PRICE 12/6

Assembling and Using Your...

Heathkit
DAYSTROM

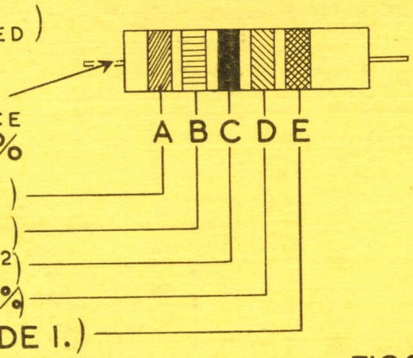
TRANSISTOR TESTER
MODEL IM-30U

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 I. RESISTANCE OF 6,800 Ω ± 5%



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

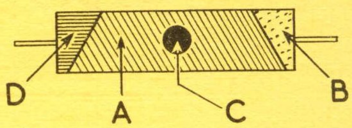


FIG 2. BODY, TIP & SPOT MARKING

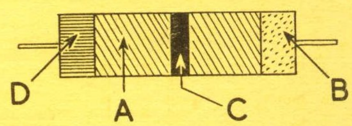
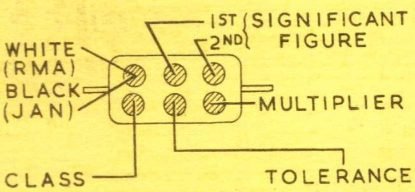


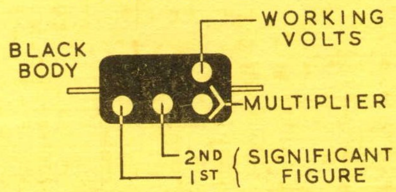
FIG 3. BODY TIP & CENTRAL BAND MARKING

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

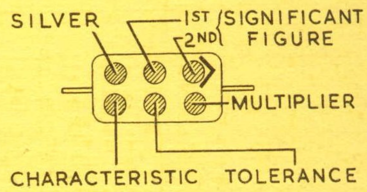
CURRENT STANDARD CODE



MOULDED FLAT CAPACITOR COMMERCIAL CODE



JAN. CODE CAPACITOR



COLOUR CODE FOR RESISTORS AND CAPACITORS

Colour	Value in Ohms 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	COL. C. (MULTIPLIER) 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.).

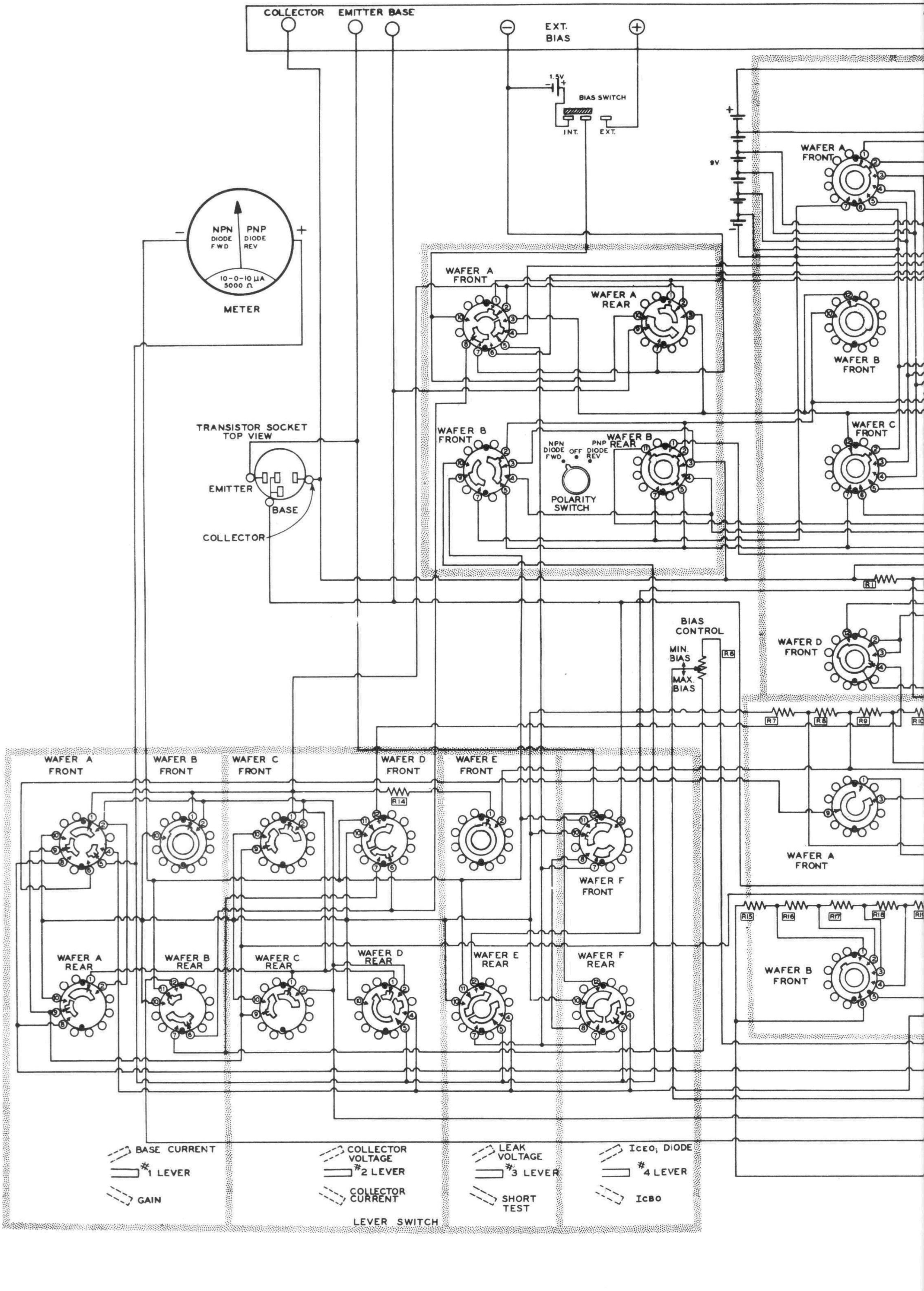
N.B. High-Stability Resistors supplied with this kit are not as a rule colour coded but enamelled in one colour on which the value in Ohms is printed in figures. Capacitors supplied in this kit usually have their capacity clearly marked in figures. Some Capacitors coded as above also have additional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

Assembly and Operation of the Heathkit Transistor Tester

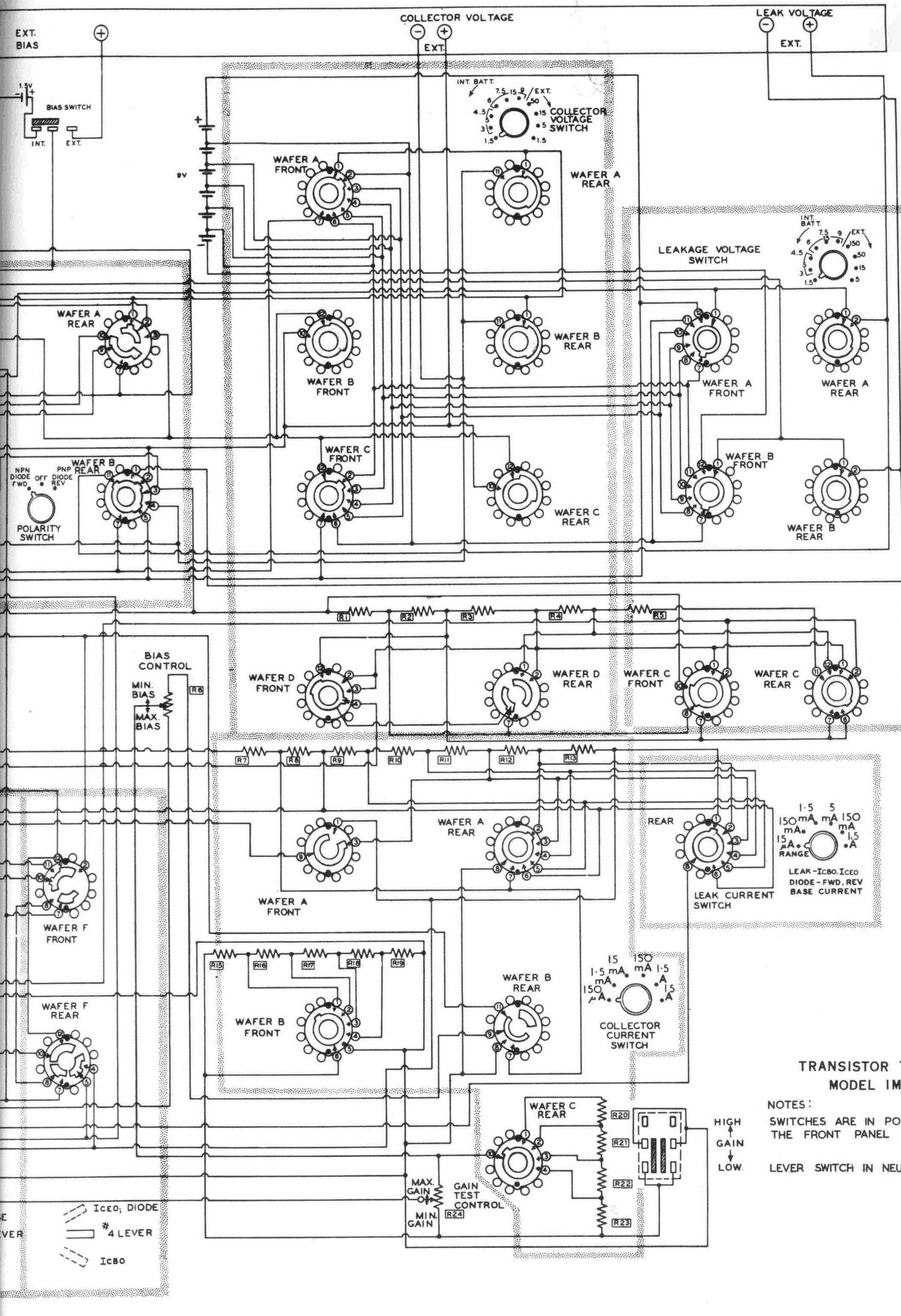
MODEL IM-30U

SPECIFICATION

Tests:	
Gain	DC beta (h_{FE}): 0-300 on two scales DC alpha (α): 0-0.9966 on two scales
Short	Collector to emitter
Leak Current	Collector to emitter, I_{ceo} Collector to base, I_{cbo}
Diodes	Forward and reverse current
By Calculation	AC current gain $\frac{\Delta I_c}{\Delta I_b}$ DC transconductance $\frac{I_c}{E_b}$ AC transconductance $\frac{\Delta I_c}{\Delta E_b}$ DC resistance, base $\frac{E_b}{I_b}$, collector $\frac{E_c}{I_c}$ AC resistance, base $\frac{\Delta E_b}{\Delta I_b}$, collector $\frac{\Delta E_c}{\Delta I_c}$
Meter:	
Scales	15-0-15 and 50-0-50
Sensitivity	10-0-10 μA, 100 K ohm/volt
Resistance	5000 ohms
Power Supply:	
Internal	Seven U2 1.5 volt batteries (not supplied with kit)
External Connectors:	
Terminals	Transistors and diodes EXTernal BIAS supply EXTernal COLLECTOR VOLTAGE supply EXTernal LEAK VOLTAGE supply



COLLECTOR
EMITTER
BASE
EXT. BIAS
1.5V
BIAS SWITCH
INT.
EXT.
9V
NPN DIODE FWD
PNP DIODE REV
10-0-10 µA 5000 Ω
METER
WAFER A FRONT
WAFER A REAR
WAFER B FRONT
WAFER B REAR
WAFER C FRONT
WAFER D FRONT
TRANSISTOR SOCKET TOP VIEW
EMITTER
BASE
COLLECTOR
NPN DIODE FWD
OFF
PNP DIODE REV
POLARITY SWITCH
R1
BIAS CONTROL
MIN. BIAS
MAX. BIAS
R6
R7
R8
R9
R10
R14
R15
R16
R17
R18
R19
WAFER A FRONT
WAFER B FRONT
WAFER C FRONT
WAFER D FRONT
WAFER E FRONT
WAFER F FRONT
WAFER A REAR
WAFER B REAR
WAFER C REAR
WAFER D REAR
WAFER E REAR
WAFER F REAR
BASE CURRENT
#1 LEVER
GAIN
COLLECTOR VOLTAGE
#2 LEVER
COLLECTOR CURRENT
LEAK VOLTAGE
#3 LEVER
SHORT TEST
ICEO; DIODE
#4 LEVER
ICBO
LEVER SWITCH



TRANSISTOR TESTER
MODEL IM-30U

NOTES:

SWITCHES ARE IN POSITION SHOWN BY THE FRONT PANEL MARKINGS.

LEVER SWITCH IN NEUTRAL POSITION.

Switches:

Lever	Selects any one of eight tests: BASE CURRENT GAIN COLLECTOR VOLTAGE COLLECTOR CURRENT LEAK VOLTAGE SHORT TEST I_{ceo} or DIODE TEST I_{cbo}
BIAS:	Selects INT. 1.5V battery or EXT. source
POLARITY:	Selects NPN or DIODE FWD, OFF, and PNP or DIODE REV.
COLLECTOR VOLTAGE:	Selects internal batteries in 1.5 volt increments up to 9 volts; selects external voltages up to 50 volts
LEAK VOLTAGE:	Selects internal batteries in 1.5 volt increments up to 9 volts; selects external voltages up to 150 volts
LEAK CURRENT:	Selects meter ranges from 15 μA to 1.5 A in steps of times 10
COLLECTOR CURRENT:	Selects meter ranges from 150 μA to 15 A in steps of times 10
GAIN, HIGH-LOW:	Selects Gain Test control scales of 0-150 Beta and 0-0.993 Alpha, or 150-300 Beta and 0.993-0.9966 Alpha

Controls:

BIAS	Adjusts collector current to any value from 0 to 15 A
Gain Test	Calibrated scale shows actual gain (Beta and Alpha) of transistor when control is adjusted to null the meter

General:

Universal transistor socket	
Dimensions	5½" high x 10¼" deep x 10¾" wide
Net Weight	8 lb.
Shipping Weight	16 lb.

RESISTANCE CHART

R1	145 KΩ	R9	0.9Ω	R17	135.7Ω
R2	350 KΩ	R10	9Ω	R18	13.5Ω
R3	1 MΩ	R11	90Ω	R19	1.5Ω
R4	3.5 MΩ	R12	900Ω	R20	1515Ω
R5	10 MΩ	R13	9 KΩ	R21	135.7Ω
R6	100Ω 4W control	R14	2.2Ω 2W	R22	13.5Ω
R7	0.01Ω	R15	13.5 KΩ	R23	1.5Ω 2W
R8	0.09Ω	R16	1350Ω	R24	15 KΩ 2W control

INTRODUCTION

The Model IM-30U Transistor Tester is a portable tester designed for production testing, incoming inspection, servicing and design work.

By using the switches any d.c. operating point of a transistor or diode can be quickly set up. The gain of a transistor is found by comparing the BASE and COLLECTOR currents, which are indicated by nulling the meter with the Gain Test control.

CIRCUIT DESCRIPTION

The IM-30U Transistor Tester tests transistors and diodes under conditions that correspond to actual d.c. operating conditions.

A.c. operating conditions can be readily found by testing the transistor at two different bias points and calculating the desired a.c. operating condition.

The 4-lever, 3-position switch selects the various tests by moving the proper lever to the desired test position. Tests selected by the Lever switch are BASE CURRENT, GAIN, COLLECTOR VOLTAGE, COLLECTOR CURRENT, LEAK VOLTAGE, SHORT TEST, I_{ceo} or DIODE and I_{cbo}.

The following paragraphs describe each test separately. Refer to the individual schematic for a better understanding of each test.

BASE CURRENT TEST (I_b)

The meter is connected in series with the base circuit and it therefore shows base current directly. R_s (resistors R7 to R13) is the meter shunt which varies in value with the position of the LEAK-DIODE-BASE CURRENT switch. Collector voltage is selected with the COLLECTOR VOLTAGE switch. BIAS control R6 is set for the specified base current. (See Figure 1.)

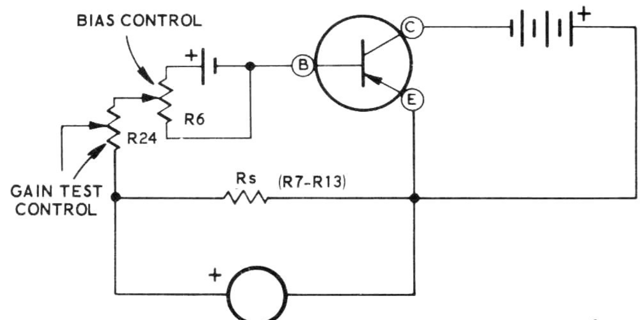


FIGURE 1

GAIN TEST (DC BETA - DC ALPHA)

For this test, the meter shows the difference between the voltage drop across R_s and that across Gain Test control R24. By adjusting R24 for meter null, the voltage drop across R_s equals the voltage drop across R24. This is, I_c (collector current) times R_s (meter shunt value) equals I_b (base current) times R24 (Gain Test control). The gain, beta, is directly proportional to the setting of R24. (See Figure 2.)

R24 has a calibrated dial (0-150) which indicates beta or alpha directly. Alpha equals beta divided by beta plus one.

If at any time the gain of a transistor is higher than 150, the GAIN HIGH-LOW switch should be placed in its HIGH position. This puts resistance R_h (which consists of resistors R15 to R19) in series with the Gain Test control and extends the beta scale from 150 to 300. Resistance R_h varies with the position of the COLLECTOR CURRENT switch.

The true gain of the transistor is shown regardless of the BIAS control setting.

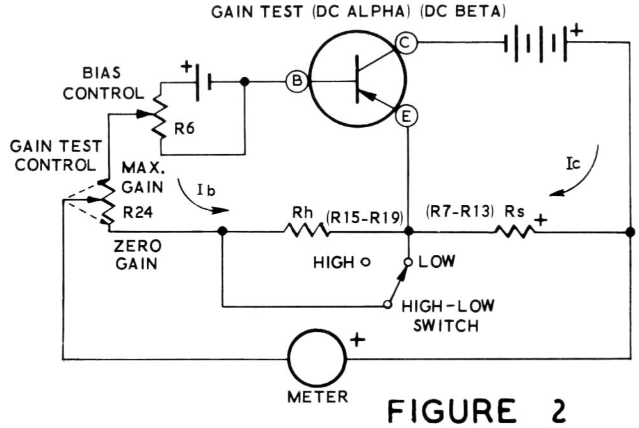


FIGURE 2

COLLECTOR VOLTAGE TEST (E_c)

The meter shows the voltage between the collector and the emitter. This voltage is selected with the COLLECTOR VOLTAGE switch. R_V is the meter shunt which is made up of resistors R1 to R5. This voltage is checked under d.c. operating conditions of the transistor (see Figure 3).

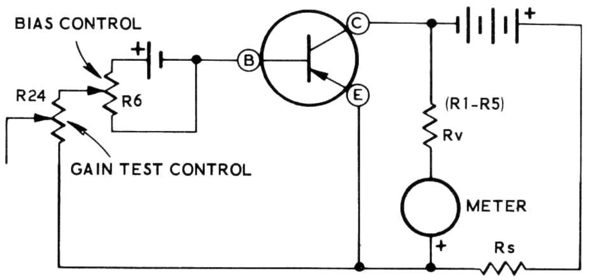


FIGURE 3

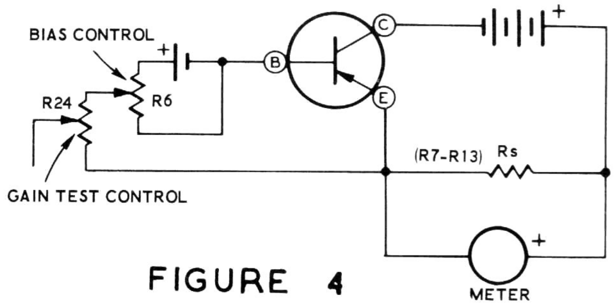


FIGURE 4

COLLECTOR CURRENT TEST (I_c)

This current is checked between collector and emitter as shown in Figure 4. The BIAS control is adjusted for the desired collector current.

LEAK VOLTAGE TEST (E_L)

In this test, the meter measures the supply voltage selected by the LEAK VOLTAGE switch. The base and emitter of the transistor are open in this test (see Figure 5).

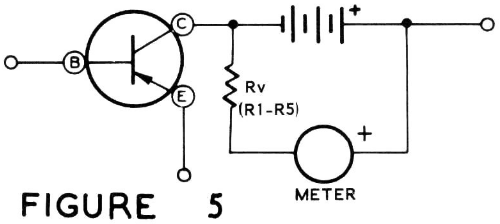


FIGURE 5

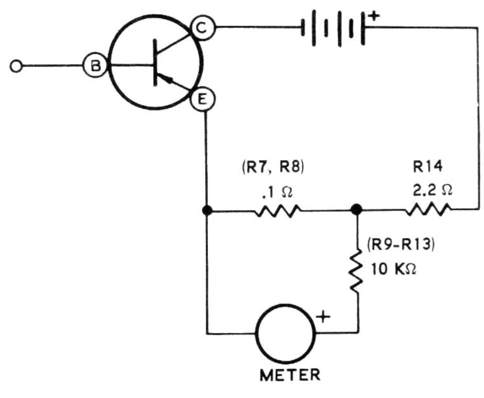


FIGURE 6

SHORT TEST

Here the meter is in series with the collector and emitter. Collector voltage is selected with the COLLECTOR VOLTAGE switch. .1Ω, 2.2Ω and 10 KΩ resistors act as the meter shunt and dropping resistors to protect the meter when a shorted transistor is checked and to give the proper meter deflection (see Figure 6).

COLLECTOR TO EMITTER LEAKAGE (I_{ceo}) OR DIODE TEST

The meter shows leakage current between collector and emitter, with the base open. Again, resistance R_s is the meter shunt, as selected by the LEAK-DIODE-BASE switch.

When checking diodes, the diode replaces the transistor as indicated in Figure 7. To check the forward current of a diode, the power supply voltage is reversed with the POLARITY switch.

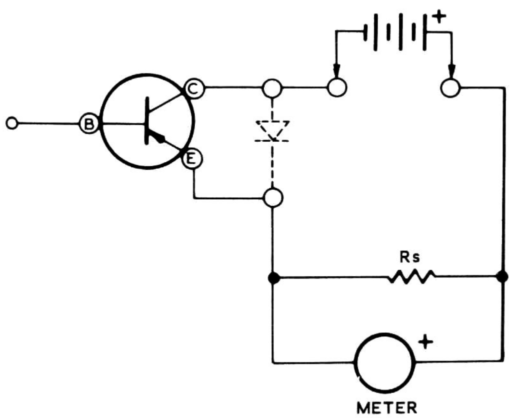


FIGURE 7

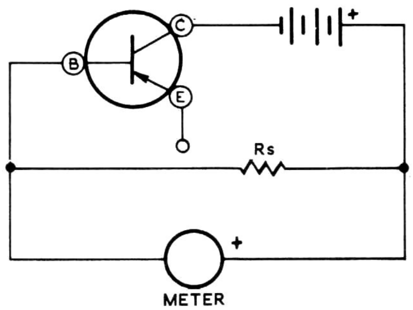
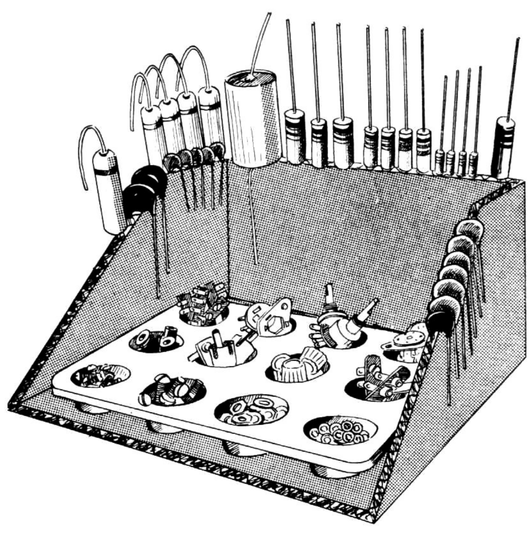


FIGURE 8

COLLECT TO BASE LEAKAGE TEST (I_{cbo})

In this test, the meter shows the leakage current between the collector and base with the emitter open. R_s is the meter shunt (see Figure 8).

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



PRELIMINARY NOTES AND INSTRUCTIONS

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

UNPACK THE KIT CAREFULLY, EXAMINE EACH PART AND CHECK IT AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. You will find it helpful to refer to the component identification sheet and also to the general details printed on the inside covers of the manual. If a shortage is found, attach the inspection slip to your claim and notify us promptly.

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.

Unless otherwise stated, use lockwashers under all nuts, and also between controls and the chassis. When shake-proof 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, tagstrips, 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 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 tagstrips, 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.

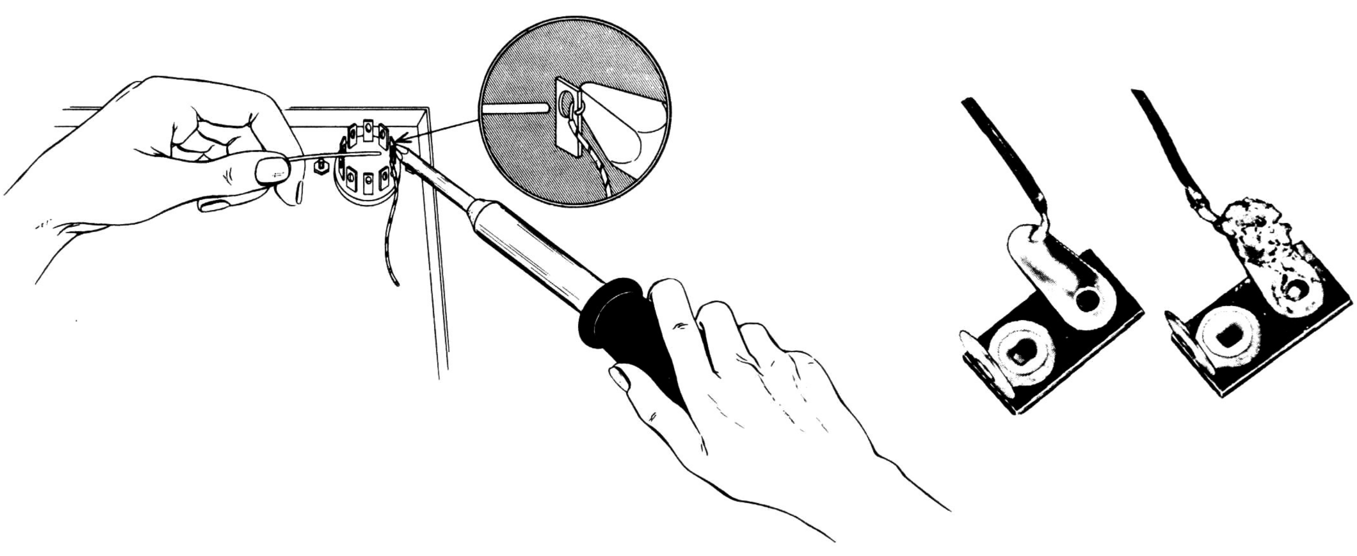
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture.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

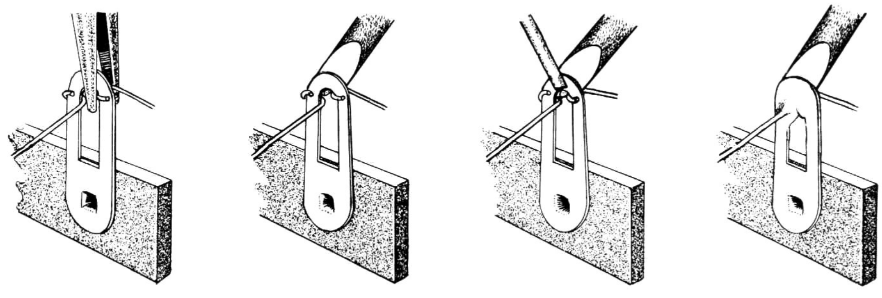
IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number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

SPECIAL NOTE: Where a wire is passed through a tag to other parts of the circuit, this will be regarded as two connections (S-2).

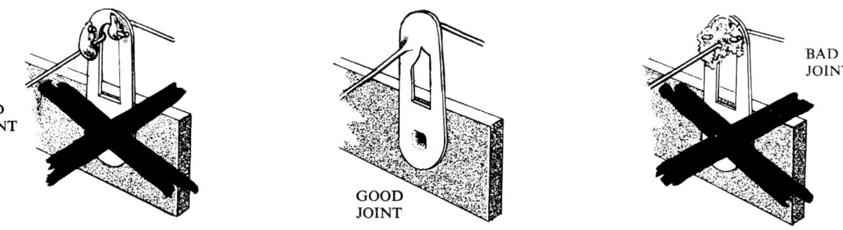
When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.



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.



CRIMP WIRES — HEAT CONNECTION — 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. Do not 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. Do not 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 be means of a rag or steel wool.

Do not apply too much solder to the soldered joint. Do not 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.

Do not 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.

STEP-BY-STEP ASSEMBLY

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

When wiring this instrument you may wish to prepare the lengths of wire ahead of time. The lengths of connecting wire needed for the wiring steps are listed at the beginning of each section. Prepare each length by stripping $\frac{1}{4}$" of insulation from each end. Arrange the wires in the sequence listed. This will save time in performing the steps.

NOTE: Use the small diameter connecting wire in all wiring steps unless large diameter (heavy) wire is specifically called for. Do not use the bare resistance wire until it is specifically called for.

PREWIRING LEAK VOLTAGE SWITCH R

Refer to Pictorial 1 for the following steps:

( ) Select the 10-position 3-wafer rotary switch (Part No. 63-559). Since there are two 3-wafer switches in the kit, make sure you have the correct switch by comparing the tag arrangement with Pictorial 1. This switch is designated as switch R. In referring to switch connections such as RA5, the first letter, R, refer to the LEAK VOLTAGE switch. The second letter A, means wafer A of the switch; the wafer nearest the front of the switch. The number 5 means tag number 5.

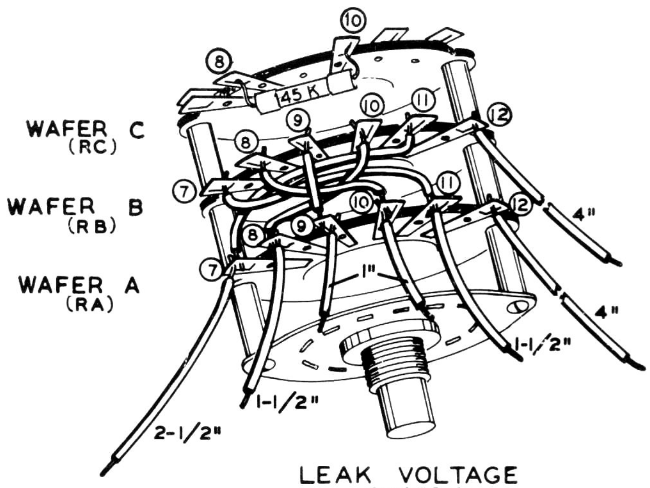
( ) Prepare the following lengths of connecting wire:

2"	$1\frac{3}{4}$"	4"	1"
$1\frac{3}{4}$"	2"	$1\frac{1}{2}$"	$1\frac{1}{2}$"
1"	4"	1"	$2\frac{1}{2}$"

NOTE: When wiring switches, ensure that solder does not run down the switch tags into the contacts as this will ruin the switch.

Prewire switch R as follows:

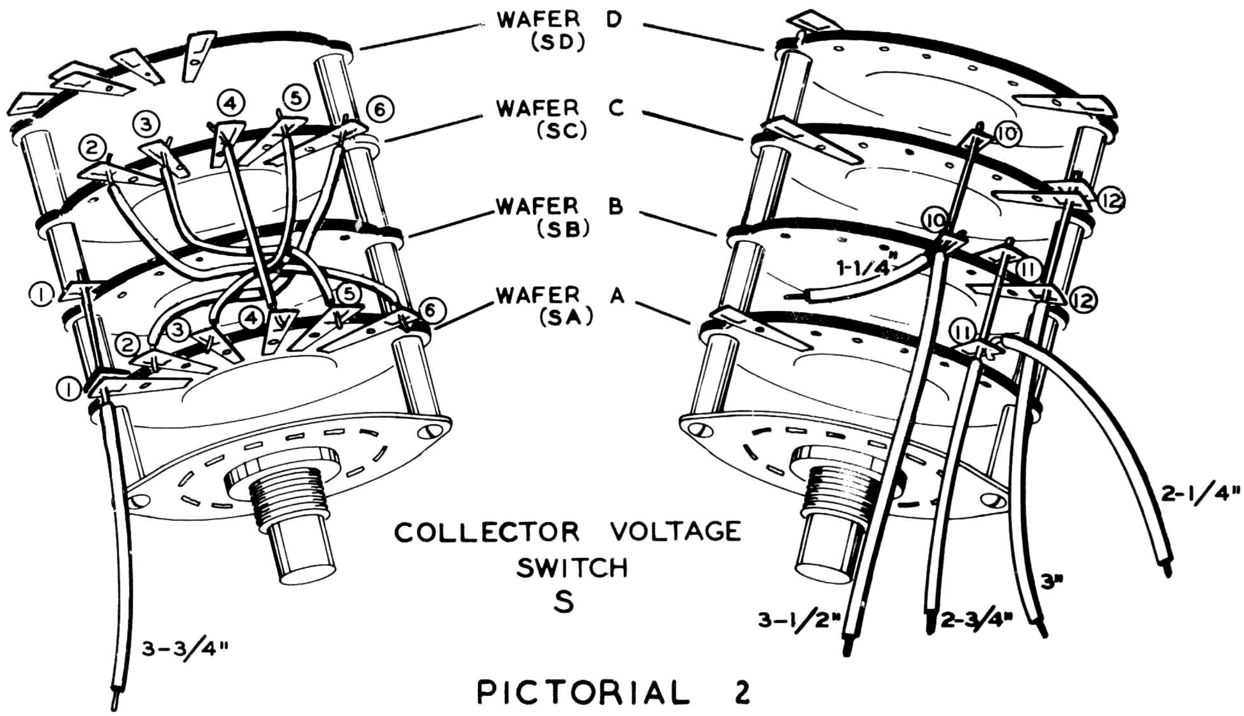
CONNECT A	FROM TAG	TO TAG
( ) 2" wire	RA7 (NS)	RB11 (S-1)
( ) $1\frac{3}{4}$" wire	RA8 (NS)	RB10 (S-1)
( ) 1" wire	RA9 (NS)	RB9 (S-1)
( ) $1\frac{3}{4}$" wire	RA10 (NS)	RB8 (S-1)
( ) 2" wire	RA11 (NS)	RB7 (S-1).
( ) 4" wire	RB12 (S-1)	not connected
( ) 4" wire	RA12 (S-1)	not connected
( ) $1\frac{1}{2}$" wire	RA11 (S-2)	not connected
( ) 1" wire	RA10 (S-2)	not connected
( ) 1" wire	RA9 (S-2)	not connected
( ) $1\frac{1}{2}$" wire	RA8 (S-2)	not connected
( ) $2\frac{1}{2}$" wire	RA7 (S-2)	not connected
( ) R1. 145 KΩ resistor	RC8 (NS)	RC10 (NS).



LEAK VOLTAGE SWITCH R

PICTORIAL 1

Set the switch aside to be installed later.



PICTORIAL 2

PREWIRING COLLECTOR VOLTAGE SWITCH S

Refer to Pictorial 2 for the following steps:

( ) Select the 10-position 4-wafer rotary switch (Part No. 63-560).

( ) Prepare the following lengths of connecting wire:

$2\frac{1}{4}$", $1\frac{3}{4}$", $1\frac{1}{4}$", $1\frac{3}{4}$", $2\frac{1}{4}$", $3\frac{3}{4}$" heavy, 3" heavy, $2\frac{3}{4}$" heavy, $2\frac{1}{4}$" heavy, $3\frac{1}{2}$" heavy, $1\frac{1}{4}$" heavy.

Prewire switch S as follows:

CONNECT A	FROM TAG	TO TAG
( ) $2\frac{1}{4}$" wire	SA2 (NS)	SC6 (NS).
( ) $1\frac{3}{4}$" wire	SA3 (NS)	SC5 (NS).
( ) $1\frac{1}{4}$" wire	SA4 (NS)	SC4 (NS).
( ) $1\frac{3}{4}$" wire	SA5 (NS)	SC3 (NS).
( ) $2\frac{1}{4}$" wire	SA6 (NS)	SC2 (NS).

NOTE: When making connections to double tags, the wire should be passed through both tags and when solder instruction is given, ensure that both tags are soldered.

( ) Strip an additional $\frac{1}{2}$" of insulation from one end of a $3\frac{3}{4}$" heavy wire. Insert this end through SA1 (NS) to SB1 (S-1). Now solder SA1 (S-2).

( ) Strip an additional $\frac{1}{2}$" of insulation from one end of a 3" heavy wire. Insert this end through SB12 (NS) to SC12 (S-1). Now solder SB12 (S-2).

( ) Strip an additional $\frac{1}{2}$" of insulation from one end of a $2\frac{3}{4}$" heavy wire. Insert this end through SA11 (NS) to SB11 (S-1).

( ) Connect a $2\frac{1}{4}$" heavy wire to SA11 (S-3). Leave the other end free.

( ) Strip an additional $\frac{1}{2}$" of insulation from one end of a $3\frac{1}{2}$" heavy wire. Insert this end through SB10 (NS) to SC10 (S-1).

( ) Connect a $1\frac{1}{4}$" heavy wire to SB10 (S-3).

The free ends of the heavy connecting wires just installed, will be connected later.

Set the switch aside for use later.

PREWIRING COLLECTOR CURRENT SWITCH V

Refer to Pictorial 3 for the following steps:

( ) Select the 6-position 3-wafer rotary switch (Part No. 63-561). The prewiring of this switch is divided into three sections: wafer A, wafer B and wafer C. Wafer C will be prewired first.

To install a resistor on switch V, bend one lead against the resistor body before making the connection. Cut off the excess lead after the connection has been soldered.

NOTE: Read each resistor value very carefully before installing the resistor as some resistor values are very similar.

WAFER C

CONNECT A	FROM TAG	TO TAG
( ) R20. 1515Ω resistor	VC1 (S-1)	VC2 (NS).
( ) R21. 135.7Ω resistor	VC2 (S-2)	VC3 (NS).
( ) R22. 13.5Ω resistor	VC3 (S-2)	VC4 (NS).
( ) R23. 1.5Ω 2 watt	VC4 (S-2)	VB6 (NS).

WAFER B

CONNECT A	FROM TAG	TO TAG
( ) R15. 13.5 KΩ resistor	VB1 (NS)	VB6 (NS).
( ) R16. 1350Ω resistor	VB1 (S-2)	VB2 (NS).
( ) R17. 135.7Ω resistor	VB2 (S-2)	VB3 (NS).
( ) R18. 13.5Ω resistor	VB3 (S-2)	VB4 (NS).
( ) R19. 1.5Ω resistor	VB4 (S-2)	VB5 (NS).

WAFER A

CONNECT A	FROM TAG	TO TAG
( ) R13. 9 KΩ resistor	VA1 (NS)	VA2 (NS).
( ) R12. 900Ω resistor	VA2 (NS)	VA3 (NS).
( ) R11. 90Ω resistor	VA3 (NS)	VA4 (NS).
( ) R10. 9Ω resistor	VA4 (NS)	VA5 (NS).
( ) R9. 0.9Ω resistor	VA5 (NS)	VA6 (NS).
( ) R8. 0.09Ω resistor	VA6 (NS)	VA7 (NS).

( ) Prepare five $2\frac{3}{4}$" lengths of wire and connect one end of each wire to:

( ) VA1 (NS). ( ) VA2 (S-3). ( ) VA3 (S-3). ( ) VA4 (S-3). ( ) VA5 (S-3).

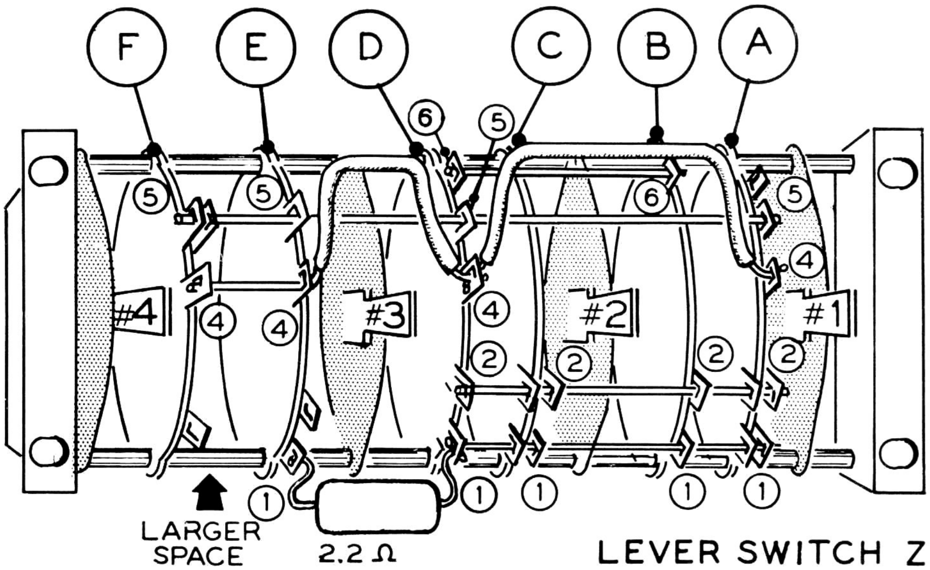
( ) Connect a $2\frac{3}{4}$" length of heavy wire to VA6 (NS). DO NOT crimp as another wire will be connected later.

( ) Connect a $\frac{3}{4}$" bare wire (stripped heavy connecting wire) from VB7 (S-1) to VA7 (S-2).

( ) Connect a 10" length of wire to VA1 (S-3).

The other ends of the wires just installed will be connected later.

Now check the switch carefully. The resistor bodies should not touch each other, switch contacts or other resistor leads. Set the switch aside for use later.



PICTORIAL 4

PREWIRING LEVER SWITCH Z

Refer to Pictorial 4 for the following steps:

NOTE: Only heavy connecting wire is used in the prewiring of the Lever switch.

( ) Prepare the following lengths of heavy connecting wire:

1.5/8", 1.5/8", 3", $2\frac{1}{2}$", 3", 1.1/8".

( ) Position the Lever switch as shown in Pictorial 4. Study the tag configuration to be sure of the proper position.

( ) Remove the insulation from a 1.5/8" heavy wire. Insert this wire through ZA1 (NS), ZB1 (NS) and ZC1 (NS), to ZD1 (NS). CAUTION: Make sure this wire does not touch the metal plate between wafers B and C. Now solder ZA1 (S-1), ZB1 (S-2) and ZC1 (S-2).

( ) R14. Connect the 2.2Ω resistor from ZD1 (S-2) to ZE1 (S-1).

( ) Remove the insulation from a 1.5/8" heavy wire. Insert this wire through ZA2 (NS), ZB2 (NS) and ZC2 (NS) to ZD2 (S-1). Now solder ZA2 (S-1), ZB2 (S-2) and ZC2 (S-2).

( ) Connect a 3" heavy wire from ZA4 (S-1) to ZD4 (NS). Position this wire as shown in Pictorial 4 to prevent lever No. 2 from contacting it when the lever is depressed.

( ) Strip an additional $\frac{1}{2}$" insulation from one end of a $2\frac{1}{2}$" heavy wire. Insert this end through ZE4 (NS) to ZF4 (S-1). Now solder ZE4 (S-2). Connect the other end of this wire to ZD4 (S-2). Position this wire as shown to prevent lever 3 from hitting it when the lever is depressed.

( ) Remove the insulation from a 3" heavy wire. Insert this wire through ZA5 (NS), ZD5 (NS) and ZE5 (NS) to ZF5 (S-1). Now solder ZA5 (S-1), ZD5 (S-2) and ZE5 (S-2).

( ) Remove the insulation from a 1.1/8" heavy wire. Insert this wire through ZB6 (NS) to ZD6 (S-1). CAUTION: Make sure this bare wire does not touch the metal plate between wafers B and C. Now solder ZB6 (S-1).

Set the switch aside for use later.

FRONT PANEL PARTS MOUNTING

( ) Position the front panel as shown in Pictorial 5. Place a cloth on your working area to prevent scratching the panel.

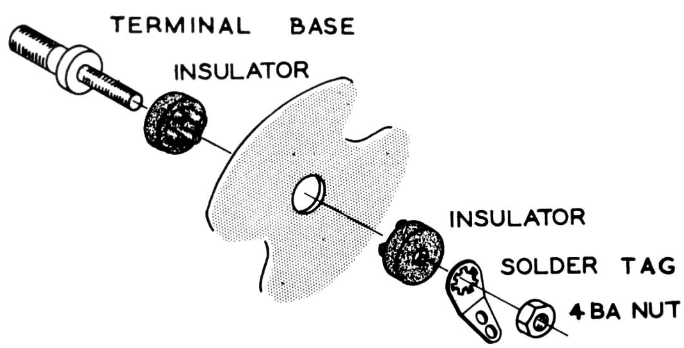
( ) Mount six 4BA speednuts, one on each L-shaped bracket, as shown in Pictorial 5. The flat side of each speednut should be toward the edge of the panel.

( ) Install the nine terminals at the top of the panel as shown in Detail 5A. Position each 4BA solder tag as shown in Pictorial 5. Mount RED terminals at G, J and L, and BLACK terminals at H, K, M, N, O and P. Orient the small hole in each terminal base at right angles to the flange of the panel.

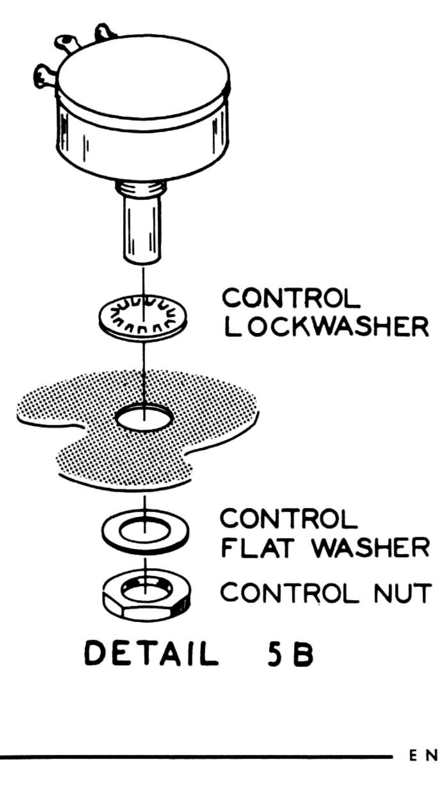
( ) Fasten the SPDT (BIAS) slide switch at location Q using 6BA x $\frac{1}{4}$" chrome plated binderhead screws and nuts. DO NOT use lockwashers.

( ) In a similar manner, fasten the DPDT (GAIN) slide switch at location X.

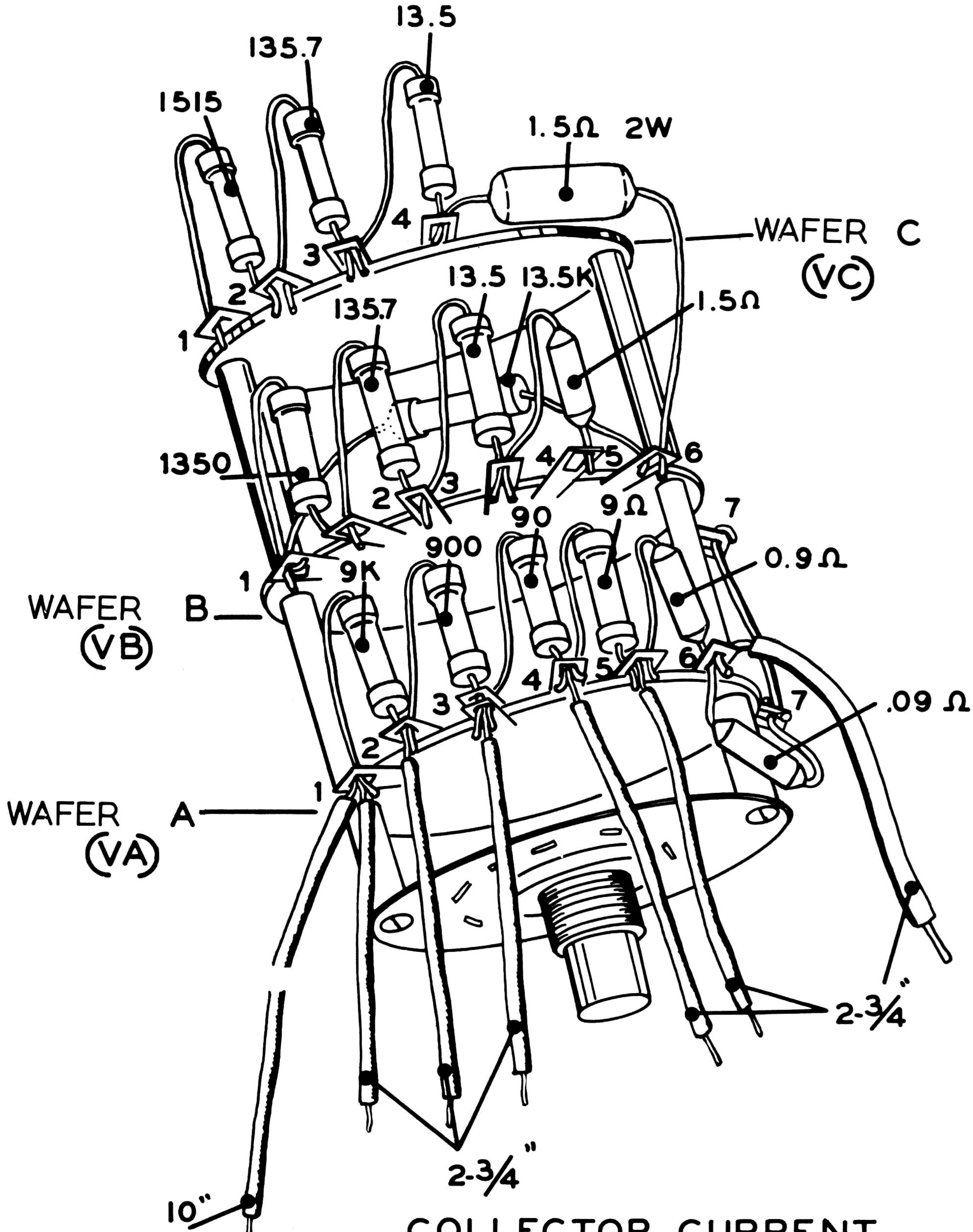
( ) R24. Mount 15 KΩ GAIN control Y using a lockwasher, flat washer and control nut as shown in Detail 5B. Position the control as shown in Pictorial 9.

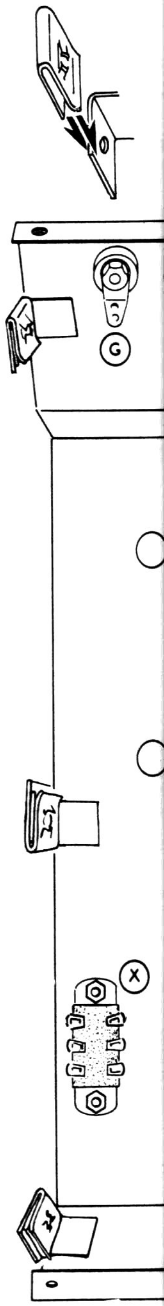


DETAIL 5A



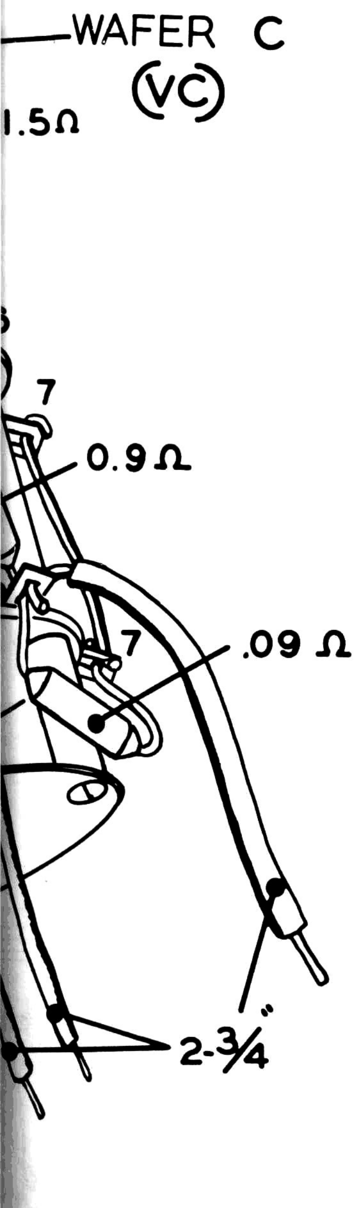
DETAIL 5B



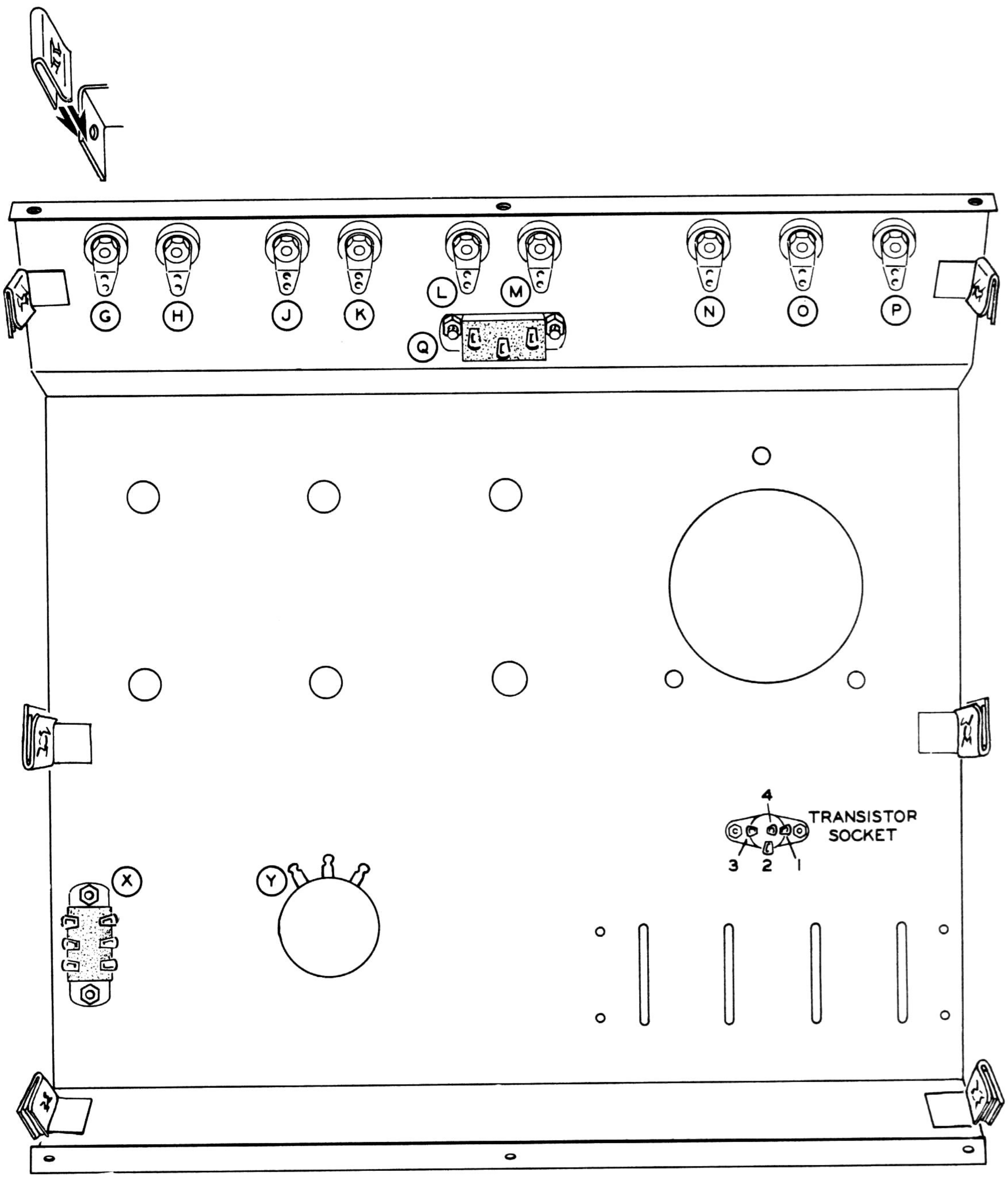


COLLECTOR CURRENT
SWITCH V

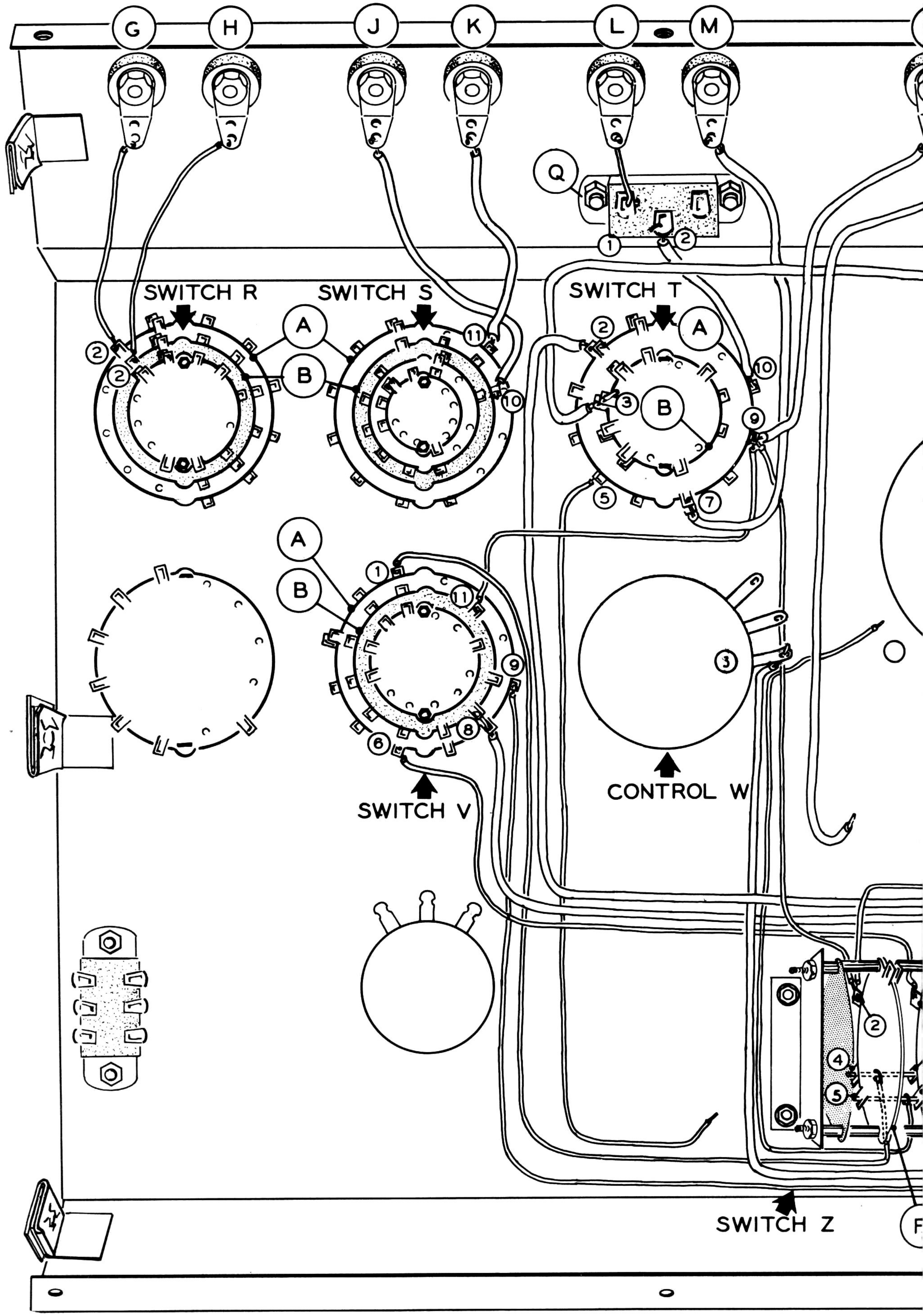
PICTORIAL 3



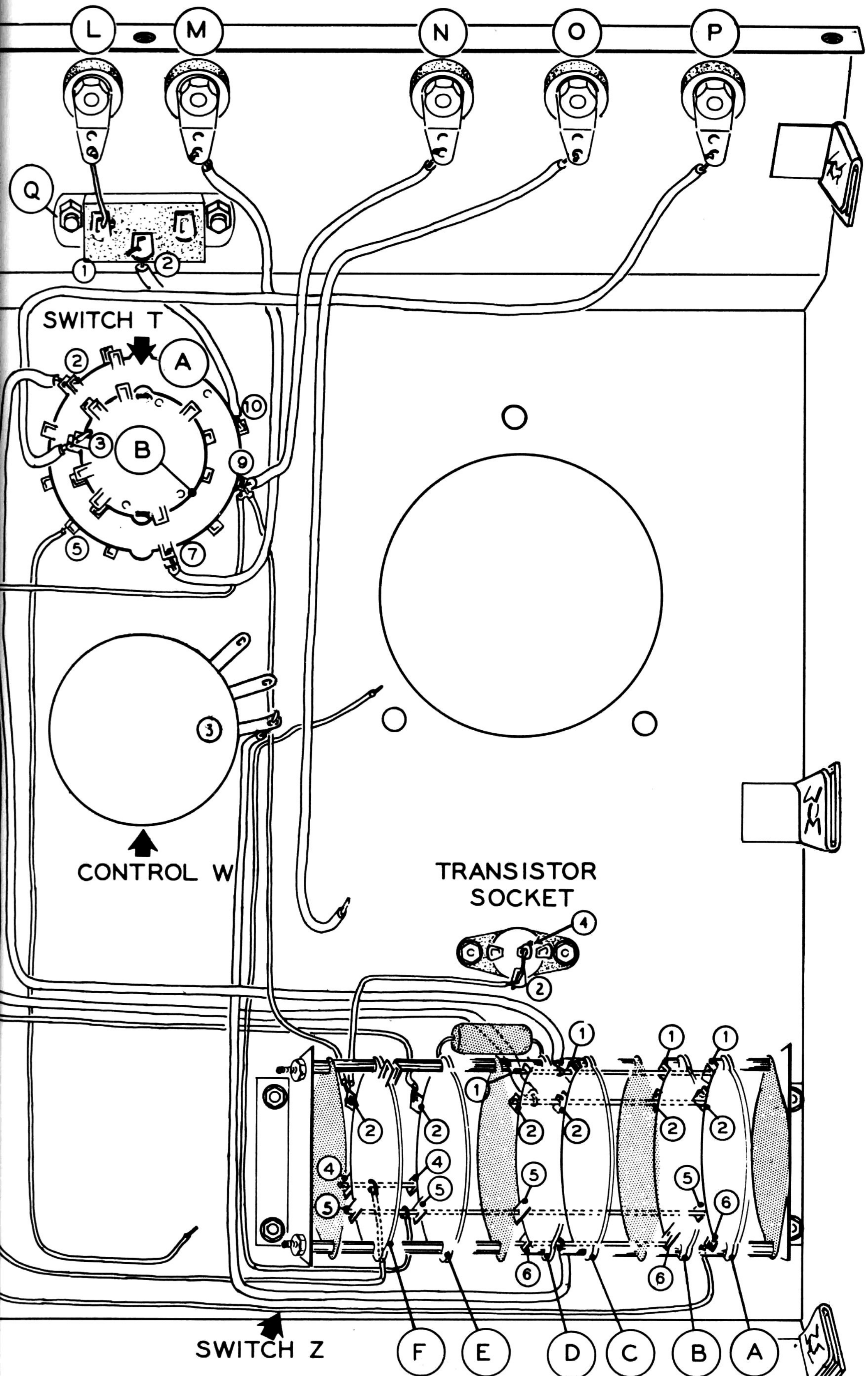
CURRENT
H V

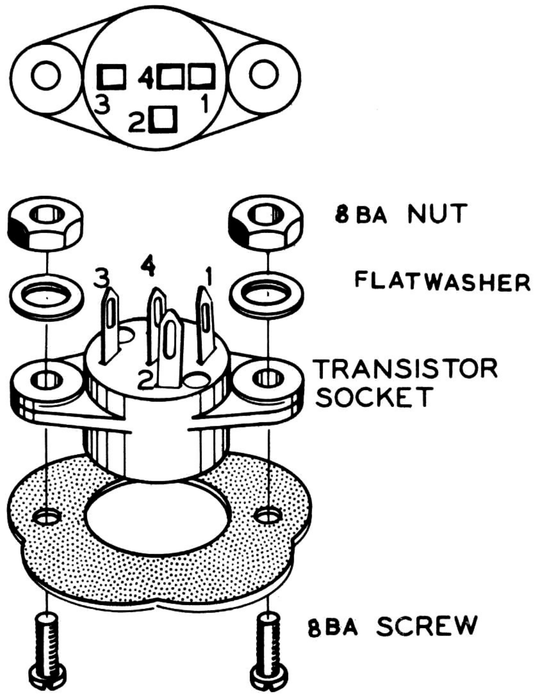


PICTORIAL 5

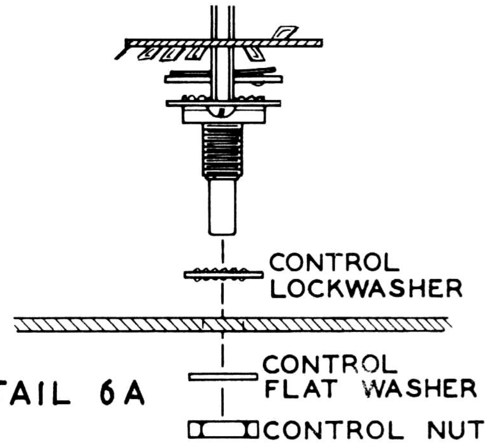

G
H
J
K
L
M
Q
1
2
SWITCH R
SWITCH S
SWITCH T
A
B
2
2
11
10
3
10
9
5
7
A
B
1
11
9
8
6
SWITCH V
3
CONTROL W
2
4
5
SWITCH Z

PICTORIAL 9


L
M
N
O
P
Q
1
2
SWITCH T
A
2
10
3
B
9
5
7
3
CONTROL W
TRANSISTOR
SOCKET
4
2
1
1
1
1
2
2
2
2
2
2
4
4
5
5
5
5
6
6
SWITCH Z
F
E
D
C
B
A

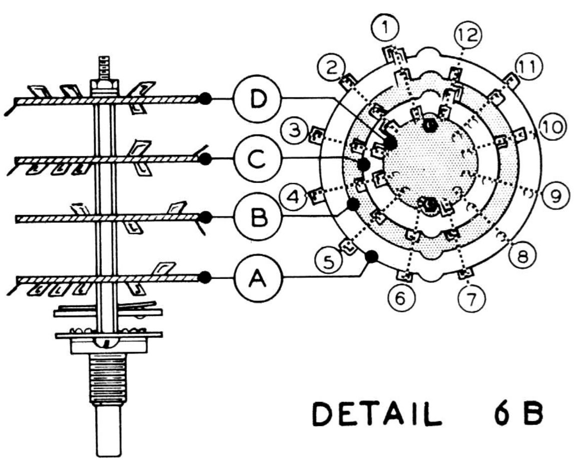


DETAIL 5C



DETAIL 6A

( ) Mount the transistor socket as shown in Detail 5C. Use 8BA x 5/16" screws, flat washers and nuts. Make sure tag 1 is toward the edge of the panel as shown.



DETAIL 6B

LEAK VOLTAGE AND COLLECTOR VOLTAGE SWITCH WIRING

Refer to Pictorial 6 and Detail 6B for the following steps:

( ) Mount the prewired 3-wafer LEAK VOLTAGE switch R (Part No. 63-559) using control lockwasher, flat washer and control nut as shown in Detail 6A. Position the switch as shown in Pictorial 6.

( ) In the same manner, mount the prewired 4-wafer COLLECTOR VOLTAGE switch S (Part No. 63-560). Position the switch as shown in Pictorial 6.

( ) Connect the wire coming from RA11 to SA2 (S-2).

( ) Connect the wire coming from RA10 to SA3 (S-2).

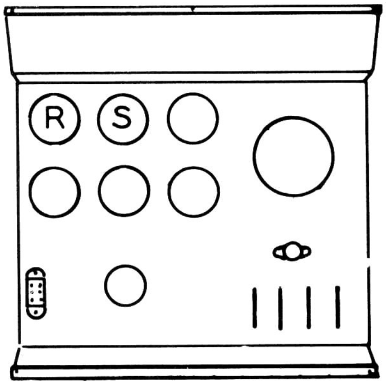
( ) Connect the wire coming from RA9 to SA4 (S-2).

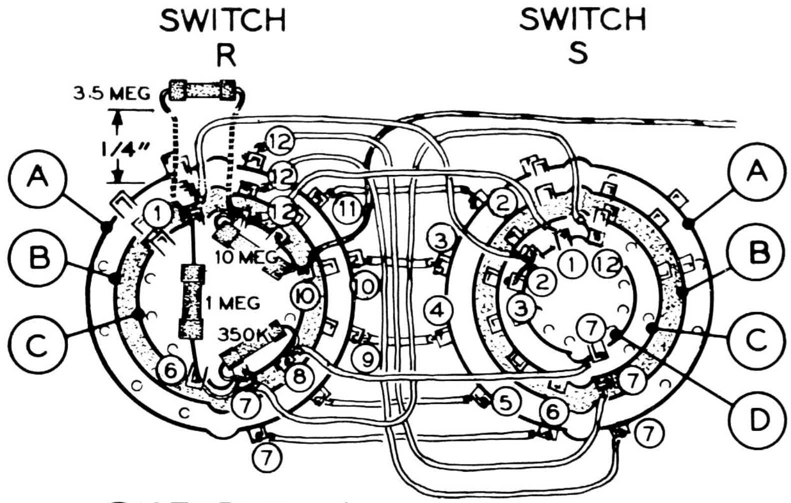
( ) Connect the wire coming from RA8 to SA5 (S-2).

( ) Connect the wire coming from RA7 to SA6 (S-2).

( ) Connect the wire coming from RA12 to SC7 (NS).

( ) Connect the wire coming from RB12 to SA7 (NS).





PICTORIAL 6

( ) Prepare the following lengths of connecting wire:

$3\frac{1}{2}$", $2\frac{1}{2}$", $4\frac{1}{2}$", 3", 2".

( ) Connect a $3\frac{1}{2}$" wire from RC7 (NS) to SD12 (S-1). Position as shown in Pictorial 6.

( ) Connect a $2\frac{1}{2}$" wire from RC8 (NS) to SD7 (S-1).

( ) Connect a $4\frac{1}{2}$" wire to RC10 (S-2). Position the other end of this wire as shown in Pictorial 6 to be connected later.

( ) Strip an additional $\frac{1}{2}$" of insulation from one end of a 3" wire. Insert this end through SD2 (NS) to SD3 (S-1). Now solder SD2 (S-2). Connect the other end of this wire to RC1 (NS).

( ) Connect a 2" wire from RC12 (NS) to SD1 (S-1)

In the next four steps, reduce the resistor leads to a convenient length.

( ) R4. Connect a 3.5 MΩ resistor from RC1 (NS) to RC12 (NS). Position as shown.

( ) R5. Connect a 10 MΩ resistor from RC11 (S-1) to RC12 (S-3).

( ) R2. Connect a 350 KΩ resistor from RC7 (NS) to RC8 (S-3).

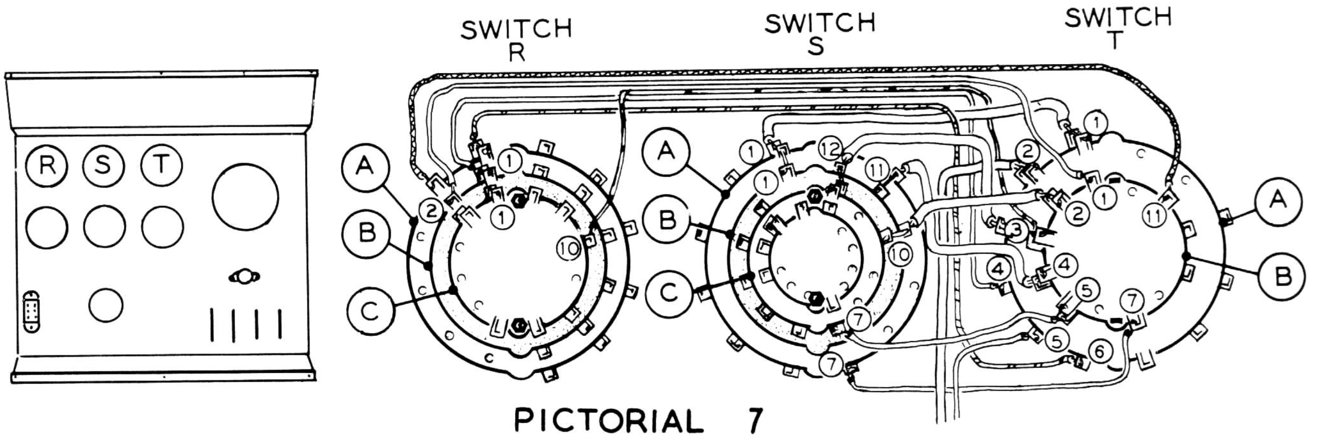
( ) R3. Insert one lead of a 1 MΩ resistor through RC6 (NS) to RC7 (S-3). Now solder RC6 (S-2). Connect the other lead of this resistor to RC1 (S-3). Ensure that the leads do not touch the switch pillars and that the resistor is sited approximately $\frac{1}{4}$" above the switch wafer.

POLARITY SWITCH WIRING

Refer to Pictorial 7 for the following steps:

( ) Prepare the following lengths of connecting wire:

6", $10\frac{1}{2}$", $5\frac{1}{2}$", $10\frac{1}{2}$" heavy, 6", 3", 2", $7\frac{1}{2}$".



PICTORIAL 7

( ) Mount 3-position 2-wafer POLARITY switch T (Part No. 63-558) using control lockwasher, flat washer and control nut as shown in Detail 6A. Position as shown in Pictorial 7.

( ) Connect a 6" wire from RA1 (S-1) to TA6 (S-1).

( ) Connect a 10½" wire to TA5 (S-1). Position the other end of this wire toward lever switch Z to be connected later. See Pictorial 9.

( ) Connect a 5½" wire from RB1 (S-1) to TA4 (S-1).

( ) Connect the heavy wire coming from SB12 to TA3 (S-1).

( ) Connect a 10½" heavy wire to TA2 (S-1). Position the other end of this wire towards lever switch Z to be connected later. See Pictorial 9.

( ) Connect the heavy wire coming from SA1 to TA1 (S-1).

( ) Connect a 6" wire from TB1 (S-1) to RB2 (NS).

( ) Connect the wire coming from RC10 to TB3 (NS).

( ) Connect one of the heavy wires coming from SA11 to TB4 (S-1).

( ) Connect the shortest heavy wire coming from SB10 to TB2 (S-1).

( ) Connect a 3" wire from SA7 (S-2) to both tags of TB7 (NS).

( ) Connect a 2" wire from SC7 (S-2) to TB5 (NS).

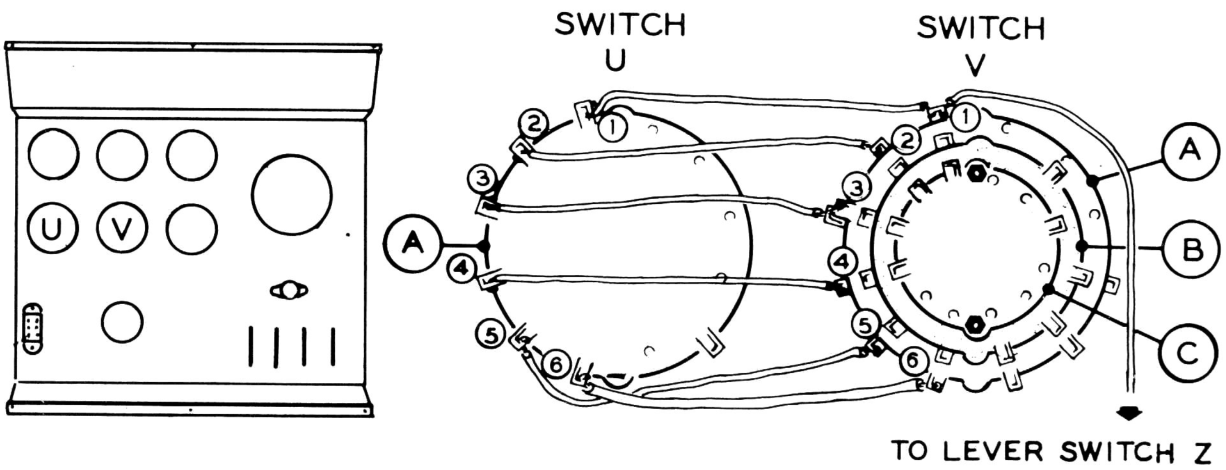
( ) Connect a 7½" wire from RA2 (NS) to TB11 (S-1).

NOTE: The remaining heavy wires coming from SB10 and SA11 will be connected later.

LEAK-DIODE-BASE AND COLLECTOR CURRENT SWITCH WIRING

Refer to Pictorial 8 for the following steps:

( ) Mount 6-position 1-wafer LEAK-DIODE-BASE switch U (Part No. 63-557) using a control lockwasher, flat washer and control nut as shown in Detail 6A. Position as shown in Pictorial 8.



PICTORIAL 8

( ) Mount 6-position 3-wafer COLLECTOR CURRENT switch V (Part No. 63-561) in the same manner. Position as shown in Pictorial 8. Route the long wire from VA1 as shown.

NOTE: Position the wires in the following steps as shown in Pictorial 8.

Connect wires coming from switch V to switch U as follows:

FROM	TO	FROM	TO	FROM	TO
( ) VA1 (short)	U1 (S-1).	( ) VA3	U3 (S-1).	( ) VA5	U5 (S-1).
( ) VA2	U2 (S-1).	( ) VA4	U4 (S-1).	( ) VA6 heavy	U6 (S-1).

FRONT PANEL WIRING

Refer to Pictorial 9 for the following steps:

( ) Prepare the following lengths of connecting wire:

$2\frac{1}{4}$", $2\frac{1}{4}$", 1" bare heavy, 2" heavy, 4" heavy, $3\frac{1}{2}$" heavy, 10" heavy, 7" heavy.

( ) Connect a $2\frac{1}{4}$" wire from RA2 (S-2) to solder tag G (S-1).

( ) Connect a $2\frac{1}{4}$" wire from RB2 (S-2) to solder tag H (S-1).

( ) Connect the heavy wire coming from SB10 to solder tag J (S-1).

( ) Connect the heavy wire coming from SA11 to solder tag K (S-1).

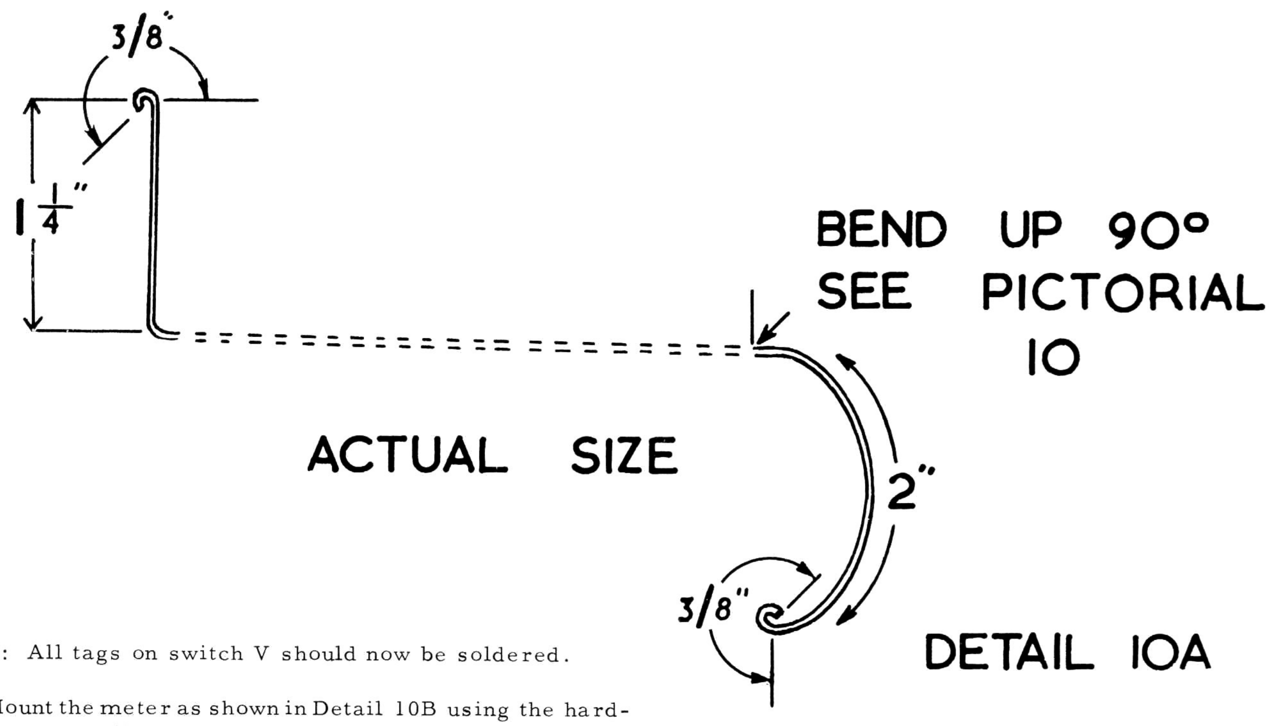
( ) Connect a 1" bare heavy wire from Q1 (S-1) to solder tag L (S-1).

( ) Connect a 2" heavy wire from Q2 (S-1) to TA10 (S-1).

( ) Connect a 4" heavy wire from TA7 (NS) to solder tag M (S-1).

( ) Connect a $3\frac{1}{2}$" heavy wire from TA9 (NS) to solder tag N (S-1).

( ) Connect a 10" heavy wire to solder tag O (S-1). Position the other end of this wire as shown to be connected later.



DETAIL 10A

NOTE: All tags on switch V should now be soldered.

( ) Mount the meter as shown in Detail 10B using the hardware supplied with the meter. Do not remove the shorting wire between the meter terminals at this stage.

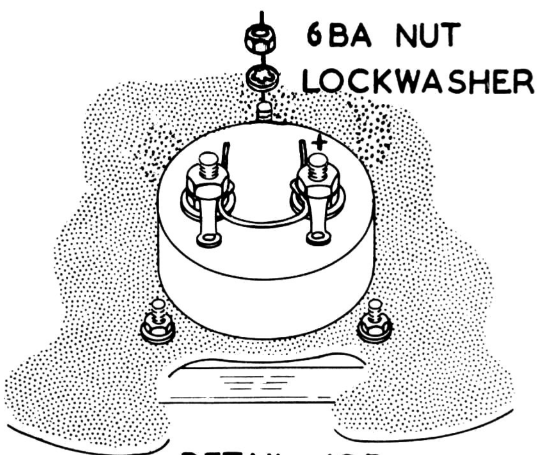
( ) Remove one half nut and flat washer from each terminal, affix one 2BA shakeproof solder tag and replace the flatwasher and half nut. Make sure that undue force is not used when tightening this nut as the meter may be damaged.

( ) Connect the wire coming from ZF5 to the positive (+) tag of the meter (NS).

( ) Connect a $4\frac{1}{2}$" wire from the bare wire connected to ZB11 (S-1) to the negative (-) tag of the meter (NS). See Pictorial 10.

NOTE: The lever switch wiring is now complete.

( ) Connect a $2\frac{3}{4}$" wire from TB9 (S-1) to the negative (-) tag of the meter (S-2).



DETAIL 10B

( ) Connect a 4" wire from TB10 (S-1) to the positive (+) tag of the meter (S-2).

BATTERY HOUSING PARTS MOUNTING

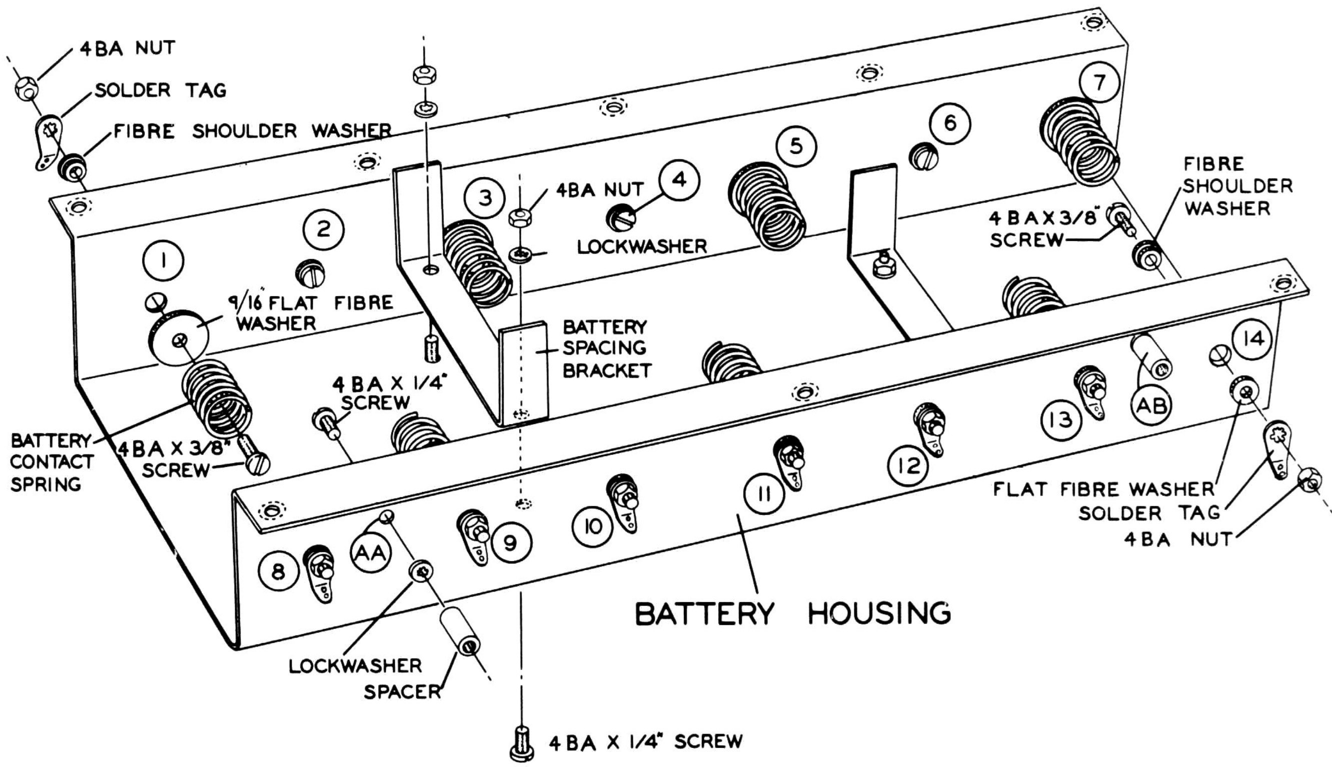
Refer to Detail 10C for the following steps:

( ) Locate the battery housing and position it as shown.

( ) Fasten a battery contact spring at hole 1 using a 4BA x 3/8" screw, 9/16" flat fibre washer, fibre shoulder washer, shakeproof 4BA solder tag and nut. Position the solder tag as shown in Detail 10C.

( ) In the same manner, fasten battery contact springs at all the odd-numbered holes; 3, 5, 7, 9, 11 and 13.

( ) Fasten a 4BA shakeproof solder tag at hole 14 using a 4BA x 3/8" screw, fibre shoulder washer, fibre flat washer, 4BA shakeproof solder tag and nut. Position the solder tag as shown in Detail 10C.



DETAIL 10C

( ) In the same manner, fasten solder tags at all the even-numbered holes; 2, 4, 6, 8, 10 and 12.

( ) Fasten a tapped spacer at hole AA using a 4BA x $\frac{1}{4}$" screw and lockwasher as shown in Detail 10C.

( ) In the same manner, fasten the remaining tapped spacer at hole AB.

( ) Fasten a battery spacing bracket in the position shown using two 4BA x $\frac{1}{4}$" screws, lockwashers and nuts.

( ) Similarly, fasten the remaining battery spacing bracket.

WIRING BATTERY HOUSING

Refer to Pictorial 10 for the following steps:

( ) At this stage, check that the nuts on terminals G, H, J, K, L, M, N, O and P are tight.

( ) Position the battery housing with the two spacers in the position shown.

NOTE: Only heavy connecting wire is used in the following steps.

( ) Prepare the following lengths of heavy connecting wire:

$1\frac{3}{4}$", $1\frac{3}{4}$", $2\frac{1}{4}$", $2\frac{1}{4}$", $1\frac{3}{4}$", 3", 6", 7", $5\frac{1}{2}$", $6\frac{1}{2}$", $6\frac{1}{2}$", $7\frac{1}{2}$", $8\frac{1}{2}$", 8".

Connect the lengths of heavy connecting wire as follows:

CONNECT A	FROM	TO	CONNECT A	FROM	TO
( ) $1\frac{3}{4}$"	solder tag 8 (S-1)	solder tag 9 (NS).	( ) 7"	TB7 (S-2)	solder tag 1 (S-1).
( ) $1\frac{3}{4}$"	solder tag 10 (NS)	solder tag 11 (S-1).	( ) $5\frac{1}{2}$"	TB5 (S-2)	solder tag 6 (S-1).
( ) $2\frac{1}{4}$"	solder tag 12 (NS)	solder tag 13 (S-1).	( ) $6\frac{1}{2}$"	TA7 (S-2)	solder tag 7 (S-1).
( ) $2\frac{1}{4}$"	solder tag 2 (NS)	solder tag 3 (S-1).	( ) $6\frac{1}{2}$"	SC2 (S-2)	solder tag 9 (S-2).
( ) $1\frac{3}{4}$"	solder tag 4 (NS)	solder tag 5 (S-1).	( ) $7\frac{1}{2}$"	SC4 (S-2)	solder tag 10 (S-2).
( ) 3"	SC3 (S-2)	solder tag 2 (S-2).	( ) $8\frac{1}{2}$"	SC6 (S-2)	solder tag 12 (S-2).
( ) 6"	SC5 (S-2)	solder tag 4 (S-2).	( ) 8"	Q3 (S-1)	solder tag 14 (S-1).

This completes wiring of the Transistor Tester. Carefully inspect the wiring for loose solder or pieces of wire. Make sure all connections have been properly soldered.

Refer to Pictorial 11 for the following steps:

( ) Fasten the battery housing to the front panel using three 4BA x 3/8" screws as shown in Pictorial 11. Do not fully tighten these screws yet. Make sure that solder tag 4 does not touch the tags on BIAS switch Q. Rotate the solder tag if necessary.

( ) Also check that no wires are pinched and that the battery housing does not touch the resistors on LEAK VOLTAGE switch R. Reposition the resistors if necessary.

( ) Remove the backing from the self-adhesive label and install it on the inside of the battery housing.

( ) Install the batteries as per instructions on the label Also see Pictorial 12.

TERMINAL CAP AND KNOB INSTALLATION

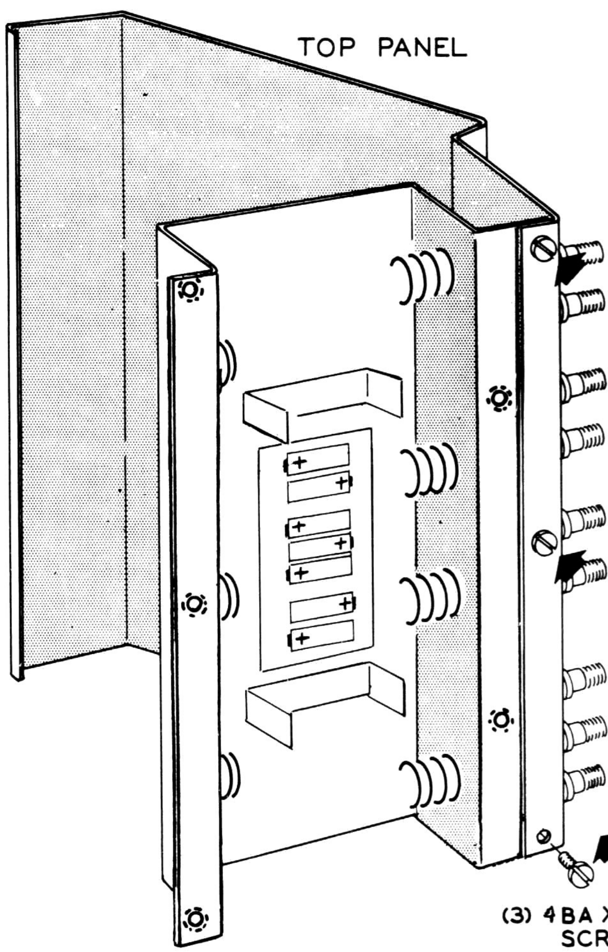
( ) Install a BLACK terminal cap on the following terminals: COLLECTOR, EMITTER, BASE and the three negative (-) terminals.

( ) Install a RED terminal cap on the three positive (+) terminals.

( ) Strip $\frac{3}{4}$" of insulation from one end and $\frac{1}{2}$" from the other end of a 3" length of heavy wire. Remove the insulating cap from a wander plug and wrap the $\frac{3}{4}$" stripped end around the plug base. Slide the cap over the free end of the wire and screw it down onto the base. Using the screw provided, attach the other end to the crocodile clip.

( ) Repeat the last step for the other two wander plugs and crocodile clips.

( ) Install a wander plug with crocodile clip in the external COLLECTOR, EMITTER and BASE terminals.



PICTORIAL 11

( ) Install control knobs on switches R, S, T, U and V. Make sure that the set screw is tightened against the flat of each switch shaft. If necessary, loosen the mounting nut and rotate the switch slightly so that the knob pointer lines up with the front panel markings.

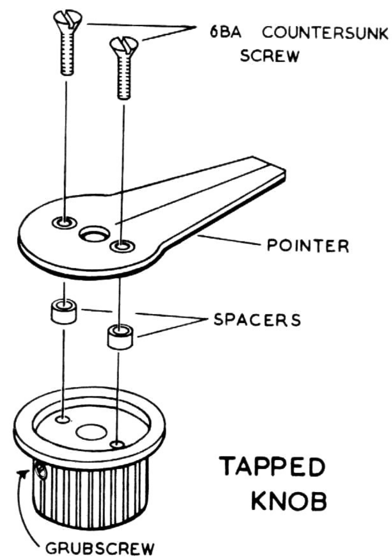
( ) Install a control knob on the control W such that the knob swings equal angles about a vertical centre line through the knob.

( ) Attach the pointer to the tapped knob as shown in Detail 12.

( ) Install this pointer knob on the GAIN test control shaft. Centre the knob so the pointer travels the same distance past the markings on each end of the scale. Do not tighten the grub screw fully yet.

( ) Press the four lever switch knobs onto the switch levers. See Figure 9.

( ) Now remove the shorting wire from between the meter terminals.



DETAIL 12

INSTRUMENT CHECKOUT

No current flows in the tester until one of the levers on the lever switch is actuated.

If the proper results are not obtained in any of the following steps, refer to the IN CASE OF DIFFICULTY section.

POLARITY SWITCH

( ) Set the POLARITY switch to PNP. Pick up the tester and shake it slightly, noting the action of the meter pointer. Turn the POLARITY switch to the OFF position and again shake the tester slightly, noting the action of the meter. This time the meter movement should be more damped, that is, very little movement should be noted. With the POLARITY switch in the OFF position the meter terminals are shorted together.

Now repeat the preceding test with the POLARITY switch in the NPN position. The results should be the same as before.

COLLECTOR VOLTAGE AND LEAK VOLTAGE SWITCHES

( ) Return the POLARITY switch to the PNP position. Set the COLLECTOR VOLTAGE switch to 1.5. Push the COLLECTOR VOLTAGE lever; the meter should deflect to the right and indicate 1.5 volts or slightly higher with fresh batteries. Now check the remaining collector voltage steps for corresponding meter indications by rotating the COLLECTOR VOLTAGE switch.

NOTE: The meter will not deflect when the COLLECTOR VOLTAGE switch is in the EXT. position.

( ) Repeat the above test with the POLARITY switch set to NPN. The meter should now deflect to the left.

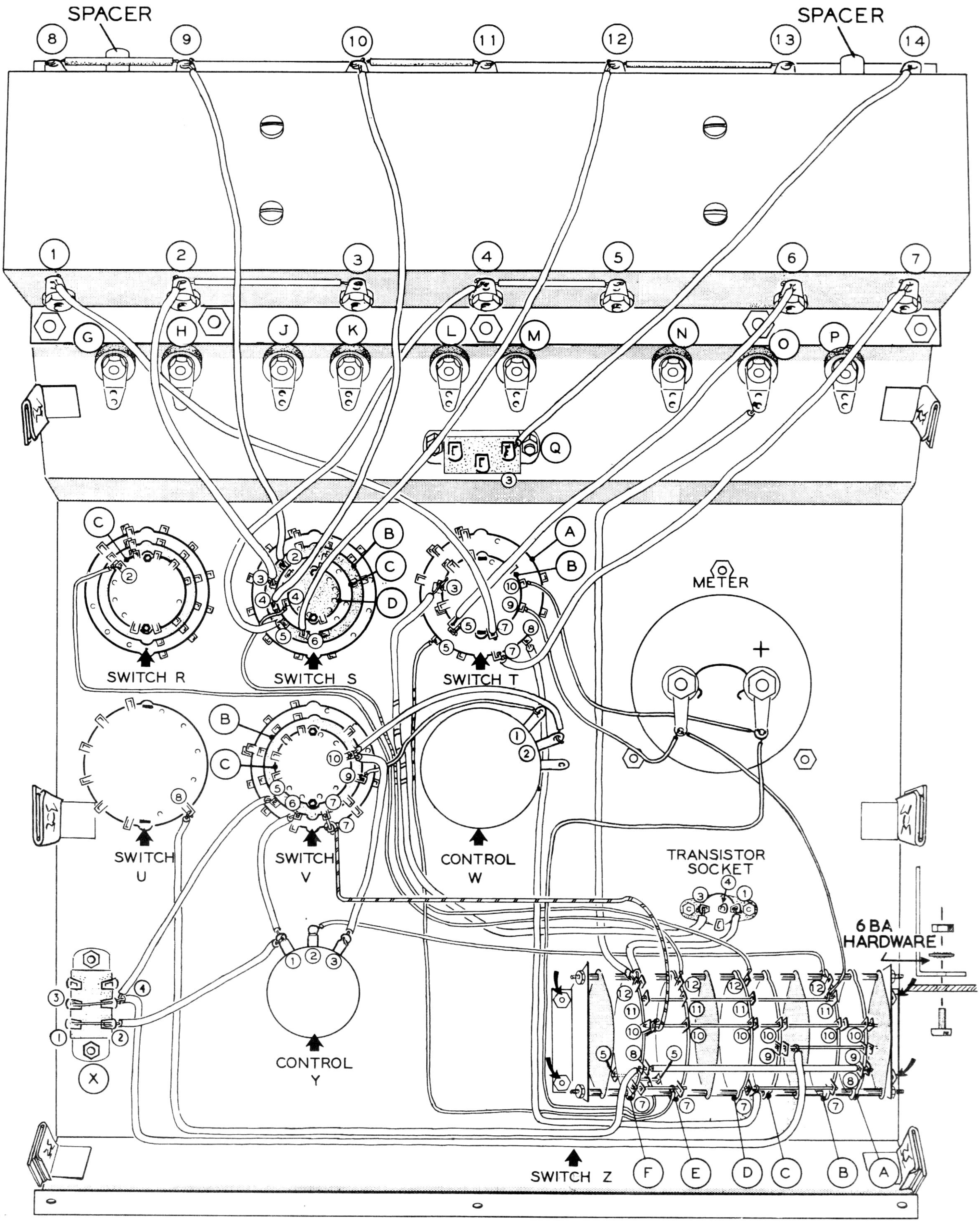
( ) Repeat the above two tests with the LEAK VOLTAGE switch while pushing the LEAK VOLTAGE lever.

BIAS CONTROL

( ) Temporarily connect a shorting wire between the EMITTER and BASE terminals. Set BIAS switch to INT., the POLARITY switch to PNP, the LEAK CURRENT switch to 15 mA, the COLLECTOR CURRENT switch to 150 mA and set the BIAS control to minimum. Push BASE CURRENT lever and advance the BIAS control slightly to deflect the meter pointer. Now set BIAS switch to EXT. and the meter pointer should return to zero.

COLLECTOR CURRENT LEVER

( ) Remove the shorting wire from between the EMITTER and BASE terminals. Now connect a shorting wire be-



PICTORIAL 10

EXT. TRANSISTOR AND DIODES

EXT. BIAS SUPPLY 5 V MAX.

EXT. COLLECTOR VOLTAGE SUPPLY 50 V MAX.

BIAS INT. - EXT. SWITCH - Selects internal 1.5 volt battery or an external source.

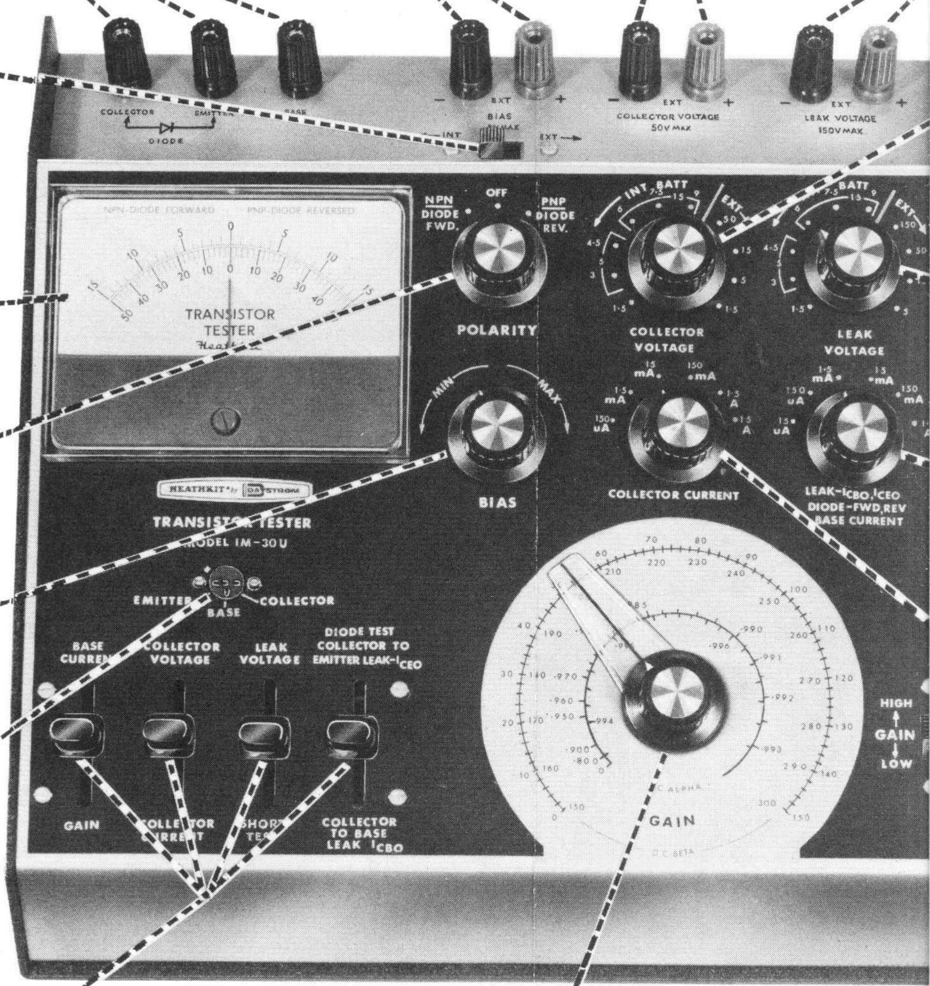
METER - Scales: 15-0-15 and 50-0-50. Sensitivity: 10-0-10 μA, 100 KΩ/volt. Resistance: 5000Ω

POLARITY SWITCH - Selects NPN or DIODE FWD, OFF, and PNP or DIODE REV.

BIAS CONTROL adjusts COLLECTOR CURRENT to any value from 0 to 15 A. Meter should have no appreciable deflection with BIAS CONTROL at minimum and COLLECTOR CURRENT lever pulled.

UNIVERSAL TRANSISTOR SOCKET

LEVER SWITCH - Selects any one of the following tests: BASE CURRENT, GAIN, COLLECTOR VOLTAGE, COLLECTOR CURRENT, LEAK VOLTAGE, SHORT TEST, Icea or DIODE TEST, and Icbo.



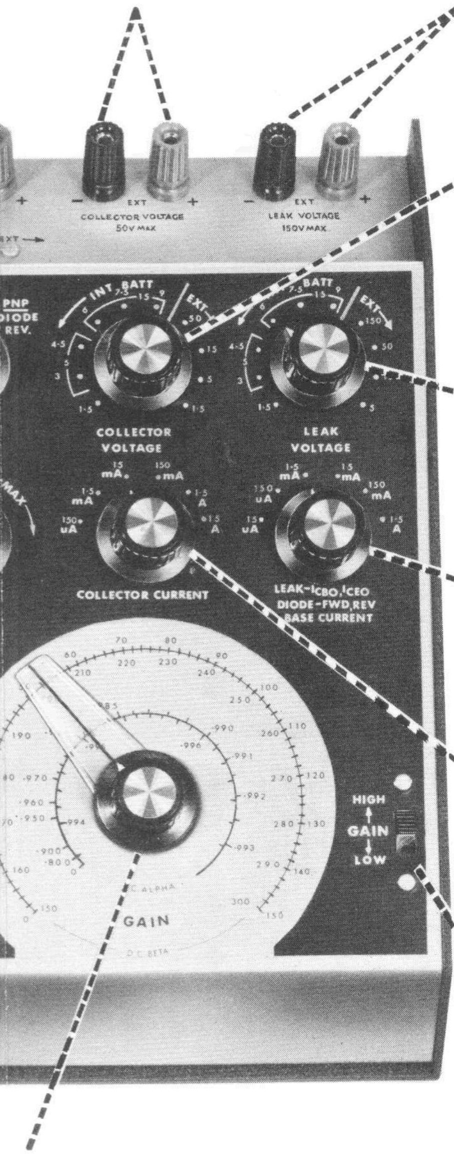
GAIN TEST CONTROL - Calibrated scale shows actual gain (Beta and Alpha) of transistor when control is adjusted to null the meter.

OPERATIONAL PICTURE

FIGURE 9

EXT. COLLECTOR VOLTAGE SUPPLY 50 V MAX.

EXT. LEAK VOLTAGE SUPPLY 150 V MAX



COLLECTOR VOLTAGE SWITCH - Selects internal batteries in 1.5 volt increments up to 9 volts; external voltages up to 50 volts.

LEAK VOLTAGE SWITCH - Selects internal batteries in 1.5 volt increments up to 9 volts; external voltages up to 150 volts.

LEAK CURRENT SWITCH - Selects meter ranges from 15 μA to 1.5 A in steps of times 10. For base current measurement, do not set less than 1/10 of COLLECTOR CURRENT switch setting.

COLLECTOR CURRENT SWITCH - Selects meter ranges from 150 μA to 15 A in steps of times 10.

OL - Calibrated scale shows l Alpha) of transistor when null the meter.

GAIN HIGH-LOW SWITCH - Selects GAIN TEST control scales of 0-150 Beta and 0-0.993 Alpha or 150-300 Beta and 0.993-0.9966 Alpha. Readjust BIAS control when changing from one position to the other.

L PICTURE

E 9

tween the COLLECTOR and EMITTER terminals. Set the COLLECTOR VOLTAGE switch to INT. 1.5, the POLARITY switch to PNP and set the COLLECTOR CURRENT switch to 15 A. Pull the COLLECTOR CURRENT lever and the meter pointer should deflect. Now set COLLECTOR CURRENT switch to 1.5 A. With the COLLECTOR CURRENT lever still pulled down, deflection of the meter point should be greater.

SHORT TEST LEVER

( ) Make sure the shorting wire is still connected between the COLLECTOR and EMITTER terminals and the COLLECTOR VOLTAGE switch at INT. 1.5 and the POLARITY switch at PNP. Pull the SHORT TEST lever and the meter pointer should deflect. Remove the shorting wire from between the COLLECTOR and EMITTER terminals. The meter should remain at zero when the SHORT TEST lever is pulled.

I_{cbo} LEVER AND LEAK CURRENT SWITCH

( ) Connect a shorting wire between the BASE and COLLECTOR terminals. Set LEAK VOLTAGE switch to INT. 1.5 and set the LEAK CURRENT switch to 1.5 A. Pull the I_{cbo} lever and the meter should deflect off-scale slightly.

GAIN HIGH-LOW SWITCH

( ) Remove the BASE to COLLECTOR shorting wire and connect it between the BASE and EMITTER terminals.

( ) Set the switches and controls as follows:

BIAS switch - INT.
POLARITY switch - PNP
COLLECTOR CURRENT switch - 15 mA
GAIN HIGH-LOW switch - LOW
BIAS control - minimum
Gain Test control - midway (75)

Pull GAIN lever and adjust the BIAS control to deflect the meter pointer to the left slightly. Now set the GAIN HIGH-LOW switch to HIGH. The meter pointer deflection should be greater.

If the Transistor Tester operated satisfactorily in the previous steps, proceed with the ADJUSTMENT section which follows.

ADJUSTMENT

METER ZERO

( ) To mechanically adjust the meter pointer to zero, slowly turn the screw on the meter face while gently tapping the meter with your finger.

GAIN TEST CONTROL CALIBRATION

( ) Connect a shorting wire between the EMITTER and BASE terminals.

( ) Set the POLARITY switch to PNP.

( ) Set the COLLECTOR VOLTAGE switch to INT. 1.5.

( ) Turn the BIAS control to minimum.

( ) Set the COLLECTOR CURRENT switch to 15 mA.

( ) Set the HIGH-LOW GAIN switch to LOW.

( ) Turn the Gain Test control to 10.

( ) Pull the GAIN lever and turn the BIAS control clockwise until the meter indicates approximately 5 on the 15 scale. Deflection should be to the left.

( ) Turn the Gain Test control fully anticlockwise. With the GAIN lever still down, slowly advance the Gain Test control until the meter starts to deflect. Note the position of the pointer on the Gain Test control with respect to zero. Now loosen the grub screw, turn the pointer to zero and retighten the grub screw. After retightening the grub screw, repeat the above test to make sure it indicates directly over zero.

( ) Remove the shorting wire from between the EMITTER and BASE terminals.

This completes adjustment of the Transistor Tester.

OPERATIONAL CHECK

The Figures 5 and 15 on the COLLECTOR VOLTAGE and LEAK VOLTAGE switch INT. scale, are the meter scales to be used when the knob pointer is in one of those ranges. The 1.5 volt position is read 1.5 on the 15 meter scale.

( ) Place a low power transistor in the transistor socket. (Use the External transistor terminals if the transistor does not fit in the socket.)

( ) Set the controls and switches as follows:

BIAS control - Minimum
BIAS switch - INT.
POLARITY switch - to type for transistor; most likely PNP.
COLLECTOR VOLTAGE switch - 1.5 volts, INT.
LEAK VOLTAGE switch - 9 volts, INT.
COLLECTOR CURRENT switch - 15 mA
LEAK CURRENT switch - 1.5 mA
GAIN HIGH-LOW switch - LOW

( ) Pull the SHORT TEST lever. If there is no meter deflection, proceed with the test. If the meter deflects, the transistor is shorted. In this case, try a different transistor and start the OPERATIONAL CHECK from the beginning.

( ) Pull the COLLECTOR CURRENT lever and slowly advance the BIAS control. Notice that collector current increases as bias is increased. This indicates a good transistor. Adjust collector current to 5 mA.

( ) Check collector voltage by pushing the COLLECTOR VOLTAGE lever. It should be approximately 1.5 volts. During this test, the 5 mA of collector current is still flowing.

( ) Pull the GAIN lever and rotate the Gain Test control for a meter null*; this will probably be between 30 and 120, depending on the particular transistor.

* Zero indication on the meter.

( ) Push the BASE CURRENT lever to check base current. The current range is set with the LEAK CURRENT switch. This setting must not be less than 1/10 of the COLLECTOR CURRENT switch setting because this would reduce the base current.

( ) Now push the LEAK VOLTAGE lever and note the meter reading of 9 volts.

( ) Push the I_{ceo} lever and note the collector to emitter leakage. Increase the setting of the LEAK CURRENT range switch if necessary; that is, if the pointer deflected beyond the end of the scale.

( ) Pull the I_{cbo} lever and read collector to base leakage on the meter. Change the setting of the LEAK CURRENT range switch if necessary. Note that I_{cbo} is much smaller than I_{ceo}.

The results obtained in the preceding steps should be typical for a good transistor of the type tested. If the Transistor Tester seems to operate normally, proceed with the installation of the cabinet. Be sure the POLARITY switch is in the OFF position.

CABINET INSTALLATION

Refer to Pictorial 12 for the following steps:

( ) Mount the four rubber feet by pressing the small ends of the feet through the mounting holes in the bottom of the cabinet. Moistening the feet will facilitate installation.

( ) Install the rear cover using five 4BA x 3/8" screws. Do not tighten.

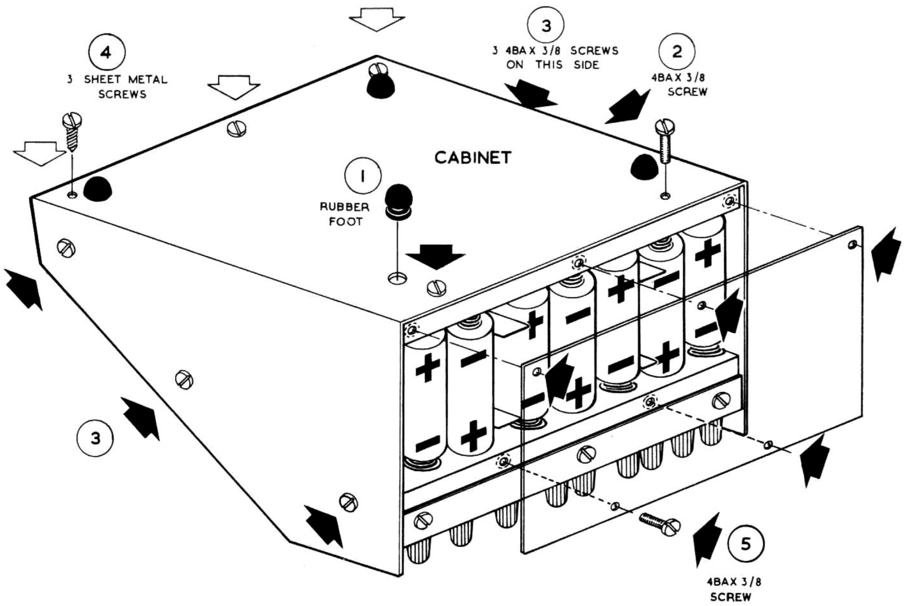
( ) Install the unit in the cabinet using three No. 6 x 3/8" sheet metal screws and two 4BA x 3/8" screws on the bottom of the cabinet. Tighten securely.

( ) Insert six 4BA x 3/8" screws in the sides of the cabinet. Do not tighten.

( ) Make sure the rear cover is flush with the front panel and tighten the eight screws on the back of the unit.

( ) Now tighten the three screws on each side of the cabinet.

Your Transistor Tester can now be put into service. Note that, in the future, the batteries may be replaced without taking the unit out of the cabinet.



PICTORIAL 12

BATTERY MAINTAINANCE

If the Transistor Tester is to be left unused for a long period, it is recommended that the batteries should be removed to avoid the risk of corrosion.

NOTE: When carrying or moving the Tester the POLARITY switch should be in the OFF position to damp movement of the meter pointer.

OPERATION

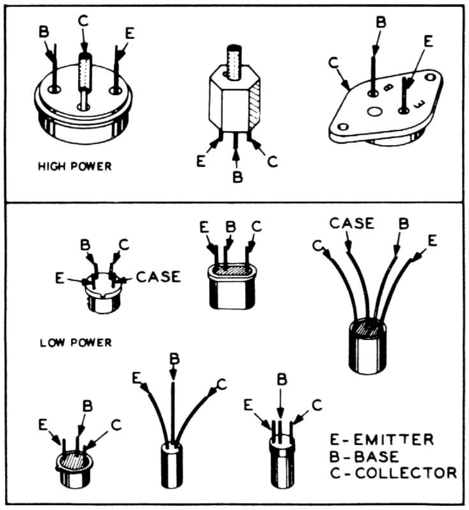
CAUTION: To prevent damage to the meter movement, use the meter only as described.

The importance of thoroughly understanding the operation of your Transistor Tester cannot be over-emphasised. Testing is performed on a qualitive, rather than quantitive, basis. Interpretation of the meter reading, instead of the reading itself, will be the determining factor in deciding whether or not to replace the transistor. Proper interpretation of the meter indications can come only from using the instrument and being familiar with its operation.

NOTE: A chart illustrating the lead connections of various typical transistor types is provided. If you are in doubt as to the type of transistor to be tested (high or low power), we suggest that the transistor in question be compared with the chart. An up-to-date transistor manual will provide any detailed information needed.

Refer to Figure 9 for a description of each control, switch and external connection.

TYPICAL TRANSISTORS



GENERAL TRANSISTOR TESTING

This procedure requires that the operator know the approximate ratings of the transistor to be tested. Sufficient information on most transistors can be found in standard transistor manuals. If you do not have ratings for the transistor, refer forward to the procedure titled TESTING TRANSISTORS WITH UNKNOWN RATINGS.

Set up conditions for the transistor being tested by setting the following switches: COLLECTOR VOLTAGE, LEAK VOLTAGE, COLLECTOR CURRENT, LEAK CURRENT and POLARITY (NPN or PNP). Set the BIAS control to minimum. Place the transistor into the transistor socket.

NOTE: The following tests are momentary and the levers should be held down only long enough to obtain a reading. Actuate one lever at a time.

Check for a shorted transistor by pulling the SHORT TEST lever. A shorted transistor will deflect the meter to 4 or more on the 15 scale.

Check I_{cbo} and I_{ceo} leakage with the proper lever position.

Pull the COLLECTOR CURRENT lever and adjust the BIAS control for proper collector current.

Push the COLLECTOR VOLTAGE lever to check collector voltage.

Now pull the GAIN lever and adjust Gain Test control for meter null. Read the gain directly.

If the GAIN HIGH-LOW switch is moved to the HIGH position, re-adjust the BIAS control for the desired collector current.

TESTING TRANSISTORS WITH UNKNOWN RATINGS

SHORT TEST

Place the transistor to be tested in the transistor socket.

Set the POLARITY switch to PNP. Set the COLLECTOR VOLTAGE switch to 1.5V INT. Pull SHORT TEST lever and watch the meter. The meter will deflect to 4 or more on the 15 scale, if the transistor is shorted. A good transistor will cause no deflection of the meter.

TESTING FOR NPN OR PNP

Insert the transistor into the socket or, if necessary, use the external transistor terminals. Assume that it is a PNP type (most are) and set the POLARITY switch to the PNP position. Set the BIAS control at minimum, the COLLECTOR VOLTAGE switch to 1.5 and set the COLLECTOR CURRENT switch to 15 mA. Pull the COLLECTOR CURRENT lever. If there is no meter deflection, advance the BIAS control to see if a collector current reading can be obtained. If there is a collector current indication, the transistor is a PNP type.

If the meter does deflect at zero bias, the transistor is an NPN type. As a final check, advance the BIAS control to deflect the meter pointer toward zero. This confirms that the transistor is an NPN type. With the POLARITY switch in the NPN position, collector current will increase normally as the BIAS control is advanced.

TESTING SMALL TRANSISTORS

Set the POLARITY switch to NPN or PNP as just determined. Then set the COLLECTOR CURRENT switch to 15 mA, the COLLECTOR VOLTAGE switch to 1.5 volts and set the LEAK VOLTAGE switch to 9 volts. Pull the COLLECTOR CURRENT lever and advance the BIAS control. If collector current increases with the advance of the BIAS setting, it can be assumed that the transistor is good. As a final check, pull the I_{cbo} lever. Leakage current should not be over 25 µA. NOTE: I_{ceo} is much larger than I_{cbo}.

TESTING POWER TRANSISTORS

Set the POLARITY switch to NPN or PNP as determined above. Then set the COLLECTOR CURRENT switch to 1.5 A, the COLLECTOR VOLTAGE switch to 1.5 volts and set the LEAK VOLTAGE switch to 9 volts. Pull the COLLECTOR CURRENT lever and advance the BIAS control. If collector current increases as the bias setting is advanced, it can be assumed that the transistor is good. As a final check, pull the I_{cbo} lever. Leakage current should not be over 5 mA.

MATCHING TRANSISTORS FOR GAIN AND LEAKAGE

Set up test as for Transistor Testing. Using identical BIAS control and LEAK VOLTAGE switch settings, insert each transistor to be checked into the transistor socket and determine gain and leakage. Then separate them into common groups.

PRODUCTION GO NO-GO TESTS

PNP TRANSISTORS

Set up the specified test conditions, check for short, then check for leakage. Each transistor must show less than the maximum allowable leakage for the particular production application.

For checking gain, set up the proper bias condition and set the Gain Test control for minimum allowable gain. With the GAIN lever pulled, each transistor having a gain higher than the minimum allowable (preset) will deflect the meter to the right. Any transistor having less gain will deflect the meter to the left.

NPN TRANSISTORS

Use the same procedure as described above, except NPN transistors having a gain higher than the minimum allowable will deflect the meter to the left. NPN transistors having less gain will deflect the meter to the right.

DC CURRENT GAIN (h_{FE})

NOTE: The BASE CURRENT switch setting should not be more than one range lower than the COLLECTOR CURRENT switch setting. If this is not done, the meter resistance will reduce the original COLLECTOR CURRENT setting.

DC CURRENT GAIN is defined as collector current (I_c) divided by base current (I_b); that is

$$\frac{I_c}{I_b} = h_{FE} = \beta_{dc}; \quad \text{alpha} = \frac{\beta_{dc}}{\beta_{dc} + 1}$$

DC current gain, beta and alpha, is read directly from the calibrated dial under the Gain Test control pointer. This gain may be found using the instructions under General Transistor Testing.

AC CURRENT GAIN

AC current gain equals $\left.\frac{\Delta I_c}{\Delta I_b}\right|_{E_c \text{ constant}}$; or $\frac{I_{c1} - I_{c2}}{I_{b1} - I_{b2}}$ at same E_c

AC current gain is defined as: The change in collector current divided by the change in base current that produced the change in collector current with collector voltage held constant.

Set the POLARITY, COLLECTOR VOLTAGE, COLLECTOR CURRENT and LEAK CURRENT switches to the desired position, depending on the type of transistor to be checked.

Pull the COLLECTOR CURRENT lever and adjust the BIAS control to the desired collector current (I_c). Push the BASE CURRENT lever and read base current (I_b) on the meter.

Now push the COLLECTOR CURRENT lever and adjust the bias to a lower collector current, say 25% of the previous value. This is I_c . Push the BASE CURRENT lever and read I_b on the meter.

Using the values determined above, calculate the a.c. current gain.

DC TRANSCONDUCTANCE (g_{FE})

DC transconductance is defined as collector current (I_c) divided by base voltage (E_b); that is $\frac{I_c}{E_b} = g_{FE}$

To find g_{FE} , set up a given bias condition and, with an external voltmeter, measure base to emitter voltage at the external transistor terminals. Then use the above formula.

AC TRANSCONDUCTANCE (g_{fe})

AC transconductance is defined as a change in base voltage (ΔE_b) that will produce a change in collector current (I_c), with collector voltage (E_c) held constant; that is $g_{fe} = \frac{\Delta I_c}{\Delta E_b} \Big|\ E_c$ constant; or $\frac{I_{c1} - I_{c2}}{E_{b1} - E_{b2}}$

To find g_{fe} , set up a given bias condition, push COLLECTOR CURRENT lever and adjust the BIAS control. Read collector current I_{c1} on the meter. With an external voltmeter measure base to emitter voltage E_{b1} at the external transistor terminals. Now push the COLLECTOR CURRENT lever, reduce the bias and read I_{c2} on the meter. Read E_{b2} on the external voltmeter.

Calculate g_{fe} by $\frac{I_{c1} - I_{c2}}{E_{b1} - E_{b2}}$

DC BASE RESISTANCE

DC base resistance is defined as base voltage (E_b) divided by base current (I_b); that is $\frac{E_b}{I_b}$

Set up a given bias condition, push COLLECTOR CURRENT lever and adjust the BIAS control. Push the BASE CURRENT lever and read I_b on the meter. With a voltmeter connected between the BASE and EMITTER transistor terminals, read base voltage E_b.

AC BASE RESISTANCE

AC base resistance is defined as the change in base voltage (E_b) divided by the change in base current (I_b) with collector voltage (E_c) held constant; that is $\frac{\Delta E_b}{\Delta I_b} \Big|\ E_c$ constant

To find a.c. base resistance, set up a given bias condition, push the COLLECTOR CURRENT lever and adjust the bias control. Push the BASE CURRENT lever and read I_{b1} . With a voltmeter connected between BASE and EMITTER external transistor terminals read base voltage E_{b1} . Now push COLLECTOR CURRENT lever and reduce bias. Push the BASE CURRENT lever and read I_{b2} . Read E_{b2} on external voltmeter.

Using the values just found, calculate a.c. base resistance as follows: $\frac{E_{b1} - E_{b2}}{I_{b1} - I_{b2}}$

DC COLLECTOR RESISTANCE

DC collector resistance is defined as collector voltage (E_c) divided by collector current (I_c); that is $\frac{E_c}{I_c}$

To find d.c. collector resistance, set up a given bias condition, push the COLLECTOR CURRENT lever and adjust the BIAS control. Read collector current I_c. Push the COLLECTOR VOLTAGE lever and read collector voltage E_c.

AC COLLECTOR RESISTANCE

AC collector resistance is defined as a change in collector voltage (E_c) divided by the change in collector current (I_c) with base current (I_b) held constant, that is: $\left.\frac{\Delta E_c}{\Delta I_c}\right|_{I_b \text{ constant}}$

To find a.c. collector resistance, set up a low collector voltage condition. Push the COLLECTOR CURRENT lever and adjust the BIAS control. Read collector current I_{c2}. Now push COLLECTOR VOLTAGE lever to read collector voltage E_{c2}.

Increase the COLLECTOR VOLTAGE switch setting, use the same bias setting as above and read E_c . Now push the COLLECTOR CURRENT lever and read I_{c1}.

Using the values just found, calculate a.c. collector resistance as follows: $\frac{E_{c1} - E_{c2}}{I_{c1} - I_{c2}}$

TRANSISTOR LEAKAGE TESTS

I_{cbo} = collector to base leakage with the emitter open.

Adjust the LEAK VOLTAGE switch to the specified voltage and set the LEAK CURRENT switch to the proper meter range. Push the I_{cbo} lever and read leakage current directly.

I_{ceo} = collector to emitter leakage with the base open.

Adjust the LEAK VOLTAGE switch to the specified voltage and set the LEAK CURRENT switch to the proper meter range. Pull the I_{ceo} lever and read leakage current directly.

I_{ces} = collector to emitter leakage with base shorted to the emitter.

Connect a shorting wire between the BASE and EMITTER terminals. Then read I_{ces} on the meter using the same procedure as outlined above for I_{ceo}.

I_{cer} = collector to emitter leakage with a specified resistance connected between the base and emitter.

Connect the specified resistance between BASE and EMITTER terminals. Then read I_{cer} on the meter using the procedure outlined above for I_{ceo}.

I_{cerv}, I_{cex} = collector to emitter leakage with specified reverse bias battery and resistance in series between the base and emitter.

Connect the specified reverse battery and resistance between the BASE and EMITTER terminals. Now read I_{cerv} or I_{cex} on the meter using the procedure outlined above for I_{ceo}.

DIODE TESTING

REVERSE CURRENT

Set the LEAK VOLTAGE switch to the proper value and set the LEAK CURRENT switch to the proper meter range. Place the POLARITY switch in the DIODE REV. position. Pull the SHORT TEST lever to see if the diode is shorted. If the diode is not shorted, push the DIODE lever and read the reverse (leakage) current on the meter.

FORWARD CURRENT

WARNING: Always connect a resistor in series with the diode before checking forward current. Without a series resistor, too much current will flow, possibly damaging the diode.

EXAMPLE: A silicon diode normally drops approximately .7 volt. If the 1.5 volt supply is used, a series resistor must be used to drop the other .8 volt.

I equals 500 mA
E equals .8V

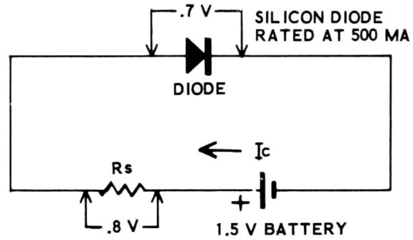
$$R_s = \frac{E}{I} = \frac{.8}{.5} = 1.6\Omega$$

Here a 2Ω resistor will prevent excessive current from damaging the diode under test.

The series resistor may be left connected when checking REVERSE CURRENT. The series resistance is normally a very small resistance compared to the high reverse-current resistance of the diode.

Connect the diode to be tested and the pre-determined series resistor to the external transistor terminals; cathode to EMITTER and anode to COLLECTOR. Set the LEAK VOLTAGE switch to the proper value and the LEAK CURRENT switch to the proper meter range. Place the POLARITY switch in the DIODE FWD. position. Push the DIODE lever and read forward current on the meter.

Other types of diodes may also be tested as just described.



Rs = SERIES RESISTANCE

FIGURE 10

EXTERNAL BIAS VOLTAGE TERMINALS

Connect the external d.c. power supply leads to the external bias terminals; the positive lead to positive (+) terminal and the negative lead to negative (-) terminal.

Set the BIAS switch to the EXT. position. The internal BIAS control is used to set the desired amount of bias. NOTE: A maximum of 5 volts may be applied to these terminals.

The external bias supply may be a battery or any high-current, low-voltage unit such as a battery eliminator.

The external BIAS terminals should be used when continuous power transistor testing is required.

EXTERNAL COLLECTOR VOLTAGE TERMINALS

Connect the external d.c. power supply to external COLLECTOR VOLTAGE terminals; the positive lead from the power supply connects to the positive (+) terminal and the negative lead to the negative (-) terminal.

Adjust the COLLECTOR VOLTAGE switch to the desired EXT. voltage range. Now set the power supply for the desired collector voltage. NOTE: A maximum of 50 volts may be applied to these terminals.

The external collector voltage power supply may be any high-current unit such as a battery eliminator.

The external collector voltage terminals should be used when continuous power transistor testing is required.

EXTERNAL LEAK VOLTAGE TERMINALS

Connect the external d.c. power supply leads to the external LEAK VOLTAGE terminals; the positive lead to positive (+) and the negative lead to negative (-) terminal.

Adjust the LEAK VOLTAGE switch to the proper EXT. voltage range. Now set the power supply for the desired leak voltage. NOTE: A maximum of 150 volts may be applied to these terminals.

The external leak voltage power supply may be any high-voltage supply such as a laboratory d.c. power supply.

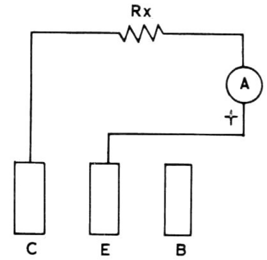
The external LEAK VOLTAGE terminals must be used when higher leak voltages are required than are available from the internal battery supply.

CHECKING CURRENT RANGES

EXT. TRANSISTOR TERMINALS

Connect an external d.c. ammeter between the COLLECTOR and EMITTER external terminals. The positive (+) side goes to the EMITTER with POLARITY switch in PNP position. Connect resistance R_x in series with the ammeter as shown in Figure 11.

Before calculating the size of resistor R_x, decide on the current range to be checked and at what voltage it will be checked.



EXT. TRANSISTOR TERMINALS

FIGURE 11

For example:

Current range to be checked - 150 milliamperes. Collector voltage used - 1.5 volts.

$$R_X = \frac{E}{I} = \frac{1.5}{.150} = 10\Omega$$

In this case a 10Ω resistor is used as R_X to limit the current to 150 milliamperes.

Set the POLARITY switch to PNP and set the COLLECTOR VOLTAGE switch to 1.5 volts. Now pull the COLLECTOR CURRENT lever and compare the current indicated on the ammeter with the current indicated by the meter on the Transistor Tester. If an appreciable difference is found between the two readings and if you are certain of the accuracy of the external ammeter, the meter and shunt resistors of your Transistor Tester should be checked.

This same procedure may be used to check the other current ranges.

CHECKING VOLTAGE RANGES

Connect an external d.c. voltmeter between the external COLLECTOR and EMITTER terminals. The positive (+) side of the meter goes to the EMITTER terminal.

INTERNAL VOLTAGE RANGES

Set the POLARITY switch to PNP and set the COLLECTOR VOLTAGE switch to the internal voltage range to be checked. Push the COLLECTOR VOLTAGE lever and compare the voltage readings on the two meters. If an appreciable difference is found between the two readings, check the meter and multiplier resistors of your Transistor Tester.

To check the LEAK VOLTAGE ranges, compare the readings obtained by pushing the LEAK VOLTAGE and COLLECTOR VOLTAGE levers with the COLLECTOR and LEAK VOLTAGE switches set for the same voltage.

EXTERNAL VOLTAGE RANGES

To check the higher external ranges, connect an external power supply to the EXTernal LEAK VOLTAGE terminals together with an external voltmeter as shown in Figure 12.

Set the LEAK VOLTAGE switch to the desired external range and push the LEAK VOLTAGE lever to read the LEAK voltage and compare the two meter readings.

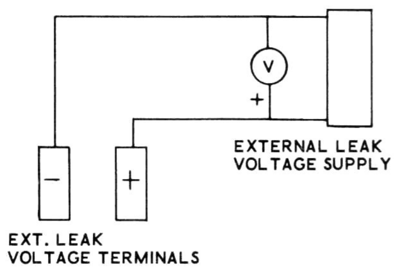


FIGURE 12

The EXTernal COLLECTOR VOLTAGE ranges should be checked in the same manner.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in coloured pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the PROPER SOLDERING PROCEDURE section of this manual.

3. Check the values of the component parts. Be sure that the proper part has been wired into the circuit as shown in the pictorial diagrams and as called for in the wiring instructions.

4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the panel.

5. A review of the CIRCUIT DESCRIPTION will prove helpful in indicating where to look for trouble.

6. Make sure the batteries are not run down. If necessary, install a fresh set of batteries.

7. Repeating the INSTRUMENT CHECKOUT procedure may be helpful in pinpointing the problem.

FAULT FINDING CHART

If one of the switches or controls does not respond properly during the INSTRUMENT CHECKOUT procedure, the chart below will show where the difficulty might be found. Refer to the correct switch or control and check the wiring of the components listed under POSSIBLE SOURCE OF DIFFICULTY. Refer to the Pictorials listed.

CONTROL or SWITCH	POSSIBLE SOURCE OF DIFFICULTY
A. POLARITY switch	POLARITY switch and meter. See Pictorial 10.
B. COLLECTOR and LEAK VOLTAGE switches	Batteries, battery housing, meter, POLARITY, COLLECTOR and LEAK VOLTAGE switches. Lever switch wafers C and E. See Pictorials 1, 2, 4, 6, 7, 9 and 10.
C. BIAS control	Batteries, battery housing, meter, BIAS, POLARITY, COLLECTOR and LEAK CURRENT switches; Lever switch wafers A and B. BIAS and Gain Test controls. External transistor terminals. See Pictorials 3, 4, 8, 9 and 10.
D. COLLECTOR CURRENT lever	Batteries, battery housing, meter, POLARITY, COLLECTOR VOLTAGE and COLLECTOR CURRENT switches; Lever switch wafers C and D. External transistor terminals. See Pictorials 2, 3, 4, 6, 7, 8, 9 and 10.
E. SHORT TEST lever	Batteries, battery housing, meter, POLARITY, COLLECTOR VOLTAGE and COLLECTOR CURRENT switches; Lever switch wafers D and E. External transistor terminals. See Pictorials 2, 3, 4, 6, 7, 8, 9 and 10.
F. I_{ceo}, I_{cbo} Lever and LEAK CURRENT switches	Batteries, battery housing, meter, POLARITY, LEAK VOLTAGE and LEAK CURRENT switches; Lever switch wafer F. External transistor terminals. See Pictorials 1, 4, 6, 7, 8, 9 and 10.
G. GAIN HIGH-LOW switch	Batteries, battery housing, meter, BIAS, POLARITY, COLLECTOR CURRENT and GAIN HIGH-LOW switches; Lever switch wafers A and B. BIAS and Gain Test controls. External transistor terminals. See Pictorials 2, 3, 4, 6, 7, 8, 9 and 10.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which we make available to our customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case of Difficulty. Possibly one of these will solve your problem.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number, invoice number and date of purchase, if available.

5. Print or type your name and address, preferably at the head of the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like him to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was sent to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be sent to you, subject to the terms of the Guarantee.

HEATHKIT equipment purchased locally and returned to Daystrom Limited for service must be accompanied by your copy of the dated sales receipt from your authorised HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Guarantee.

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 Department are at your disposal. Your instrument may be returned carriage paid to Daystrom Limited, 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).

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although Daystrom Ltd. sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than Daystrom Limited.

REPLACEMENTS

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

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.
B. Identify the type and model number of kit in which it is used.
C. Mention date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

Daystrom Limited will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. 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.

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 Limited 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 instructions given in this Manual to ensure successful results. Daystrom Limited 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.

GUARANTEE

Daystrom Limited guarantee subject to the following terms to repair or replace free of charge any defective parts of this Heathkit 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 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.

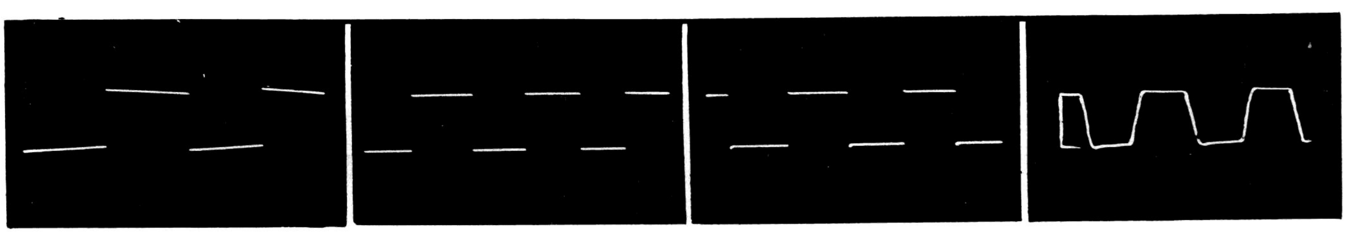
Assembly and Operation of the
Heathkit OSCILLOSCOPE

MODEL IO-12U

SPECIFICATION

Vertical Channel

Sensitivity:	10 mV rms per cm at 1 kc/s
Frequency Response (0 dB ref. 1 kc/s):	± 1 dB 8 c/s - 2.5 Mc/s ± 3 dB 3 c/s - 4.5 Mc/s
Overshoot:	10% or less
Rise Time:	0.08 μSec or less
Transient Response:	Oscillograms below are unretouched displays of square wave signals. (Rise time of source generator was less than 0.02 μSec.)



50 CPS 1000 CPS 100 KC 1 MC

Input Impedance:	In X1 position - 2.9 MΩ + 21 pF In X10 and X100 positions - 3.4 MΩ + 12 pF
Attenuator:	Three position, switch type, fully compensated
Input Characteristics:	Input blocking capacitor rated at 600V d.c.

HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual thoroughly to familiarise yourself with the general procedure. Note the relative location of pictorial inserts in respect of the progress of the assembly procedure outlined.
This information is offered primarily for the convenience of the novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronic enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialised equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 25-50 watt iron with a small tip. The use of long nose pliers and a diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of resin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that the valve holders are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer colour coded wires will be available at the proper chassis opening. Make it a standard practice to use lockwashers under all 4BA and 2BA nuts. The only exception being in the use of soldering tags - the necessary locking feature is already incorporated in the design of the soldering tags. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.
When installing terminals that require the use of fibre insulating washers, it is good practice to slip the shouldered washer over the terminal stud before installing the mounting stud in the panel hole provided. Next, install a flat fibre washer and a soldering tag under the mounting nut. Be sure that the shouldered washer is properly centred in the panel to prevent possible shorting of the terminal.

WIRING

When following the wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.
When removing insulation from the end of connecting wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect of nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.
In mounting parts such as resistors or capacitors, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use insulated sleeving over exposed wires that might short to nearby wiring. It is urgently recommended that the wiring and parts layout as shown in the construction manual be faithfully followed. In every instance the desirability of this arrangement was carefully determined following the construction of a series of laboratory models.

SOLDERING

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

AERIAL	CAPACITOR (VARIABLE)	SWITCH — SINGLE POLE (S.P.) SINGLE THROW (S.T.)	BATTERY +
LOOP	RESISTOR	SWITCH — DOUBLE POLE (D.P.) DOUBLE THROW (D.T.)	FUSE OR
DIPOLE	RESISTOR (TAPPED)	SWITCH — TRIPLE POLE (T.P.) DOUBLE THROW (D.T.)	CRYSTAL
EARTH	RESISTOR (VARIABLE)	LOUDSPEAKER	TERMINAL & TERMINAL STRIP
INDUCTOR (COIL OR R.F. CHOKE)	POTENTIOMETER	RECTIFIER	WIRING BETWEEN LIKE LETTERS IS UNDERSTOOD →X →Y XY XY
R.F. COIL WITH ADJUSTABLE IRON DUST CORE	JACK (TWO CONDUCTOR)	MICROPHONE	MICRO (X 1/1,000,000) = μ
L.F. CHOKE (IRON CORED) WITH TAPPINGS	JACK (THREE CONDUCTOR)	TYPICAL TUBE SYMBOL: ANODE, SUPPRESSOR GRID, 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. (A)	TRANSISTOR (N.P.N. TYPE)	OMEGA (OHMS) = Ω
CAPACITOR	NEON LAMP STABILISER VALVE	SOCKET OUTLET — CO AXIAL	MICROFARAD = μF
CAPACITOR (ELECTROLYTIC) + −	LAMP PILOT OR ILLUMINATING	TWO PIN SOCKET AND TWO PIN PLUG	PICOFARAD = pF MICRO MICRO FARAD = μμF

DAYSTROM LIMITED

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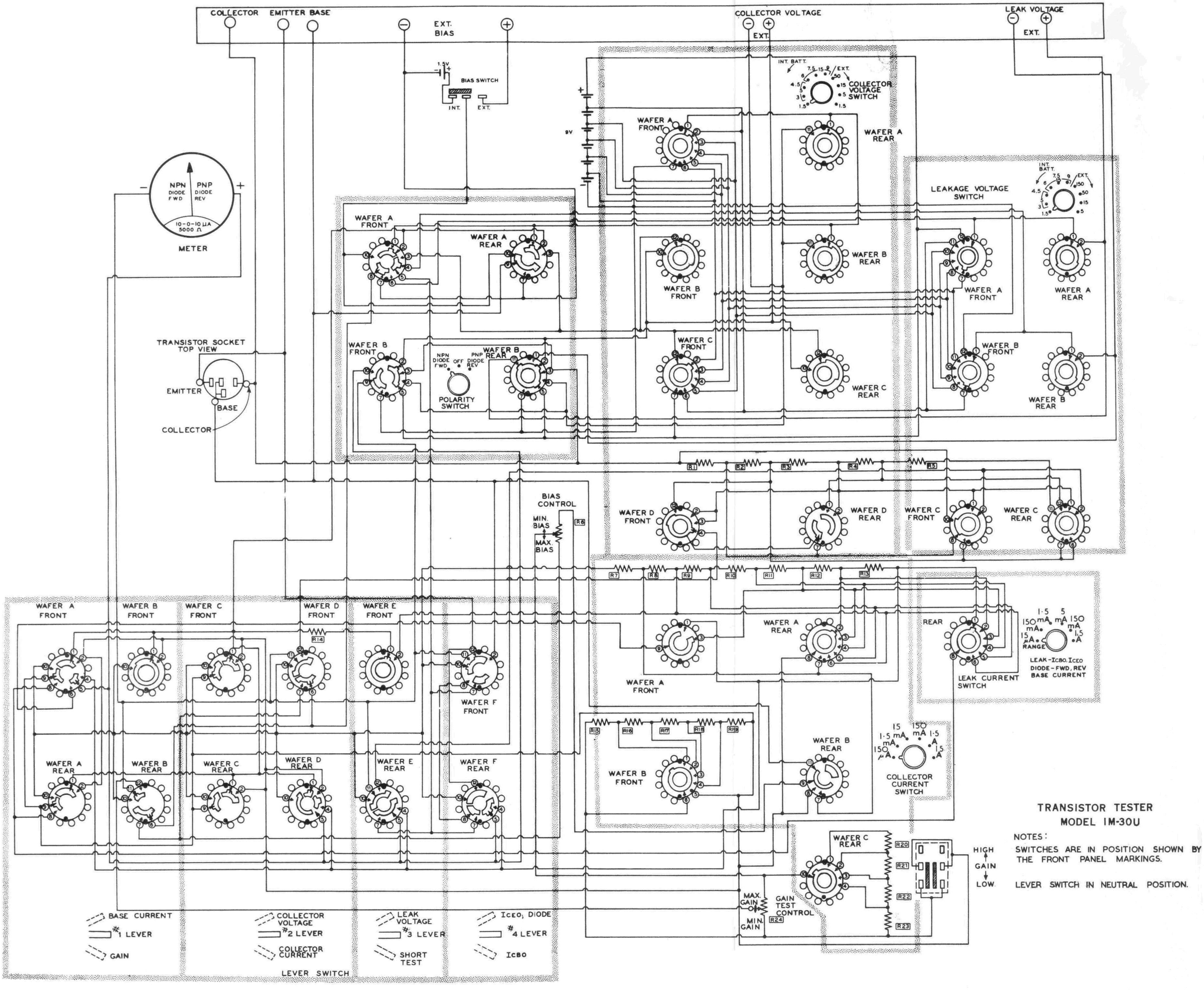
THE WORLDS LARGEST MANUFACTURERS
OF ELECTRONIC KITS

GLOUCESTER, ENGLAND

MC 110 4/65

Printed in England



TRANSISTOR TESTER
MODEL IM-30U

NOTES:

SWITCHES ARE IN POSITION SHOWN BY THE FRONT PANEL MARKINGS.

LEVER SWITCH IN NEUTRAL POSITION.

EXT. TRANSISTOR AND DIODES

EXT. BIAS SUPPLY 5 V MAX.

EXT. COLLECTOR VOLTAGE SUPPLY 50 V MAX.

EXT. LEAK VOLTAGE SUPPLY 150 V MAX

BIAS INT. - EXT. SWITCH - Selects internal 1.5 volt battery or an external source.

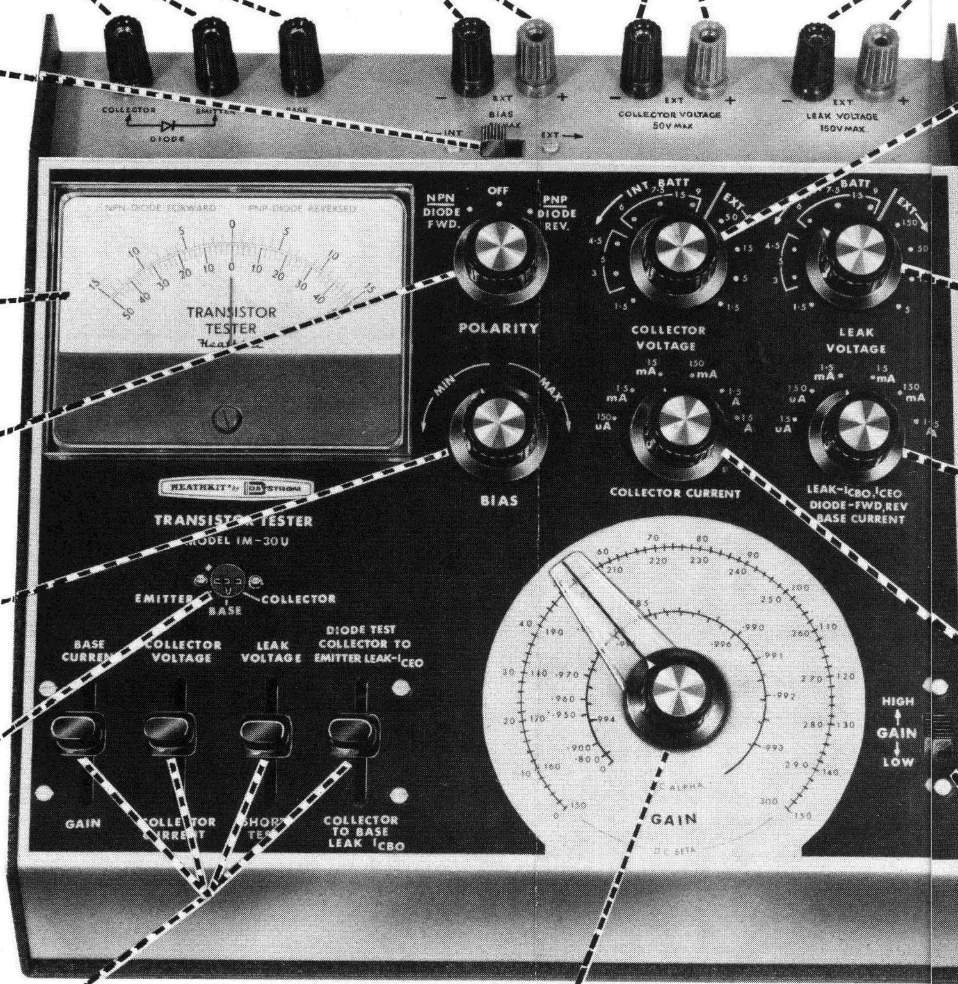
METER - Scales: 15-0-15 and 50-0-50. Sensitivity: 10-0-10 μA, 100 KΩ/volt. Resistance: 5000Ω

POLARITY SWITCH - Selects NPN or DIODE FWD, OFF, and PNP or DIODE REV.

BIAS CONTROL adjusts COLLECTOR CURRENT to any value from 0 to 15 A. Meter should have no appreciable deflection with BIAS CONTROL at minimum and COLLECTOR CURRENT lever pulled.

UNIVERSAL TRANSISTOR SOCKET

LEVER SWITCH - Selects any one of the following tests: BASE CURRENT, GAIN, COLLECTOR VOLTAGE, COLLECTOR CURRENT, LEAK VOLTAGE, SHORT TEST, Icea or DIODE TEST, and Icbo.



COLLECTOR VOLTAGE SWITCH - Selects internal batteries in 1.5 volt increments up to 9 volts; external voltages up to 50 volts.

LEAK VOLTAGE SWITCH - Selects internal batteries in 1.5 volt increments up to 9 volts; external voltages up to 150 volts.

LEAK CURRENT SWITCH - Selects meter ranges from 15 μA to 1.5 A in steps of times 10. For base current measurement, do not set less than 1/10 of COLLECTOR CURRENT switch setting.

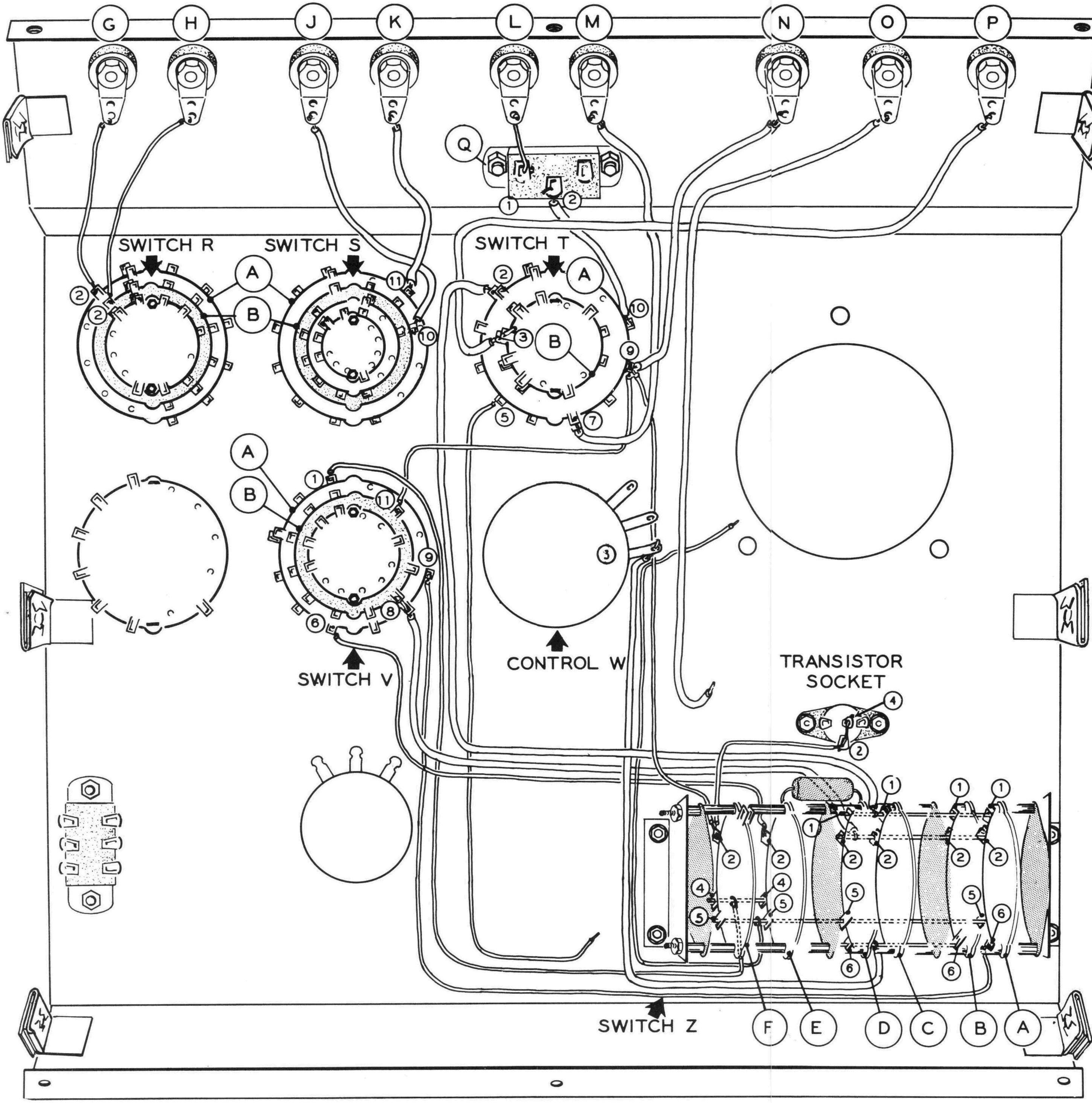
COLLECTOR CURRENT SWITCH - Selects meter ranges from 150 μA to 15 A in steps of times 10.

GAIN TEST CONTROL - Calibrated scale shows actual gain (Beta and Alpha) of transistor when control is adjusted to null the meter.

GAIN HIGH-LOW SWITCH - Selects GAIN TEST control scales of 0-150 Beta and 0-0.993 Alpha or 150-300 Beta and 0.993-0.9966 Alpha. Readjust BIAS control when changing from one position to the other.

OPERATIONAL PICTURE

FIGURE 9


G
H
J
K
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M
N
O
P
Q
SWITCH R
SWITCH S
SWITCH T
A
B
SWITCH V
CONTROL W
TRANSISTOR SOCKET
SWITCH Z
F
E
D
C
B
A

PICTORIAL 9