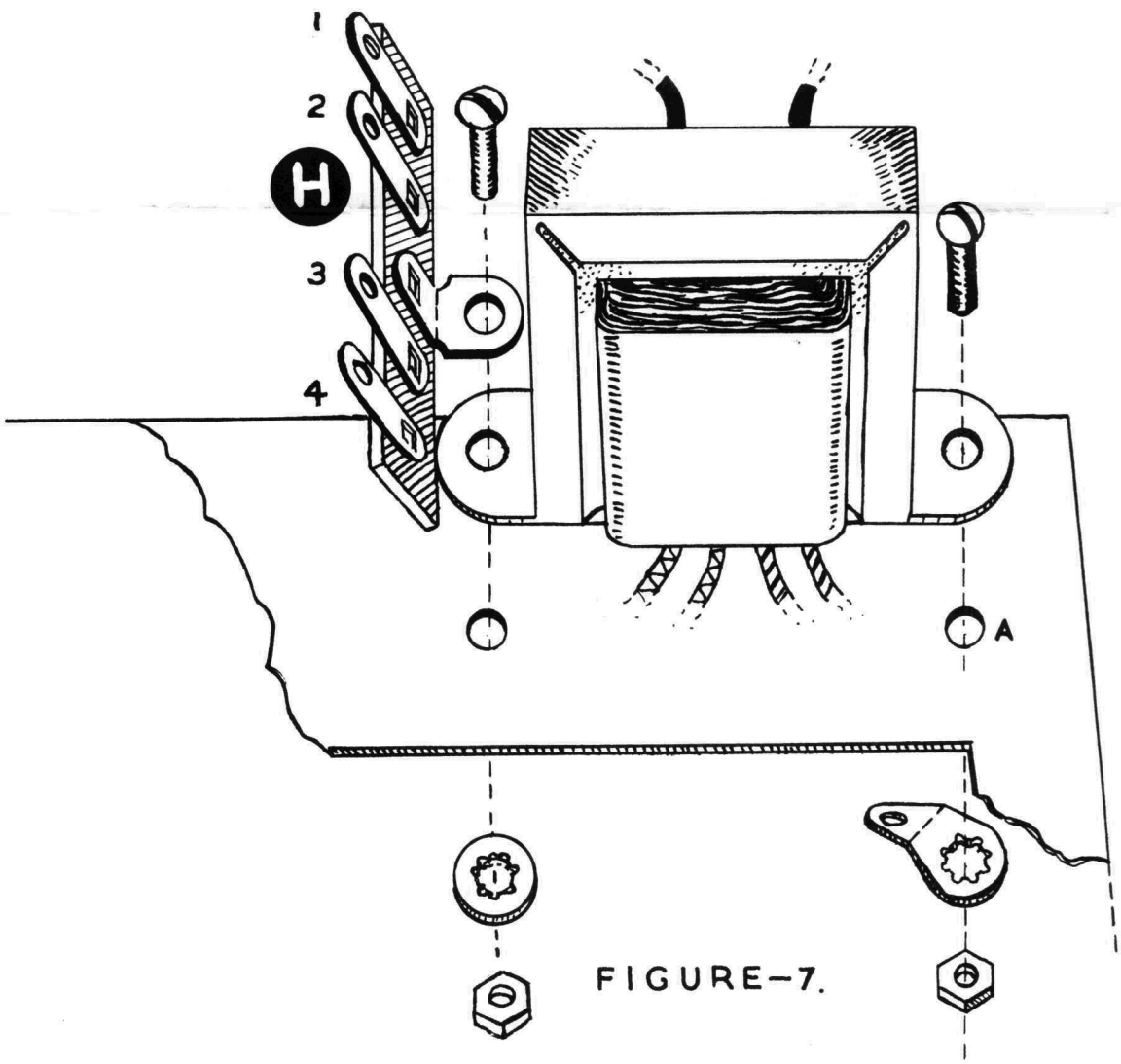
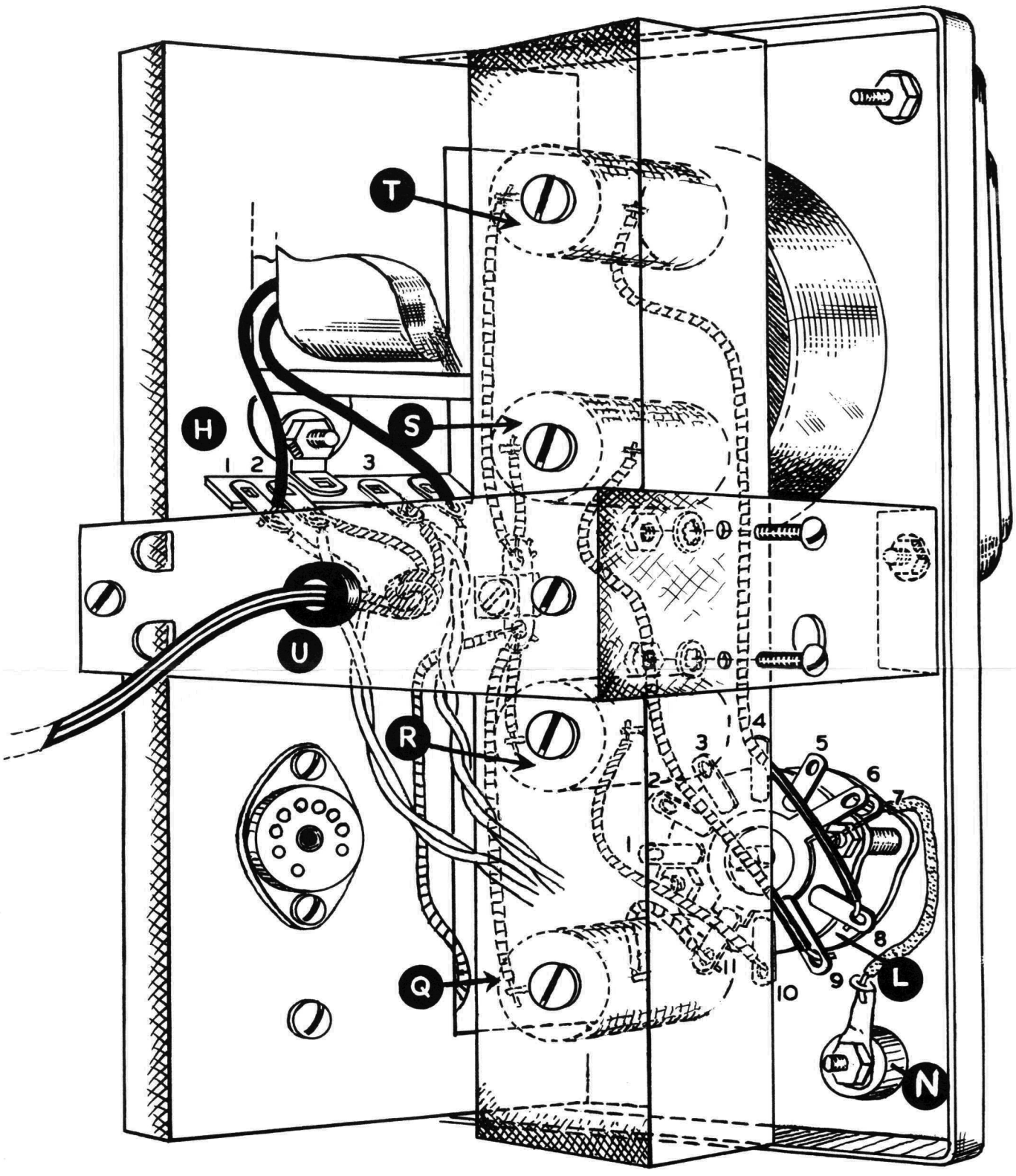
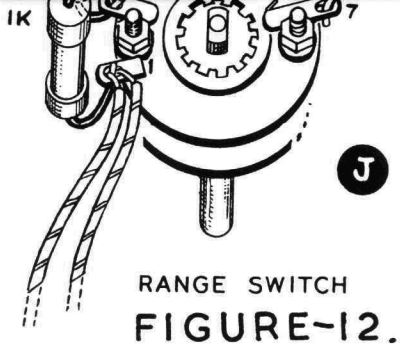


FIGURE–7.



FIGURE—16.



RANGE SWITCH

FIGURE-12.

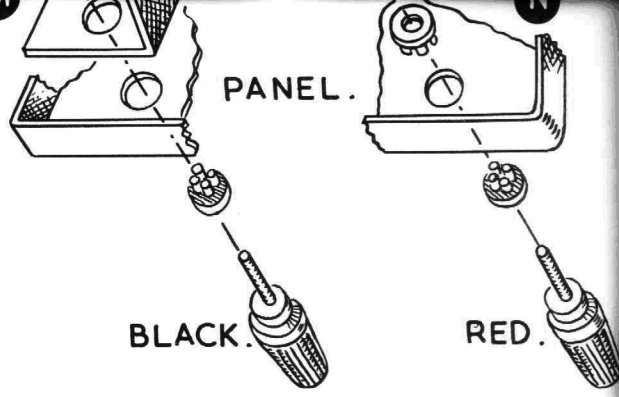


FIGURE-10.

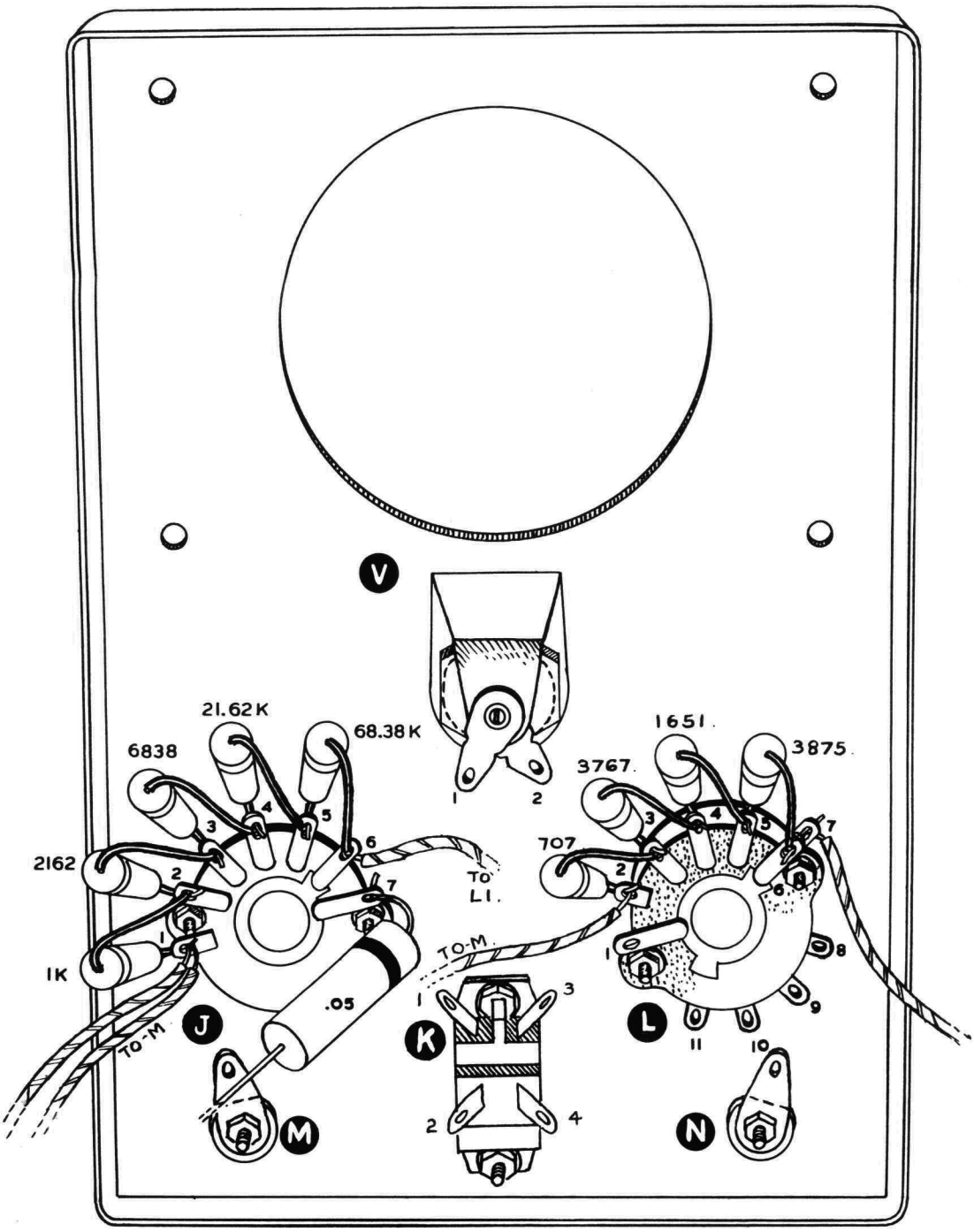
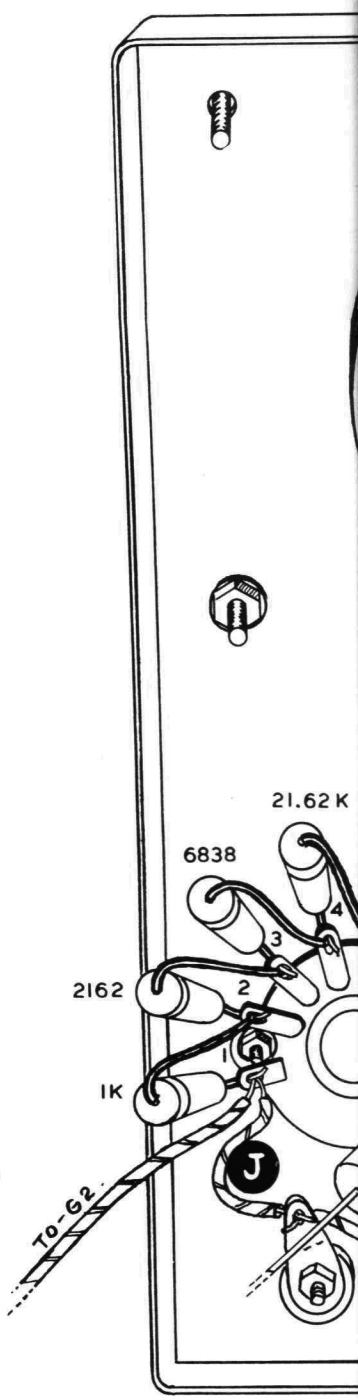
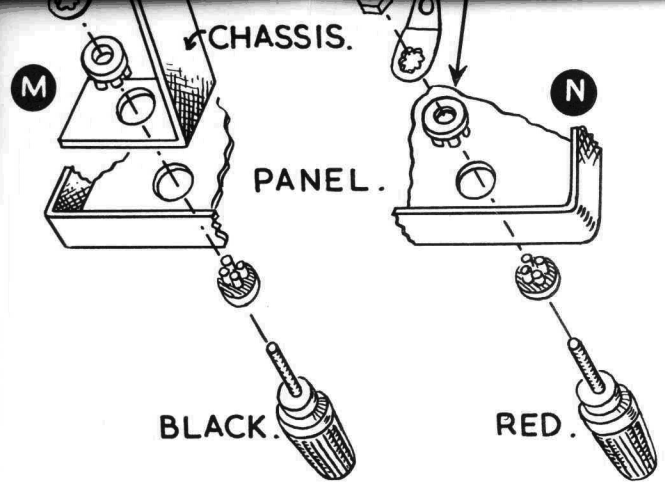


FIGURE-9.





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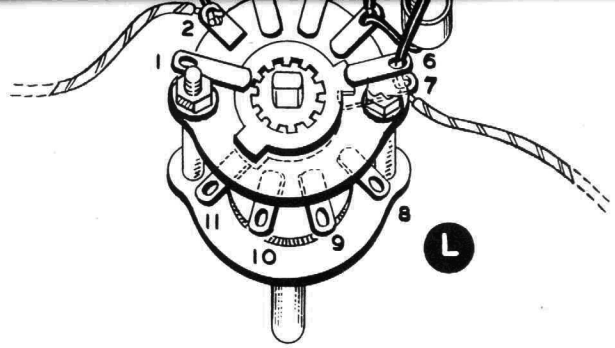
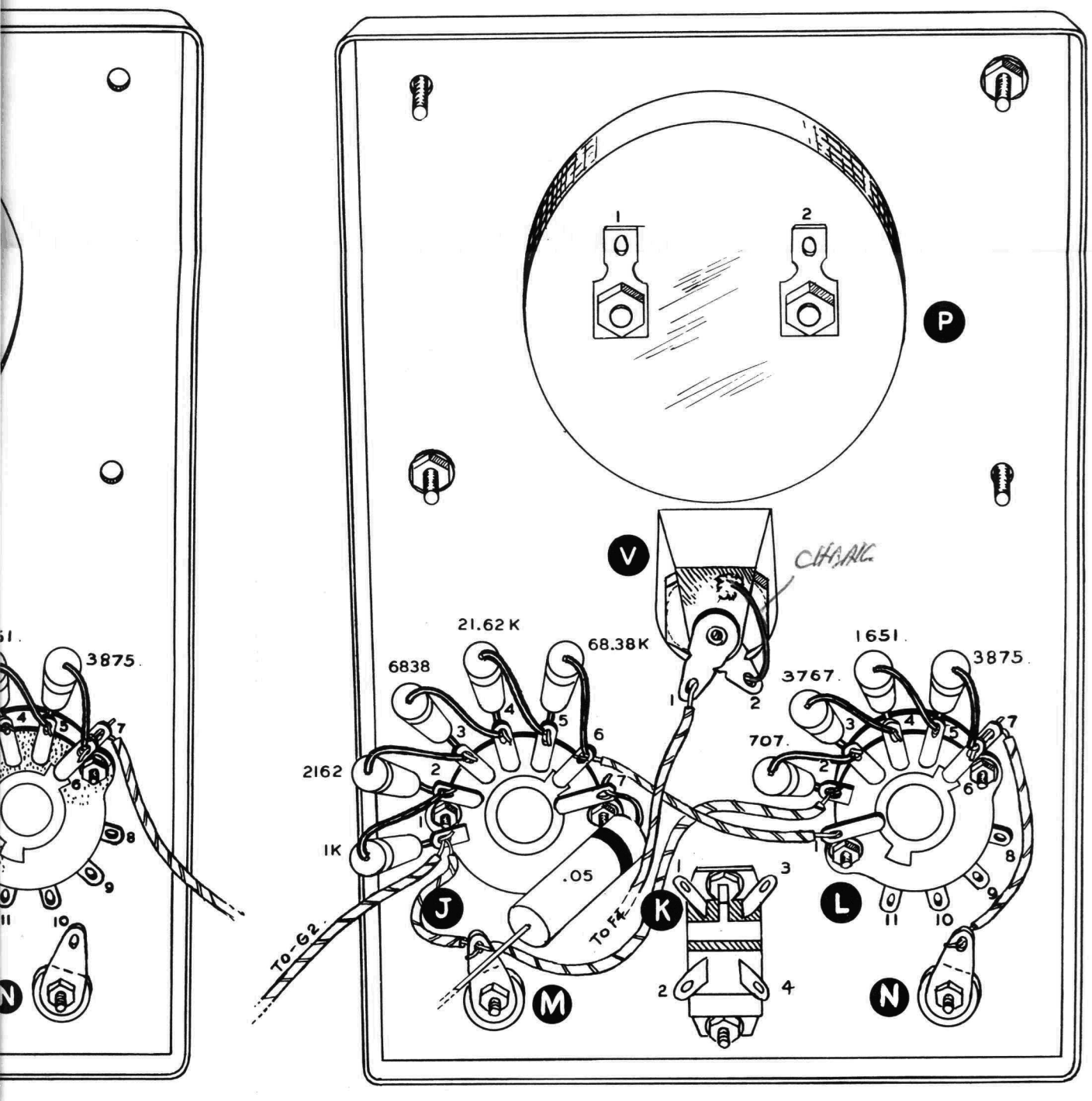


SELECTOR SWITCH

FIGURE-13.



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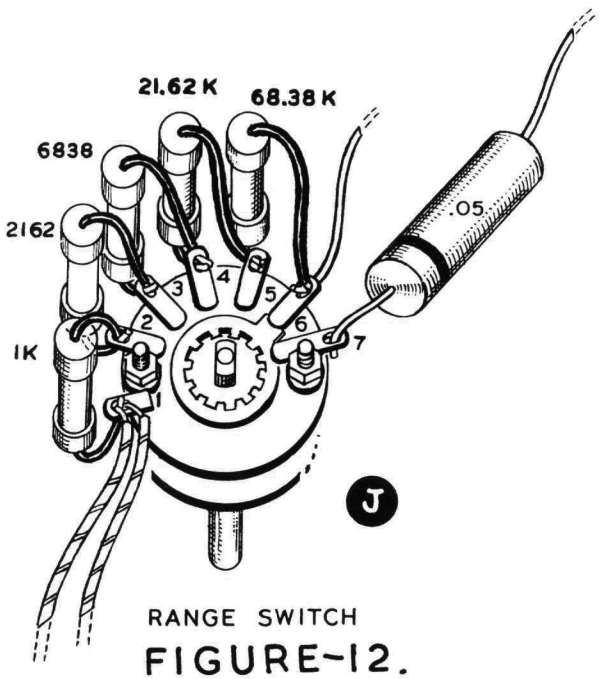


RANGE SWITCH

FIGURE-12.

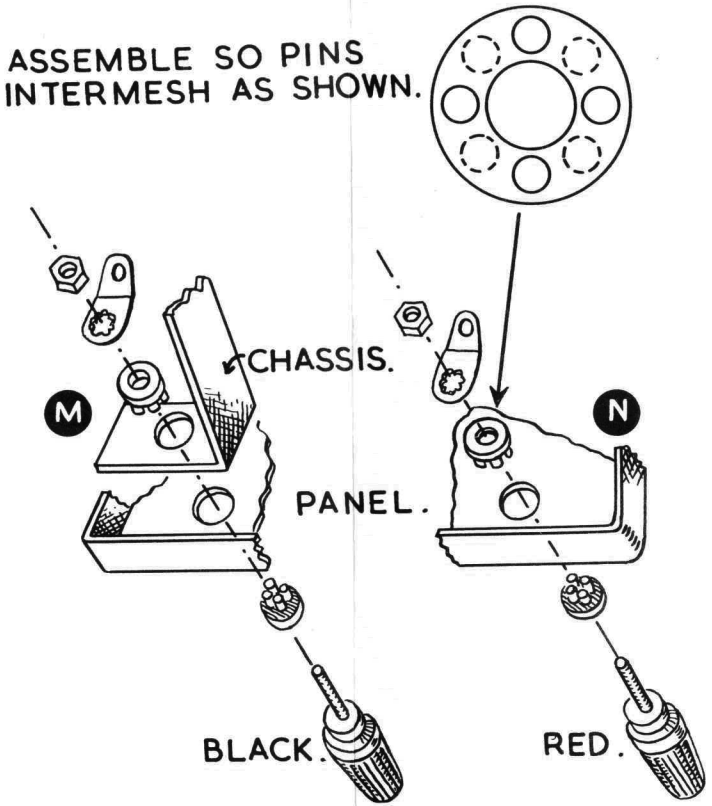
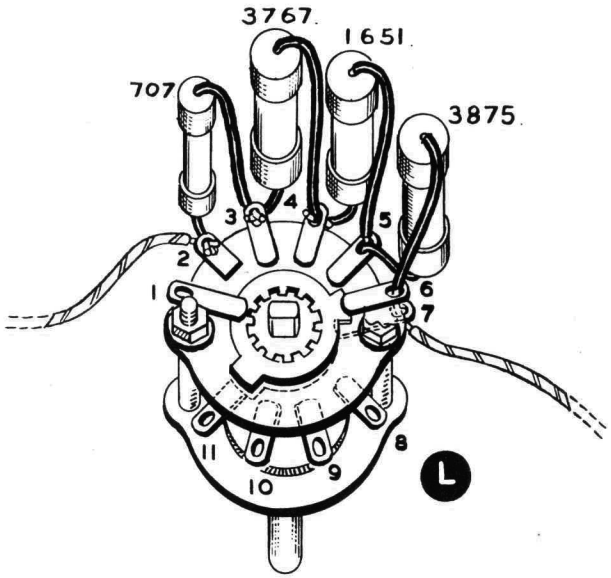
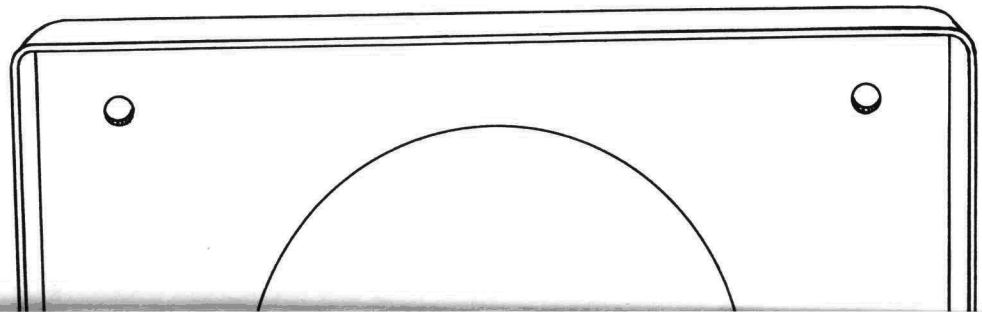


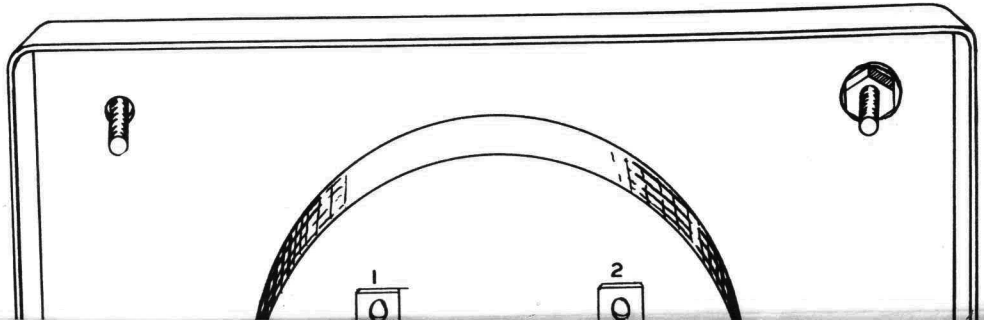
FIGURE-10.



SELECTOR SWITCH

FIGURE-13.





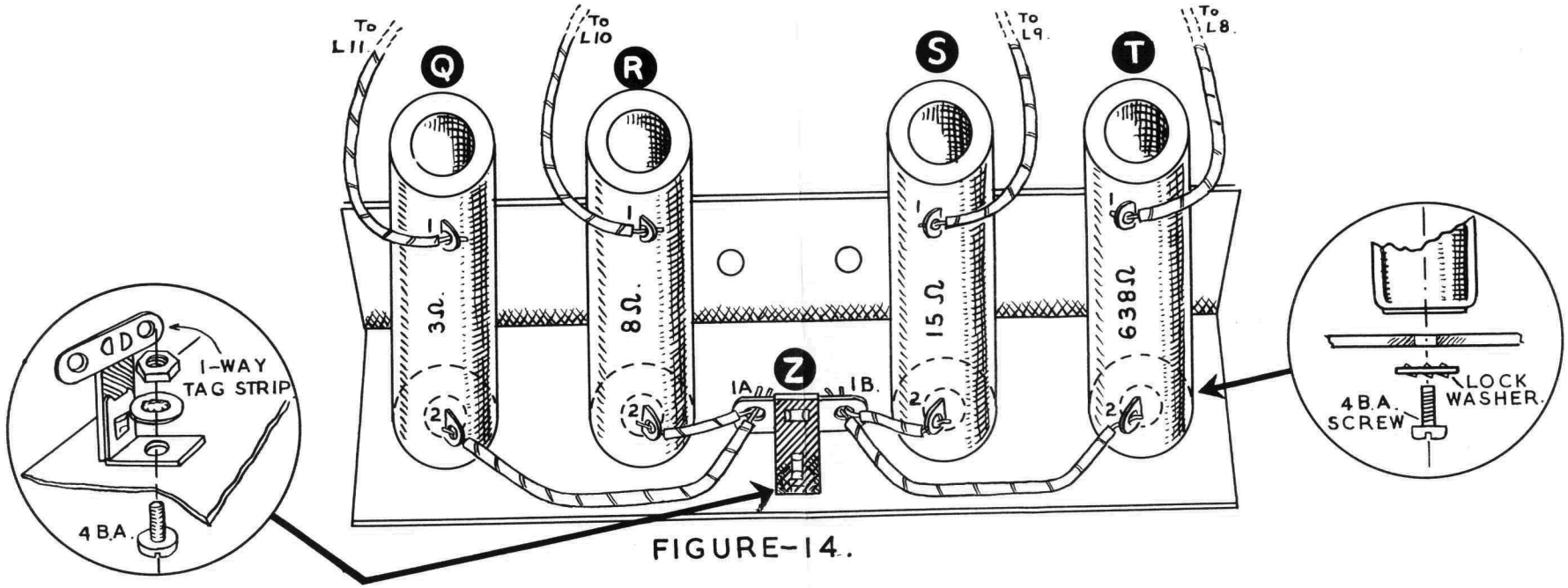
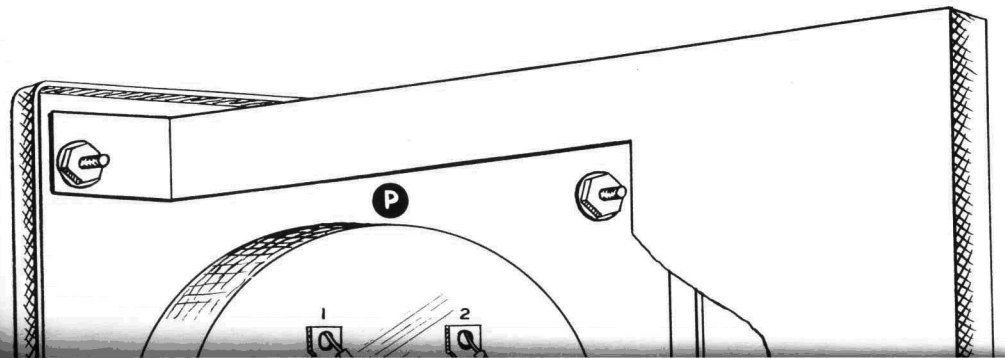
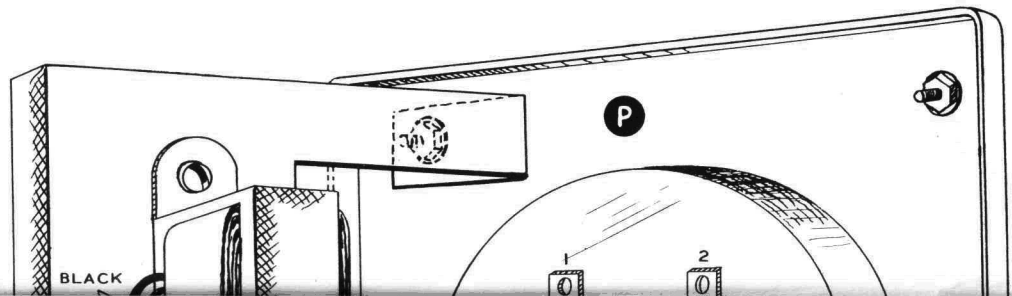

To L11.
To L10.
To L9.
To L8.
Q
R
S
T
Z
1A
1B.
3Ω.
8Ω.
15Ω
638Ω
1-WAY TAG STRIP.
4 B.A.
LOCK WASHER.
4 B.A. SCREW

FIGURE-14.


P
1
2


P
BLACK
1
2