OPERATING INSTRUCTIONS FOR

PRECISION

MODEL 10-60

Electronamic® TUBE TESTER

TRANSISTOR & CRYSTAL DIODE TESTER

Voltage Regulator & Picture Tube Tester

PRECISION
TEST EQUIPMENT
Standard of Accuracy

PRECISION APPARATUS COMPANY, INC.

70-31 84th STREET • GLENDALE 27, L. I., N. Y.

EXPORT DIVISION: 458 BROADWAY, NEW YORK CITY, U.S.A. CABLES: MORHANEX
CANADIAN SALES DIVISION: ATLAS RADIO CORP., LTD., 560 KING STREET W., TORONTO 2B, ONTARIO

CONTENTS

CONDENSED PROCEDURE
for
TUBE TESTS

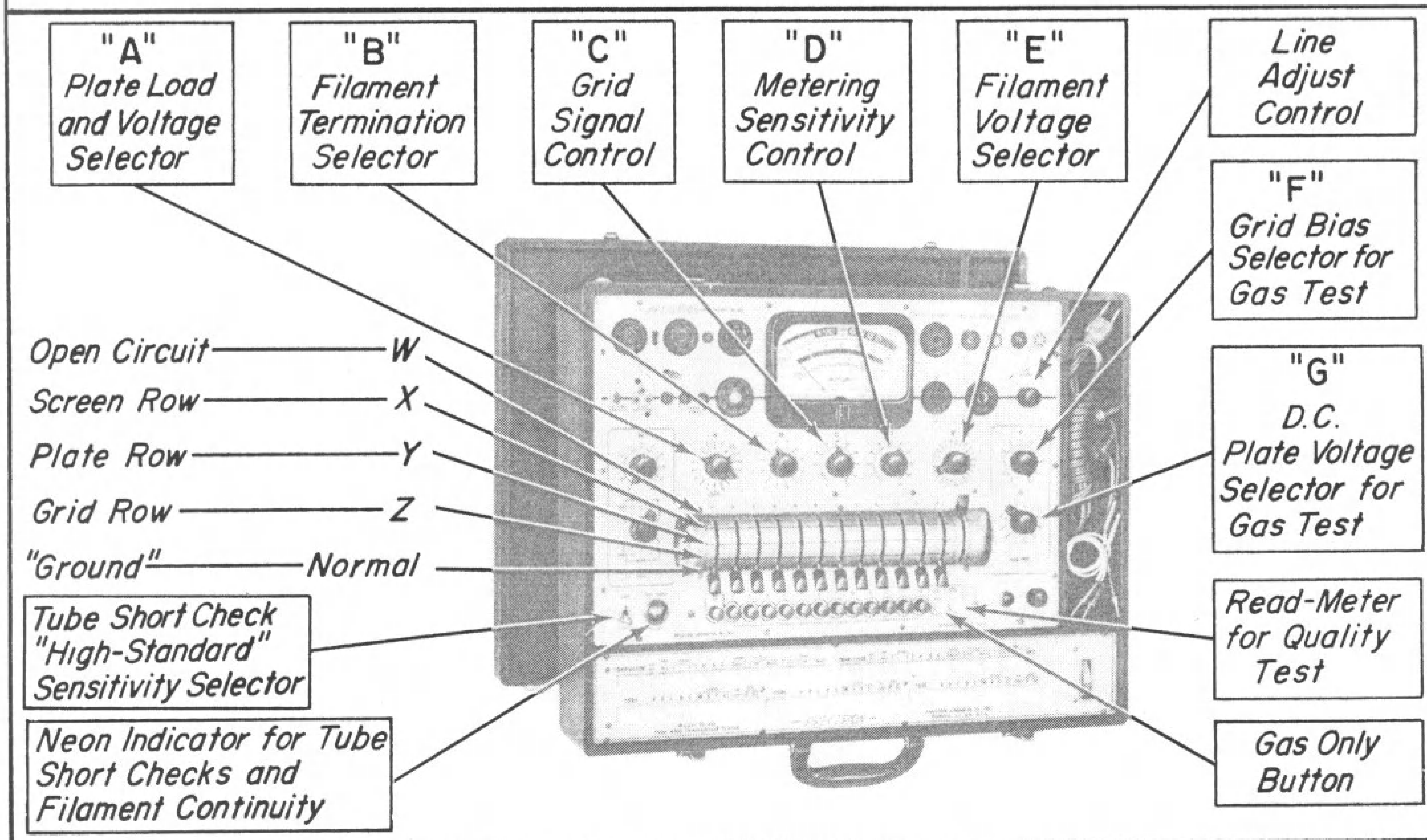
A

See detailed instructions on Page 12

1. Depress "OFF" button and connect Model 10-60 Line plug to 110-125 volts, 50-60 cycle source.
2. Set Controls "A", "B", "C", "D" and "E" to positions listed on Roller Chart.
3. RETURN ALL LEVERS TO "NORMAL" POSITION by use of the "Lever Return" mechanism.
4. Release "OFF" button by depressing "READ METER" button.
5. Insert tube to be tested and ALLOW TO HEAT.
6. Rotate "LINE AND VR ADJUST" Control until meter points to "LINE" indication.
7. Set "HIGH-STANDARD" Short Check Sensitivity Selector to "STANDARD" position.
8. Perform SHORT/LEAKAGE TESTS by depressing buttons 1 through 12, watching the neon lamp as each button is depressed. If neon bulb glows as any one or more buttons are depressed (WITH THE EXCEPTION OF BUTTONS LISTED UNDER "FIL. CONT.", or those buttons listed as special Roller Chart notations), the tube should be discarded as defective.
9. If short circuits have not been indicated, and neon glow has been obtained on those buttons listed under "FIL. CONT." (and those buttons specifically noted on the Roller Chart), THEN throw those levers to the positions indicated on the Roller Chart under headings W-X-Y-Z.
10. Depress the "READ METER" button and observe the tube Quality meter reading on upper 3 colored arc.

TO TEST FOR GAS:- Do not change any settings unless specifically instructed to do so by test data. Set "F" and "G" as indicated on Roller Chart. Depress "GAS ONLY" button and note reading on 0-15 "GAS" scale. Leave "GAS ONLY" button depressed and wait at least 2 minutes, then again note reading. If the gas reading was originally within limits and there has been no noticeable change, then the tube is OK. If there is a noticeable increase in gas reading, observe the meter to see if gas rises above permissible limit. After completing gas check, set "G" Switch to "OFF" as a safety measure.

Gas Limits: Voltage Amplifier Types:- 2 microamperes Maximum
Power Amplifier Types:- 5 microamperes Maximum



CONDENSED TEST PROCEDURE
for
PICTURE-TUBE BEAM CURRENT TESTS

See detailed instructions on Page 19

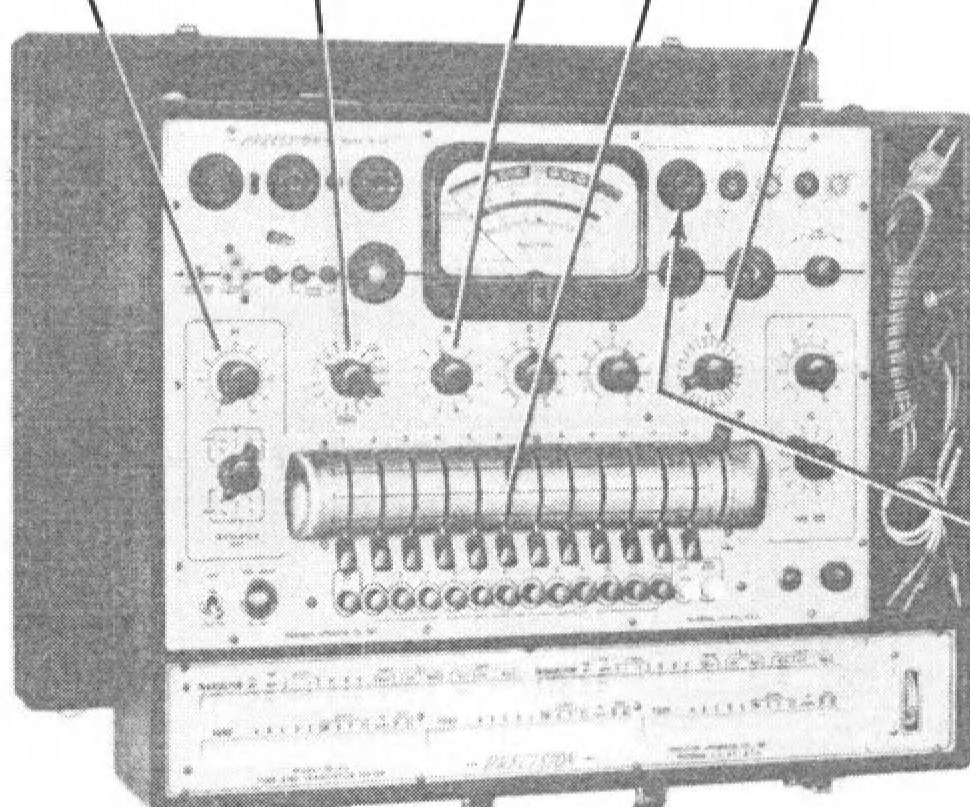
1. Set "H" to 0, "A" to "PIX TUBES", "B" to 1, "E" to 9, and turn Model 10-60 on.

2. Plug one end of "PTA" Cable to picture tube, clip alligator lead to HV anode. Plug octal end of "PTA" Cable into octal socket of 10-60. Rotate Line control to obtain meter "Line" indication.

3. Check Filament Continuity by depressing buttons 1 and 8 individually. Check for shorts by depressing buttons 2, 4, 5, 6, 7 individually.

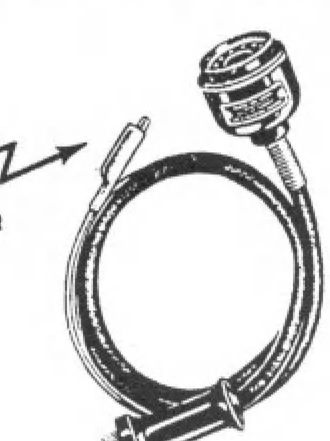
4. Throw Lever 6 to Row "Y". Depress "READ METER" button and rotate "H" Control up from 0 to 20. If the meter goes off-scale before "H" Control reaches 20, consider that a reading in green sector was obtained. Otherwise with "H" Control at 20 and "READ METER" button depressed, read picture tube Quality on (lower) 3 colored picture tube scale.

H	A	B	E	—Levers— W X Y Z
"O" then slowly up to 20 during the final Beam Current Test	*"Pix Tubes"*	I	9	— — 6 —



Plug this Adapter into the 10-60 Octal Socket

connect alligator clip to H.V. Anode



Use Model PAA Adapter For 110° Pix Tubes

CONDENSED OPERATING INSTRUCTIONS
VOLTAGE REGULATOR TESTS

See Page 21 for detailed step by step instructions

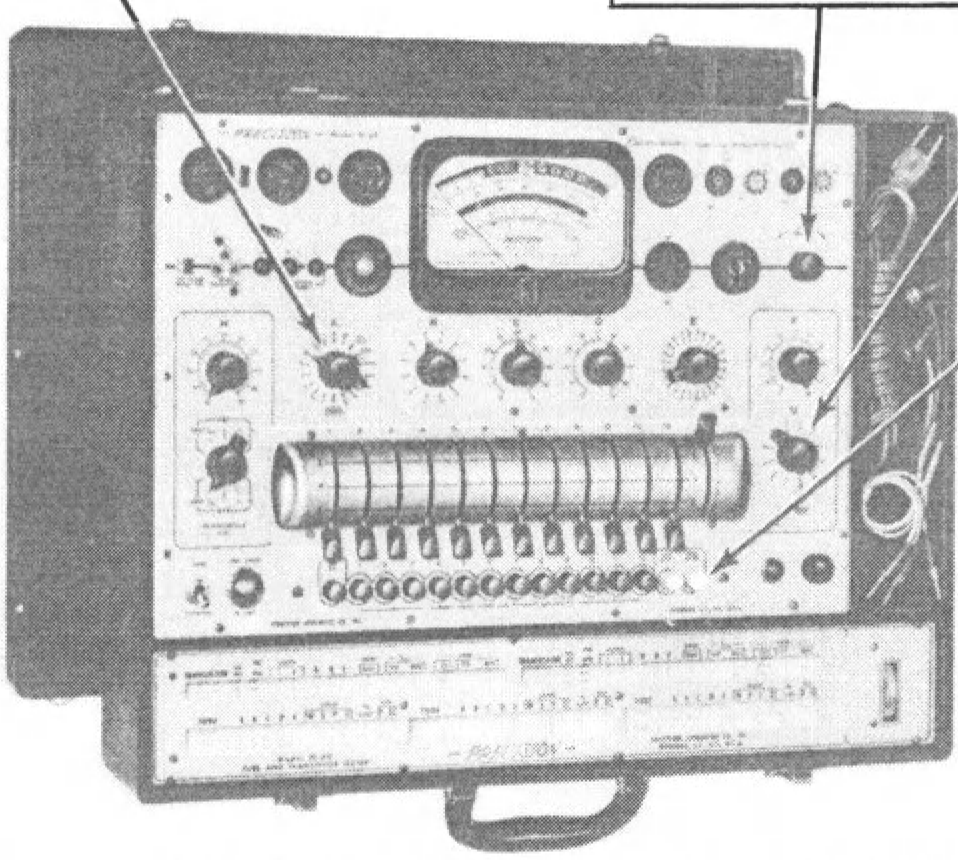
SET-UP					LIMITS				
Type	"A" Switch Positions	LEVER SETTINGS W	LEVER SETTINGS Y	"G" Switch	Maximum Firing Voltage	OPERATING CURRENT Minimum	OPERATING CURRENT Maximum	MAXIMUM REGULATION Change in voltage between minimum and maximum Operating Current	Extremes of operating voltage at any current within the Operating Current Range
OA2	250V and 50Ma	3-6	1-5	9	185V	5Ma	30Ma	6 Volts	140V to 168V

① Set "A" switch to "VR-250V" position.

② Set indicated levers to "W" and "Y" Rows.

③ Rotate "Line and VR Adj" control to extreme counter-clockwise position

④ Set "G" switch as shown.



⑤ Now plug-in VR tube, Depress "READ METER" button and rotate "LINE and VR ADJ" control until tube fires, (Tube fires when voltage drops). Voltage just before tube fires should be below maximum firing voltage, for a good tube.

⑥ Set "A" switch to VR current position indicated (50 Ma in this example). Depress "Read Meter" button and rotate "Line" control to obtain minimum operating current indicated for tube. Keep button depressed, rotate "A" switch back to voltage position and note voltage reading. (Button can now be released.)

⑦ Set "A" switch to current position. Depress "Read Meter" button and rotate "Line and VR Adj." control to obtain maximum operating current indicated for tube. If maximum current can not be obtained with "G" switch setting shown, first rotate "Line" control back to extreme counter clockwise position, then set "G" switch to next higher number, (except skip position 10 and go to 11 if required) depress button and rotate "Line" control to obtain desired current.

⑧ Rotate "A" switch back to voltage position, but do not change any other settings. Depress button and note voltage reading. The difference in voltage readings between steps ⑧ and ⑥ is the regulation. This change in voltage should be less than the maximum indicated for the tube.

⑨ The values of voltage noted in steps ⑥ and ⑧ are <u>operating voltages</u>. These voltages should be within the limits of operating voltages noted for the tube.

CONDENSED PROCEDURE FOR DIODE TESTS

(See detailed instructions on Page 22)

Diode	D_F (Forward Current)				D_R (Reverse Current)		
	D	E	"D_F CAL" Position Rotate Line Control To Set Meter To:	"D_F TEST" Position Reject Diode if Meter Reads Above	E	H	"D_R TEST" Position Reject Diode if Meter Reads Above:
IN34	50	3	86	20	19	0	5

① Set "A" Switch to "D_F Cal."

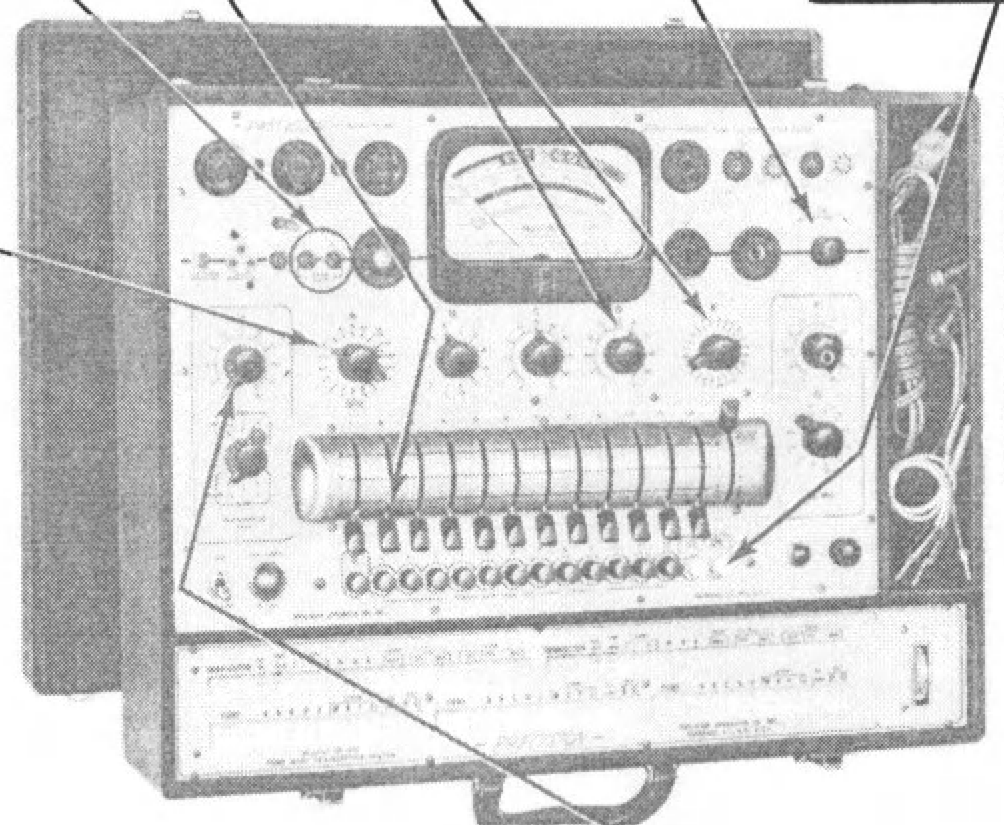
② Insert diode cathode(+) in pin jack 3, anode(−) in pin jack 2 (Use adapter cable if necessary.

③ Set Lever #2 to Row Z

④ Set "D" and "E" as indicated for Diode under Test.

⑤ Rotate "Line" Control to extreme counter-clockwise Position.

⑥ Depress "Read Meter" Button and rotate "Line" Control to set meter to value indicated. ("E" switch may be set to next higher position, but no higher, if necessary, to obtain meter reading.)



⑦ Release "Read Meter" Button, leave all settings unchanged except rotate "A" Switch to "D_F Test." Now depress "Read Meter" Button and note meter reading.

⑧ Set "A" switch to "D_R Test." With "Read Meter" Button in Normal Position, rotate "Line" Control until meter points to "Line" Calibration.

⑨ Reset "E" Switch as indicated for diode under test.

⑩ Set "H" Switch as indicated for diode under test

⑪ Depress "Read Meter" Button and note Meter reading.

Diode	D_F (Forward Current)				D_R (Reverse Current)		
	D	E	"D_F CAL" Position Rotate Line Control To Set Meter To:	"D_F TEST" Position Reject Diode if Meter Reads Above	E	H	"D_R TEST" Position Reject Diode if Meter Reads Above:
IN34	50	3	86	20	19	0	5

E

CONDENSED PROCEDURE for TRANSISTOR TESTS

(See Page 23 for detailed step by step instructions)

(Set Switch "A" To TRANSISTORS") TRANSISTOR	FIG NO.	PNP OR NPN	Levers X	Levers Z	H	D	E	Short MAX	IcBo TYP	IcBo MAX	GAIN TEST	GAIN TYP	GAIN MIN
2N137	LP 1	PNP	4	2	50	50	6	4		15	G_1-L		15

① Set "A" Switch to "Transistors"

② Plug transistor in socket in accord with Fig. No. (or use adapter cable if necessary.

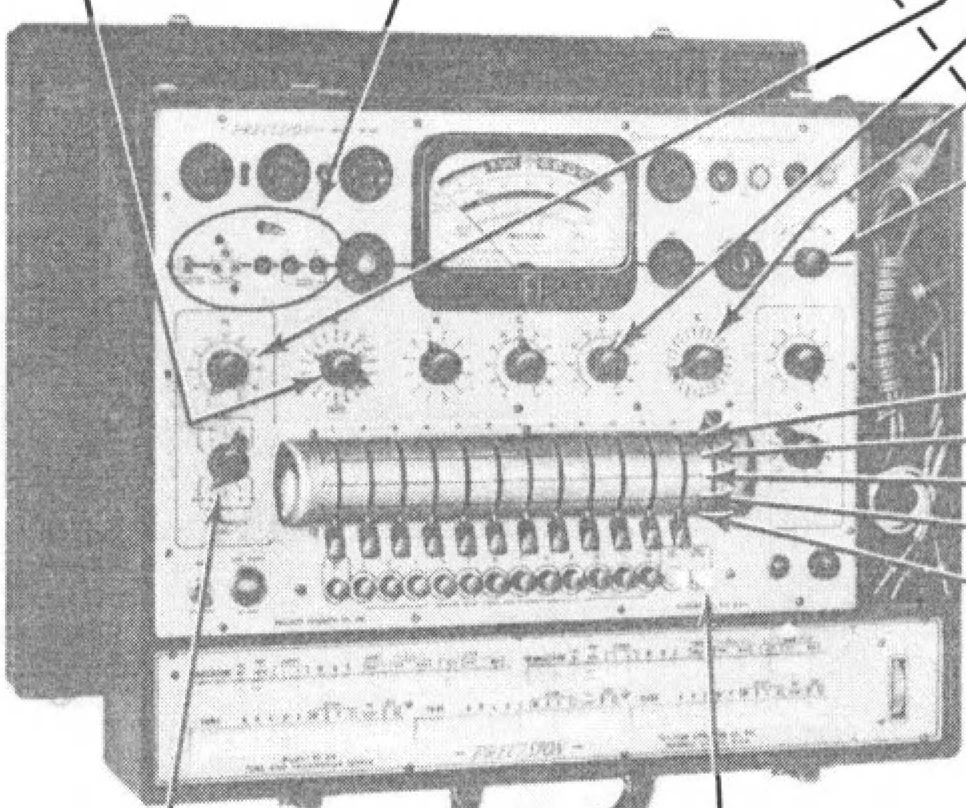
③ Set indicated levers to appropriate row.

④ Set "H"

⑤ Set "D"

⑥ Set "E"

⑦ Rotate "Line and VR Adj" Control until meter points to "Line" indication.



Row W
Row X
Row Y
Row Z
Normal Row

⑪ If "G_1-L is indicated under "TEST," Set "Transister Test" switch to "L," depress "Read Meter" button and note reading. Then set "Transistor Test" switch to "G_1" depress button and note reading. Then see step 12 (If "G_2" is indicated under "Test," ignore "L" and "Gi" positions and set switch to "G_2").

⑧ Set "Transistor Test" Switch to PNP or NPN "Short" as indicated.

⑨ Depress "Read Meter" button. Reject transistor if meter reads above indicated maximum.

⑩ Set "Transistor Test" switch to appropriate "IcBo" position (NPN or PNP) and depress "Read Meter" button. Reject transistor if meter reads above indicated maximum.

⑫ If "Gi" minus "L" reading (or "G_2") is less than indicated minimum reject transistor.

TRANSISTOR	FIG. NO.	PNP OR NPN	Levers X	Levers Z	H	D	E	Short MAX	IcBo TYP	IcBo MAX	GAIN TEST	GAIN TYP	GAIN MIN
2N137	LP 1	PNP	4	2	50	50	6	4		15	G_1-L		15

MODEL 10-60

INTRODUCTION

The Model 10-60 Electronamic Tube and Transistor Tester has been designed to provide the Service Lab with complete facilities for the following tests:-

*1. Complete Tube Tests:- *Electronamic Quality, Shorts and Leakage, and Gas Content. *SEE PRINCIPLES OF "ELECTRONAMIC TUBE TESTING" at the rear of this manual.

2. Comprehensive sequential Transistor Tests (Low Power through Power types) Measures Icbo and DC Beta (Gain).

3. Crystal Diode tests (Separate tests for Forward and Reverse characteristics).

4. Picture Tube Beam Current Tests.

5. Voltage Regulator Tube Tests:- Direct voltage and current readings under variable load conditions.

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The five major Test Functions of the Model 10-60 are supplemented by a carefully designed variety of functional facilities specifically aimed at simplification of Test operations:-

BASIC TUBE TEST FEATURES

1. ACCOMMODATES ALL MODERN TUBE TYPES AND FILAMENT VOLTAGES from .75 to 117 volts. Tests noval button 9 pin tubes, 7 and 8 pin sub-miniature types, hearing aid and pocket radio tubes, double-cap U.H.F. types, loctals, single-ended (TV and FM amplifiers), regular Octals (MG, G and metals), spray-shield and glass types, and miniature 7 pin types.

2. BUILT-IN MINIATURE 7 and 9 pin Straighteners:- Rustproof, long-lived, stainless steel pin straighteners provide means for convenient and rapid adjustment of bent base pins. Assures longer trouble-free life from tube sockets and better contact when tubes are returned to original apparatus sockets.

3. QUALITATIVE TUBE MERIT readings directly indicated on a single three colored TUBE QUALITY SCALE supplemented by a linear scale for tube matching and qualitative comparison purposes.

4. DUAL FREE-POINT FILAMENT TERMINAL SELECTION locates terminals of ALL filaments (single, double, center-tapped) regardless of rotating pin positions.

5. VISIBLE FILAMENT CONTINUITY TESTS:- Rapidly performed by the PRECISION NUMBERED PUSH BUTTON SYSTEM; shows up open filaments for all types of tubes regardless of filament base connections. In addition, this PRECISION feature immediately reveals the open section of tapped filaments.

6. MASTER ELEMENT LEVER-OPERATED SELECTOR SYSTEM: This highly important PRECISION feature COMPLETELY ELIMINATES ALL POSSIBILITIES OF INFLEXIBILITY due to unusual multiple tube basing terminations of new tubes and tubes yet to be developed. Maximum speed in the use of the lever system is accomplished by the unique fool-proof MASTER LEVER RETURN MECHANISM which allows for instantaneous return of ALL levers to "Normal" position before testing a tube. Individual time-consuming return of each lever is thereby completely eliminated. In addition, simplified tube analysis is made possible by the Standard element numbering system employed.

7. SPECIFIC INDIVIDUAL LOADS AND VOLTAGES (control grid, screen, plate, etc.) applied to each respective element of tube under test.

8. METER READS IN PLATE CIRCUIT ONLY. Indications, therefore, are entirely dependent upon control action and condition of ALL intervening elements.

9. OPEN ELEMENTS: Shows up tubes with open elements. The exclusive "ELECTRONAMIC" TUBE TEST NECESSITATES ALL ELEMENTS INTACT FOR PROPER reading.

10. TESTS diodes, triodes, rectifiers, tetrodes, pentodes, multi-purpose tubes, gaseous types such as OY4, OZ3 and OZ4 and remote control gaseous types such as OA4 and 2A4, regardless of varying filaments or other element positions.

11. MULTI-SECTION TUBES: Individual tests for each section of multi-section tubes including visible tests of the fluorescent screen, winking effect on cathode ray indicator tubes and FM/AM alignment ray indicator tubes. No shifting of tubes is necessary to obtain all tests.

12. HOT CATHODE LEAKAGE TEST: Sensitive neon method quickly shows up poor cathode structure in accord with leakage specifications of leading tube manufacturers.

13. DUAL SENSITIVITY HOT INTER-ELEMENT SHORT TESTS made ingeniously simple through the use of PRECISION Automatic Interlocking Push-Buttons, and lens-protected magnified neon lamp. Double sensitivity is made available through the flip of a switch to permit special application tube selection to more rigid standards.

GAS TEST FEATURES

1. Gas measurement is taken Directly in the grid circuit of the tube to be checked. Meter reads Direct Gas on a special 0-15 microampere scale.

2. Distinctly separate panel controls provide for a Direct Gas test on all tubes where tube gas content is a factor in circuit operation.

3. A selected variety of plate potentials are available which are pre-calculated in conjunction with applied bias to insure sufficient power development for reliable Gas detection.

4. "Gas" button is "locking-release" type. This feature allows for gas-development time, required in some cases for true build-up of gas.

5. The sensitive Meter is fully protected against inadvertent overload during gas tests by a meter-protective circuit.

VOLTAGE REGULATOR TEST FEATURES

1. The basic Lab type Voltage Regulator Tests included in Model 10-60 permit direct comparison of test results with published data for VR tubes:-

   (a) The load on VR tubes can be directly varied from minimum to maximum, directly monitored current-wise on the 10-60 Meter.

   (b) Voltage regulation at any load point between Maximum and Minimum is read directly on the 10-60 Meter.

2. Firing and extinction potentials can be checked and read directly on the Meter.

3. Facilities provide for test of all types of VR tubes from below 65 volts to above 150 volts.

PICTURE TUBE BEAM-CURRENT TEST FEATURES

1. The extra-high Sensitivity of the 10-60 indicator circuits permits Beam Current Measurement of Picture Tubes (current measurement from Cathode through G_1, to G_2) through use of Accessory Cable, Model PTA.

   Beam Current bears direct relationship to Picture Brightness inasmuch as current collected on G_2 emanates from the small picture-producing area of the Cathode. This type of test is preferred by Pix tube manufacturers as compared to a standard Emission test (Cathode to G_1) because of Beam Current's direct relationship to Picture Brightness.

TRANSISTOR AND CRYSTAL DIODE TESTING FEATURES

1. 17 DC Collector voltages are available for test of Icbo to insure most accurate comparison with manufacturers' specifications. Meter sensitivity continuously variable from 120 microamperes full scale to 24 milliamperes full scale insures complete coverage for all types of transistors.
2. Provides for Direct Beta (Gain) Readings for POWER TRANSISTORS as well as Low Power Types. Readings are supplemented by a Leakage Reading in the case of Low Power Transistors for maximum accuracy of Gain Readings. A safety-type Short test is provided as the first step for all Transistor tests.
3. Transistor socket terminations are distributed to the 10-60 test circuits through the Master Lever Distribution System. This tie-in with the Lever System insures utmost flexibility for accommodation of future transistor releases.
4. A universal flexible-lead Adapter Cable is supplied with your Model 10-60 to permit connection to unusual types which are not adaptable to standard sockets. This cable also permits connection of new types of transistors yet to be released which may not mate with panel sockets.
5. All Crystal Diodes are checked for Forward and Reverse current directly in accordance with the diode manufacturers' data.
6. All transistor test data is completely listed on the 10-60 Roller Chart. Specific SHORT, Icbo and GAIN figures are listed for each transistor type. In those cases where specific limits are available from the transistor manufacturer, they are listed under the "Max" or "Min" column on the roller chart. In those cases where the manufacturer has not yet set a specific field reject limit, "Typ" values for Icbo and Gain are listed for guidance.
7. All test potentials are compensated for variations in line voltages by means of a heavy duty continuously variable panel mounted line voltage control.

MISCELLANEOUS FEATURES

1. FIVE WINDOW, HIGH SPEED DUAL FUNCTION ROLLER CHART SYSTEM. Provides complete listings of all up-to-date Tubes and Transistors. 3 column Tube Data, 2 column Transistor Data. Provides "years" of space for new tube and transistor releases.

   ROLLER CHART ASSEMBLY COMPLETELY DETACHED FROM THE INSTRUMENT ITSELF.

2. MASTER LEVER ELEMENT SELECTOR-DISTRIBUTION SYSTEM:- This important PRECISION feature ELIMINATES INFLEXIBILITY OR OBSOLESCENCE due to multiple and changing basing terminations of new tubes and transistors.

3. LARGE, EASY-TO-READ, rugged, double-jeweled "PACE" Meter, accurately balanced and factory-calibrated to within 2%. 50 microamperes full scale sensitivity.

4. FACTORY-CALIBRATED ACCURACY of the tube and transistor test circuits is closely maintained by the use of individual calibrating controls, adjusted and sealed at the factory against laboratory standards, and through use of individual, 1% bridge-calibrated wire wound shunts.

5. TELEPHONE-CABLED PLASTIC INSULATED WIRING EMPLOYED THROUGHOUT, is highly resistant to moisture. Assures reliable performance even under highly humid conditions.

6. TEST CIRCUITS COMPLETELY TRANSFORMER ISOLATED FROM POWER LINE.

7. MICRO-LINE ADJUSTMENT, read directly on meter, provided by use of continuously variable, 50 watt line voltage control.

8. DEEP-ETCHED ENAMEL-FILLED SATIN ALUMINUM INSTRUMENT AND ROLLER CHART PANELS: Provide truly permanent legibility.

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FUNCTIONS OF PANEL COMPONENTS

(As they relate to TUBE TEST)

1. SWITCH "A":- Load and Voltage Selector - This switch (in positions 1 thru 8) selects the load and plate potential applicable to the particular tube under test. In addition, Switch "A" provides for variation of the basic meter sensitivity, allowing for standardized testing of diodes, low current types, and other special vacuum tubes.

2. SWITCH "B":- Filament Return Selector - Control "B" provides free-point filament terminal selection for all type tubes, regardless of filament base termination arrangement.

3. CONTROL "C":- Control-grid Voltage Potentiometer - Provides selected test input circuit potentials which are automatically applied to the control grid selected by the MASTER LEVER SYSTEM.

4. CONTROL "D":- Meter Sensitivity Potentiometer - A special-tolerance, tapered potentiometer enabling the setting of calibration limits for all tubes as noted on the tube test roller chart.

5. CONTROL "E":- Filament Voltage Selector - Provides a complete range of 17 filament operating potentials from .75 through 117 volts.

6. MASTER LEVER SWITCH (Master Element Selector) - This MASTER switch consists of 12 individual 5 position switches. Each switch is individually numbered from 1 through 12. Each number represents a tube element number as listed by Tube Manufacturers and the Electronic Industries Association. For example, consider the case of a screen grid tube type 6SJ7. The tube element numbering, as listed in standard tube manuals, is as follows:

Pin 1 - Envelope
Pin 2 - Heater
Pin 3 - Suppressor
Pin 4 - Control grid
Pin 5 - Cathode
Pin 6 - Screen grid
Pin 7 - Heater
Pin 8 - Plate

When, for example, a type 6SJ7 tube is inserted into its socket, pin 1 of the tube is automatically connected to Master lever 1; pin 2 to Master lever 2; pin 3 to Master lever 3; etc. (Each numbered lever, therefore, controls the application of its corresponding tube element into the appropriate tube test circuit.) It will be noted that each Master lever can be thrown into any one of 5 positions, indicated as: W, X, Y, Z and "Normal". Circuit identification of these positions are listed as follows:

Position "W" - Open position. Any lever thrown to the "W" position open-circuits its corresponding tube element.

Position "X" - Screen Grid position. In the case of the 6SJ7 example, element 6 is Screen Grid. Lever 6 therefore, becomes the Screen lever, and this lever is thrown to position "X".

Position "Y" - Plate circuit position. Element 8 of type 6SJ7 is a Plate. Lever 8 therefore, becomes the Plate lever and this lever is thrown to "Y" position.

Position "Z" - Grid circuit position. Element 4 of 6SJ7 is Control Grid. Lever 4 therefore, becomes the Grid lever and this lever is thrown to "Z" position.

Position "Normal" - Common termination to cathode and/or reference potential. All elements requiring a "normal" or cathode potential lever such as Suppressor grids, cathode, etc., are accordingly accommodated by leaving the corresponding levers in "Normal" position.

It is therefore seen that the complete lever setting for type 6SJ7 tube is simply set up as follows:

W	X	Y	Z
-	6	8	4

Only 3 levers in this example require actuation. All other levers are untouched and are left in the "NORMAL" position.

Although the connecting network of the MASTER LEVER SELECTOR appears complicated behind the instrument panel, its operation from the top of the panel is unusually simple and straightforward.

7. THE "LINE AND VR ADJUST" CONTROL - This control permits adjustment for the operating line voltage when the meter pointer is brought to the arrow-head center of the scale plate marked "LINE". This control is a heavy duty, continuously variable, wire wound potentiometer, assuring step-free, positive, micro-voltage adjustment.

8. THE PUSH BUTTON SYSTEM -(Buttons 1 through 12). These buttons, in conjunction with the dual sensitivity neon test circuit, permit rapid short and leakage check of all tube elements, merely by consecutively depressing buttons 1 through 12 and observing the neon lamp indications. Visible filament continuity tests are also provided by the push button system in conjunction with data listed under "Fil. Cont." on the roller chart.

9. "READ METER" BUTTON - This button (when held down) provides the meter reading for tube performance quality tests. When depressed, it also automatically releases any other buttons which may have previously been depressed.

10. "OFF" BUTTON - This button (when in the down or depressed position), shuts the instrument OFF. To turn the instrument ON, the "Read Meter" button is depressed, releasing the OFF button.

11. SOCKETS - This instrument incorporates the 7 and 8 pin sub-miniatures. Noval Button 9 pin, loctal, combination 7 prong, Button 7 pin, 6 prong, 5 prong and 4 prong sockets, and also a special 12 prong socket which provides a centralized terminal for direct access to all 12 tube testing circuits.

All tube analysis, ie: filament continuity, hot cathode leakage, hot neon short check, tube quality tests and ballast unit tests, are obtained from each of the test sockets, in accordance with the type of tube base involved.

12. "F" CONTROL - Sets Grid bias voltage for Gas tests.

13. "G" SWITCH - Sets Plate (and Screen) potentials for Gas tests. This switch should be returned to "OFF" position (position 12) as a precautionary measure after making test.

14. "GAS ONLY" BUTTON - After making tube short and quality checks, if gas is suspected, set "F" and "G" as indicated on roll chart and depress "GAS ONLY" button. This button will latch and stay depressed to allow time for build up of gas. After taking a Gas reading, depress the "Read Meter" button to release the "GAS ONLY" button.

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FUNCTIONS OF PANEL COMPONENTS

(As they relate to PICTURE TUBE TEST)

1. "A" SWITCH - "Pix Tubes" (position 9 of "A" Switch) selects the proper circuit for CRT picture tube tests.
2. "B" SWITCH selects the filament termination.
3. "E" SWITCH selects the filament voltage.
4. CONTROL "H" varies the basic meter sensitivity.
5. MASTER LEVER SWITCH allows selection of proper CRT terminals for application of required voltages.
6. PUSH-BUTTONS 1 through 12 check for shorts, leakage and filament continuity, in conjunction with neon indicator and "High-Standard" leakage sensitivity switch.
7. "READ METER" BUTTON provides picture tube quality check when depressed.

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FUNCTIONS OF PANEL COMPONENTS

(As they relate to VOLTAGE REGULATOR TUBE TESTS)

1. "A" SWITCH:- Positions 10 through 13 (marked "VR" on the panel) set up the proper test circuits and meter sensitivities for voltage regulator and voltage reference tubes.
2. "G" SWITCH:- Selects proper supply voltages.
3. "LINE AND VR ADJUST" CONTROL in conjunction with "G" Switch allows for variation of VR load current over its specified operating range.
4. MASTER LEVER SWITCH allows selection of proper VR tube terminals for application of required voltages.
5. "READ METER" BUTTON when depressed, allows reading of VR tube voltage or current depending on "A" Switch setting.

NOTE: No short tests are necessary for VR tubes.

FUNCTIONS OF PANEL COMPONENTS

(As they relate to CRYSTAL DIODE TESTS)

1. "A" SWITCH:- Positions 14 through 16 ("Df Cal", "Df Test" and "Dr Test") select the proper diode test circuits.
2. "D" CONTROL:- Selects meter sensitivity for "Df Cal" setting.
3. "E" CONTROL:- Selects required potentials for all diode test settings. (Normally has to be changed from previous setting for "Dr Test".)
4. "H" CONTROL:- Selects meter sensitivity for "Dr Test".
5. MASTER LEVER SWITCH selects proper diode terminal for application of required voltages.
6. "LINE AND VR ADJUST" CONTROL allows setting of diode forward current in "Df Cal" position. This control is reset for "Dr Test" to bring the meter pointer to the normal "Line Adjust" calibration.
7. "READ METER" BUTTON when depressed, allows test readings to be made.

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FUNCTIONS OF PANEL COMPONENTS

(As they relate to TRANSISTOR TESTS)

1. CONTROL "H":- Determines the meter sensitivity for Icbo readings.
2. SELECTOR SWITCH "A":- The "TRANSISTORS" position of this switch sets up the internal circuitry in preparation for transistor tests.
3. CONTROL "D":- Determines the meter sensitivity for Gain checks.
4. SWITCH "E":- Collector Voltage Selector for Icbo readings. Provides 17 predetermined values of Collector voltage from .5 volts DC to 160 volts DC.
5. "PNP" - "NPN" "TRANSISTOR TEST" SWITCH:- Provides sequential selection of Test Functions for all classes of transistors. Two Gain positions, labeled "G_1" and "G_2" are listed. "G_1" will be used on all Low Power transistors. "G_2" is used for Power types.
6. THE MASTER LEVER SYSTEM is the universal circuit selector for Transistors as well as for Tubes:-

   Levers thrown to position "W" open-circuit the corresponding transistor elements.

   Levers thrown to position "X" connect the corresponding transistor elements to the Collector Test circuits in the 10-60.

   Levers thrown to position "Y" connect the corresponding transistor elements to the Tetrode Test circuits in the 10-60.

   Levers thrown to position "Z" connect the corresponding transistor elements to the Base Test circuits in the 10-60.

   Levers thrown to position "Normal" connect the corresponding transistor elements to the Emitter Test circuits in the 10-60.
7. THE "READ METER" BUTTON is used to obtain Meter readings for all Transistor Tests.
8. THE "LINE AND VR ADJUST" CONTROL is used to Adjust for Line Voltage variations same as is done for Tube Test.

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INTRODUCTION TO TRANSISTOR TESTING

In order to more clearly acquaint the technician with the function of the Model 10-60 Transistor Tester, it may be helpful to review a few of the more pertinent characteristics of transistors and their relation to the operating equipment. The scope of this instruction manual prohibits a complete discussion of the principles of transistors. It must be assumed that the technician has familiarized himself with these basic principles through a study of technical literature such as listed in the bibliography on Page 32 of this instruction manual.

Because of the relative newness of the transistor field itself, a variety of test procedures and limits have thus far been advanced for field checking of transistors. One parameter however has been found to be superior to most others in the determination of transistor quality. This parameter labeled "Icbo" (to be discussed further on in this instruction manual) is a reliable indication of the original quality of the transistor in the manufacturing process and can be successfully used as a yardstick for determining deterioration of the transistor after it has been installed and used in commercial equipment. The reading to be taken on an "Icbo" test is usually in the order of microamperes and therefore requires a sensitive indicator in the test instrument. Many commercial transistor testers have been designed away from this important "Icbo" test because of this meter sensitivity problem and, as a result, rely upon other less revealing characteristics to determine transistor condition. The Model 10-60, therefore, is one of the few service type instruments which can be used in direct comparison with laboratory type transistor test equipment.

Transistor manufacturers have standardized a number of nomenclature symbols for the various characteristics of transistors: Explanations for several of these symbols are listed as follows:-

1. Icbo - This symbol indicates the current flowing between the Collector and Base with the Emitter open. See Fig. 2 , second illustration. It will be noticed therefore that the first two symbols after the "I" indicate the circuit in which the current is to be measured: the symbol missing in this particular example is the "E" (Emitter). The "O" at the end of the symbol indicates that the missing symbol ("E" in this case) is open-circuited for this particular type of test. In other words, if we had a case where the test required a measurement of current flowing between the Emitter and the Base, with the Collector open, the symbol would read "Iebo". In fact, "Iebo" is a characteristic used by the transistor manufacturer for some types of tests. (See pages 27 and 28).

2. Icbs - This function follows the same type of nomenclature as in the above example except that the missing element (Emitter in this case) is not open but is shorted to Base. The "S" in this case indicates a shorting of the missing element.

3. Beta - "Beta" is the description for Current Gain and is analogous to amplification factor in a receiving tube. Specifically it is defined as the Current Gain from Collector to Base with the output shorted and with a constant DC Collector Voltage. Beta can refer to either AC or DC Current Gain. DC signal is used in the Model 10-60. In the Model 10-60, Beta or Gain is indicated by first observing a reading of Emitter to Collector current with Base open; then obtaining a second reading with a predetermined value of current injected into the Base to produce an increased Collector current reading. The increase in Collector current will be an indication of the Gain or Beta of the transistor. Extensive tests have yielded results which show close correlation between AC and DC Beta readings under these conditions.

Other symbols may be encountered by the technician when reading technical literature. They would however follow the same pattern as described above.

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The schematic representation of a transistor is illustrated in Figure 1 , Page 9 . Figure 1 shows the relationship between the schematic representation and actual physical structure of the transistor. The two indium pellets which constitute the Emitter and Collector terminations of the transistor are spaced quite closely to each other and create diffused regions, separated only by an extremely thin wall of crystal material. It becomes obvious therefore that shorts may occur between Emitter and Collector: the "short" position of the transistor test facilities of the Model 10-60 is therefore the first important test. See Fig. 2 , "Short Test". A shorted or low resistance transistor should be rejected without further testing.

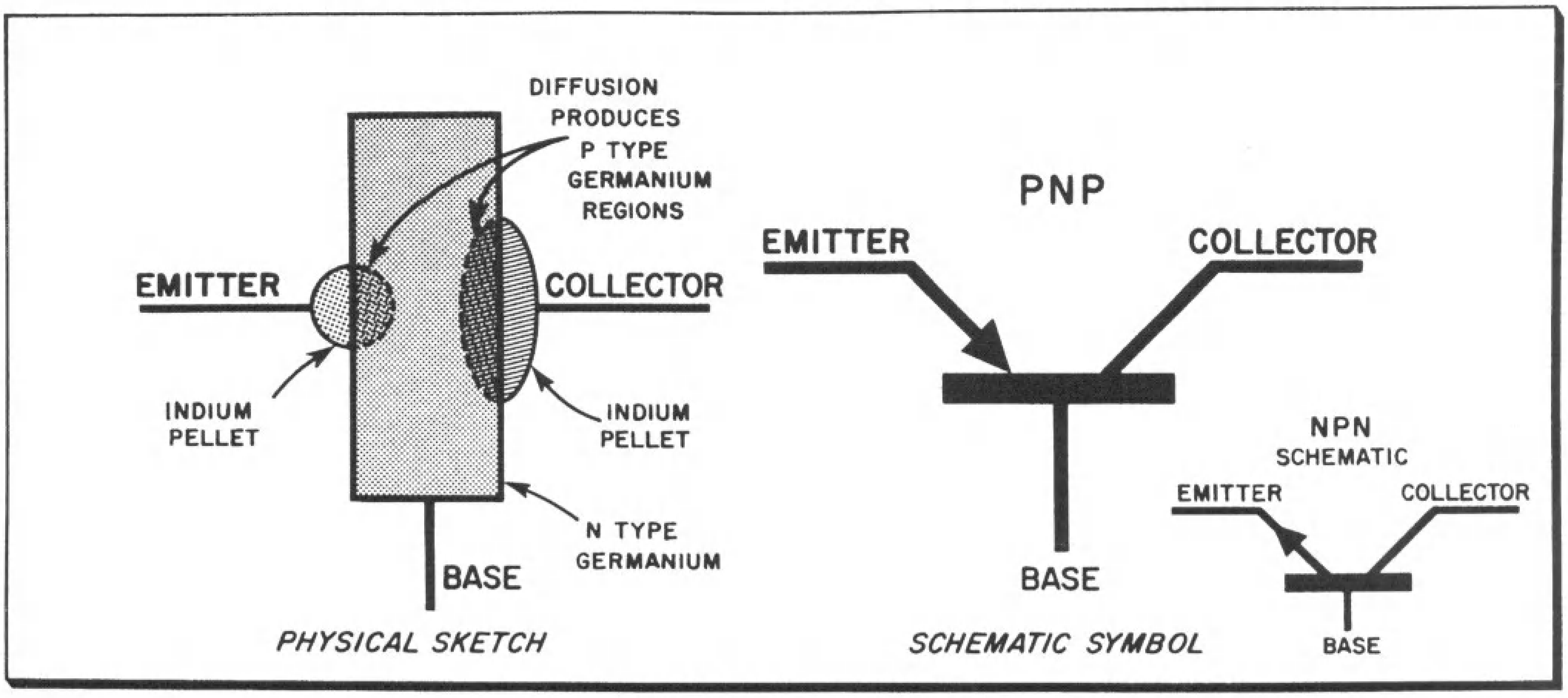

FIG. 1 DIFFUSED JUNCTION PNP TRANSISTOR

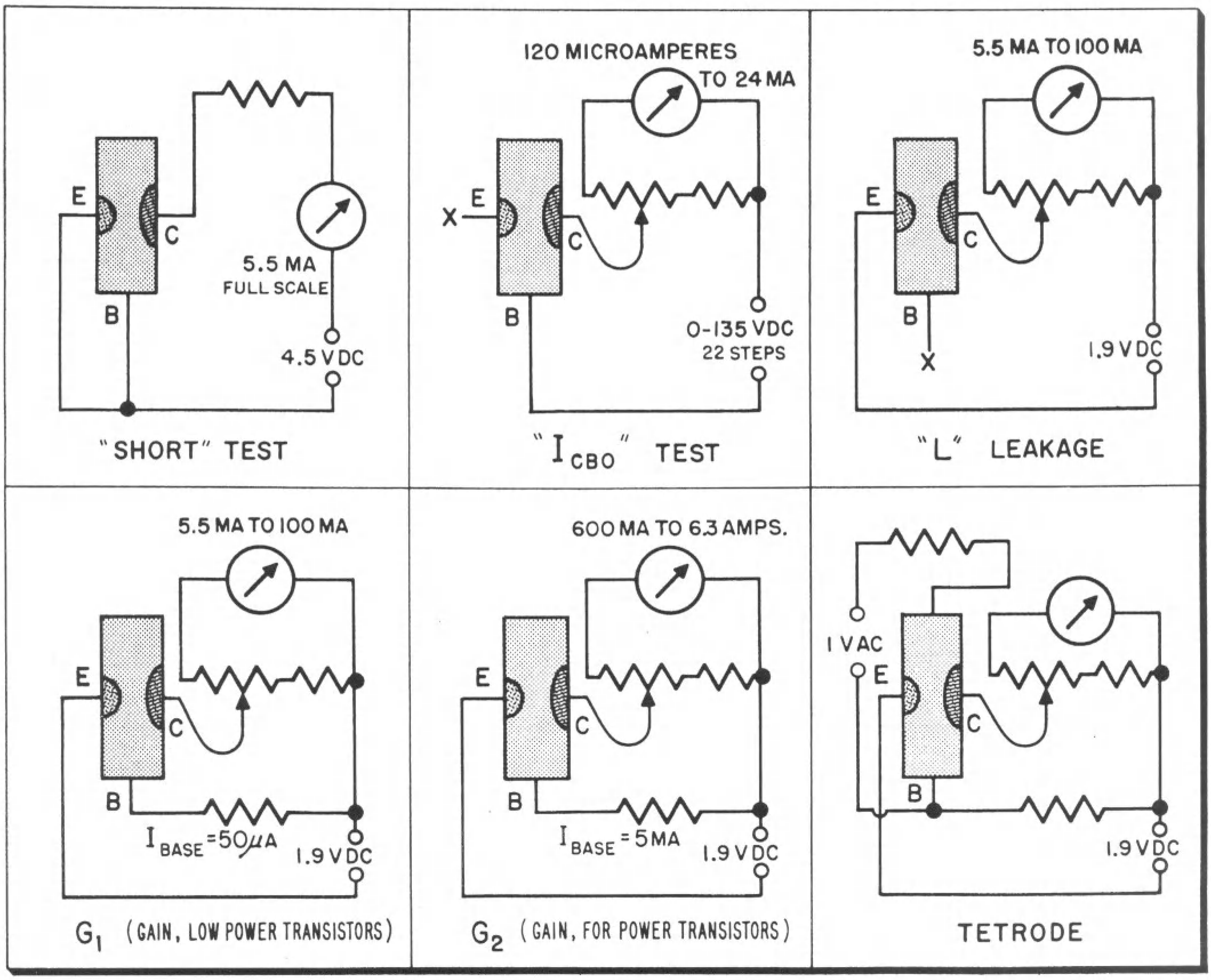

FIG. 2 BASIC CIRCUITS 10-60 TRANSISTOR TESTS

As noted previously, Icbo (Collector Cut-off Current), which is measured per Fig.2, second illustration, is the basic transistor test parameter, and is the second test performed on all transistors by the 10-60.

The third transistor test is designated as "L" or Leakage. The basic circuit for this leakage test is indicated in Fig. 2, third illustration, and provides a meter reading which is essentially the Icbo of the transistor multiplied by the Beta (Gain). Test position "L" on the "TRANSISTOR TEST" Switch sets up instrument for this Leakage test. This Leakage test in itself is of no special significance insofar as the condition of the transistor is concerned. IT MERELY SERVES AS AN INITIAL READING TO BE SUBTRACTED FROM THE NEXT TEST WHICH IS DESIGNATED ON THE PANEL AS "G_1" FOR "GAIN". SEE FIG. 2, FOURTH ILLUSTRATION.

These two positions, the "L" position and the "G_1" position, are therefore used to determine the Beta or Gain of a Low Power Transistor and is simply done on the 10-60 by subtraction of the "L" reading from the "G_1" reading to yield an actual Gain number. (G_1 position is used for Low Power Transistors: G_2 position is used for Power Transistors only.)

It is interesting to note that in the case of a transistor wherein the Icbo is normal (a low value) and the Beta is also normal, the Leakage reading will be quite small and, in many cases, negligible. For example, if a transistor has a Gain (Beta) of 50 and the Icbo is inherently quite low, multiplication of a very low Icbo times Beta of 50 will yield a very small Leakage number as compared to the second reading (Gain) and could almost be ignored. On the other hand, if the Icbo is quite high, the Leakage reading will become significant and should not be ignored in obtaining the Gain reading. It is good practice in the case of Low Power Transistors therefore to always perform the Leakage or "L" test and subtract it from the "G_1"or second reading in order to insure that an accurate Gain reading be obtained. The Leakage reading is not used in the case of POWER Transistors for reasons detailed further on in this manual.

Tetrode Transistors are similar in construction to the usual three terminal transistor with the exception that an additional base connection is made externally which serves the function of a Tetrode connection . In order to test for Tetrode action, it is merely necessary to perform the usual Icbo, Leakage, and Gain tests, and then, finally, apply a selected potential to the Tetrode connection to produce a potential difference between the Tetrode and Base of the transistor. This difference of potential will then cause the Gain reading to decrease. Therefore, Tetrodes will be treated in the same fashion as three terminal transistors with the exception of the additional test to indicate Tetrode operation.

ONE MAJOR DIFFERENCE BETWEEN RECEIVING TUBE TESTING AND TRANSISTOR TESTING LIES IN THE FACT THAT TRANSISTORS ARE TEMPERATURE SENSITIVE. A test performed upon a transistor at rated temperature (approximately 77° Fahrenheit) may yield noticeably different results as compared to the same test performed in direct sunlight, for example, at 95° Fahrenheit, or in a cold room at 40 to 50° Fahrenheit. The operator must therefore bear in mind that any unusual results obtained when testing transistors at temperatures which vary considerably from 77° Fahrenheit must be verified by repeating the test at room temperature. Sensitivity to temperature is such that different readings can be obtained if the operator holds the transistor in his fingertips while performing the test as compared to a test where the hand is removed from the transistor. These precautions regarding temperature are important when questionable current readings are obtained during transistor tests.

Transistors are classified as PNP or NPN type. The only difference, so far as testing of the transistor is concerned, between these two classes is the polarity of the applied test voltage and of the metering circuit. In other words, all tests on a PNP transistor are the same as would be performed on the NPN with the exception that "TRANSISTOR TEST" Selector of Model 10-60 applies test voltages of the correct polarity to the transistor. A PNP transistor will have a negative potential applied to its Collector: a NPN transistor will have a positive potential applied to its Collector.

The above basic principles of transistor testing apply to both Low Power (Audio and RF) and to Power transistors. The major difference between the operation and test of POWER transistors as compared to LOW POWER transistors is in the heavier current capabilities of the Power Transistor. In the case of Low Power Transistors, the Beta (Gain) measurement is obtained by injecting a predetermined current into the Base and obtaining a meter reading which will bear a relationship to the Gain of the transistor. In Low Power Transistors, if a current of 30 microamperes is injected into the Base, a reading of 3000 microamperes will be obtained if the Gain of the transistor is 100. However, in the case of Power Transistors, the Collector currents in operation will be of the order of 100 milliamperes or greater. It therefore becomes necessary to inject greater Base currents to obtain Collector currents of this order of magnitude. This requirement is met in the Model 10-60 by the use of a separate Gain Selector position on "TRANSISTOR TEST" Switch marked "G_2". All POWER transistors are therefore Gain checked not in position "G_1" but in position "G_2". Note that "L" or Leakage tests should not be made with POWER transistors. Results will be in error if "L" readings are subtracted from "G_2" readings due to the fact that "G_2" meter readings are not intended to relate to "L" readings.

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PICTURE TUBE TESTING

The Model 10-60 also includes complete facilities for BEAM CURRENT testing of PICTURE TUBES when used with PRECISION "Picture Tube Adapter Cable", a separate accessory cable available from your favorite distributor or directly from the Service Department of PRECISION APPARATUS COMPANY, INC. Beam Current checking differs from the usual type of picture tube Emission testing, by revealing the true brightness capability of the picture tube. The intensity or magnitude of Beam Current directly determines the degree of screen brightness and is therefore the most significant factor in the determination of tube **condition.** The PICTURE-PRODUCING BEAM itself originates from a relatively small area in the center of the cathode disc: the remainder of cathode area has little or no effect upon the cathode beam. It is therefore most important that the Emission capabilities of this central area of the cathode be examined and that the remainder of the cathode area be eliminated from the actual brightness check. See Fig. 3 below.

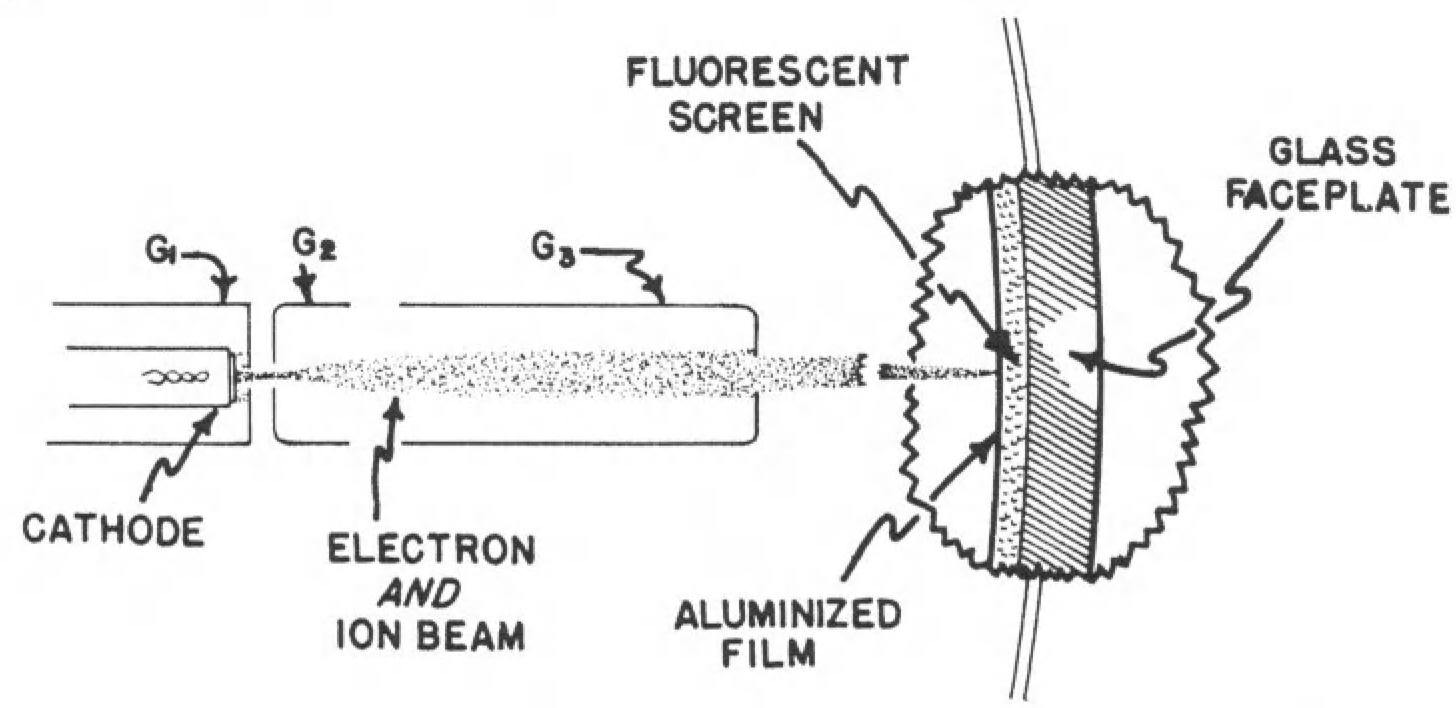

Fig. 3

This most important condition is satisfied only by a set of test conditions which will measure the magnitude of the true Beam Current. The high sensitivity meter of the Model 10-60 reads only that current which passes through the small aperture in Grid #1 of the picture tube (true Beam Current) as can be seen from Fig. 3 . The emissive capabilities of the remainder of the cathode do not contribute to the picture-producing beam and are therefore not included in the Beam Current reading. It becomes obvious therefore that the usual type of Emission check which reads Total Emission from the complete cathode disc would reveal little or nothing as regards the condition of the small central area of the cathode.

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CRYSTAL DIODE TESTS

Crystal Diodes are an important factor in modern TV and communication circuits. The most reliable accepted test for Crystal Diodes is a comparison with manufacturers' specifications on the basis of forward and reverse current at specified test voltages. The usual forward and reverse resistance check (using ohmmeter type circuits) are useful only in those cases where relatively large deterioration of the crystal has occurred. In the case of your Model 10-60, the forward and reverse current characteristics of the crystal can be correlated with manufacturers' specifications. The wide variety of DC test potentials available in the Model 10-60 (0 to 160V. D.C.) in 22 steps assures availability of test voltages exactly equal or closely similar to manufacturers' test voltages for reverse current.

OPERATING INSTRUCTIONS

TUBE TEST

1. With "OFF" button depressed, connect the line plug of the instrument to any 50-60 cycle 110-125 volt A. C. source.

2. By means of the "LEVER-RETURN" button on the right side of the MASTER LEVER DRUM, throw ALL levers to the "NORMAL" position.

3. Refer to the tube test roller chart windows for the tube type number to be tested and set CONTROLS "A", "B", "C", "D", "E" to positions designated for that tube.

   For simplicity in locating any tube type number, it will be helpful to note that all tubes are listed in strict numerical order beginning at the top of the left hand window opening, continuing downward to the end of the roller chart and thence to the top of the right hand window opening, etc.

4. PRESS (and then remove finger from) the "READ METER" button to turn instrument "ON". (It will be noted that the "OFF" button is thereby released to the up or "ON" position.) Then rotate the "LINE AND VR ADJUST" control knob to bring pointer of meter to the "Line" indication on the meter scale.

5. Insert tube to be tested into its respective socket and allow the tube to heat. Use black overhead cap when necessary except where use of Red cap is specifically indicated on the roller chart. Any deviation of the meter pointer from the "LINE" position (after tube has heated) should be corrected by rotating the "LINE AND VR ADJUST" knob to bring the meter pointer back to "Line" indication.

   (DO NOT ATTEMPT TO OBTAIN TUBE QUALITY METER INDICATION UNTIL AFTER SHORT TESTS ARE MADE, ELSE SERIOUS DAMAGE MAY RESULT TO INSTRUMENT.)

6. Next, proceed to Short and Leakage Tests (WITH ALL LEVERS IN THE "NORMAL" POSITION) as follows:

7. Press the numbered push buttons 1 through 12, in consecutive order. Watch the neon lamp "Tube Shorts" indicator for glow or continuous flicker. The tube under test should be LIGHTLY tapped during "Short" tests, to reveal loose elements which might become shorted under vibration.

   IMPORTANT: NEON LAMP SHOULD GLOW ONLY ON THOSE BUTTONS DESIGNATED ON TUBE CHART FOR FILAMENT CONTINUITY, ("FIL. CONT.") OR ON THOSE ADDITIONAL BUTTONS SPECIFICALLY NOTED ON THE ROLLER CHART.

   Inasmuch as the filament of the tube under test is disengaged when the "FIL. CONT." buttons (designated on the roller chart) are depressed, it is necessary that these buttons be immediately returned to normal "up" position (by depressing any other button) and thereby allowing the tube to remain in a heated condition for further test.

   THE TUBE UNDER TEST SHOULD BE REJECTED AS DEFECTIVE (OPEN FILAMENT) IF NEON LAMP FAILS TO GLOW WHEN THE DESIGNATED FILAMENT CONTINUITY BUTTONS ARE DEPRESSED.

   DISREGARD ANY MOMENTARY NEON LAMP FLASHES AS BUTTONS ARE DEPRESSED. These flashes are merely the discharge of the blocking condenser in the short check circuit.

   Inasmuch as the short check push button numbers directly coincide with socket prong numbers, it becomes apparent that the operator (for short check purposes) need only depress that quantity of buttons equal to the number of socket prongs involved. For example: If the tube under test inserts into the 4 prong socket, then only buttons 1 through 4 need be short-checked; if the tube inserts into the 5 prong socket, then buttons 1 through 5 are the only ones involved, etc. If a top grid cap is present, then add button #11 to the short check procedure.

8. A discernible neon lamp glow or continuous flicker, when any one of the numbered buttons "1 to 12" are depressed, (with the exception of the designated "FIL CONT" buttons) indicates an inter-electrode high resistance leakage or short and the tube should be rejected without further testing, (unless otherwise noted on the tube test roller chart). Inasmuch as these tests are made while the tube is in a heated condition, the tube should be allowed time to heat up sufficiently. In this manner, shorts or leakage that may occur due to expansion of internal elements can be more readily detected.

Because all tube elements connect to individually numbered push-buttons, there is no necessity to employ a separate cathode leakage button. Cathode leakage will be detected when the respective button , (corresponding to a particular tube's cathode), is depressed.

Push-buttons 1 through 12 are numbered in accordance with standard tube basing sequence. Should short indications be obtained on any one or more buttons, (for example on buttons 5, 6 and 8), then the tube elements, corresponding to tube pins No. 5, 6 and 8 are either internally shorted or are connected through low leakage paths to other elements of the tube.

The flexible element selection circuit of the Model 10-60 allows for either series or parallel connection of center-tapped filaments. In order to obtain uniformity of test settings and to minimize operating errors, all tubes with center-tapped filaments are tested in parallel connection. Should the neon lamp fail to glow when any one of the push buttons (listed on the roller chart under "Fil. Cont.") are depressed, (during filament continuity test), the tube should be discarded.

If, however, one section of a center-tapped filament be indicated to be open-circuited, and for some reason the operator does perform a Quality test, it will be found in many cases that a reading in the upper section of the red, "Replace" sector can be obtained. This is, of course, due to the parallel filament connection. The intact portion of the filament is still operating and causing a partial meter reading to be obtained. Such tubes should have been previously discarded as a result of the "Fil. Cont." test failure.

9. AFTER SHORT AND FILAMENT CONTINUITY CHECKS AND LINE ADJUSTMENTS HAVE BEEN ACCOMPLISHED, throw the levers indicated (on the roll chart) under "W-X-Y-Z" to the positions called for. All other levers MUST REMAIN IN "NORMAL" POSITION.

10. Then depress the "READ METER" button and obtain the (PERFORMANCE MERIT) Quality Indication.

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GAS TEST

NOTE: As a standard operating procedure, it is not necessary to check all types of tubes for gas. The operator should choose to make a gas test only on those tubes where the operating circuit will be affected by excessive gas currents. Tubes used in Low Power circuits are seldom subject to gas current problems. Gas data is therefore not listed for Low Power tubes such as are used in portable battery receivers, etc., inasmuch as experience has proven that trouble-producing gas is not developed in these Low Power tubes.

After the Quality test has been completed, any tube (other than diodes or rectifier types) may be checked for excessive gas content as follows:

1. With all Controls, Switches and Levers set up for Quality test, (unless otherwise instructed on Roller Chart) set "F" and "G" as indicated.

2. Depress the "Gas Only" button and note the meter reading on the 0-15 "Gas" scale directly below the Red portion of Tube Quality arc. If the gas reading is above the limit listed (see NOTE 1) reject the tube without further test. If the gas reading is below the limit, leave the "Gas Only" button depressed (button will stay down until released) and wait at least 2 minutes (see NOTE 2), then again note the meter reading. At the end of 2 minutes, if there has been no change in the meter reading, the tube can be assumed to be free of gas. If the meter reading has changed, observe the meter pointer to see if the gas reading continues to climb above the limit.

3. After completing the Gas test, set "G" Switch to "OFF" and depress "READ METER" button to release "Gas Only" button.

NOTE 1. Gas Limits.

Voltage Amplifier Tube Types:- 2 µa. Maximum
Power Amplifier Tube Types:- 5 µa. Maximum

The above limits are based on informal Industry standards. However the technician should bear in mind that these limits are general and may not apply to all situations. For example, if an Output tube (Power Amplifier type) in a receiver produces obvious distortion after warm-up, and the 10-60 detects 1 or 2 microamperes of gas, then the technician has obviously evolved a specific gas limit for that tube type when used in that particular type of circuit. The technician might further note, as a guide, that circuits involving high values of grid resistance will usually tolerate less gas current than will circuits where the grid resistance is low.

NOTE 2. Gas Build-Up.

The operator should note that troublesome gas will not be developed (and therefore not indicated on the meter) until at least a few minutes of gas bombardment has taken place within the tube. If a tube is suspected of being gassy, it is important that these few minutes be permitted for the Gas test inasmuch as this small expenditure of time may save considerable trouble-shooting time in the receiver or operating equipment itself.

It is of interest to note that the 10-60 Gas Test circuit will also detect two other possible sources of trouble at the same time:- grid emission and grid leakage. Grid emission is usually due to sputtering of cathode material onto the grid and may also take some time to build up. Grid leakage, on the other hand, will usually be indicated immediately by the Gas Test. Note that the same limits apply for the test regardless of the cause, since the effect will be the same.

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SPECIAL ROLLER CHART NOTATIONS FOR TUBE TESTS

By means of the flexible multi-channel circuit design of PRECISION "Electronamic" testers, three types of tests are performed upon standard and FM types of "eye" and alignment indicator tubes aside from the standard triode performance test.

Single Target Type. This type is typified by types 6E5 and 6G5: For example, a roller chart line for type 6E5 appears as follows:

TUBE	SECTION	A	B	C	D	E	Fil. Cont.	Lever W	Lever X	Lever Y	Lever Z
6E5	Eye	1	1	0	0	9		-	-	2-4	-

The following test procedure must be employed:

After performing the standard "short" test, set all Switches and Levers as indicated on the roller chart. Depress the "READ METER" button and observe the circular fluorescent screen which should illuminate completely.

Next, throw the FIRST of the two levers indicated under the "Y" setting (in this example, lever 2) TO THE "Z" POSITION.

A good tube will now exhibit the typical angular shadow. Return the same first lever to its original "Y" position and note closure of the shadow angle. DISREGARD METER INDICATIONS.

Double Target Type. (Twin electron ray indicator tubes) This type is typified by type 6AF6 and 6AD6: For example, a typical roller chart line for type 6AD6 appears as follows:

TUBE	SECTION	A	B	C	D	E	Fil. Cont.	Lever W	Lever X	Lever Y	Lever Z
6AD6	Eye	1	2	0	0	9	2-7	-	-	3-4-5	-

The following test procedure must be employed:

After performing the standard "short" test, set all Switches and Levers as indicated on the roller chart.

Depress "READ METER" button and observe the circular fluorescent screen which should illuminate completely.

Next, throw the FIRST of the three levers under the "Y" settings (in this example, lever 3) TO THE "Z" POSITION. A good tube will now exhibit a typical angular shadow.

Next, throw the SECOND of the three levers under the "Y" settings (in this example, lever 4) TO THE "Z" POSITION. The tube, if good, will exhibit another angular shadow opposite the position occupied by the first shadow.

FM/AM Eye Tubes (Tuning indicator tubes). This type of electron ray tube is typified by type 6AL7 and is tested simply and positively through virtue of the flexibility of the PRECISION ELECTRONAMIC MODEL 10-60.

Test procedure is as follows:

After performing the standard "short" test, set all Switches and Levers as indicated on the roller chart.

Depress the "READ METER" button and observe the two rectangular fluorescent patterns on the screen of the tube.

With the "READ METER" button depressed, throw the FIRST lever listed under the "Z" setting on the roller chart to "NORMAL" POSITION. One rectangular pattern should then become shorter in length; then return this lever back to its original "Z" position.

Next, throw the SECOND lever listed under the "Z" setting to "NORMAL" POSITION. The other rectangular pattern should then become shorter in length; then return this lever back to its original "Z" position.

Next, throw the THIRD lever listed under the "Z" setting to "NORMAL" POSITION. BOTH ends of the pattern (opposite to the ends noted in 3 and 4 above) should then slightly decrease in length. Observe these ends closely as the movement may be slight.

Special Rectifier Test (Types 7OA7 and 117N7)

Because of unusual internal connections (plate tied to one side of filament), the 7OA7 and 117N7 RECTIFIER sections require slightly special test procedures.

7OA7 - Rect. Section. Set all controls and levers in accordance with the roller chart. AFTER the tube has heated sufficiently, throw BOTH levers 2 and 7 rapidly to "W" position, then quickly depress the "READ METER" button. The first meter deflection obtained is the significant reading, inasmuch as the meter reading will quickly recede coincidental with cooling of the heater.

117N7 - Rect. Section. Set all controls in accordance with roller chart. ALL levers including levers 2, 6 and 7 must FIRST be in the "NORMAL" position. AFTER the tube has heated SUFFICIENTLY, throw lever 2 rapidly to "W" position AND lever 7 rapidly to "Y" position, then quickly depress the "READ METER" button. The first meter deflection obtained is the significant reading, inasmuch as the meter reading will quickly recede coincidental with cooling of the heater.

Special Short Indication Notes. Listings for several tubes on the roller chart bear notes indicating that certain tubes "Must show short" on one or more push button numbers in addition to the "Fil. Cont." buttons. For normal usage any tube which does NOT show short on the designated buttons should be considered a defective tube.

However, due to multiple terminations of elements in many modern tubes, certain of these tubes may be salvaged for specific applications wherein the exact circuit application is known. Two of these cases are noted below.

a) Tubes with the negative filament connection terminating in 2 base pins. Should one of the two base pin connections become open, the tube may be salvaged and the remaining pin may be used for negative filament termination only if the radio or electronic circuit will allow the use of that pin or BOTH.

b) Tubes with an element such as plate, grid, etc., terminating at two or more base pins. Again, if one terminating pin remains connected to the element, the tube may be salvaged if the electronic circuit will allow the use of that pin and does not require the use of the open-circuited base pin or BOTH.

Gas Type Rectifiers OY4, OZ3 and OZ4

When testing these gas rectifier types, it will be noted that the meter pointer will remain, for s short interval, in the REPLACE sector and then deflect rapidly into the GOOD sector. This condition is normal for a good gas rectifier. However, should the meter pointer remain constantly in the REPLACE sector (after the lapse of several seconds), then the gas rectifier should be rejected.

MULTI-SECTION TUBE TESTS

Full-wave rectifiers and other multi-section tubes such as double triodes, triode-diodes, pentode-diodes, duo-diodes, frequency converters, pentode-triodes and pentode-rectifiers, contain either a second plate, a second triode or other combination of sections. These tubes are designated on the tube chart wherein each of these sections is separately described and settings given.

Treat each of these sections as if testing individual tubes for the QUALITY test as outlined previously: Set controls and levers designated for each section. The circuit employed in this instrument permits testing of the individual sections of multi-section tubes and a complete test must be given these types, since any one poor section will hinder proper operation.

SUB-MINIATURE TUBE TESTS

The sub-miniature type of vacuum tube, (typified by types 1C8 and 2E31), employs closely-spaced flexible leads for element terminations in contrast to standard rigid pin basing. In addition, two bulb shapes are in production: The ROUND type with lead terminations arranged circularly, and the FLAT type with lead terminations arranged in one linear plane. The two sub-miniature sockets in the upper left hand area of the 10-60 panel provide facilities for connecting both of these types of tubes to the 10-60. The small rectangular sub-miniature socket on the 10-60 is keyed only by a small molded "nib" in the corner of the socket. The Flat type of tube which is to be plugged into this socket includes a small red dot at the base of the glass bulb which identifies that end of the tube which should be adjacent to the above mentioned "nib". See Fig. 4 below.

Many sub-miniature tubes are directly soldered into operating circuits with leads cut to varying lengths. When these tubes are removed from the circuit, it is usually difficult to insert their leads into the panel-mounted sockets of the 10-60. Considering this condition, PRECISION engineers offer a simple but FLEXIBLE AND UNIVERSAL sub-miniature tube test adapter unit with flexible leads and positive contact clips. This adapter unit permits positive connection of sub-miniature tubes with maximum facility regardless of lead length variations, and with a minimum possibility of inter-lead shorting. See Fig. 5.

This adapter, PRECISION No. G-110, is available as an optional accessory, and can be obtained directly from your distributor or the factory, at nominal cost.

The Flat type of tube is keyed by a red dot at one corner. The leads read from the right to the left, with lead #1 nearest the red dot. The socket is keyed by a dot (or nib) on the top surface of the socket. The socket contact nearest this nib is Contact #1. See Fig. 4 below.

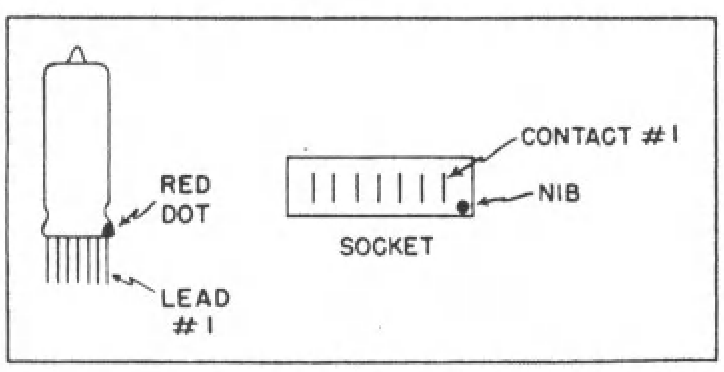

Fig. 4

ADAPTER G-110

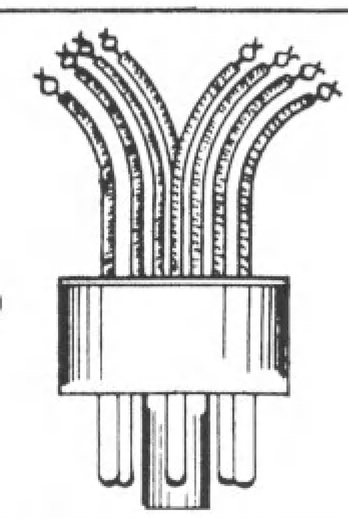

Fig. 5

TUBE BRAND VARIATIONS

In determining the tube test limits for this instrument, PRECISION engineers, in cooperation with the engineering divisions of leading tube manufacturers, have spent considerable time checking thousands of tubes from the production runs of leading tube manufacturers. From the information so gathered, the data on the roller chart, accompanying this instrument, has been compiled.

Inasmuch as extensive and intensive research is constantly being made in the radio tube industry to improve and stabilize the electrical and mechanical construction of tubes, it is not uncommon for a tube manufacturer to make a change in a particular tube's specifications. This change, though not necessarily readily noticeable in radio set performance, may nevertheless be made to improve tube stability and life. This change or variation may, however, indicate itself on the PRECISION ELECTRONAMIC Model 10-60 and necessitate a new test limit for that particular type number.

Therefore, should a particular type number be found to vary consistently from the assigned average roller chart limits, merely redetermine the new CONTROL "D" average setting required to pass these tubes at approximately 82 (on 120 scale) of the green GOOD sector, and record same for future reference with respect to that manufacturer.

It can readily be seen that a consistently low or high reading for any particular tube type of a definite manufacturer is not to be taken as indicative of a poorer or better run of tubes, nor as a defect in the tube tester.

PILOT LAMP TESTS

The miniature base socket, located in the center of the combination seven prong tube socket, accommodates all miniature screw and bayonet base type pilot lamps, Christmas tree bulbs, etc. Test procedure is as follows:

a) Select proper filament voltage by setting CONTROL "E" to the applicable voltage:

VOLTS	POS.	VOLTS	POS.	VOLTS	POS.
.75	1	5.0	8	18.5	16
1.5	2	6.3	9	21	17
2.0	3	7.5	10	25	18
2.5	4	8.4	11	30	19
3.3	5	10	12	50	20
4.2	6	12.6	13	70	21
4.7	7	15.0	14	110	22
		16.8	15		

b) Set CONTROL "B" to position 1; turn instrument "ON"; adjust for "LINE"; insert bulb.
NOTE: ALL LEVER SWITCHES MUST BE IN "NORMAL" POSITION.

* * * * * * *

BALLAST TESTING

The neon short check circuit, in conjunction with the numbered Push-Button system provides a simple and positive method for obtaining the following ballast tests:

1. Point to point continuity test of each section of single unit as well as multiple section ballasts.
2. Tests for loose elements.
3. Tests for leakage between sections of multi-element ballasts.

NOTE: Frequently, one may encounter privately numbered ballast tubes, whose numbers have no relationship to the standard EIA Ballast Coding System. A uniform method of ballast resistor test can only be devised on the basis of some type of system. The PRECISION ballast test data, which follows, is related to the Standard EIA Code. Therefore, privately numbered ballasts should be referred to ballast manufacturer's replacement manuals for identification of this ballast in terms of the Standard EIA Code.

BALLAST RESISTOR CODE

A sample and interpretation of the code appearing on standard octal type and replacement type ballasts are as follows:

(EIA STANDARD OCTAL TYPE) BK49AG
REPLACEMENT TYPE) BKX55AG

The first letter "B" on both types, if used, indicates ballast action.
The letter "K", "L" or "M" on both types, indicates type of pilot lamp.
The letter "X", "Y" or "Z", immediately following the pilot lamp designation, denotes a particular SERIES of base wiring and appears only on replacement type ballasts.
The numerals "49" or "55", appearing on the respective types, indicate the total voltage drop produced by the ballast resistor including the pilot lamp.
The letter "A" or B-C-D-E-F-G-H-J, appearing on both types (and immediately following the voltage drop numerals0 designates the particular BASE WIRING circuit used.
The letter "G" following the base wiring circuit designation on both types, if used, merely indicates octal base glass unit, and is of no importance as far as testing is concerned.
The letter "J", following the base wiring designation such as K55CJ, refers to an internal jumper between pins 3 and 4. (See TEST PROCEDURE)
Where the letter "P" or "PR" appears after the base wiring designation, such as K55CP or K55CPR, this indicates an additional resistor section is employed for the rectifier plate circuit. (See TEST PROCEDURE)

FOR STANDARD EIA OCTAL TYPE BALLASTS, THE BASE WIRING DESIGNATION (A-B-C-D-E-F-G-H-J) IS THE ONLY INFORMATION NECESSARY FOR TEST PURPOSES.

FOR REPLACEMENT TYPE BALLASTS, THE X, Y OR Z SERIES AND BASE WIRING DESIGNATION IS THE INFORMATION NECESSARY FOR THE TESTING OF THESE TYPES.

BALLAST TEST PROCEDURE

The OCTAL SOCKET is used to accommodate all octal base type ballasts.

1. ALL CONTROLS AND LEVERS MUST BE IN THE FOLLOWING DESIGNATED POSITIONS BEFORE ANY ATTEMPT IS MADE TO TEST BALLAST UNITS:

   Set CONTROL "A" to #1 position
   Set CONTROL "B" to #12 position
   Set CONTROL "C" to 0 position
   Set CONTROL "D" to 0 position
   Set CONTROL "E" to #24 position
   Throw all levers to "NORMAL" position

2. Turn instrument "ON" and adjust for "LINE" indication on meter. Insert the Ballast.

3. Classify the ballast unit to be tested according to its EIA BASE WIRING. The push buttons then to be depressed (one at a time), will correspond with the numbers designated on the appropriate schematic in Fig. 6 on following page.

   For example, Ballast type BK86A is an "A" type base wired unit. It is checked by referring to diagram "A" of Fig. 6 , which reveals that button 3, then button 7 must be depressed. Neon lamp should glow as each of these 2 buttons is depressed. (Should the ballast incorporate a jumper (for example from pin 3 to pin 4 as for ballast designation BK86AJ), neon glow must also be obtained when button 4 is depressed.

   CAUTION: NEVER DEPRESS "READ METER" BUTTON DURING BALLAST TESTS.

4. A continuous neon lamp glow, after each numbered push-button (called for) is depressed, indicates that the section is not open-circuited. An open section (anywhere in the chain) will cause the neon lamp to extinguish when that section's numbered button is depressed.

   It is advisable to tap the ballast units while each push-button (called for) is being depressed. In this manner, loose elements can be ascertained by noticing flickering instead of continuous glow of the neon lamp.

   NOTE: Where letter "P" or "PR" follows the base wiring designation, such as BK86AP or BK86APR, then it is also necessary to depress button 5, in addition to the buttons required for the base wiring code "A".

BALLAST LEAKAGE TESTS

Tests for leakage between sections of multi-section ballast units having BASE WIRING designations "F", "G", "H", or "I" are accomplished by depressing BOTH buttons 2 and 3 (simultaneously), with all other push-buttons remaining in the "UP" position. A neon lamp glow will indicate leakage or short between the two independent sections, and the ballast should be rejected as defective.

If any special ballast resistors are encountered (which cannot be identified with any standard basing), then determine the internal wiring and proceed as outlined for all ballast continuity checks.

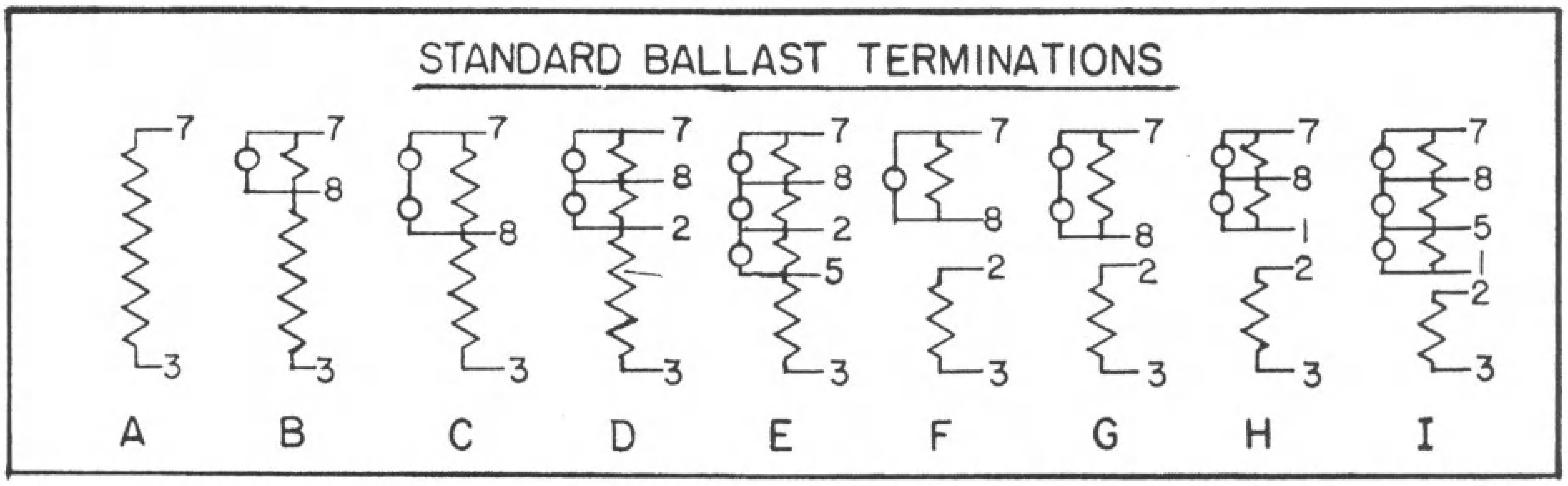

Fig. 6

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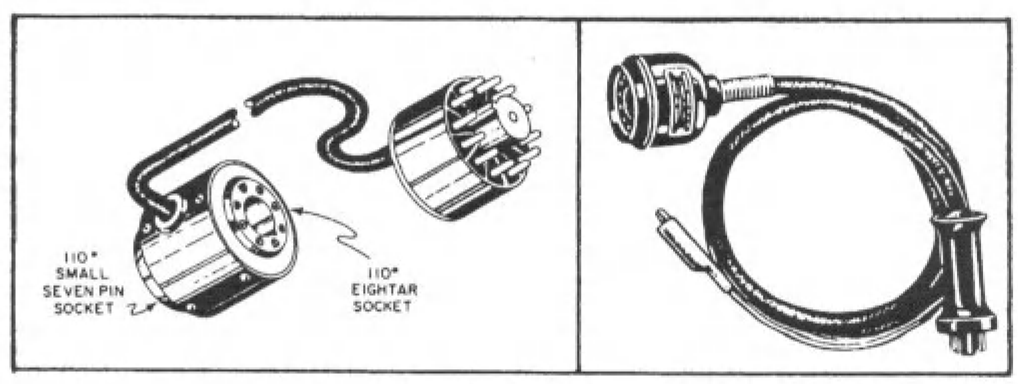
OPERATING INSTRUCTIONS

PICTURE TUBE BEAM CURRENT TESTS

Beam Current Tests using Model 10-60 require the use of an Adapter Cable to connect the Picture tube to the octal socket of the Tester. Use PRECISION Model PTA Adapter Cable. For 110° picture tubes, Model PAA Adapter Cable is required in addition to PTA Cable. Both are available at your favorite distributor.



1. Set "H" to 0, "A" to "PIX TUBES", "B" to 1 and "E" to 9.

   (NOTE: The above settings are for 90° tubes. See PAA instructions for 110° types.)

2. Connect the Duodecal end of the PTA Cable to the picture tube base and plug the other end of the PTA Cable into the octal socket of the 10-60. Connect the alligator clip of the PTA to the HV anode of the Picture tube. Make sure that there is no High Voltage on the Picture Tube HV Anode before touching the tube.
3. Release "OFF" "ON" button of the 10-60 and set the "LINE AND VR ADJUST" Control.
4. Perform "SHORT" test by pressing Push Buttons 2, 4, 5, 6 and 7 INDIVIDUALLY. Neon Lamp should NOT glow as each button is pressed. (Ignore quick neon flashes as the buttons are pressed. Steady neon glow is an indication of Shorts.) If the filament is OK, then neon glow should be obtained and buttons 1 and 8 are depressed.
5. If the Picture Tube passes the "SHORT" Test, throw Lever 6 to "Y" position, press the "READ METER" button, and slowly turn the "H" Control from its "0" position up to #20.

   Control "H" functions as a meter sensitivity control for Picture Tube Tests. With this Control set to Zero, it affords maximum shunt protection for the meter. Therefore this procedure for use of the "H" Control helps to protect the meter in those cases wherein gas or unusually high Beam Current may be encountered.

6. If the meter pointer approaches Full scale before #20 on the "H" Control is reached, stop the test and consider that an off-scale reading was obtained. Otherwise, with "H" Control set to #20, read picture tube Quality on the lower 3 colored arc.

SEE NEXT PAGE FOR DESCRIPTION OF BEAM CURRENT LIMITS:-

USE THE FOLLOWING NOTES AS A GUIDE TO PICTURE-TUBE-TEST METER READINGS:-

NEW Magnetic CR tube production limits for Beam Current, as set up by CR tube manufacturers, are relatively wide range, and as a result, produce 10-60 readings between approximately 65 to 120 on the 0-120 meter scale. All NEW tubes which read above approximately 65 can be considered to be of equal merit irrespective of differences in numerical readings. High Beam Current tubes usually level off at lower values after a few hours of usage.

NEW, unused CR tubes which read below approximately 50 can be immediately suspected to be defective in manufacture and can be dealt with accordingly.

Most CR tubes which have been subjected to considerable use in the field, produce a Beam Current reading below approximately 65 on the meter scale as a result of gradual cathode deterioration.

It is important to note, however, that USED CR tubes which produce readings above approximately 95 up to higher than full scale can be suspected as gassy tubes.

USED tubes which read in the range from approximately 65 on the meter scale down to 25, can be considered quite satisfactory for continued use, with the following qualification: Within the range between approximately 45 down to 25, USED picture tubes will exhibit sufficient overall brilliance for general continued usage. However, the intensity of the peak whites (or bright scene highlights) begins to reduce in brightness below 45 on the scale. Whether or not this reduction of peak white intensity is to be of concern in any one particular case, depends wholly upon the reaction or degree of observation of any particular TV set owner. Experience indicates that the average TV set owner will, in many cases, find this degree of peak white intensity reduction quite tolerable should he even be aware of the condition, particularly when weighed against the alternative of replacing a tube which exhibits satisfactory overall brightness. The use (by some TV set owners) of various kinds of filters would tend to substantiate the wide latitude of peak whites they accept as desirable.

The next portion of the meter scale to be considered is yellow sector (15 to 25 on the 0-120 scale). As the meter reading progresses from 25 down to 15, it will be noticed that the meter pointer gradually passes from a predominantly Green area into a Yellow area. Analysis of USED tubes falling into this "Dim to Bright" sector will depend, in most instances, (in the case of picture tubes) upon the attitude of the particular TV set owner. In general, it may be stated that USED tubes falling into the upper half of the yellow sector can be considered "useable" tubes, in those cases where the set owner is not particularly discriminating and is willing to tolerate reduced overall brilliance and loss of highlights.

USED tubes falling into the lower half of the yellow sector can generally be classified as low limit tubes suitable for rejection except in those rare individual cases wherein set owners are willing to tolerate low brilliance and loss of highlights for an additional period of time.

IMPORTANT NOTE: It should be remembered that there is no hard and fast all-inclusive rule for interpretation of the yellow sector readings: The above interpretation of this sector is offered only as a general guide in those cases wherein a definite opinion of the individual set owner is not forthcoming.

The RED sector is a definite reject area: USED or NEW Picture tubes which fall into this sector are definite rejects.

* * * * * * *

OPERATING INSTRUCTIONS

VOLTAGE REGULATOR TUBES

NOTE: Test Data for Voltage Regulator Tubes is listed in the "TEST DATA" book supplied with your 10-60.

1. Set Switches "A" and "G" as indicated in the Test Data. (Set "A" Switch to Voltage position first.)
2. Set "LINE AND VR ADJUST" Control to extreme counter-clockwise position.
3. Set Levers as indicated.
4. Insert tube in socket.
5. Depress "READ METER" button and observe tube to make sure that it has not fired. (A violet glow due to ionization of gas can be seen when the VR tube fires.) If the VR tube has fired, set the "G" Switch to the next lower number.
6. With "READ METER" button depressed, observe voltage on appropriate voltage scale corresponding to "A" Switch position (250V or 150V), and rotate "LINE AND VR ADJUST" Control until tube fires. As a rule, it is sufficient to watch the meter indication only. It will be observed that the voltage will keep increasing until the tube fires. Then the meter pointer will drop back down slightly. At this point, look carefully at the tube and the characteristic ionization glow should be seen although it should be fairly faint. Make a note of the firing voltage (highest voltage obtained just before the tube fires), to see that it corresponds to the limit indicated for this tube type.
7. Release the "READ METER" button and set the "A" Switch to the current indicating position associated with the VR voltage range used in Step 6. (50Ma. if VR 250V range is used, or 15Ma. if VR 150V range is used).
8. Depress the "READ METER" button and observe the current indication on the appropriate VR current scale. With the button depressed rotate the "LINE AND VR ADJUST" Control until the lower current operating range for the tube is reached. Keep the "READ METER" button depressed.
9. Leave all settings unchanged except reset the "A" Switch to the previous VR voltage range used, and note the voltage. Release button.
10. Reset the "A" Switch to the current position. Depress button and rotate "LINE AND VR ADJUST" Control clockwise until the upper current operating range for the tube is reached. In some cases in may be necessary to reset the "G" Switch to the next higher position* to reach the upper current range. In that case, first rotate the "LINE AND VR ADJUST" Control to the extreme counter-clockwise position before resetting the "G" Switch to the next higher position. When the upper current operating limit for tube is reached, release the "READ METER" button.

   *NOTE: Position 10 is an unused position. If voltage in position 9 of "G" Switch is not sufficient, skip to position 11.

11. Leave all settings unchanged except reset the "A" Switch to the previous VR voltage range. Depress the "READ METER" button and note the voltage. The difference in voltage between Steps 11 and 9 indicates the voltage regulation of the tube over its current operating range. The regulation for the tube being measured should be equal to or less than the value indicated for that tube type for a good tube. The actual values of the voltages noted in Steps 9 and 11 are operating voltages. These actual voltages should be between the extremes of operating voltage indicated on the test data.
12. Reset "G" Switch to "OFF" position (position 12).

* * * * * * *

OPERATING INSTRUCTIONS

DIODE TESTS

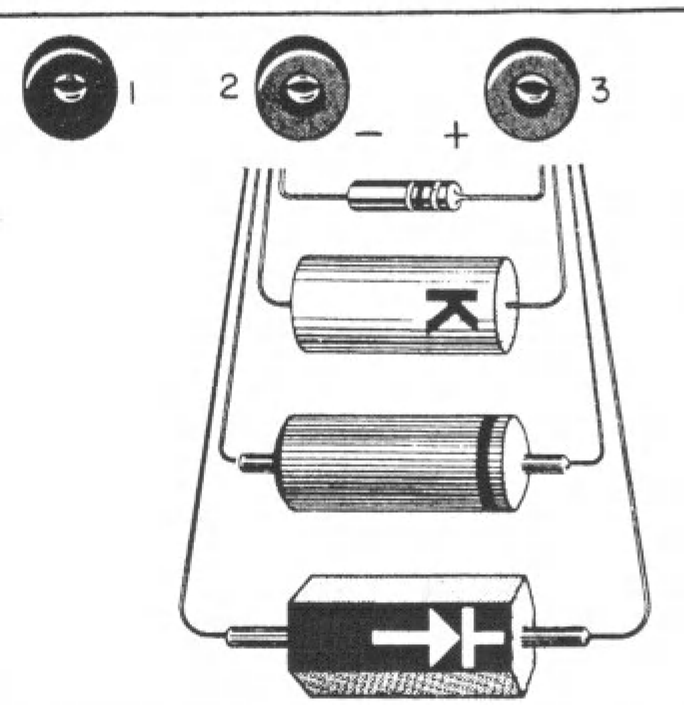
1. Set "A" Switch to "Df Cal" position.
2. Set Lever #2 to Row "Z".
3. Set "D" and "E" Controls as indicated under "Df (Forward Current)" for diode type.
4. Rotate "LINE AND VR ADJUST" Control to extreme counter-clockwise position.
5. Insert diode between pin jacks 2 and 3. Positive (cathode) side of diode connects to 3, negative (anode) side of diode to 2. Use adapter cable, if necessary. See Fig. 6 for common methods of diode polarity identification. (Note that diode can actually be connected between any socket pins 2 and 3 as long as proper polarity is observed.)
6. Depress "READ METER" button and observe meter reading on "Transistors and Crystal Diodes" arc. (If meter reads higher than figure indicated under "Df Cal" setting in diode test data, set "E" Switch to next lower position.) With button depressed, rotate "LINE AND VR ADJUST" Control until meter reads value indicated for "Df Cal" position. If indicated meter reading cannot be reached, rotate "LINE AND VR ADJUST" Control back to extreme counter-clockwise position and set "E" Switch to next higher position. Do not set "E" Switch more than 1 position higher than indicated in test data in any case. Now again, rotate "LINE AND VR ADJUST" Control clockwise with "READ METER" button depressed. If indicated meter reading still cannot be reached, then diode is either open, or it has been inserted with the wrong polarity (provided all other settings are correct as per instructions). If the user is uncertain of diode polarity, the diode connections may be reversed and the "Df Cal" procedure begun again. If the desired meter indication still cannot be obtained, then the diode must be presumed to be open-circuited or nearly open. Reject open diodes without further test.
7. When the indicated meter reading for "Df Cal" has been obtained, release the "READ METER" button. Leave all settings unchanged except set the "A" Switch to "Df Test" position and then depress the "READ METER" button. For a good diode, the meter reading should be equal to or less than the reading shown under "Df Test" for that diode type. If the meter reading is higher, reject the diode without further testing. If the meter reading is 0 or close to 0, see the paragraph under 9 below.
8. Release the "READ METER" button. Set the "A" Switch to "Dr Test". Rotate the "LINE AND VR ADJUST" Control until the meter pointer coincides with the "LINE" calibration on the scaleplate.
9. Set "H" and "E" Controls as indicated for "Dr Test". Leave all other settings as is.

   If a reading close to 0 was obtained under "Df Test", set "H" Control to 0. ("E" Control is still set as indicated for "Dr Test") Now depress "READ METER" button and rotate "H" Control slowly up to indicated setting. If the meter reads higher than that noted under "Dr Test" before the proper "H" setting is reached, reject the diode. This precaution protects against shorted or partially shorted diodes.
10. Depress "READ METER" button and note reading on "Transistors and Crystal Diodes" arc. For a good diode, reading should be equal to or less than that indicated under "Dr Test" for that diode type.

    NOTE: Diode reverse test readings are sensitive to temperature. Readings indicated under "Dr Test" are based on a room temperature of approximately 75° F. Diode reverse readings can double for a temperature increase of approximately 20° F (room temperature about 95° F) or halve for a temperature decrease of 20° F (room temperature about 55° F) from this 75° F reference. This temperature factor should be taken into account in evaluating the results of "Dr Test" readings which are close to the specified maximum.

FIG. 6

DIODE POLARITY IDENTIFICATION



OPERATING INSTRUCTIONS

TRANSISTOR TESTS

TRANSISTORS ARE TEMPERATURE SENSITIVE. When making the Icbo test on Transistors, the operator should remember that all limits are based on an ambient temperature of 77° Fahrenheit (25° C). Icbo readings can double for an 18° F increase in temperature and will conversely read approximately one half of the 77° F reading for an 18° F reduction in temperature. If the Icbo reading is quite low to start with, then the operator need not be especially concerned with temperature. However, if readings close to the value listed under "Max" on the roller chart are obtained, the operator should check the room temperature before judging the transistor. Do not hold the transistor in the fingertips while performing the Icbo test inasmuch as the heat from the fingers may affect the reading.

NOTE: It is important (especially for transistor tests) that the meter be checked for an accurate mechanical zero adjustment. To do this, set the instrument in the position in which it will be used (horizontal, vertical, or at an angle). With the Power off, rotate the meter's bakelite zero adjuster with the proper sized screw driver till the meter pointer is aligned with the "0" calibration on the 0-120 meter scale.

A. LOW POWER TRANSISTORS (Audio, RF, Computer, etc.)

1. Set Switch "A" to "TRANSISTORS"

2. From the Transistor Roller Chart Data, set:-

   Control "H"
   Control "D"
   Switch "E"
   Indicated Levers

3. From the Roller Chart determine whether the Transistor is "PNP" type or "NPN" type and set the PNP-NPN "Transistor Test" switch to the "Short" position accordingly.

4. Release the "OFF"/"ON" push button (by pushing the "READ METER" button at the right hand end of the row of push button switches) and set the "LINE AND VR ADJUST" Control so that the meter pointer lines up with the "LINE" indication.

5. Refer to the Transistor Illustrations at the end of this manual to identify the terminals of the transistor and insert the transistor into the appropriate socket. If it is not convenient to use any one of three panel sockets, plug the 3 lead Adapter into the 3 panel-mounted pin jacks and connect the transistor leads to the alligator clips of the Adapter. The small alligator lead just above the #1 tip jack is used for transistor terminations and is designated as #4.

SEE NEXT PAGE FOR
TYPICAL TRANSISTOR CONNECTIONS

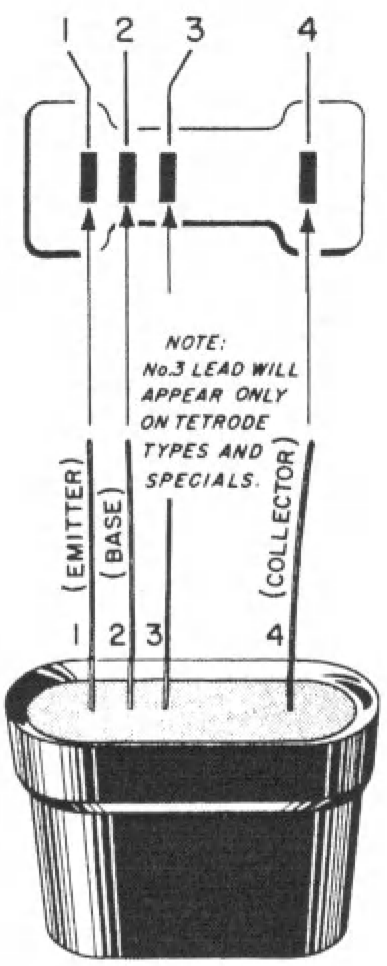
6. Depress the "READ METER" button and read the 0-120 Transistor Scale for "Short Test" as listed under "Shorts" on the Roller Chart. (A full scale reading indicates a direct short). If the transistor does not pass the Short Test, no further tests should be performed inasmuch as a shorted transistor can cause excessive Meter current to flow in subsequent tests.

7. Rotate the "TRANSISTOR TEST" Switch to "Icbo", depress the "READ METER" button and read Icbo in accord with the Data. (Icbo for GOOD transistors will read between Zero and the "MAXIMUM" reading listed on the Roller Chart).

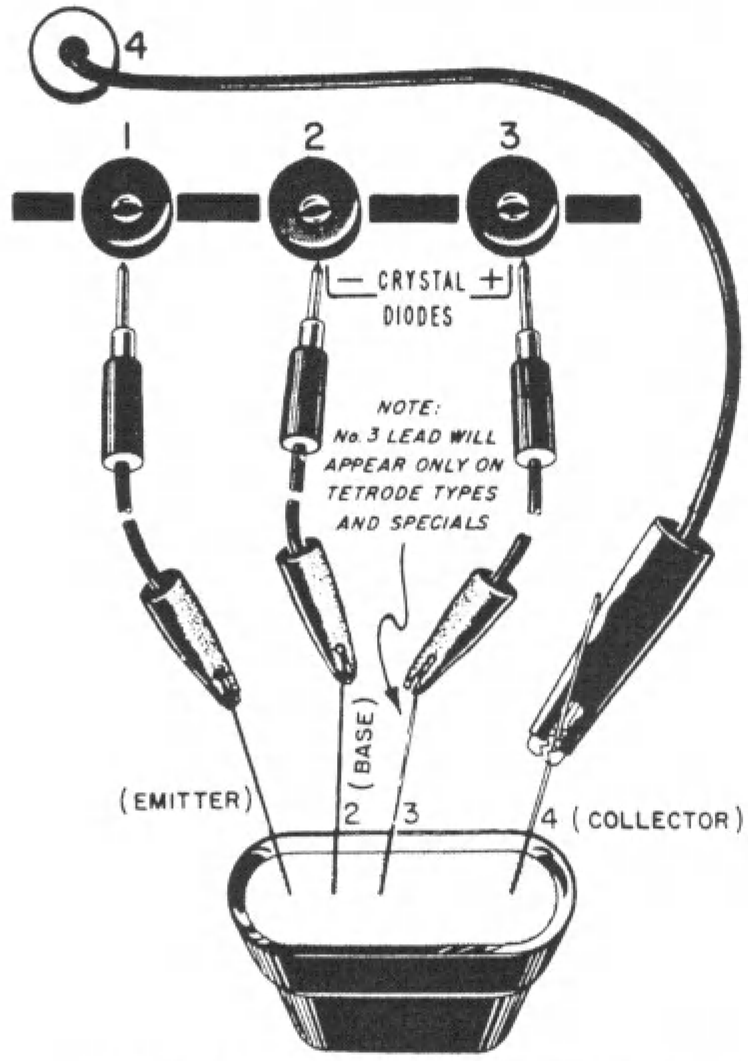
   NOTE: In some cases the Icbo reading may increase as the button is held down. If the Icbo reading doubles in a period of 10 seconds, the transistor should be rejected. If the Icbo reading is within limits and goes down with time, it is of course good.

CONNECTION OF TYPICAL TRANSISTOR TYPES TO THE SOCKETS AND FLEXIBLE ALLIGATOR LEADS OF MODEL 10-60

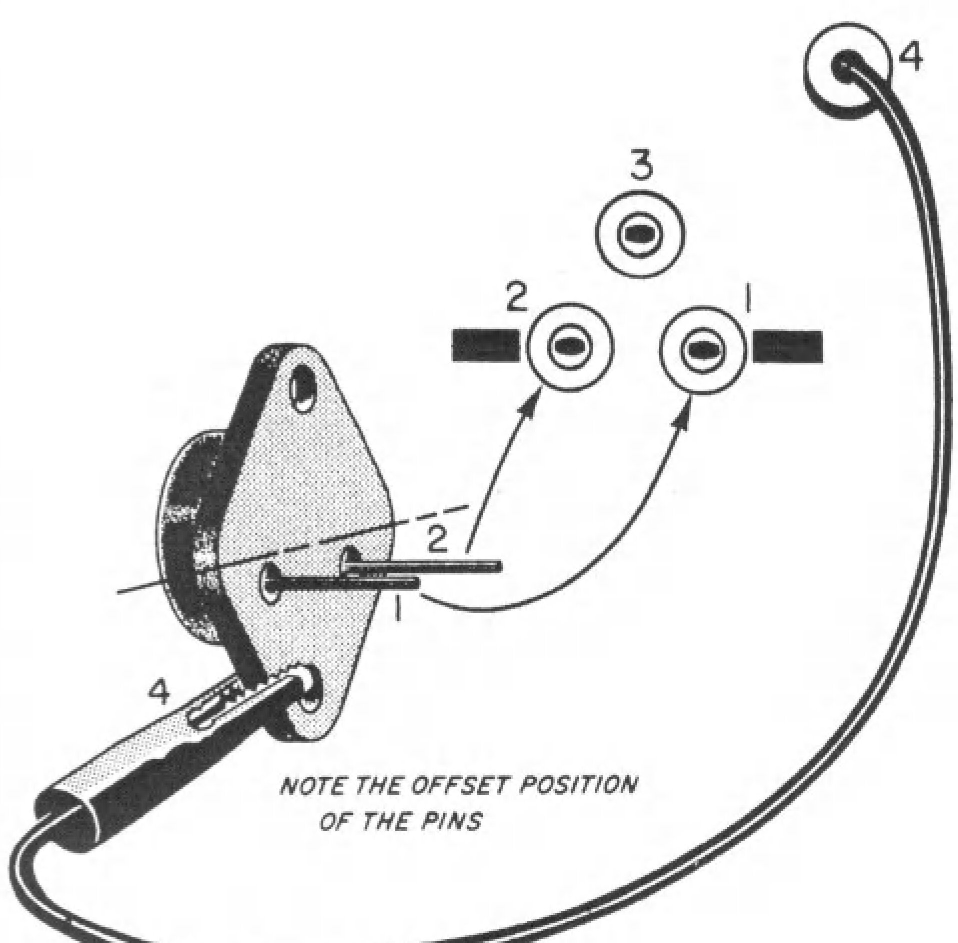
(SEE PAGES AT THE REAR OF THIS MANUAL FOR COMPLETE ILLUSTRATION)



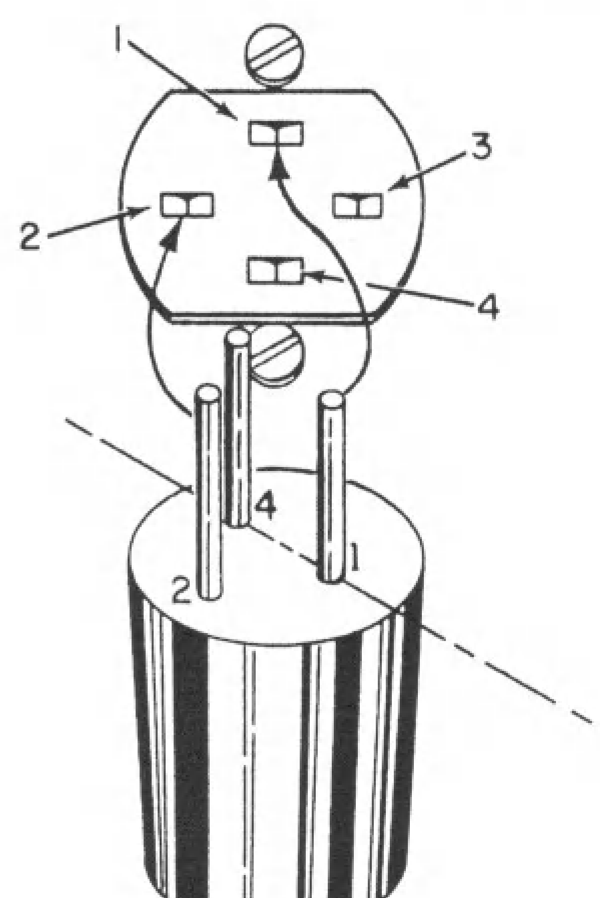
PLUG-IN TYPE
LOW POWER TRANSISTOR



INTERCONNECTION OF LOW POWER
TRANSISTOR TO PANEL JACKS
USING ADAPTER CABLE



"TOP HAT" TYPE TRANSISTOR



NOTE: Red dot on transistor identifies #4 pin.

LP-3

SPECIAL NOTE: As an extra precaution, the user can start with the "H" Control set at "0" which provides maximum shunting protection for the meter. Then with the "READ METER" button depressed, rotate the "H" Control to the position indicated on the Roller Chart for Icbo. This precaution applies particularly where a reading close to the reject point has been obtained under "Short" Test.

8. Rotate the "TRANSISTOR TEST" Switch to "L" (Leakage). Depress the "READ METER" button.

   NOTE: This "L" or Leakage reading is to be arithmetically subtracted from the next reading ("G_1") to yield a final, accurate Gain value for the Transistor. This is the only significant use for the "L" reading: The "Leakage" reading is not to be used as a direct indication of a transistor characteristic.

9. Rotate the "TRANSISTOR TEST" Switch to "G_1" (Gain) position and press the "READ METER" button. Read the Gain value on the 0-120 meter scale. If the meter reads higher than full scale, see special note on Page 26.

   Subtract the "L" or Leakage reading obtained in Step 8 from the "G_1" or Gain reading. The net result is the Gain of the transistor.

   NOTE: Do not keep the "READ METER" button depressed any longer than necessary to take a reading in the "G_1" position. Most transistors will increase in reading if the button is kept depressed unnecessarily due to heating of the Collector junction. However, the initial reading is the correct one to use.

10. If the transistor has a Tetrode connection, proceed as follows:-

    After the "G_1" Test has been completed, throw the numbered Lever which corresponds to the pin number of the Transistor Tetrode connection to the "Y" row (Tetrode row), press the "READ METER" button and watch for a reading LOWER than the "G_1" reading. If the reading does not differ from the "G_1" reading, then the condition of the Tetrode connection of the Transistor is to be questioned.

IMPORTANT NOTE: "G_2" position is for Power transistors only. Never depress "READ METER" switch with a Low Power transistor accidentally set to "G_2" position or you may burn out the transistor.

B. POWER TRANSISTORS

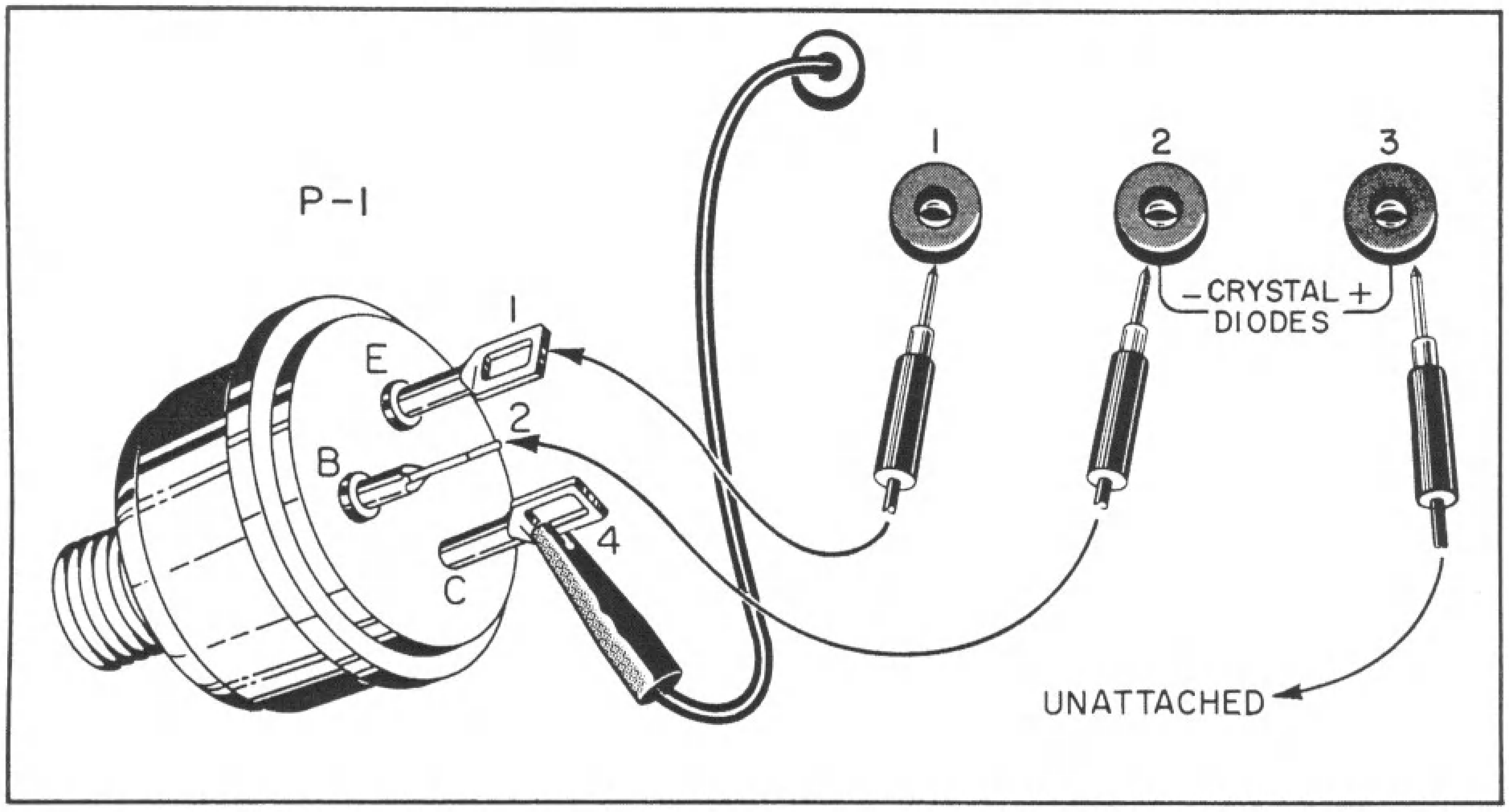
Follow the same instructions for Low Power Transistors with the following exceptions:-

1. Do not take an "L" reading for Power Transistors. Gain figures will be erroneous if the operator subtracts "L" from "G_2" readings for Power Transistors, since the respective meter sensitivities for these tests are different. (The "L" test was not set up for Power Transistors because the "L" reading would be negligible in comparison with "G_2" readings.)

2. Use the "G_2" position of the "TRANSISTOR TEST" Switch for Gain Tests. ("G_1" position is used only for Low Power Transistors.)

   NOTE: Do not forget to clip the small alligator lead (emerging just above the No. 1 tip jack) to #4 Transistor termination if the alligator adapter cable is used to connect the transistor to the 10-60.

SEE TYPICAL CONNECTION ILLUSTRATION, NEXT PAGE



SPECIAL NOTE REGARDING METER SENSITIVITY FOR TRANSISTOR GAIN AND LEAKAGE TESTS

The Model 10-60 "D" Control setting determines the RANGE of the Meter for any Test. The "D" Control setting of 50 listed for most Transistors on the Roller Chart makes the meter read directly as a 0-120 Gain scale. However, occasionally, a transistor will have a Gain so much higher than others of its type (above 120) that the meter may go offscale with the prescribed "D" Control setting of 50. For these exceptional transistors (Low Power types) special settings of the "D" Control can be used to multiply the Range of the Meter when taking both "L" and "G_1" readings, as follows:-

"D" Control Setting (For "L" and "G_1" Tests)	Multiply Meter readings by:
50 (most common)	x1
31	x2
15	x5
6	x10

In addition to "standard" Gain transistors, a few High Gain transistors are listed on the Roller Chart. Inasmuch as the expected Gain reading for these may be above 120, a "D" Control setting of 31 (for example) is listed on the Data which makes the meter scale a 0-240 Gain scale instead of a direct 0-120 scale (see the above Table). For the purposes of simplicity on the Data Sheet, the figure listed under "Gain" for these High Gain transistors is a direct reading Reject number which does not include the multiplication factor. The true Gain figure can always be calculated by the operator if he so desires as follows:

Set the "D" Control to the nearest value listed above which will insure an on-scale "G_1" reading to be taken, and note the "G_1" reading in terms of the 0-120 scale read directly. With the same "D" Control setting read "L" directly on the 0-120 scale. The true gain is equal to "G_1" minus "L" times the multiplying factor listed in the table for the "D" Control setting used.

CAUTION. High Gain Transistors will tend to heat up at the Collector junction (to a greater degree than Low Gain Transistors) if the "READ METER" button is kept depressed when a "G_1" reading is being taken. Therefore do not keep the button depressed longer than is necessary to take a reading in the "G_1" position.

The same discussion as above applies to meter sensitivity for Power Transistor Gain readings in "G_2" position. (No Leakage readings are taken for Power Transistors)

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SPECIAL TESTS FOR TRANSISTORS

Transistor manufacturers sometimes list additional tests on their data sheets for a transistor type and recommend that these parameters be checked when the transistor is used in certain applications. The versatility of the Model 10-60 lever system of testing and multiple voltages available enables the user to perform these special tests as is indicated below. Note that these tests are mainly SUPPLEMENTARY tests for those interested in examining further characteristics of a transistor. IF THE TRANSISTOR CHECKS GOOD ON SHORT, Icbo AND GAIN, IT IS UNLIKELY THAT OTHER PARAMETERS WILL GO OUT OF SPECIFICATION IN A JUNCTION TYPE TRANSISTOR.

A. Iebo Test (sometimes listed as Ieo)

This test measures the reverse current between Emitter and Base with Collector open, just as Icbo measures reverse current between Collector and Base with Emitter open. The Iebo measurement is sometimes recommended by transistor manufacturers (and is usually part of their production test) when the transistor is intended for oscillator applications or Class B application.

The procedure for making the Iebo test in the Model 10-60 is as follows:-

1. Set the "TRANSISTOR TEST" Switch on "Icbo" position (NPN for NPN type transistor, PNP for PNP type transistor).
2. Throw numbered lever corresponding to transistor Base connection to Position "Z" (Base circuit).
3. Leave the numbered lever corresponding to transistor Emitter connection in the "Normal" position (Emitter circuit).
4. Throw numbered lever corresponding to transistor Collector connection to Position "W" (Open circuit).
5. All other levers should remain in "Normal" row (Emitter circuit).
6. Set up test voltage with "E" Switch, and meter sensitivity with "H" Control in accord with limits specified on manufacturer's transistor data sheet. The tables below indicate available Model 10-60 test voltages and meter sensitivities in the "Icbo" position.

"E" Switch Position	Test Voltage in "Icbo" Position	"H" Control Setting	Full Scale Meter Current in "Icbo" Position
1	.5	50	120 ua.
2	1.5		
3	2.5	26	240 ua.
4	3.4		
5	4.5	12	600 ua.
6	5.6		
7	6.6	7	1.2 Ma.
8	7.5		
9	9.1	0	24 Ma.
10	11		
11	12.5		
12	15		
13	18.5		
14	23		
15	26		
16	28.5		
17	31		
18	37		
19	46		
20	73		
21	100		
22	160		

For example: The manufacturer's specifications for a transistor state that Iebo at Ve (Emitter Voltage) of 12V shall be no more than 5ua. The Model 10-60 "E" Switch would be set at 10 and the "H" Control set at 50. The current would be read in microamperes directly on the 0-120 scale of the Model 10-60.

Note that if the transistor being tested has been in use for some time, the maximum allowable current should be multiplied by 3 before rejecting. For the example given, the reject current for Iebo would then be 3 x 5ua. = 15ua. or greater.

If manufacturer's specifications are not available, approximate test values for Iebo are as follows:-

RF types having a rated Collector voltage of 12V or more should have a maximum Iebo of 50ua. at an Emitter-to-Base voltage of 3 Volts.

Audio types having a rated Collector voltage of 20V or more should have a maximum Iebo of 100ua. at an Emitter-to-Base voltage of 3 Volts.

7. Depress "READ METER" button to read Iebo current.

* * * * * * *

B. <u>Icbs TEST</u>

This test measures the reverse current between Collector and Base with Emitter shorted to Base. This parameter is sometimes specified by the transistor manufacturer instead of, or in addition to Icbo, particularly with Power Transistors used in output stages.

The procedure for making the Icbs test in the Model 10-60 is as follows:-

1. Set the "TRANSISTOR TEST" Switch in "Icbo" position (NPN or PNP according to transistor type).
2. Throw numbered lever corresponding to transistor Base connection to Position "Z" (Base circuit).
3. Throw numbered lever corresponding to transistor Emitter connection to Position "Z" (Base circuit).
4. Throw numbered lever corresponding to transistor Collector connection to Position "X" (Collector circuit).
5. All other levers should remain in "Normal" row (Emitter circuit).
6. Set up test voltage with "E" Switch; and meter sensitivity with "H" Control in accord with limits specified by manufacturer. (See preceding tables for "E" and "H" settings). If the transistor has been in use for some time, multiply the manufacturer's maximum Icbs current by a factor of 2 for reject limits. If the manufacturer only lists typical values, then you can only operate on a comparison basis with a known good transistor.
7. Depress the "READ METER" button to read Icbs current.

NOTE: Transistor manufacturers sometimes specify a modified Icbs test in which the Emitter is not shorted to the Base but a specified value of resistance is placed between Emitter and Base. This test can be carried out in the Model 10-60 by connecting one end of the specified resistor to the Emitter and inserting the other end of the resistor in the socket (or use the pin jacks if more convenient). The procedure then follows Steps 1 through 7 above.

* * * * * * *

SERVICE NOTES

The PRECISION Model 10-60 has not only been designed as an accurate Test Instrument, but has also been constructed to withstand the abuses of general field use. All components have been exhaustively sample-tested by Precision's Test Engineering Laboratory and have been approved for general long-life usage. Generous mechanical design is a major Precision precept.

However . . . . It is impossible to fully control the two major contributions to inoperative instruments namely:

1) Failure of components after instruments have passed Precision's Performance Test Department and

2) Damage of components due to misoperation, accidental or otherwise, including failure to OBSERVE PRESCRIBED OPERATING PROCEDURES.

Therefore, in order to expedite rehabilitation of your instrument (should the need arise) the most commonly encountered possible failures and recommended remedial measures are listed as follows:-

IMPORTANT NOTE: Your PRECISION Model 10-60 is a relatively complex instrument, and has been carefully inspected and calibrated by Precision's Performance Test Department. - - DO NOT attempt repairs or modifications other than those listed below unless upon specific recommendation by Precision's SERVICE DEPARTMENT.

1. Instrument does not become energized upon application of line voltage.

   a) Remove the 2 ampere 3AG fuse. If blown, replace with same size and type fuse only if the cause for blowing of fuse is known and has been remedied.

   Reasons for fuse-blowing may be:

   Failure to short-check a tube before attempting Quality test.

   Shorted power transformer windings or other internal shorts.

2. Several type tubes with the same "A" Switch setting do not provide meter merit indications.

   2) The load resistor associated with the particular "A" Switch position may be open. Refer to the schematic, check the resistor with an ohmmeter. If open-circuited, contact Precision's Service Department for a replacement Resistor.

3. "LINE AND VR ADJUST" is erratic.

   a) Examine the "LINE AND VR ADJUST" potentiometer for shorted, open or worn turns. Unsolder the three leads and check for continuity with an ohmmeter. If defective, contact Precision's Service Department.

4. Erratic checks of several tubes with the same type base.

   a) Examine that particular socket and check for loose or broken contacts. If new sockets are required, contact Precision's Service Department or your parts distributor.

5. Tubes with overhead caps check improperly.

   a) Check cap leads for continuity especially at the cap end. Continuous use and attendant flexing of the wire occasionally cause breakage.

6. Apparent defective operation of the instrument meter.

   a) Repair and recalibration of the meter of a Model 10-60 is a delicate and highly specialized operation. DO NOT ATTEMPT TO REPAIR AN INOPERATIVE METER. Always contact Precision's Service Department should your meter appear defective or damaged.

SPECIAL NOTES RE REPAIR SERVICE

When returning a PRECISION instrument for repair-recalibration service, ALWAYS pack carefully in a strong oversized corrugated shipping container, using a generous supply of padding such as excelsior, shredded paper or crumpled newspaper. The original container and filling pads (if available) are ideal for this purpose. Please ship via Railway Express PREPAID and mark for:

PRECISION APPARATUS COMPANY, INC.
70-31 - 84th Street
Glendale 27, L. I., N. Y.
ATT: SERVICE DIVISION

FRAGILE label should appear on at least four sides of the carton. NEVER return an instrument unless it is accompanied by full explanation of difficulties encountered. The more explicit the details, the more rapidly your instrument can be handled and processed.

SPECIAL SUBSCRIPTION SERVICE

NEW TEST DATA

IN LINE WITH "PRECISION'S" DESIRE TO EXTEND UTMOST SERVICE TO USERS OF "PRECISION" TEST EQUIPMENT, NEW TUBE, TRANSISTOR AND DIODE TEST DATA IS NOW BEING MADE AVAILABLE ON A SPECIAL SUBSCRIPTION BASIS.

THIS PLAN ENTITLES THE SUBSCRIBER TO RECEIVE, AUTOMATICALLY, 2 UP-TO-DATE ROLL CHARTS AND A MINIMUM OF 2 ADDITIONAL SUPPLEMENTS DURING A ONE YEAR SUBSCRIPTION PERIOD.

NOTE FOR NEW OWNERS: THE FIRST YEAR'S SUBSCRIPTION IS ENTERED FREE OF CHARGE UPON OUR RECEIPT OF YOUR REGISTRATION-SUBSCRIPTION CARD COVERING THE PURCHASE OF A NEW "PRECISION" TUBE TESTER. IT IS IMPORTANT THAT THIS REGISTRATION-SUBSCRIPTION CARD BE COMPLETELY FILLED-IN AND RETURNED TO US IMMEDIATELY, IN ORDER THAT YOU MAY RECEIVE THE FULL BENEFITS OF THIS SPECIAL SERVICE.

PLEASE NOTE: UPON OUR RECEIPT OF YOUR REGISTRATION-SUBSCRIPTION CARD, WE WILL RESPOND WITH TWO SEPARATE CARDS:-

a) ONE CARD ACKNOWLEDGES REGISTRATION OF YOUR NEW TUBE TESTER.

b) THE OTHER CARD, (WHICH WILL FOLLOW A FEW DAYS LATER), CONFIRMS YOUR ONE YEAR FREE TUBE TEST DATA SUBSCRIPTION.

UPON EXPIRATION OF THE FIRST ONE YEAR'S FREE SUBSCRIPTION, YOU WILL HAVE THE OPPORTUNITY TO RENEW THE SAME EFFICIENT SERVICE FOR THE NOMINAL CHARGE OF ONLY $2.50 PER YEAR. ADEQUATE ADVANCE NOTICE OF END OF SUBSCRIPTION IS SENT TO ALL SUBSCRIBERS. FOR THOSE WHO MAY NOT WISH TO RENEW THIS AUTOMATIC SERVICE, CHARTS WILL BE AVAILABLE, UPON REQUEST, AT THE NOMINAL COST OF $1.25 EACH. IT IS VERY IMPORTANT THAT SUCH SEPARATE ROLL CHART REQUESTS LIST THE FOLLOWING INFORMATION:-

A. MODEL NO. OF TUBE TESTER

B. SERIAL NO. OF TUBE TESTER

C. FORM NO. OF YOUR PRESENT CHART
(PRINTED AT UPPER LEFT-HAND CORNER OF CHART)

THIS INFORMATION PERMITS OUR TUBE TEST DATA DEPARTMENT TO RESPOND WITH THE CORRECT CHARTS FOR YOUR PARTICULAR TUBE TESTER.

SPECIAL NOTE: PAID SUBSCRIPTION SERVICE APPLIES ONLY TO CONTINENTAL U. S. A., CANADA AND U. S. POSSESSIONS.

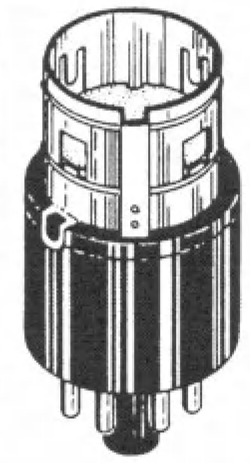
ACCESSORIES SUPPLIED:

1 - Transistor Adapter Cable

* * * * * * *

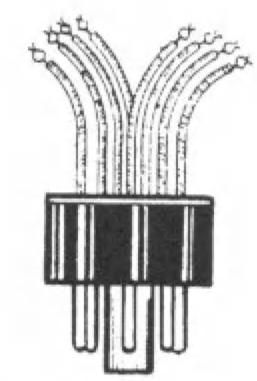
ACCESSORY ADAPTERS AVAILABLE FOR YOUR TUBE TESTER

1. Model G-118 Foreign Tube Adapter for "Pico 8" basing. This Adapter plugs into the octal socket of your Model 10-60 and converts this socket for use with special European 8 pin miniature tubes.



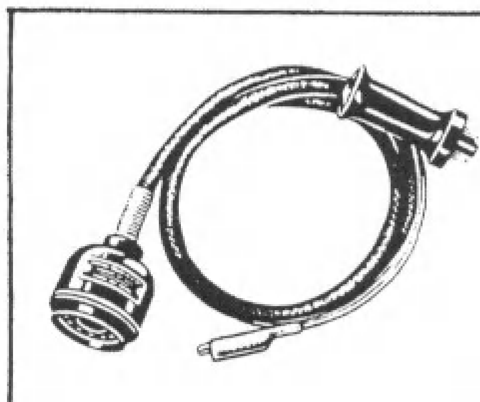
G-118
"Pico 8"
Foreign Tube Adapter

2. Model G-110 Sub-miniature Flexible Lead Adapter. In addition to the sub-miniature tubes with short straight pins (which can be inserted into the two sub-miniature sockets mounted in the upper left hand panel area of your Model 10-60), there are also special types with long flexible leads which are soldered directly into their respective operating circuits, with the leads cut to varying lengths. In the event a tube of this type has to be removed from its circuit for test, the operator may find it difficult to insert the tube leads into the 10-60 sockets. Because of this, PRECISION offers a simple universal sub-miniature tube test adapter with flexible leads and miniature contact clips. This special adapter permits test regardless of lead length variations.



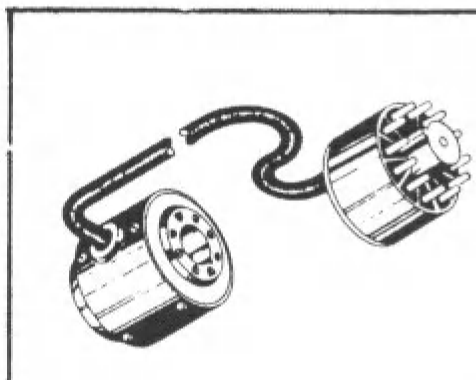
G-110 SUBMIN. ADAPTER

3. Model PTA TV Picture Tube Adapter. This Adapter, described in the section under "Picture Tube Tests", enables the operator to connect standard TV Picture Tubes to the Model 10-60 for test.



"PTA" - STANDARD PICTURE TUBE ADAPTER

4. Model PAA 110° Picture Tube Adapter. Modern 110° Picture Tubes utilize two different types of special basings as compared to the standard duodecal basing of the older type of picture tubes. This special Adapter which is intended for use with the Model PTA Adapter listed above, adapts the duodecal socket of Model PTA to these two new types of 110° basings.



"PAA" - 110° PICTURE TUBE ADAPTER

* * * * * *

ALL THE ABOVE ADAPTERS ARE AVAILABLE EITHER FROM YOUR FAVORITE DISTRIBUTOR OR FROM THE FACTORY SERVICE DEPARTMENT.

PRECISION APPARATUS COMPANY, INC.
70-31 - 84th Street
Glendale 27, L. I., N. Y.

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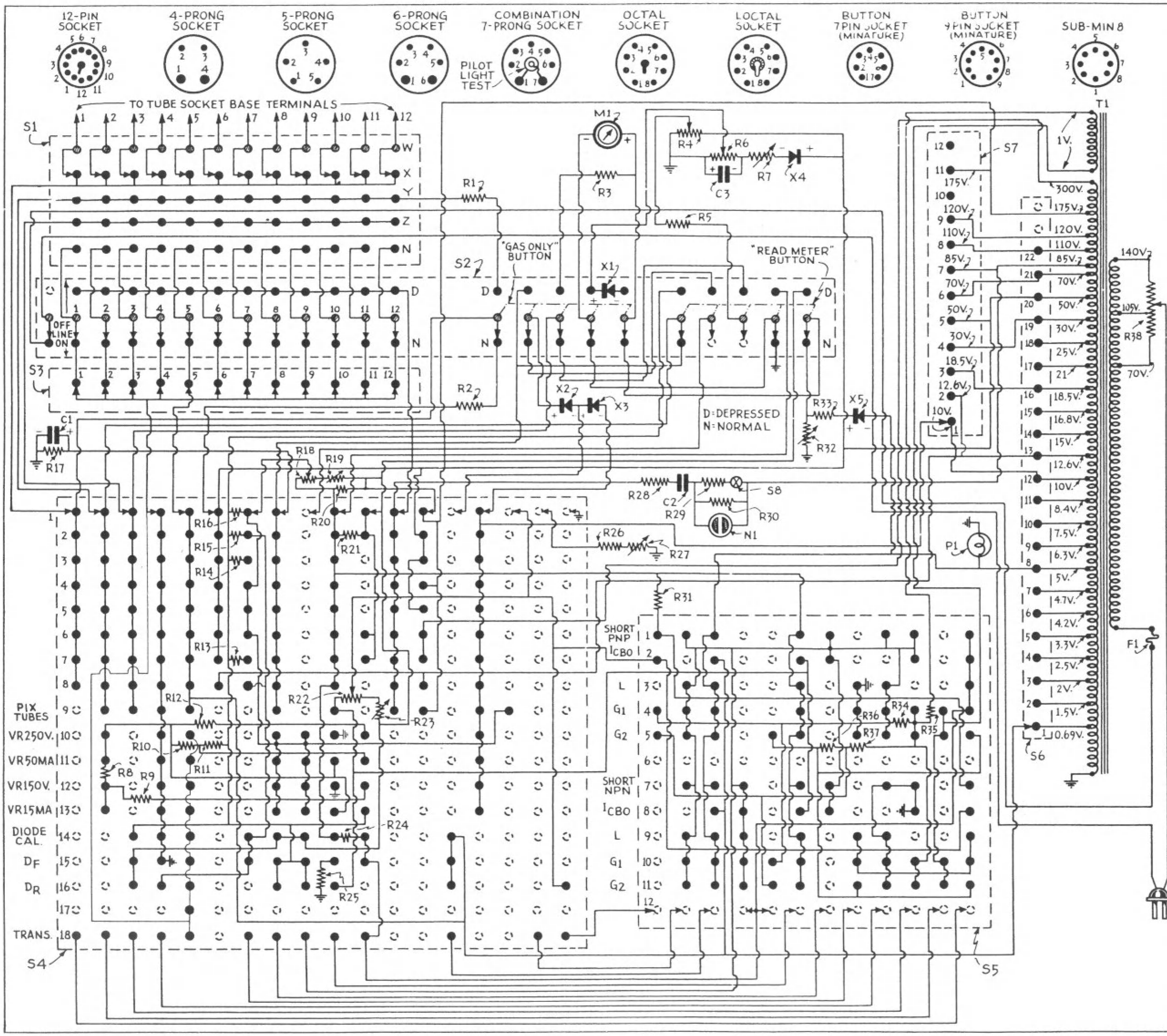
U. S. A.

DWG. NO. 1094



PART NO.	SPECIFICATION
R38	300 Ω 50W. LINE ADJUST CONTROL
R37	280 Ω
R36	.267 Ω
R35	470 Ω
R34	39.5K Ω
R33	820 Ω
R32	0-60 Ω
R31	750 Ω
R30	1.8 MEG. Ω
R29	1.8 MEG. Ω
R28	22K Ω
R27	200 Ω
R26	22 Ω
R25	116.8K Ω
R24	40 Ω
R23	40 Ω
R22	"H" CONTROL 2280 Ω
R21	53.3 Ω
R20	168.4 Ω
R19	40 Ω
R18	"D" CONTROL 300 Ω
R17	220K Ω
R16	2K Ω
R15	3K Ω
R14	5100 Ω
R13	3 MEG. Ω
R12	5 MEG. Ω
R11	7.5 Ω
R10	3.2 Ω
R9	3 MEG. Ω
R8	8200 Ω
R7	4K Ω
R6	"F" CONTROL 10K Ω
R5	510 Ω 1W
R4	"C" CONTROL 1000 Ω
R3	22K Ω
R2	510 Ω 1W
R1	100 Ω
X5	IN48 RECTIFIER
X4	SELENIUM RECTIFIER 4Y1 OR EQUAL
X3	SILICON RECTIFIER IN1445 OR EQUAL
X2	SILICON-RECTIFIER IN1449 OR EQUAL
X1	COPPER OXIDE RECTIFIER CONANT BH OR EQUAL
T1	POWER TRANSFORMER
S8	HI-STD SWITCH
S7	SELECTOR SWITCH "G"
S6	SELECTOR SWITCH "E"
S5	TRANSISTOR TESTS SW.
S4	SELECTOR SWITCH "A"
S3	SELECTOR SWITCH "B" FILAMENT PIN SELECTOR
S2	15 SECTION PUSH BUTTON ELEMENT SHORT TEST
S1	12 SECTION-5 POSITION MASTER LEVER SWITCH
P1	PILOT LIGHT
N1	NEON LAMP
M1	50 μa 160MV. 3.2K Ω METER
F1	2 AMP. FUSE
C3	25 MFD., 75V.
C2	0.1-MFD.
C1	100 MFD.

PRECISION APPARATUS Co. Inc.
GLENDALE 27, L.I., N.Y.

MODEL 10-60 TUBE AND TRANSISTOR TESTER

DRAWN BY: W. Kadlecek DATE: 5-12-58
CHECKED BY: M. K. DATE: 5-13-58

THE

PRECISION

*Electronamic**

TUBE TESTER

*REG. U.S. PAT. OFF.

PRINCIPLES OF *Electronamic* TUBE TESTING

The All-Inclusive, Single Operation
POSITIVE VACUUM TUBE PERFORMANCE TEST
that is Not Limited to Mutual Conductance Alone

☆ A most perplexing issue which confronts the electronics engineer and service technician is the choice of tube testing equipment that will solve tube test problems with **greatest possible accuracy and reliability.** With this thought foremost in mind, ***PRECISION*** engineers have devoted much time in extensive vacuum tube testing research and development.

All varieties of tests were conducted upon thousands of tubes, at our own fully equipped laboratories and at the plants of leading tube manufacturers. From this, a vital point stood out, above all others, which dictated that **"the resultant tube tester design cannot be based upon just one selected characteristic, such as just mutual conductance alone."**

☆ A tube test based upon **just any one characteristic** does **not** fully vouchsafe the **over-all** performance capabilities of an amplifying tube.

When a vacuum tube is "receiver tested", the electronic circuits demand **performance** predicted upon the simultaneous presence and interaction of a multiplicity of tube characteristics including the following:

Electron Emission

Amplification Factor

Plate Resistance

Mutual Conductance (Transconductance)

Plate Current

Power Output, etc.

☆ To perform a whole series of such **individual** tests, in order to evaluate the overall merit of a tube, involves a collection of laboratory equipment hardly available to the general user of vacuum tubes. In addition, these characteristics are very closely knit to operating parameters. This means that these variable characteristic values are dependent upon the voltage, current and load conditions to which the tube, under consideration, may be subjected. This further means that for ANY GIVEN TUBE TYPE, **there is not** just one value of mutual conductance or power output, etc. characteristic of that tube.

For this very reason, tube characteristic manuals list CURVES (graphs) of operation to assist the design engineer in selecting tubes and circuit parameters which he **desires** to employ in the particular receiver or other electronic apparatus being developed.

The data listed in tube manufacturers' manuals are not fixed and inflexible ratings. Rather, such examples of operating conditions are given merely as guiding information. The tubes can be and are used under **any** suitable conditions within their maximum ratings. The **curves** provide the information to determine the proper operating points which will yield a required characteristic.

☆ Another aspect of the tube engineering problem is the question of rejection limits for any particular characteristic. This actually is a double-barrelled topic. New tube production is concerned with **"Production Tolerance Limits."** The electronic design engineer, and of course the apparatus which uses the tubes, are further interested in **"Life Test End Limits."**

Electronic apparatus, using vacuum tubes, must not only perform well with tubes which are within "Production Tolerance Limits," but should be able to perform until the tube has reached its "Life Test End Limit."

Detailed specifications of such "limits" are not generally available to the field and of course, specific **numerical** characteristics tests (such as micromhos) are inconclusive unless compared to a detailed table of limits paralleling actual test parameters or actual operating conditions.

Moreover, numerical characteristics readings (such as micromhos) are not fully meaningful unless the tester **duplicates** the exact voltages and loads under which the particular tube in question is actually operating in the specific circuit from which it has been removed. It would furthermore require reference to the tube's plate family and transfer characteristic curves in order to determine what the numerical characteristic SHOULD be under the particular conditions in which the receiver is using this tube.

☆ Therefore, since the numerical value (such as micromhos) of a tube characteristic varies so widely with the applied element potentials, it is necessary that TRUE vacuum tube characteristics **measuring** instruments provide:

1. Means for **metering** and reading each and every applied element potential.
2. Appropriate means for **metering** and reading each tube element current.
3. Suitable devices for **adjustment** and **control** of every element potential to duplicate operating conditions or to set up the specific operating point being investigated.

☆ It is obviously impractical to construct such a device, for general tube testing, as would permit the operator to do this; not only from the viewpoint of simplicity of operation, but also in consideration of the extremely high cost and physical size.

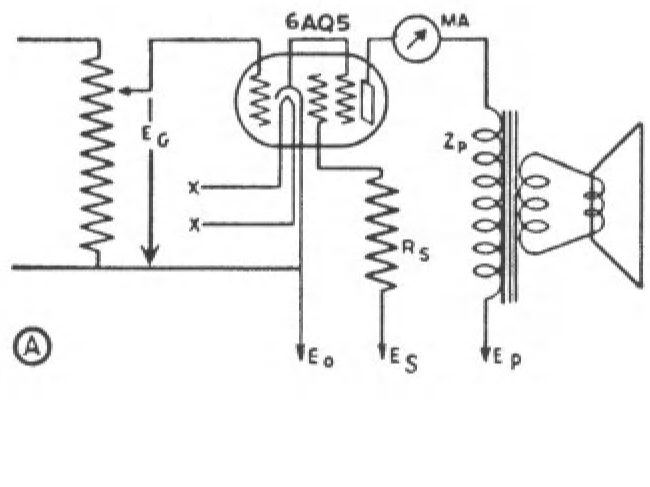
Accordingly, such equipment (for actual **numerical** characteristics investigation) is usually only found in research and production laboratories. These are the only places wherein such elaborate equipment might ever be required.

Needless to say, it would also not be practical for a tube tester's chart data to offer a multiplicity of alternative test settings for each and every tube.

☆ It has therefore been the constant purpose of ***PRECISION*** engineers to develop a tube tester circuit which would best meet the **realistic** needs of the electronic maintenance and Radio-TV service professions; to develop a basic test circuit affording the ultimate in correlation between test results and actual "in application" performance.

In the course of such investigations, it becomes conclusively apparent, that regardless of amplifier tube type number or variety of circuit applications, one phenomenon constantly manifests itself: **the tube output (voltage or power) is the result of a plate current caused by an applied control grid voltage, which current must be adequate even at full peak operating conditions.** This being a basic concept of amplifier tube operation (involving all operating characteristics), it led to the now famous time-proven and tried, ***PRECISION Electronamic*** tube tester. (Reg'd U. S. Patent Office)

☆ In offering the ***Electronamic*** tube tester, to the discriminating purchaser, ***PRECISION*** does so with a **"performance checked"** background. Such "performance" tests, heavily emphasized during World War II, were based upon the primary purpose of the instrument—**TO FIND BAD TUBES!**



(A)

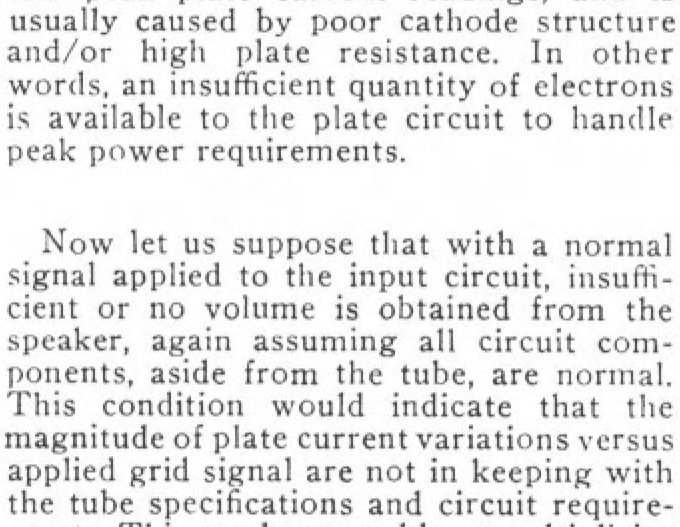
☆ To familiarize ourselves with the principles of the ***PRECISION Electronamic*** circuit, let us briefly observe the operation of a simple modern pentode such as the 6AQ5, in a standard power amplifier stage, shown in **Diagram A,** with the addition of a current indicating meter in the plate circuit.

The primary purpose of this tube is to deliver electrical output to the speaker through plate load Zp, in the following manner: with filament and plate supply operating and with zero signal applied to the input circuit, the plate milliammeter "MA" will indicate a steady current flow dependent upon cathode emissive power and the potentials of the interspaced elements. This zero signal meter reading is an indication of the tube's plate conductance. By applying an audio signal, Eg, to the input grid, THE PLATE CURRENT THROUGH Zp MUST VARY IN ACCORD WITH THE CHANGES IN GRID VOLTAGE. This is dependent upon the mutual conductance, plate resistance, amplification factor, load resistance, etc. The greater the grid voltage swing, the greater should be the plate current excursions, and accordingly, the louder the sound from the speaker.

Let us now assume that a high order of peak grid signal voltage is applied, (that is in keeping with the tube operating conditions), but severe distortion is nevertheless produced at the speaker, even though all circuit components, aside from the tube, are normal. This condition coincides with low peak plate current readings, and is usually caused by poor cathode structure and/or high plate resistance. In other words, an insufficient quantity of electrons is available to the plate circuit to handle peak power requirements.

Now let us suppose that with a normal signal applied to the input circuit, insufficient or no volume is obtained from the speaker, again assuming all circuit components, aside from the tube, are normal. This condition would indicate that the magnitude of plate current variations versus applied grid signal are not in keeping with the tube specifications and circuit requirements. This can be caused by a multiplicity of internal tube conditions, including reduced amplification factor, low mutual conductance, open, misplaced or shorted screen, control grid, suppressor, or plate, even though the tube's cathode structure may be absolutely normal.

In the case of resistance-coupled amplifiers, the change in plate current produces a change in voltage drop across the plate load resistor. This is then passed on through suitable coupling means to the succeeding stage.



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☆ It can therefore again be readily seen that the overall PERFORMANCE Merit of a tube is absolutely dependent on the ability of **output plate current to respond to the applied grid voltage, over the full range of possible operating conditions, which involves More than just Mutual Conductance.**

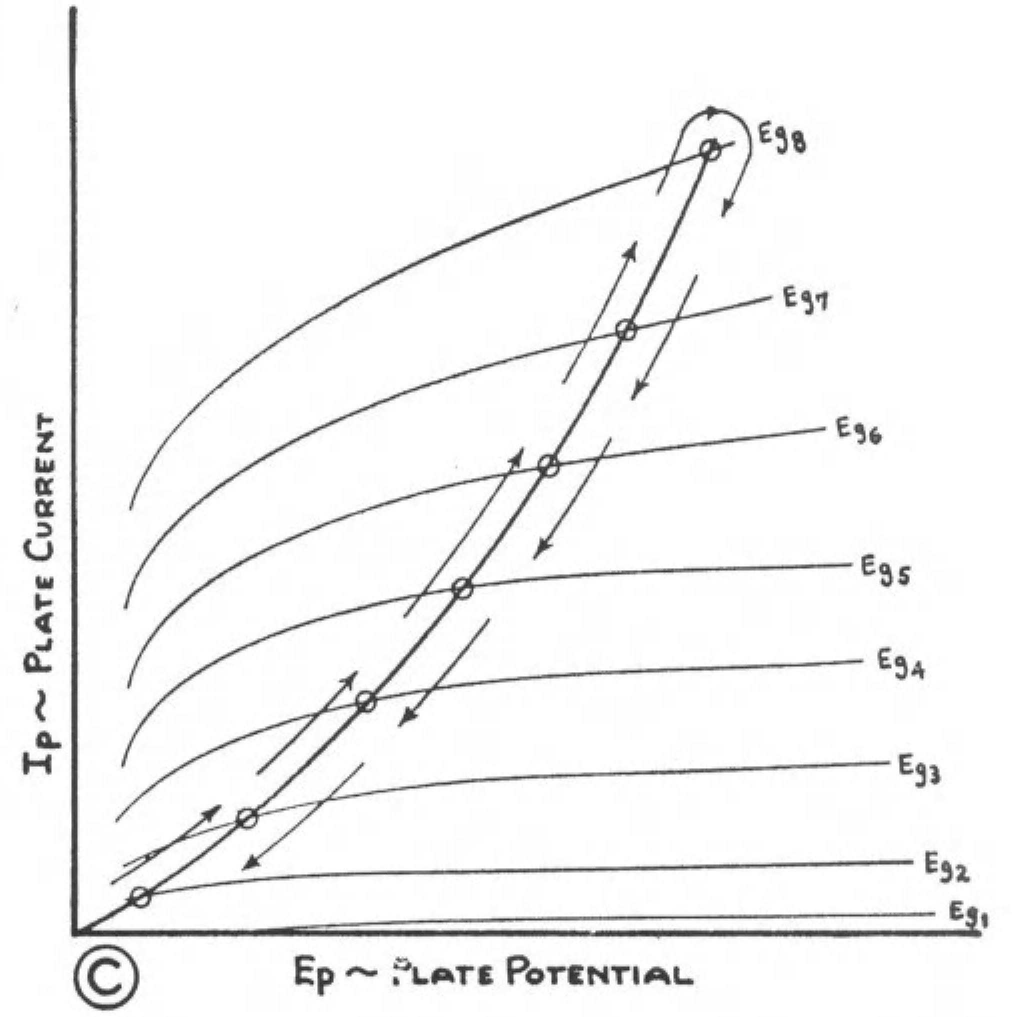
Diagram B shows the ***PRECISION Electronamic*** circuit set up to check the same type 6AQ5. Note that individual plate, screen and grid voltages and loads are applied to the respective elements of the tube under test and it is thereby being ***Electronamic***ally tested as a pentode. Plate supply voltages from 12 to as high as 300 volts are applied to the tubes under test depending on the individual tube's requirements.

Appropriate treatment is accorded all amplifier tubes depending on whether they are triodes, tetrodes, etc. Multi-purpose tubes are treated and tested as two or more completely independent tubes, WITHOUT REMOVING THE TUBE FROM THE TEST SOCKET. All plate, screen, grid and filament test voltages and respective loads are factory calibrated (per the roller chart) to assure the high tube performance correlation for which the ***Electronamic*** tube testers are known to the field, both civilian and the military—a performance check based upon the **peak service** for which the tube was designed rather than just an arbitrarily chosen low or midpoint.

☆ As previously outlined, the overall quality or performance merit of a tube is dependent on how well control grid voltage "controls" plate current over a complete **range** of tube application.

For this reason, the ***PRECISION Electronamic*** circuit places the TUBE MERIT METER in the plate or output section of the tubes under test. Accordingly, the resultant quality or performance figure of merit involves a whole **series** of meaningful operational factors, not just one inconclusive characteristic. Such demanding test will reject all tubes which do not come up to the same standards from which the tube chart data is prepared.

☆ Much of the success of the ***Electronamic*** tube tester is attributable to the ELECTRO-DYNAMIC SWEEP nature of its circuit operation. Through application of appropriately phased individual element potentials, the tube under test is dynamically swept over a **Path of Operation**, on a sinusoidal time base, encompassing a wide range of plate family characteristics curves. In brief, the tube under test is made to **perform** on a basis which involves its ability to operate at a multiplicity of potential peak conditions rather than at just one arbitrarily chosen point.



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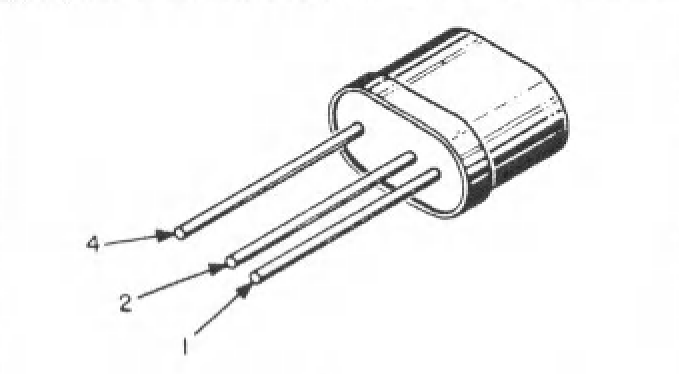
Reference to **Diagram C** graphically and directly illustrates this ***Electronamic*** picture. It is this encompassing **Path of Operation, involving More than just Mutual Conductance,** which is automatically integrated by the meter as the resultant figure of merit in the direct and non-confusing terms of REPLACE-WEAK-GOOD.

☆ The very nature of the ***Electronamic*** circuit necessitates and assures utmost instrument flexibility, to permit positive location and selection of all tube elements. This is accomplished in the "10-00" Model Tube Testers via design and use of a free-point LEVER TYPE master element selector system in combination with a multiple push-button short-check unit, PLUS specially engineered rotary, load and element potential selectors.

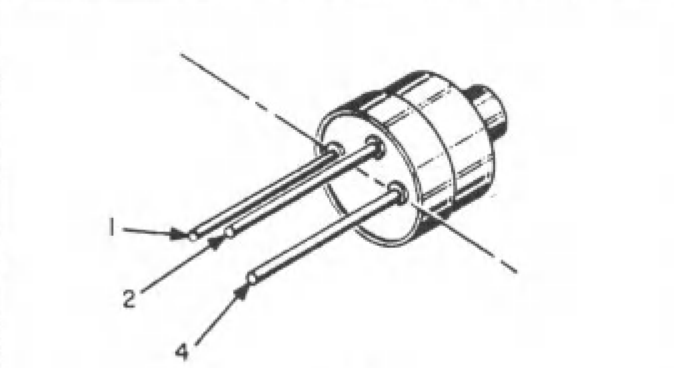
☆ Aside from the development of the complete ***Electronamic*** circuit, special consideration was given to the design of a reliable direct reading Gas Test, Hot Cathode Leakage Test, inter-element Short Check, and instantaneous Filament Continuity Test, to show up electrical and mechanical tube defects such as cathode to filament leakage, shorted, loose or open elements, open filaments, etc. THE CATHODE LEAKAGE CIRCUIT SENSITIVITY AND TEST VOLTAGE IS ADJUSTED TO COMPLY WITH THE APPROVED LEAKAGE SPECIFICATIONS OF LEADING TUBE MANUFACTURERS. **Inter-element short-check voltages have been critically selected to provide most effective test results without electrostatic damage to sensitive tube elements.** Additional independent circuit facilities appropriately accommodate diodes, rectifiers, tuning eyes, gas rectifiers, thyratrons, voltage regulators, etc.

☆ Modern methods of instrument construction, telephone cabled wiring and highest quality of materials afford maximum ruggedness for long-lasting satisfaction. INDIVIDUAL DUAL CALIBRATION against laboratory standards, insures maximum accuracy, and controlled, uniform ***PRECISION*** performance.

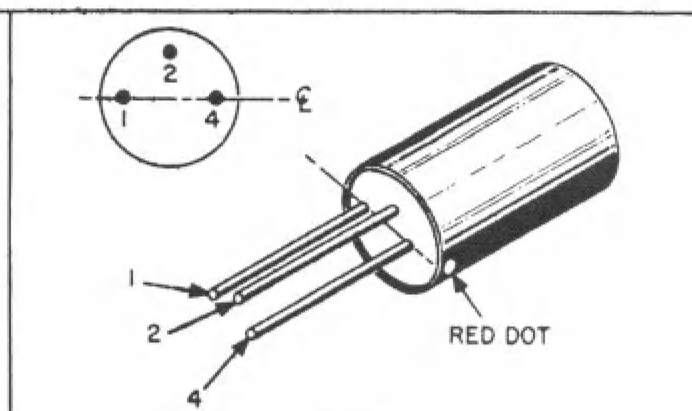
LOW POWER TRANSISTORS



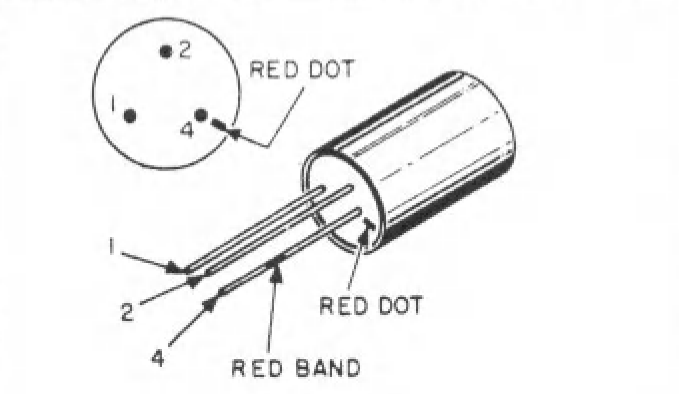
LP1



LP2



LP3



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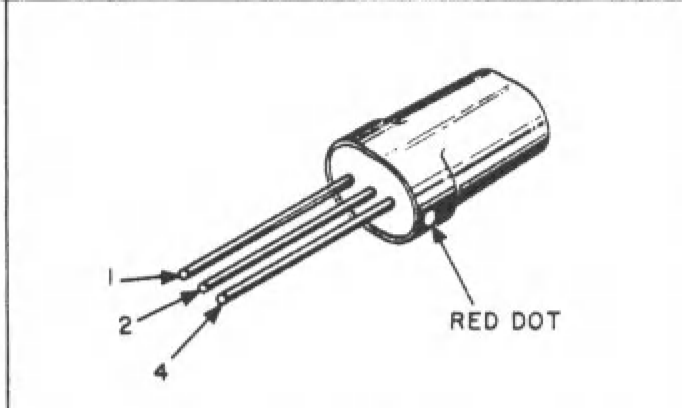
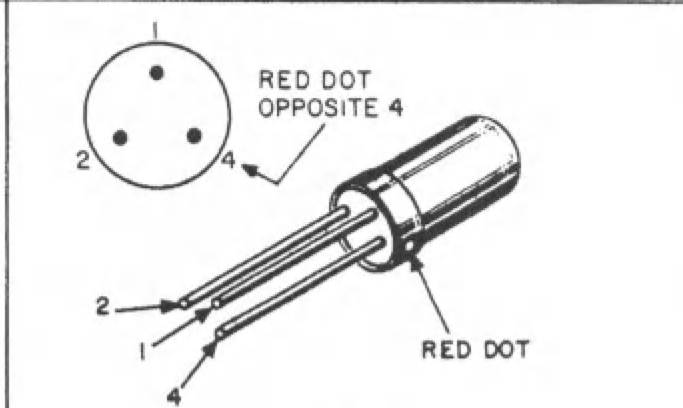


LP5



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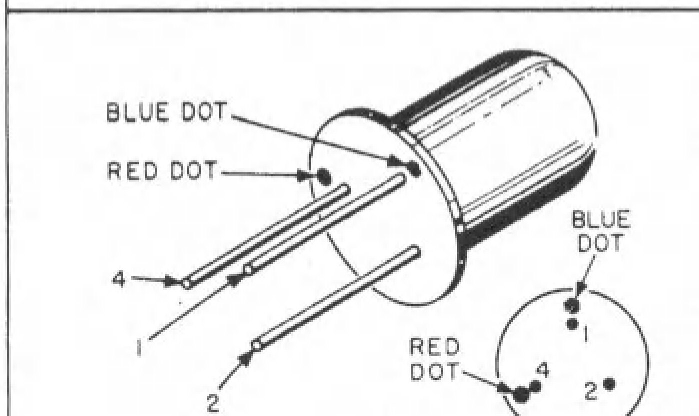
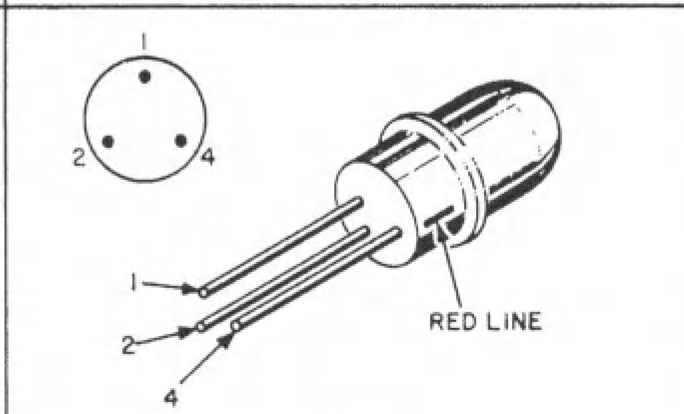


LP7



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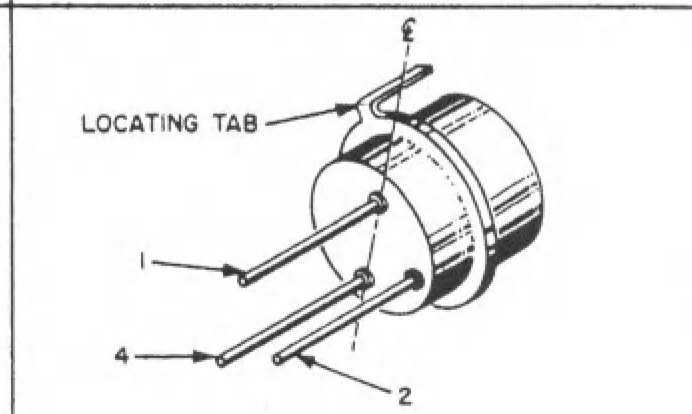

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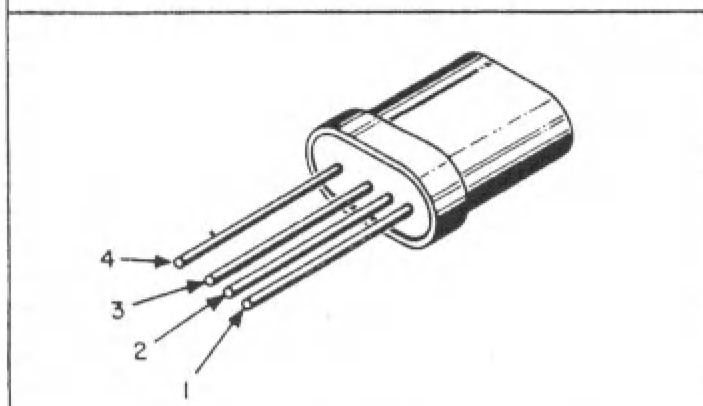

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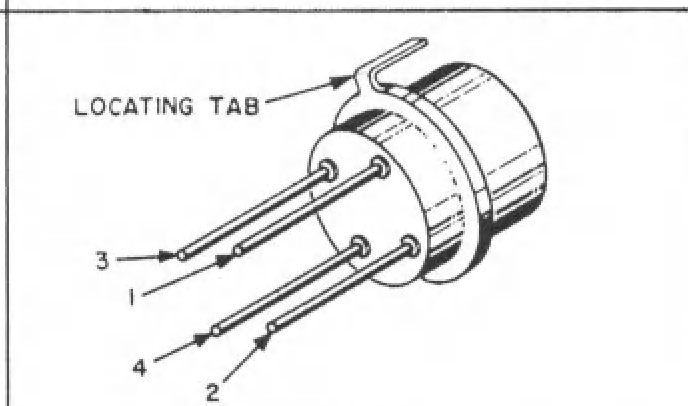

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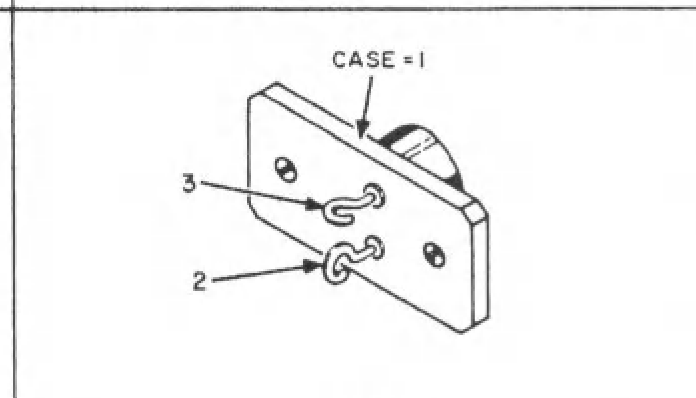

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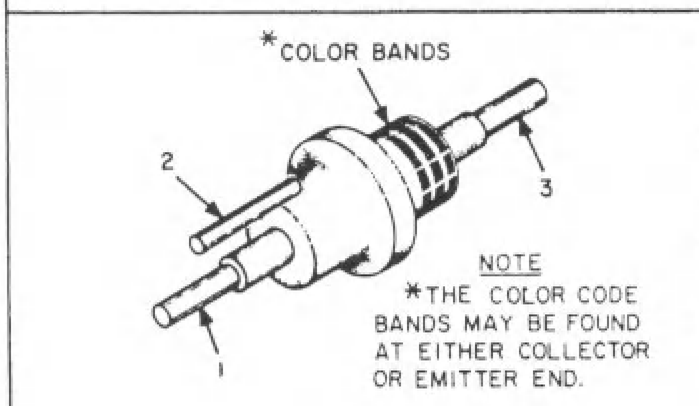

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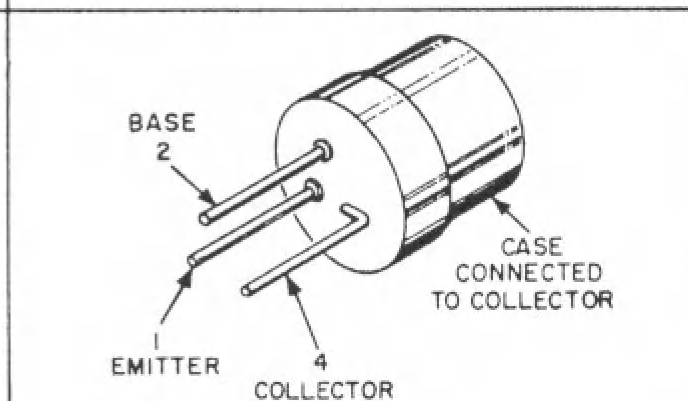

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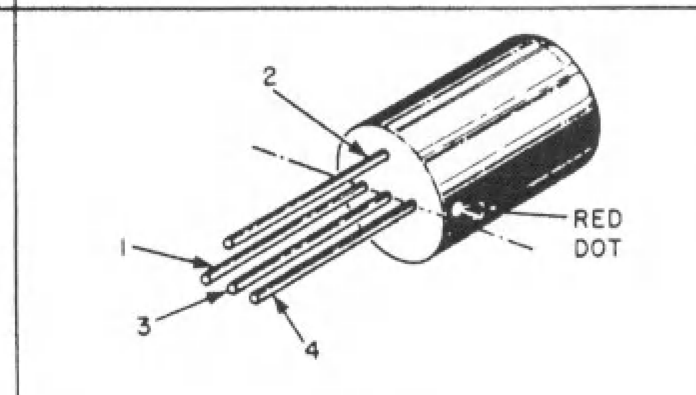

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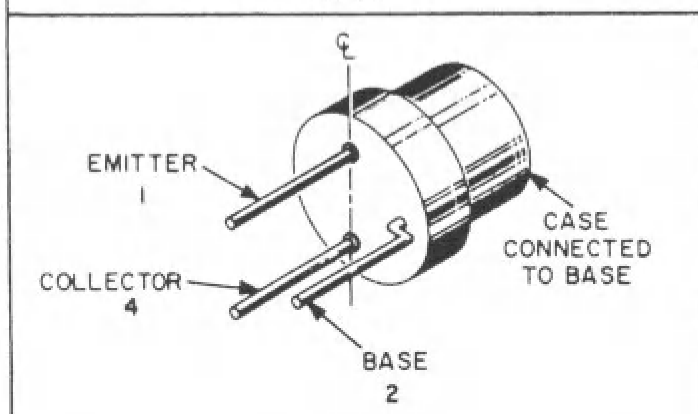
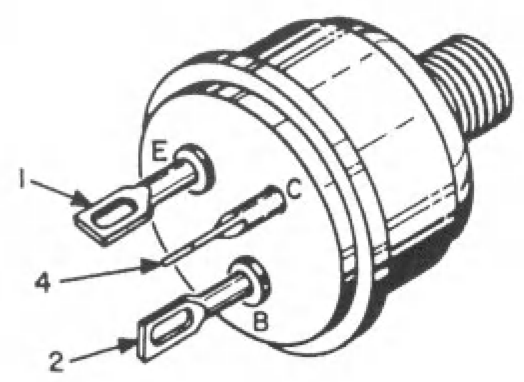


LP16

POWER TRANSISTORS



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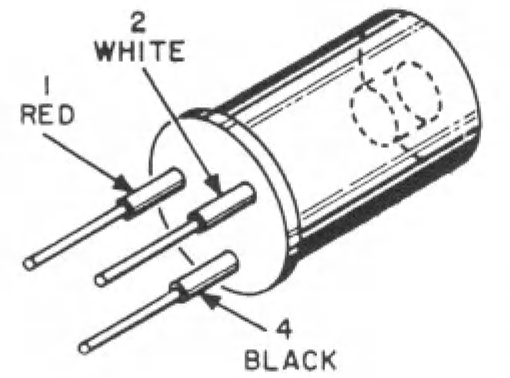

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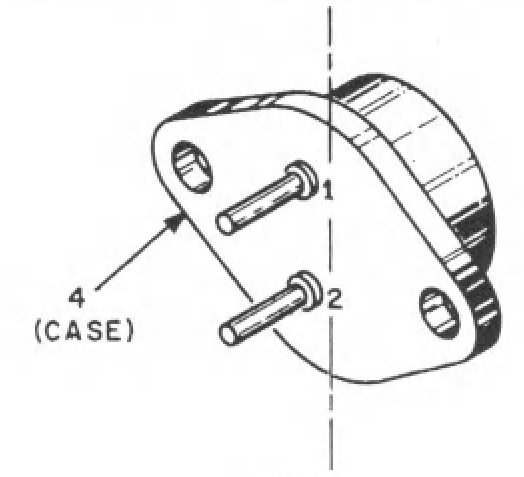

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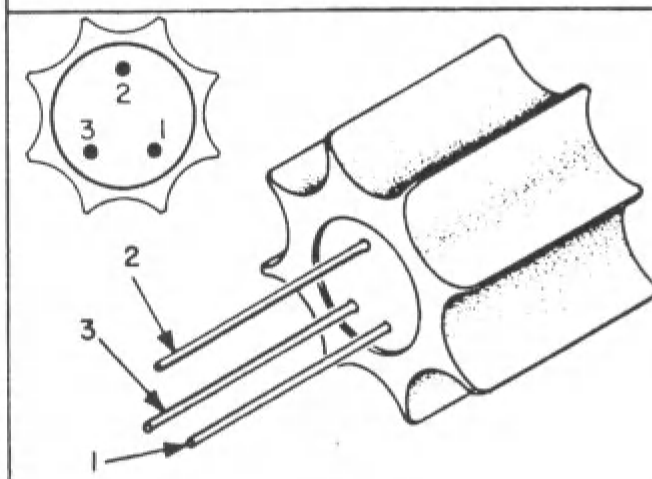

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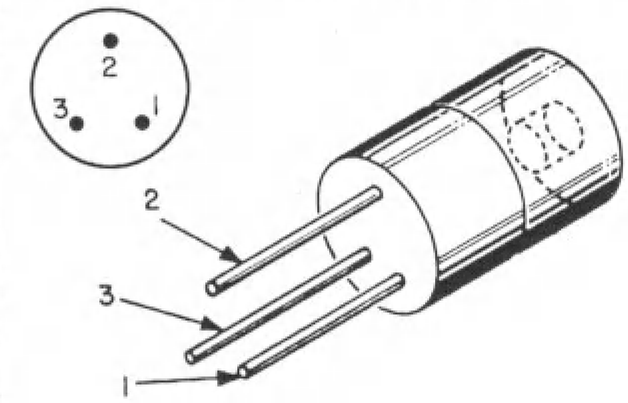

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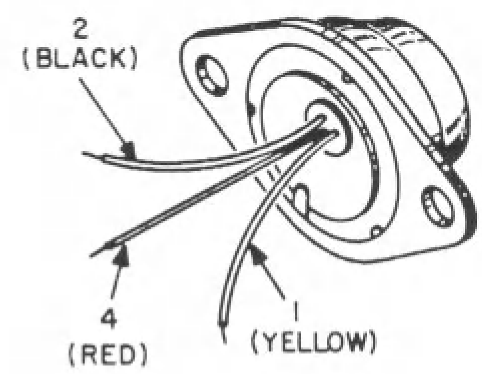

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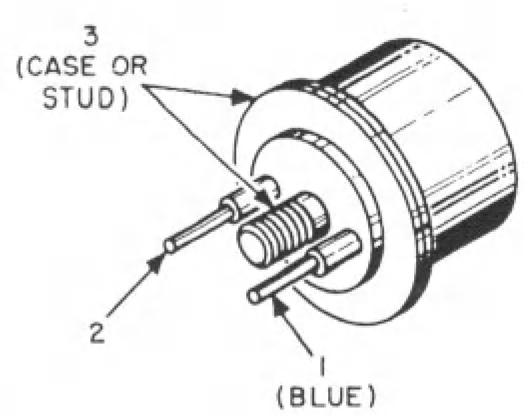

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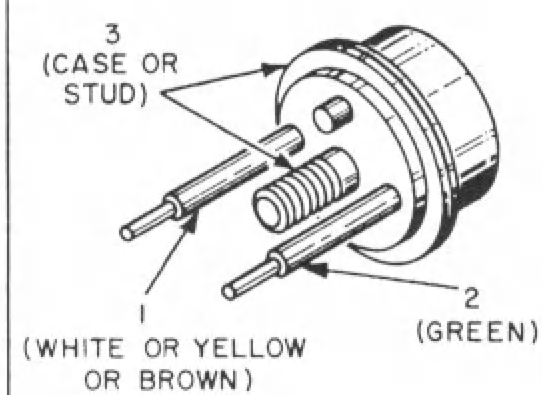

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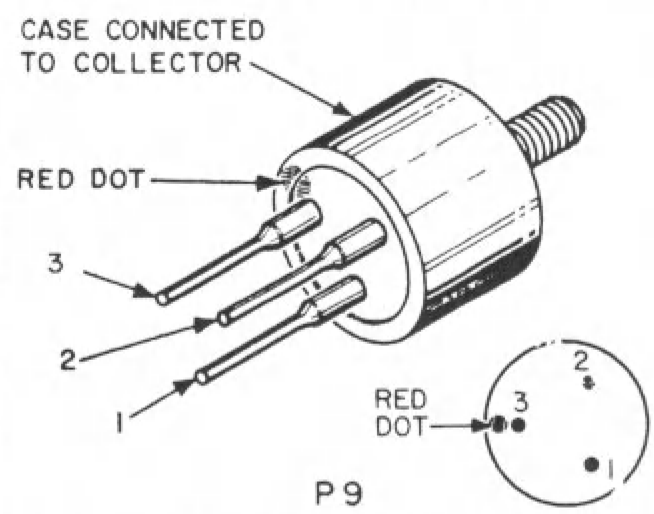

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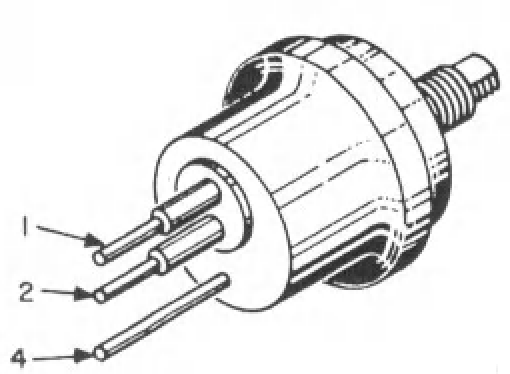

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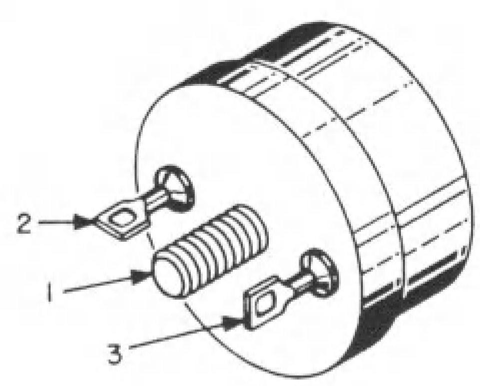

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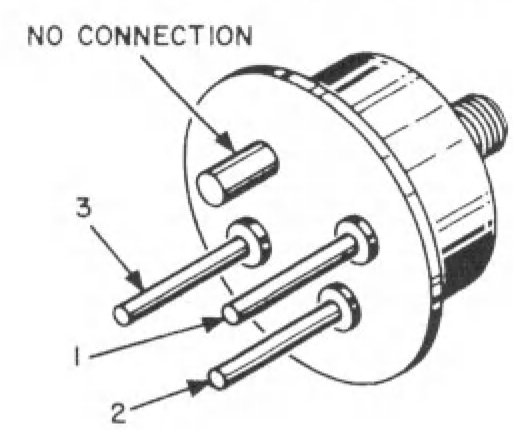

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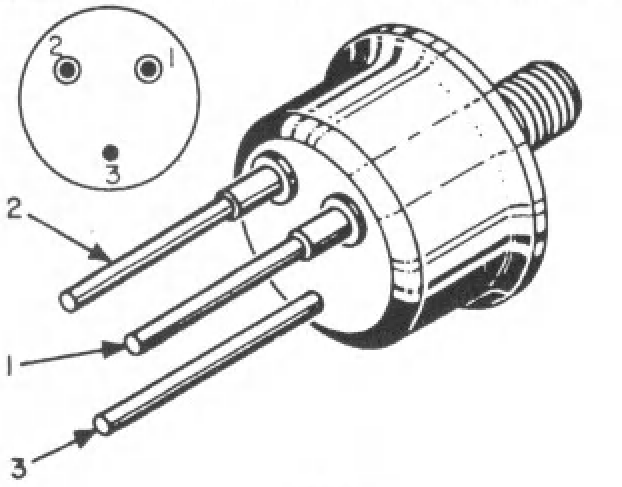

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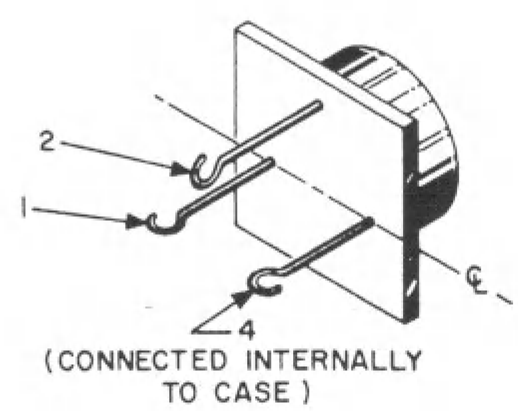

P 14