

PRECISION

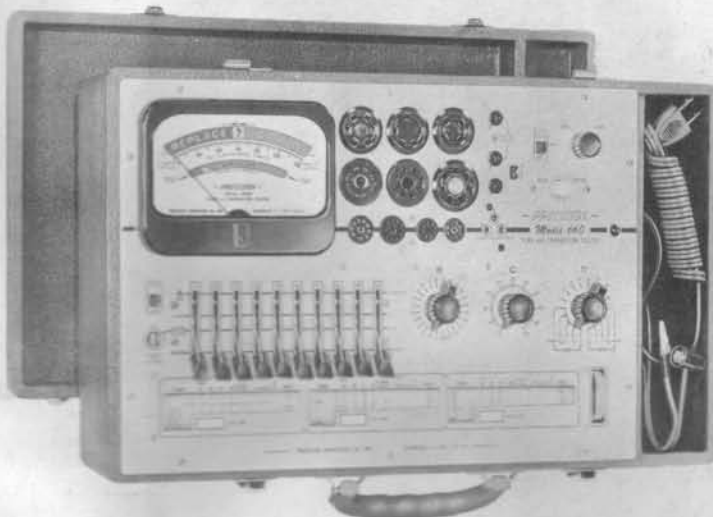
TEST INSTRUMENTS BY



PACOTRONICS

OPERATING INSTRUCTIONS FOR

PRECISION



MODEL

660

**CATHODE CONDUCTANCE TUBE TESTER,
TRANSISTOR TESTER,
Picture Tube and Crystal Diode Tester**



PRECISION APPARATUS COMPANY, INC.

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MODEL 660

THE MODEL 660 IS A MODERN, FOUR-WAY, LEVER-OPERATED TESTER ESPECIALLY ENGINEERED TO TEST ALL POPULAR AM-FM-TV RECEIVING TUBES, TRANSISTORS, CRYSTAL DIODES AND TV PICTURE TUBES.

- A - CATHODE CONDUCTANCE TUBE TESTER - DESIGNED ACCORDING TO TIME-PROVEN EMISSION TESTING PRINCIPLES AS WERE ORIGINALLY RECOMMENDED BY RETMA AND TUBE MANUFACTURERS.
- B - COMPREHENSIVE TRANSISTOR TESTER - DESIGNED WITH THE ASSISTANCE OF ENGINEERING RECOMMENDATIONS FROM LEADING TRANSISTOR MANUFACTURERS. TESTS ICBO, GAIN, SHORTS AND LEAKAGE FOR ALL RF, AUDIO, POWER AND TETRODE TRANSISTORS - - NPN AND PNP TYPES.
- C - CRYSTAL DIODES ARE ACCOMMODATED IN A SPECIAL CIRCUIT, FOR BOTH FORWARD AND REVERSE CURRENT.
- D - TV PICTURE TUBES ARE ACCURATELY TESTED IN A SPECIALLY ENGINEERED CIRCUIT, FOR PICTURE-PRODUCING BEAM CURRENT, (NOT JUST CATHODE EMISSION). USES OPTIONAL ACCESSORY PICTURE TUBE ADAPTER CABLE, #PTA.

THE MODEL 660 WAS DEVELOPED FOR MAXIMUM SPEED IN USE WITH UTMOST SIMPLICITY OF OPERATION. "FREE-POINT" CIRCUIT ENGINEERING ASSURES THE HIGHEST DEGREE OF INSURANCE AGAINST OBSOLESCENCE.

ASIDE FROM ITS MANY DESIRABLE ELECTRICAL FEATURES, THE MODEL 660 EMPHASIZES ADVANCED FUNCTIONAL DESIGN AS IS EVIDENT IN ITS "APPLICATION-ENGINEERED" PANEL LAYOUT; - - - HIGH SPEED, THREE-WINDOW ROLL CHART WITH TIME-SAVING "TUBE-FINDER" TABS; - - - AND WIDE-ANGLE, FULL VIEW, 5-1/4" PACE METER.

OUTSTANDING TUBE TESTING FEATURES OF THE MODEL 660

1. ACCOMMODATES ALL SERIES STRING AND OTHER UP-TO-DATE TYPES. 22 INDIVIDUAL FILAMENT VOLTAGES FROM .75 TO 110 VOLTS. TESTS NOVAL BUTTON 9 PIN TUBES, LOCTALS, SINGLE-ENDED (TV AND FM AMPLIFIERS), REGULAR OCTALS (MG, G AND METALS), SPRAY-SHIELD AND GLASS TYPES AND MINIATURE 7 PIN TYPES, ETC.
2. TIME-PROVEN CATHODE CONDUCTANCE TUBE TESTING CIRCUIT SUBJECTS ALL TUBES TO A RELIABLE, STANDARDIZED EMISSIVE-CAPABILITY TEST.
3. OPEN ELEMENT TEST: - THIS SPECIAL TEST FACILITY SUPPLEMENTS THE PRIMARY CATHODE CONDUCTANCE TEST.
4. 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.
5. TRIPLE-WINDOW, HIGH SPEED, GEAR-OPERATED ROLLER TUBE CHART WITH TIME-SAVING. "TUBE-FINDER" PANEL TABS.
6. FREE-POINT FILAMENT TERMINAL SELECTION LOCATES TERMINALS OF ALL FILAMENTS (SINGLE, DOUBLE, CENTER-TAPPED) REGARDLESS OF ROTATING PIN POSITIONS.
7. VISIBLE FILAMENT CONTINUITY TESTS: - RAPIDLY SHOWS UP OPEN FILAMENTS INCLUDING OPEN SECTIONS OF TAPPED FILAMENTS.
8. BUILT-IN MINIATURE 7 AND 9 PIN STRAIGHTENERS.
9. TESTS SPECIAL-PURPOSE TUBES AND GAS RECTIFIER TYPES SUCH AS OY₄, OZ₃, OZ₄ AND REMOTE CONTROL GASEOUS TYPES SUCH AS OA₄ AND 2A₄, REGARDLESS OF VARYING FILAMENT TERMINATIONS OR OTHER ROTATING ELEMENT POSITIONS.
10. TESTS MULTI-SECTION TUBES: - INDIVIDUAL TESTS FOR EACH SECTION OF MULTI-SECTION TUBES. (WHERE REQUIRED), INCLUDING VISIBLE TESTS OF CATHODE RAY INDICATOR TUBES AND FM/AM TUNING INDICATOR TUBES.
11. HOT CATHODE LEAKAGE TESTS: - RELIABLE, SENSITIVE NEON METHOD QUICKLY SHOWS UP POOR CATHODE STRUCTURE IN ACCORD WITH LEAKAGE SPECIFICATIONS OF LEADING TUBE MANUFACTURERS.
12. DUAL-SENSITIVITY, INTER-ELEMENT SHORT TESTS MADE UNIVERSALLY SIMPLE THROUGH THE USE OF PRECISION LEVER DISTRIBUTION SYSTEM, AND SENSITIVE NEON CIRCUIT. DOUBLE SENSITIVITY IS MADE AVAILABLE THROUGH THE FLIP OF A SWITCH TO PERMIT SPECIAL TUBE SELECTION TO MORE RIGID STANDARDS.
13. BALLAST TEST: - THE REGULAR TUBE TEST SOCKETS ACCOMMODATE ALL BALLAST UNIT TESTS FOR OPEN AND LOOSE ELEMENTS AND LEAKAGE BETWEEN SECTIONS OF MULTI-SECTION BALLAST.

14. PILOT LIGHT TESTS FOR ALL MINIATURE SCREW-BASE AND BAYONET TYPE LAMPS.
15. 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.
16. LARGE, EASY-TO-READ, RUGGED, DOUBLE-JEWELLED PACE METER, ACCURATELY BALANCED AND FACTORY-CALIBRATED TO WITHIN ± 2 PERCENT. 100 MICROAMPERES SENSITIVITY.
17. MICRO-LINE ADJUSTMENT, READ DIRECTLY ON METER, PROVIDED BY USE OF CONTINUOUSLY VARIABLE, HEAVY DUTY LINE VOLTAGE CONTROL.
18. TELEPHONE-CABLED PLASTIC INSULATED WIRING EMPLOYED THROUGHOUT, IS HIGHLY RESISTANT TO MOISTURE. ASSURES RELIABLE TESTER PERFORMANCE EVEN UNDER HIGHLY HUMID CONDITIONS.
19. TEST CIRCUITS COMPLETELY TRANSFORMER ISOLATED FROM POWER LINE.

SPECIAL TRANSISTOR, CRYSTAL DIODE, AND PICTURE TUBE TESTING FEATURES

IN ADDITION TO THE PRECEDING INSTRUMENT FEATURES, THE MODEL 660 ALSO PROVIDES THE FOLLOWING SPECIALIZED TEST FEATURES:-

1. TESTS POWER TRANSISTORS AS WELL AS LOW POWER AUDIO AND RF TYPES. COLLECTOR TEST CURRENTS ARE SUFFICIENTLY HIGH TO INSURE TRUE CORRELATION WITH ACTUAL PERFORMANCE.
2. MEASURES ICBO IN TERMS OF MICROAMPERES OF COLLECTOR CURRENT.
3. PROVIDES FOR DIRECT DC BETA (GAIN) READINGS. THESE READINGS, IN THE CASE OF LOW POWER TRANSISTORS, ARE SUPPLEMENTED BY A LEAKAGE READING FOR MAXIMUM GAIN ACCURACY.
4. PROVIDES SAFETY-TYPE COLLECTOR SHORT TEST AS THE FIRST TEST STEP.
5. ALL TRANSISTOR SOCKET TERMINATIONS ARE DISTRIBUTED TO TEST CIRCUITS THROUGH THE MASTER LEVER SYSTEM. THIS ASSURES UTMOST FLEXIBILITY FOR ACCOMMODATION OF FUTURE TRANSISTOR RELEASES.
6. SPECIAL SOCKETS FOR TRANSISTOR TESTS ARE SUPPLEMENTED BY A UNIVERSAL TRANSISTOR TEST CABLE. THIS ARRANGEMENT MINIMIZES OBSOLESCENCE.
7. CRYSTAL DIODES CHECKED IN ACCORDANCE WITH MANUFACTURERS' SPECS FOR FORWARD AND REVERSE CURRENT, AT SPECIFIED TEST VOLTAGES.
8. TV PICTURE TUBES ARE TESTED THROUGH USE OF ACCESSORY PTA CABLE FOR TRUE PICTURE-PRODUCING BEAM CURRENT, NOT CATHODE EMISSION.

* * * * *

TRANSISTOR TESTING

IN ORDER TO MORE CLEARLY ACQUAINT THE TECHNICIAN WITH THE FUNCTION OF THE MODEL 660 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 THE LAST PAGE 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 " I_{cbo} " (TO BE DISCUSSED IN DETAIL 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 " I_{cbo} " 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 " I_{cbo} " TEST BECAUSE OF THIS METER SENSITIVITY PROBLEM AND, AS A RESULT, RELY UPON OTHER LESS REVEALING CHARACTERISTICS TO DETERMINE TRANSISTOR CONDITION. THE MODEL 660, 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. I_{cbo} - 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 " I_{ebo} ". IN FACT, " I_{ebo} " IS A CHARACTERISTIC USED BY THE TRANSISTOR MANUFACTURER FOR SOME TYPES OF TESTS. (SEE PAGES 15, 16, AND 17)
2. I_{cbs} - 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 660. IN THE MODEL 660, 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.

* * * * *

THE SCHEMATIC REPRESENTATION OF A TRANSISTOR IS ILLUSTRATED IN FIGURE 1, PAGE 4. 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 660 IS THEREFORE THE FIRST IMPORTANT TEST. SEE FIG. 2, "SHORT TEST". A SHORTED OR LOW RESISTANCE TRANSISTOR SHOULD BE REJECTED WITHOUT FURTHER TESTING.

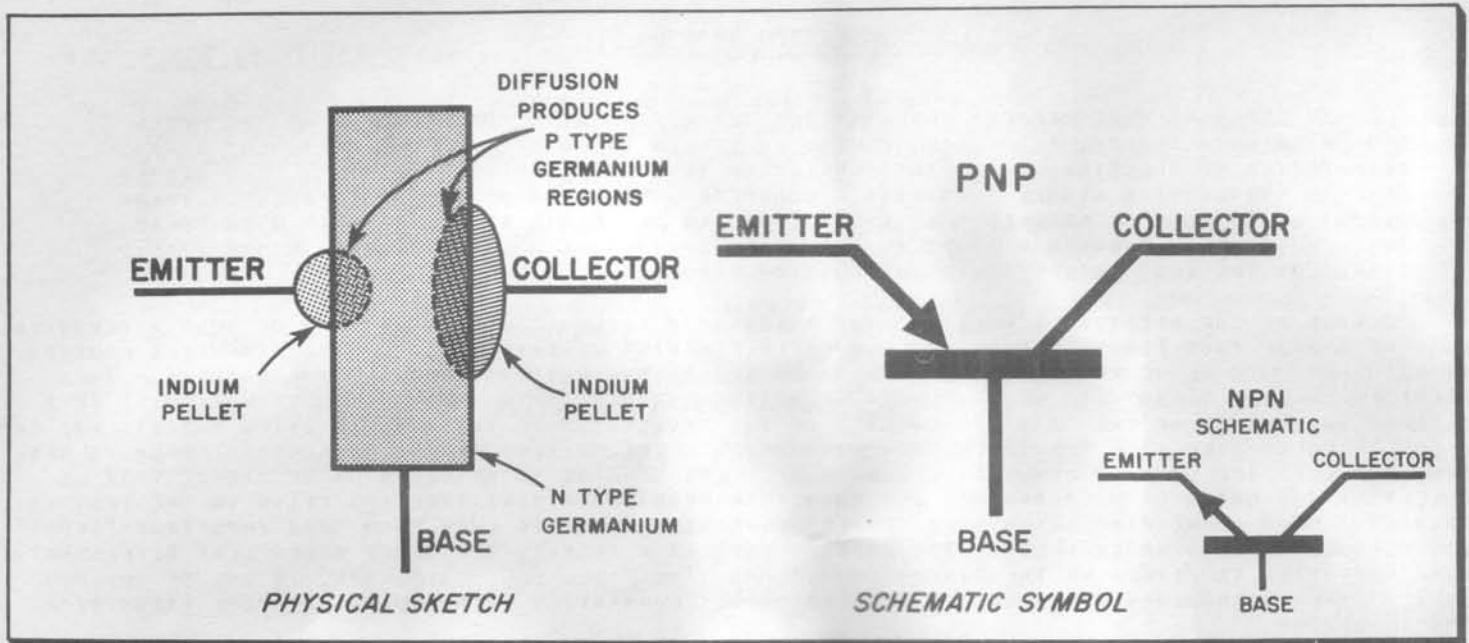


FIG. 1 DIFFUSED JUNCTION PNP TRANSISTOR

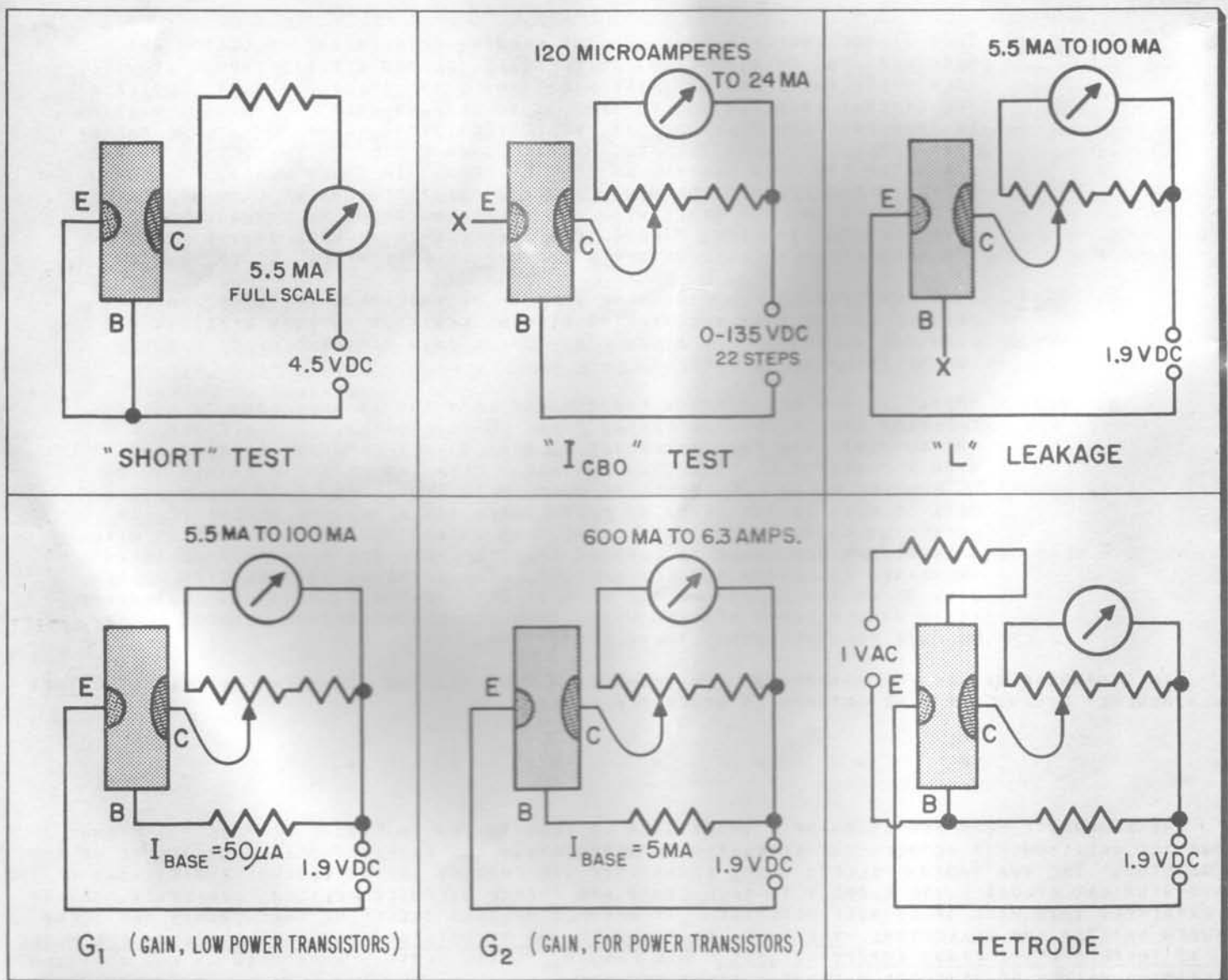


FIG. 2 BASIC CIRCUITS • 660 TRANSISTOR TESTS

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 660.

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 "D" SWITCH OF THE 660 SETS UP THE 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 "G₁" FOR "GAIN". SEE FIG. 2, FOURTH ILLUSTRATION.

THESE TWO POSITIONS, THE "L" POSITION AND THE "G₁" POSITION, ARE THEREFORE USED TO DETERMINE THE BETA OR GAIN OF A LOW POWER TRANSISTOR AND IS SIMPLY DONE ON THE 660 BY SUBTRACTION OF THE "L" READING FROM THE "G₁" READING TO YIELD AN ACTUAL GAIN NUMBER. (G₁ POSITION IS USED FOR LOW POWER TRANSISTORS: G₂ 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 GAIN 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.

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.

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 SELECTOR SWITCH "D" OF MODEL 660 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 PRE-DETERMINED 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 660 BY THE USE OF A SEPARATE GAIN SELECTOR SWITCH POSITION ON SWITCH "D" MARKED "G₂". ALL POWER TRANSISTORS ARE THEREFORE GAIN CHECKED NOT IN POSITION G₁ BUT IN POSITION G₂. NOTE THAT "L" OR LEAKAGE TESTS SHOULD NOT BE MADE WITH POWER TRANSISTORS. RESULTS WILL BE IN ERROR IF "L" READINGS ARE SUBTRACTED FROM "G₂" READINGS DUE TO THE FACT THAT G₂ METER READINGS ARE NOT INTENDED TO RELATE TO "L" READINGS.

PICTURE TUBE TESTING

THE MODEL 660 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.

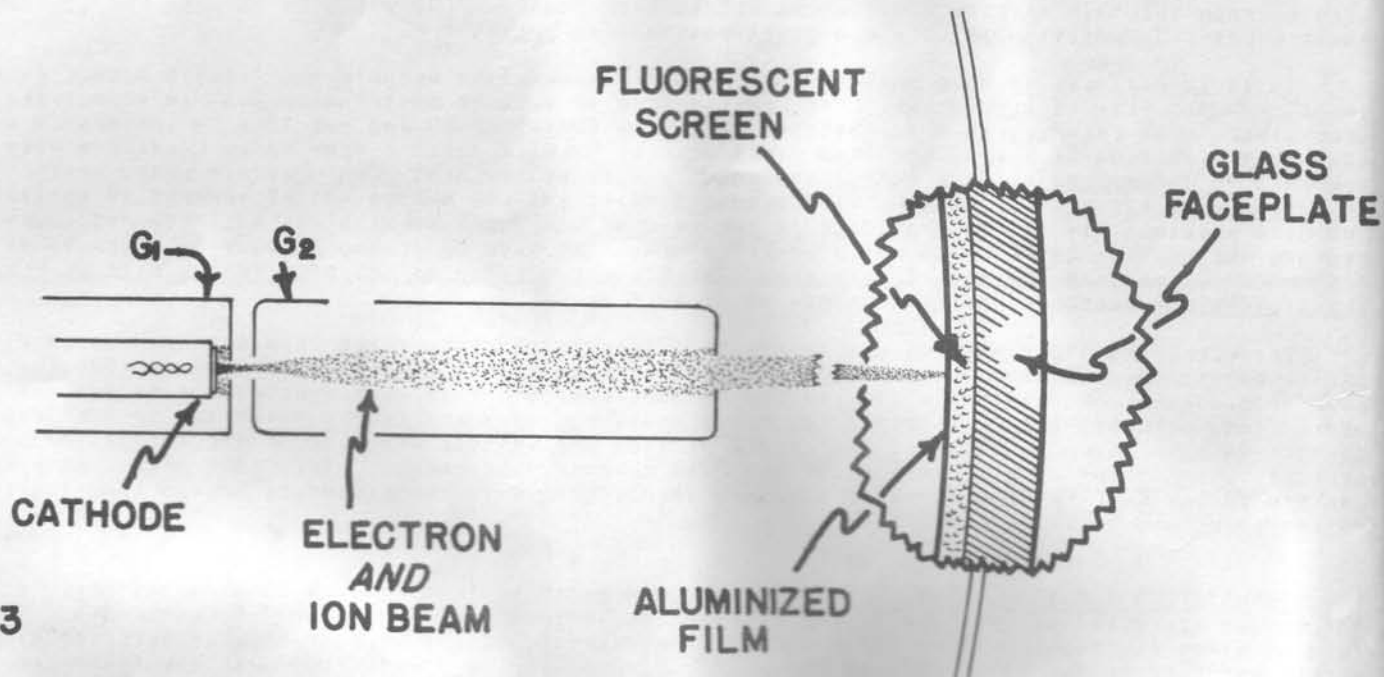


FIG. 3

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 660 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 660, 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 660 (0 TO 135V. D.C.) IN 22 STEPS ASSURES AVAILABILITY OF TEST VOLTAGES EXACTLY EQUAL OR CLOSELY SIMILAR TO MANUFACTURERS' TEST VOLTAGES FOR REVERSE CURRENT.

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OPERATING INSTRUCTIONS

A. TUBE TEST INSTRUCTIONS

1. CONNECT LINE PLUG TO 110-125 VOLTS 50-60 CYCLES SOURCE. (FIL)
2. REFER TO THE ROLLER CHART AND SET THE LEVER LISTED UNDER "A" TO THE "A" ROW, AND CONTROLS B, C, AND D TO THE POSITIONS LISTED ON THE ROLLER CHART (ALL LEVERS OTHER THAN THE ONE THROWN TO THE "A" ROW REMAIN IN THE "NORMAL" ROW).
3. SET "SHORT CHECK" SLIDE SWITCH (ADJACENT TO NEON LAMP) TO "STD" POSITION (1/2 MEGOHM SENSITIVITY). THROW SWITCH TO "HIGH" POSITION IF DOUBLE SENSITIVITY ON SHORT TEST IS DESIRED.
4. THROW THE POWER SLIDE SWITCH TO THE "ON" POSITION.
5. INSERT THE TUBE AND ALLOW TO HEAT.

NOTE: FILAMENT CONTINUITY CAN BE CHECKED AT THIS POINT IF SO DESIRED AS FOLLOWS:-

MOVE THE LEVER WHICH WAS JUST SET TO THE "A" POSITION DOWN TO THE TEST POSITION AND THEN BACK TO "A". THE NEON LAMP SHOULD GLOW WHEN THE LEVER IS IN THE TEST POSITION. IF NO GLOW IS OBTAINED, REJECT THE TUBE WITHOUT FURTHER TEST. DISREGARD ANY MOMENTARY NEON LAMP FLASHES AS LEVERS ARE MOVED. THESE FLASHES ARE MERELY THE DISCHARGE OF THE BLOCKING CONDENSER IN THE SHORT CHECK CIRCUIT.

6. ROTATE THE "ADJ LINE" CONTROL UNTIL THE METER POINTER LINES UP WITH THE "ADJ LINE" INDICATION.
7. AFTER THE TUBE HAS HEATED, THROW WHATEVER LEVERS ARE LISTED UNDER "CATH SHORT" SIMULTANEOUSLY TO THE "TEST" ROW AND THEN BACK TO NORMAL. THE NEON LAMP SHOULD NOT GLOW WHEN THE LEVERS ARE IN THE "TEST" POSITION. IF GLOW IS OBTAINED, A CATHODE SHORT EXISTS, AND THE TUBE SHOULD BE REJECTED WITHOUT FURTHER TESTING. THE TUBE SHOULD BE LIGHTLY TAPPED DURING THIS TEST.
8. ANY LEVERS LISTED UNDER "CONTINUITY" SHOULD BE THROWN INDIVIDUALLY TO THE "TEST" ROW AND THEN BACK TO NORMAL. THE NEON LAMP SHOULD GLOW WHEN EACH LEVER IS IN THE "TEST" POSITION.
9. THROW EACH LEVER LISTED UNDER "TEST" UP TO TEST ROW, ONE BY ONE, IN THE ORDER LISTED ON THE CHART. WATCH THE NEON LAMP AS EACH LEVER IS THROWN TO THE TEST ROW. NEON SHOULD NOT GLOW (UNLESS OTHERWISE INDICATED ON THE ROLLER CHART). IF A GLOW IS OBTAINED, A SHORTED ELEMENT IS INDICATED AND THE TUBE SHOULD BE REJECTED. THE TUBE SHOULD BE LIGHTLY TAPPED DURING THIS TEST.
10. WHEN ALL INDICATED LEVERS ARE IN THE TEST POSITION, PRESS THE "READ METER" BUTTON AND READ TUBE QUALITY ON THE METER.

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B. SPECIAL TUBE TEST NOTES

1. OPEN ELEMENT TESTS

SHOULD THE CATHODE OR CONTROL GRID OF A TUBE TO BE TESTED BE OPEN CIRCUITED WITHIN THE TUBE (AN UNUSUAL OCCURRENCE) A "REPLACE" INDICATION WILL AUTOMATICALLY BE OBTAINED DURING THE QUALITY TEST. SHOULD THE RELATIVELY RARE CONDITION OF AN OPEN CIRCUITED SCREEN OR PLATE, ETC., OCCUR, THE CONDITION MAY BE ASCERTAINED DURING THE QUALITY TEST BY HOLDING THE "READ METER" BUTTON DOWN AND INDIVIDUALLY THROWING THE LEVERS UNDER "TEST" POSITION ON THE ROLLER CHART TO "OPEN" POSITION AND THEN BACK TO "TEST" POSITION. IF AN ELEMENT IS OPEN CIRCUITED NO MOVEMENT OF THE METER POINTER WILL BE NOTED AS ITS CORRESPONDING NUMBERED LEVER IS ACTUATED.

2. "EYE TESTS" (ELECTRON RAY TYPE INDICATOR TUBES)

NOTE: FOR A COMPLETE SHORT TEST ON "EYE" TUBES, WATCH FOR NEON GLOW ON THE "TEST" LEVERS SAME AS IS DONE FOR ALL OTHER TYPES OF TUBES.

(A) SINGLE TARGET TYPE. THIS TYPE IS TYPIFIED BY TYPES 6E5 AND 6G5: FOR EXAMPLE, A ROLLER CHART LINE FOR THE "EYE" SECTION TYPE 6E5 APPEARS AS FOLLOWS:-

TUBE		A	B	C	D	TEST
6E5	EYE	1	9	0	4	2 4

THE FOLLOWING TEST PROCEDURE MUST BE EMPLOYED:- SET ALL SWITCHES AND LEVERS AS INDICATED ON THE ROLLER CHART FOR "EYE". 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 "TEST" LEVER SETTING (IN THIS EXAMPLE, LEVER 2) TO THE "NORMAL" POSITION.

A GOOD TUBE WILL NOW EXHIBIT A TYPICAL ANGULAR SHADOW. RETURN THE SAME FIRST LEVER TO ITS ORIGINAL "TEST" POSITION AND NOTE CLOSURE OF THE SHADOW ANGLE. DISREGARD METER INDICATIONS.

(B) DOUBLE TARGET TYPE. (TWIN ELECTRON RAY INDICATOR TUBES SUCH AS 6AD6 AND 6AF6)

FOR EXAMPLE, A TYPICAL ROLLER CHART LINE FOR TYPE 6AD6 APPEARS AS FOLLOWS:-

TUBE	EYE	A	B	C	D	CATH SHORT	TEST
6AD6		2	9	0	4	8	3-4-5

TEST PROCEDURE IS AS FOLLOWS:- SET "A", "B", "C", "D" AS INDICATED. PERFORM CATHODE SHORT TEST. SET LEVERS 3, 4, AND 5 TO "TEST" ROW AND OBSERVE NEON BULB FOR SHORT INDICATIONS. DEPRESS THE "READ METER" BUTTON AND OBSERVE THE CIRCULAR FLUORESCENT SCREEN WHICH SHOULD ILLUMINATE COMPLETELY.

NEXT, THROW THE FIRST OF THE THREE LEVERS UNDER THE "TEST" SETTINGS (IN THIS EXAMPLE, LEVER 3) TO THE "NORMAL" POSITION. A GOOD TUBE WILL NOW EXHIBIT A TYPICAL ANGULAR SHADOW.

NEXT, THROW THE SECOND OF THE THREE LEVERS UNDER THE "TEST" SETTINGS (IN THIS EXAMPLE, LEVER 4) TO THE "NORMAL" POSITION. THE TUBE, IF GOOD, WILL EXHIBIT ANOTHER ANGULAR SHADOW OPPOSITE THE POSITION OCCUPIED BY THE FIRST SHADOW. DISREGARD METER INDICATIONS.

(C) FM/AM EYE TESTS (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 660.

TEST PROCEDURE IS AS FOLLOWS:- SET ALL LEVERS AND SWITCHES 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 IN THE PARENTHESIS FROM ITS "A" POSITION TO "OPEN" POSITION. ONE RECTANGULAR PATTERN SHOULD BECOME SLIGHTLY SHORTER IN LENGTH.

NEXT, THROW THE SECOND LEVER LISTED IN THE PARENTHESIS FROM ITS "A" POSITION TO "OPEN" POSITION. THE OTHER RECTANGULAR PATTERN SHOULD THEN BECOME SHORTER IN LENGTH.

NEXT, THROW THE THIRD LEVER LISTED IN THE PARENTHESIS FROM ITS "A" POSITION TO "OPEN" POSITION. BOTH ENDS OF THE PATTERN (OPPOSITE TO THE ENDS NOTED ABOVE) SHOULD THEN SLIGHTLY DECREASE IN LENGTH. OBSERVE THESE ENDS CLOSELY AS THE MOVEMENT MAY BE SLIGHT.

3. SPECIAL RECTIFIER TESTS (TYPES 70A7, 117N7 AND 117P7)

BECAUSE OF UNUSUAL INTERNAL CONNECTIONS (PLATE TIES TO ONE SIDE OF FILAMENT) THE 70A7, 117N7 AND 117P7 RECTIFIER SECTIONS REQUIRE SLIGHTLY SPECIAL TEST PROCEDURES.

70A7 - RECTIFIER SECTION. SET ALL CONTROLS AND LEVER 2 IN ACCORDANCE WITH THE ROLLER CHART. AFTER THE TUBE HAS HEATED SUFFICIENTLY THROW BOTH LEVERS 2 AND 7 RAPIDLY TO "OPEN" POSITION AND THEN LEVER 6 RAPIDLY TO "TEST" 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 AND 117P7 - RECTIFIER SECTION. SET ALL CONTROLS AND LEVER 2 IN ACCORDANCE WITH THE ROLLER CHART. ALL LEVERS, WITH THE EXCEPTION OF LEVER 2, MUST BE IN "NORMAL" POSITION. AFTER THE TUBE HAS HEATED SUFFICIENTLY, THROW LEVER 2 RAPIDLY TO "OPEN" POSITION AND LEVER 7 RAPIDLY TO "TEST" 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.

4. TUBES WITH AN ELEMENT (OR ELEMENTS) WHICH TERMINATE IN MORE THAN 1 PIN

PIN NUMBERS LISTED UNDER THE "CONTINUITY" COLUMN ON THE ROLLER CHART MUST SHOW SHORT (CONTINUITY) WHEN THE CORRESPONDING LEVER IS THROWN TO "TEST" POSITION. FOR NORMAL USAGE ANY TUBE WHICH DOES NOT SHOW SHORT ON THE DESIGNATED LEVERS SHOULD BE CONSIDERED A DEFECTIVE TUBE; HOWEVER, SOME OF THESE TUBES MAY BE SALVAGED:- FOR EXAMPLE

(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.

5. GAS TYPE RECTIFIERS OY4, OZ3 AND OZ4

WHEN TESTING THESE GAS RECTIFIER TYPES, IT WILL BE NOTED THAT THE METER POINTER WILL REMAIN, FOR A 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.

6. SUB-MINIATURE TUBE TESTS

THE PRECISION DUAL G-116 ADAPTER HAS BEEN DEVELOPED AS THE MOST PRACTICAL AND ECONOMIC MEANS FOR RAPID CHECK OF SUB-MINIATURE TUBES IN PRECISION TUBE TESTERS.

THIS ADAPTER PROVIDES TEST SOCKETS FOR BOTH THE ROUND AND FLAT TUBE TYPES AS SHOWN IN FIG. 4.

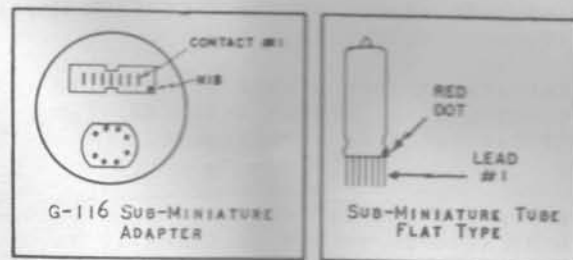


FIG. 4

THE ROUND TYPE OF SUB-MINIATURE TUBE IS KEYED IN THE SAME MANNER AS THE POPULAR MINIATURE 7 PIN TYPE, WHICH MAKES FOR SIMPLE IDENTIFICATION FOR INSERTION IN THE SOCKET.

THE FLAT TYPE OF TUBE IS KEYED BY A RED DOT AT ONE CORNER. THE LEADS READ IN SEQUENCE FROM THAT CORNER, WITH LEAD #1 BEING THE LEAD 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.

THE PRECISION "G-116 SUBMINIATURE ADAPTER" IS AVAILABLE DIRECTLY FROM PRECISION FACTORY SERVICE DEPT.

APPLICATION OF THE G-116 SUBMINIATURE ADAPTER

1. INSERT THE ADAPTER INTO THE OCTAL SOCKET OF YOUR MODEL 660.
2. THE TEST DATA FOR THE PARTICULAR SUBMINIATURE TUBE TO BE TESTED WILL BE FOUND ON EITHER THE ROLLER CHART OR SUPPLEMENT SHEETS WHICH ACCOMPANY EACH TUBE TESTER.

3. SET UP THE CONTROLS AND SWITCHES OF THE TUBE TESTER IN THE SAME FASHION AS IS DONE FOR ALL OTHER TUBES.
4. CAREFULLY INSERT THE LEADS OF THE SUBMINIATURE TUBE INTO THE PROPER SOCKET (ROUND OR FLAT AS THE CASE MAY BE). THE LEADS OF SUBMINIATURE TYPE TUBES CAN BE VERY EASILY BENT OUT OF LINE. IN THE CASE OF THE FLAT TYPE BE SURE TO FOLLOW THE KEYING IDENTIFICATION NOTED PREVIOUSLY.
5. PROCEED WITH ALL STANDARD TESTS AS DETAILED IN THIS MANUAL.

NOTE: IN ADDITION TO SUBMINIATURE TUBES INTENDED FOR USE WITH SOCKETS, THERE ARE ALSO TYPES WITH LONG FLEXIBLE LEADS WHICH ARE DIRECTLY SOLDERED INTO THEIR RESPECTIVE OPERATING CIRCUITS (WITH THE LEADS CUT TO VARYING LENGTHS). IN THE EVENT A TUBE OF THIS TYPE HAS BEEN REMOVED FROM ITS CIRCUIT FOR TEST, THE OPERATOR MAY FIND IT DIFFICULT TO INSERT THE TUBE LEADS INTO THE G-116 ADAPTER SOCKETS.

TO COPE WITH THIS SPECIAL PROBLEM A UNIVERSAL SUBMINIATURE ADAPTER IS ALSO MADE, ---PRECISION G-110. THIS ADAPTER HAS FLEXIBLE LEADS TERMINATING IN INDIVIDUAL CONTACT CLIPS. THIS ADAPTER IS ALSO AVAILABLE FROM PRECISION'S FACTORY SERVICE DEPT.

7. TUBE-BRAND VARIATIONS

IN DETERMINING THE TUBE TEST LIMITS FOR THIS INSTRUMENT, PRECISION ENGINEERS 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 MODEL 660 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 "C" AVERAGE SETTING REQUIRED TO PASS THESE TUBES AT APPROXIMATELY 84 OF THE 0-120 SCALE BELOW THE 3 COLOR TUBE TESTING ARC.

IT CAN READILY BE SEEN THAT A CONSISTENTLY LOW OR HIGH READING FOR ANY PARTICULAR TUBE TYPE OF A DEFINITE MANUFACTURER IS NOT NECESSARILY TO BE TAKEN AS INDICATIVE OF A POORER OR BETTER RUN OF TUBES, NOR AS A DEFECT IN THE TUBE TESTER.

8. 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 SWITCH "B" TO ONE OF THE FOLLOWING APPLICABLE VOLTAGES:-

VOLTS	"B" POS.
.75	1
1.5	2
2.0	3
2.5	4
3.3	5
4.2	6
4.7	7
5.0	8
6.3	9
7.5	10
8.4	11

VOLTS	"B" POS.
10	12
12.6	13
15	14
16.8	15
18.5	16
21	17
25	18
30	19
50	20
70	21
110	22

- (B) SET LEVER #1 TO POSITION "A"; TURN INSTRUMENT "ON"; ADJUST FOR "LINE"; INSERT BULB. **NOTE:** LEVER SWITCHES 2 THROUGH 0 MUST BE IN "NORMAL" POSITION.

C. OPERATING INSTRUCTIONS FOR TRANSISTOR TESTS

- NOTE 1:** ALL TEST READINGS ARE ACCURATE ONLY WHEN THE SURROUNDING TEMPERATURE IS IN THE REGION OF 77° FAHRENHEIT.
- NOTE 2:** 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.
- NOTE 3:** NEVER PLACE LOAD SWITCH "D" IN TUBE TEST POSITIONS (POSITIONS 1-5) WHEN TESTING TRANSISTORS. USE ONLY APPROPRIATE (RED) "D" SWITCH POSITIONS FOR TRANSISTORS.

(A) LOW POWER TRANSISTORS (AUDIO, RF, COMPUTER, ETC.)

- (1) FROM THE TRANSISTOR TEST DATA SHEET SUPPLIED WITH YOUR 660, SET THE LEVER SWITCHES TO THE SETTINGS INDICATED FOR THE TRANSISTOR TO BE TESTED.
- (2) SET SWITCH "B" AND CONTROL "C" IN ACCORD WITH THE DATA.
- (3) FROM THE DATA, DETERMINE WHETHER THE TRANSISTOR IS PNP OR NPN TYPE AND SET SWITCH "D" TO "SHORT" POSITION ACCORDINGLY.
- (4) THROW "PWR" SWITCH TO "ON" AND SET "ADJ LINE" CONTROL SO THAT THE METER LINES UP WITH THE "ADJ LINE" CALIBRATION.
- (5) PLUG THE TRANSISTOR INTO THE SMALL RECTANGULAR TRANSISTOR SOCKET IF THE CONDITION OF THE TRANSISTOR LEADS PERMIT. NOTE THE POLARIZATION AND IDENTIFICATION OF THE LEADS IN FIG. 5 BELOW. (FOR ADDITIONAL TRANSISTOR TYPES, SEE ILLUSTRATION AT THE END OF THIS MANUAL).

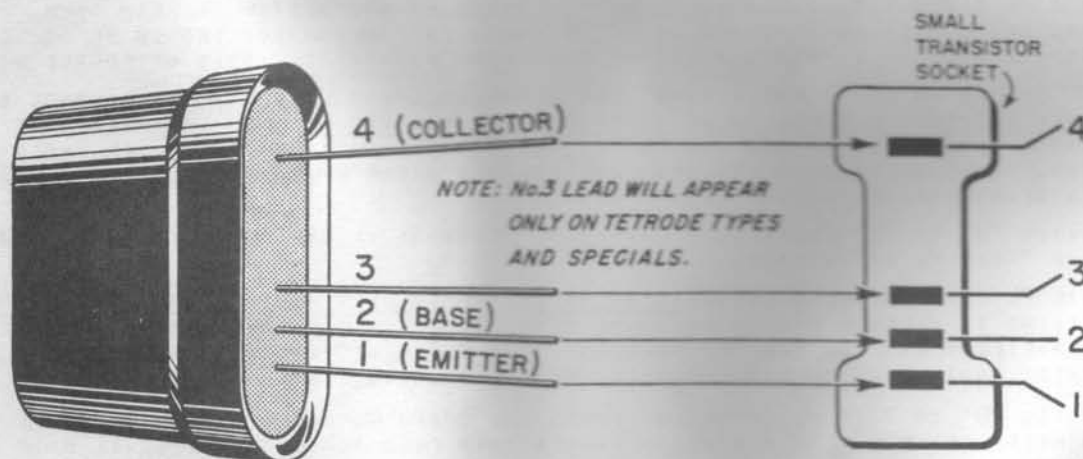


FIG. 5 PLUG-IN TYPE LOW POWER TRANSISTOR

- (6) IF THE TRANSISTOR LEADS DO NOT PERMIT INSERTION INTO THE SOCKET, USE THE ADAPTER LEADS FURNISHED WITH YOUR 660 AND CONNECT BETWEEN THE THREE PANEL JACKS AND THE TRANSISTOR AS ILLUSTRATED IN FIG. 6 ON THE NEXT PAGE. (USE THE RED ALLIGATOR LEAD WHICH COMES UP OUT OF THE TOOL COMPARTMENT TO CONNECT THE COLLECTOR LEAD OF THE TRANSISTOR)

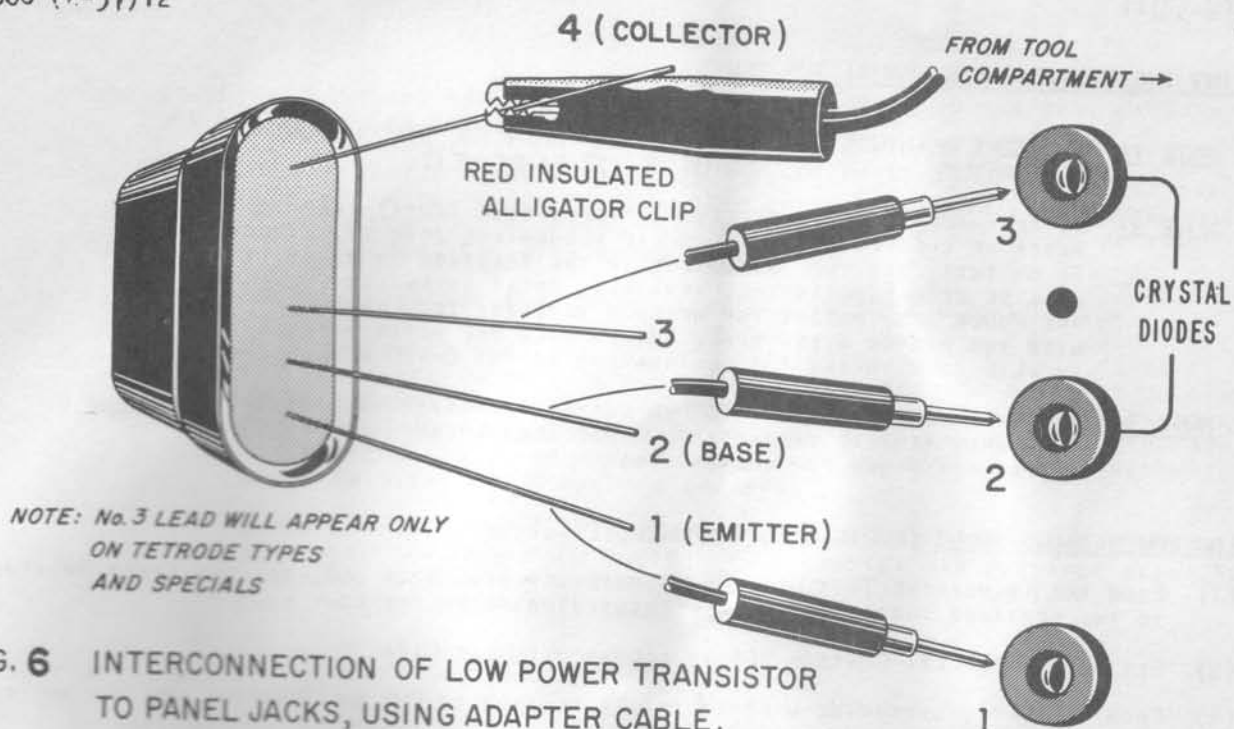


FIG. 6 INTERCONNECTION OF LOW POWER TRANSISTOR TO PANEL JACKS, USING ADAPTER CABLE.

(7) DEPRESS THE "READ METER" BUTTON AND READ THE 0-120 TRANSISTOR SCALE FOR "SHORT TEST" AS LISTED ON THE TEST DATA SHEET. (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 AN ICBO TEST.

(8) ROTATE SWITCH "D" TO "ICBO", DEPRESS "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 DATA).

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.

SPECIAL NOTE: AS AN EXTRA PRECAUTION, THE USER CAN START WITH THE "C" CONTROL SET AT "0" WHICH PROVIDES MAXIMUM SHUNTING PROTECTION FOR THE METER. THEN WITH THE "READ METER" BUTTON DEPRESSED, ROTATE THE "C" CONTROL TO THE POSITION INDICATED UNDER TEST DATA FOR ICBO. THIS PRECAUTION APPLIES PARTICULARLY WHERE A READING CLOSE TO THE REJECT POINT HAS BEEN OBTAINED UNDER "SHORT" TEST.

(9) ROTATE SWITCH "D" TO "L" (LEAKAGE). RESET "C" CONTROL IF SO INDICATED ON TEST DATA SHEET. DEPRESS THE "READ METER" BUTTON.

NOTE: THIS "L" OR LEAKAGE READING IS TO BE ARITHMETICALLY SUBTRACTED FROM THE "G₁" (GAIN) READING 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.

(10) ROTATE SWITCH "D" TO "G₁" POSITION AND PRESS THE "READ METER" BUTTON. READ THE GAIN VALUE ON THE 0-120 METER SCALE. IF METER READS HIGHER THAN FULL SCALE, SEE SPECIAL NOTE ON PAGE 15. SUBTRACT THE "L" OR LEAKAGE READING OBTAINED IN STEP 9 FROM THE "G₁" 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 "G₁" 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.

(11) IF THE TRANSISTOR HAS A TETRODE CONNECTION, PROCEED AS FOLLOWS:-

AFTER THE G₁ TEST HAS BEEN COMPLETED, THROW THE LEVER WHICH CORRESPONDS TO THE TETRODE CONNECTION TO THE "TETRODE" ROW, PRESS THE "READ METER" BUTTON AND WATCH FOR A READING LOWER THAN THE G₁ READING. IF THE READING DOES NOT DIFFER FROM THE G₁ READING, THEN THE CONDITION OF THE TETRODE CONNECTION OF THE TRANSISTOR IS TO BE QUESTIONED.

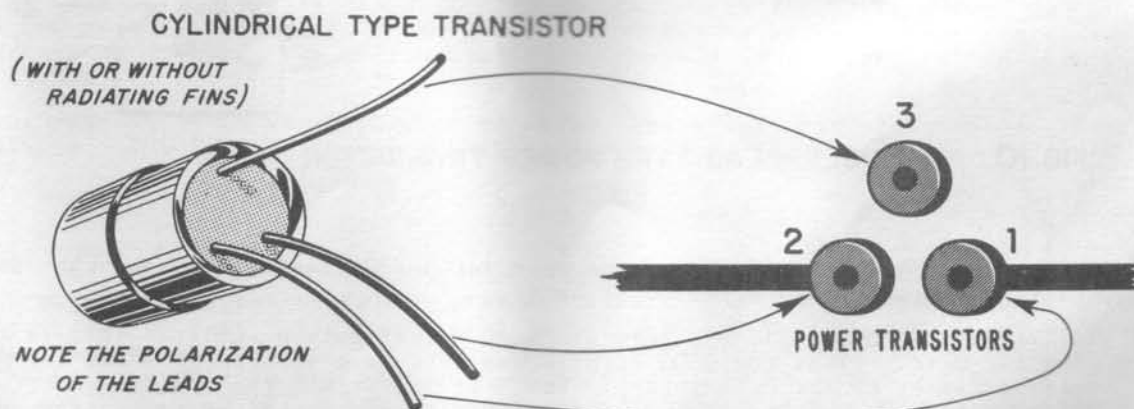
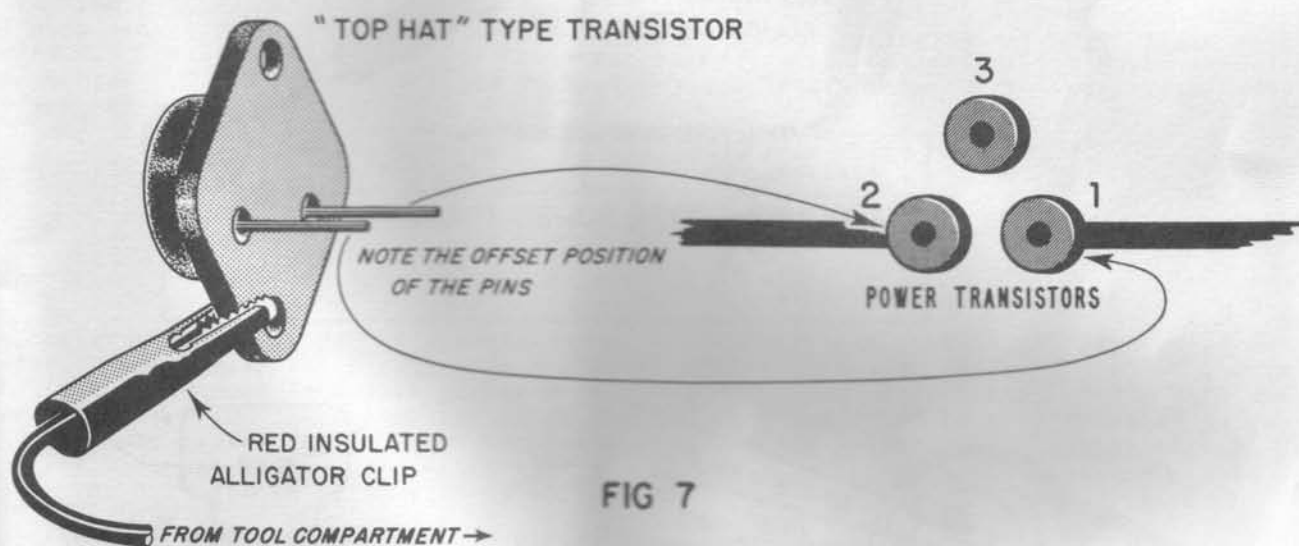
IMPORTANT NOTE: "G₂" POSITION IS FOR POWER TRANSISTORS ONLY. NEVER DEPRESS "READ METER" SWITCH WITH A LOW POWER TRANSISTOR ACCIDENTALLY SET TO "G₂" POSITION OR YOU MAY BURN OUT THE TRANSISTOR.

(B) POWER TRANSISTORS

NOTE 1: ALL TEST READINGS ARE ACCURATE ONLY WHEN THE SURROUNDING TEMPERATURE IS IN THE REGION OF 77° FAHRENHEIT.

NOTE 2: NEVER PLACE LOAD SWITCH "D" IN TUBE TEST POSITIONS (POSITIONS 1-5) WHEN TESTING TRANSISTORS. USE ONLY APPROPRIATE (RED) "D" SWITCH POSITIONS FOR TRANSISTORS.

- (1) FROM THE TRANSISTOR TEST DATA SHEET SUPPLIED WITH YOUR 660, SET THE LEVER SWITCHES TO THE SETTINGS INDICATED FOR THE TRANSISTOR TO BE TESTED.
- (2) SET SWITCH "B" AND CONTROL "C" IN ACCORD WITH THE DATA.
- (3) FROM THE DATA, DETERMINE WHETHER THE TRANSISTOR IS PNP OR NPN TYPE AND SET SWITCH "D" TO "SHORT" POSITION ACCORDINGLY.
- (4) THROW "PWR" SWITCH TO "ON" AND SET "ADJ LINE" CONTROL SO THAT THE METER LINES UP WITH THE "ADJ LINE" CALIBRATION.
- (5) PLUG IN TRANSISTOR AS INDICATED IN THE FOLLOWING ILLUSTRATIONS. (FOR ADDITIONAL TRANSISTOR TYPES, SEE ILLUSTRATIONS AT THE END OF THIS MANUAL).



- (6) IF THE TRANSISTOR LEADS DO NOT PERMIT INSERTION INTO THE SOCKET, USE THE ADAPTER LEADS FURNISHED WITH YOUR 660.

NOTE: REFER TO THE RELATED FIGURE IN THIS MANUAL WHICH ILLUSTRATES THE TRANSISTOR LEAD NUMBERING SYSTEM. USE THE ADAPTER CABLE TO CONNECT THE NUMBERED TRANSISTOR TERMINALS TO THEIR CORRESPONDING NUMBERED PANEL-JACK. IF A TRANSISTOR TERMINAL IS NUMBERED "4", CONNECT THE ALLIGATOR CLIP WHICH EMERGES FROM THE TOOL COMPARTMENT TO THIS LEAD. (ONLY LEADS 1 AND 2 OF THE ADAPTER CABLE SHOULD BE USED IN THIS LATTER EXAMPLE)

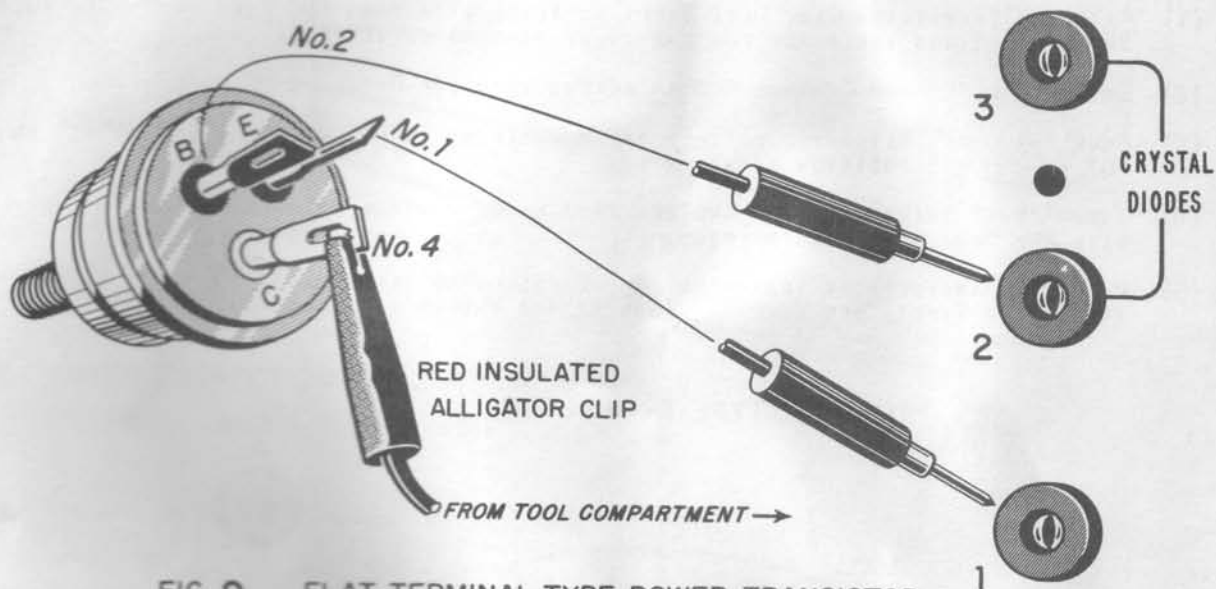


FIG. 9 FLAT-TERMINAL TYPE POWER TRANSISTOR

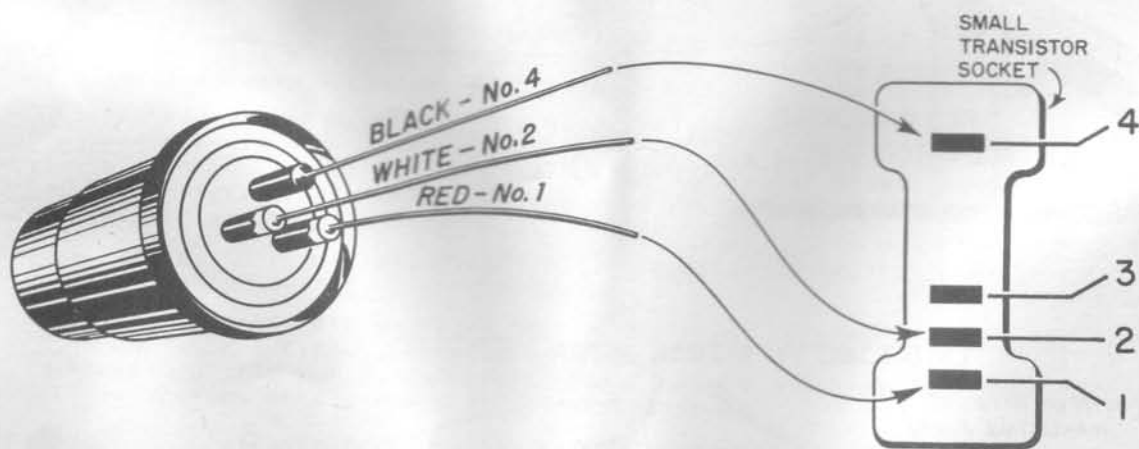


FIG. 10 FLEXIBLE-LEAD TYPE POWER TRANSISTOR

- (7) DEPRESS THE "READ METER" BUTTON AND READ THE 0-120 TRANSISTOR SCALE FOR "SHORT REJECT" AS LISTED ON THE TEST DATA SHEET.
- (8) ROTATE SWITCH "D" TO "ICBO", DEPRESS "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 DATA SHEET). SEE PAGE 16, ITEM 6 FOR TABLE OF "FULL SCALE METER CURRENT . . ." VERSUS "C" CONTROL SETTINGS TO RELATE METER READING TO ICBO IN TRUE CURRENT.

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.

SPECIAL NOTE: AS AN EXTRA PRECAUTION, THE USER CAN START WITH THE "C" CONTROL SET AT "0" WHICH PROVIDES MAXIMUM SHUNTING PROTECTION FOR THE METER. THEN WITH THE "READ METER" BUTTON DEPRESSED, ROTATE THE "C" CONTROL TO THE POSITION INDICATED UNDER TEST DATA FOR ICBO. THIS PRECAUTION APPLIES PARTICULARLY WHERE A READING CLOSE TO THE REJECT POINT HAS BEEN OBTAINED UNDER SHORT TEST.

- (9) IT IS NOT NECESSARY TO TAKE AN "L" (LEAKAGE) READING FOR POWER TRANSISTORS INASMUCH AS THE "L" READING WOULD BE A NEGLIGIBLE VALUE COMPARED TO THE LARGE COLLECTOR CURRENTS INVOLVED IN THE "G₂" (GAIN) TEST.
- (10) ROTATE SWITCH "D" TO "G₂" POSITION (G₁ IS USED ONLY FOR LOW POWER TRANSISTORS). RESET "C" CONTROL IF SO INDICATED ON TEST DATA SHEET. PRESS THE "READ METER" BUTTON AND READ THE GAIN VALUE ON THE 0-120 METER SCALE. (Do NOT TAKE AN "L" READING FOR POWER TRANSISTORS)
- (11) IF THE TRANSISTOR HAS A TETRODE CONNECTION, PROCEED AS FOLLOWS:-

AFTER THE G₂ TEST HAS BEEN COMPLETED, THROW THE LEVER WHICH CORRESPONDS TO THE TETRODE CONNECTION TO THE "TETRODE" ROW, PRESS THE "READ METER" BUTTON AND WATCH FOR A READING LOWER THAN THE G₂ READING. IF THE READING DOES NOT DIFFER FROM THE G₂ READING, THEN THE CONDITION OF THE TETRODE CONNECTION OF THE TRANSISTOR IS TO BE QUESTIONED.

* * * * *

SPECIAL NOTE REGARDING METER SENSITIVITY FOR TRANSISTOR GAIN AND LEAKAGE TESTS

THE MODEL 660 "C" CONTROL SETTING DETERMINES THE RANGE OF THE METER FOR ANY TEST. THE "C" CONTROL SETTING OF 50 LISTED FOR MOST TRANSISTORS UNDER "GAIN TEST" ON THE TEST DATA SHEET 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 "C" CONTROL SETTING OF 50. FOR THESE EXCEPTIONAL TRANSISTORS (LOW POWER TYPES) SPECIAL SETTINGS OF THE "C" CONTROL CAN BE USED TO MULTIPLY THE RANGE OF THE METER WHEN TAKING BOTH L AND G₁ READINGS, AS FOLLOWS:-

"C" 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 DATA SHEET. INASMUCH AS THE EXPECTED GAIN READING FOR THESE MAY BE ABOVE 120, A "C" 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 "C" CONTROL TO THE NEAREST VALUE LISTED ABOVE WHICH WILL INSURE AN ON-SCALE "G₁" READING TO BE TAKEN, AND NOTE THE "G₁" READING IN TERMS OF THE 0-120 SCALE READ DIRECTLY. WITH THE SAME "C" CONTROL SETTING READ "L" DIRECTLY ON THE 0-120 SCALE. THE TRUE GAIN IS EQUAL TO "G₁" MINUS "L" TIMES THE MULTIPLYING FACTOR LISTED IN THE TABLE FOR THE "C" 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 IN THE "G₁" POSITION. THEREFORE DO NOT KEEP THE BUTTON DEPRESSED LONGER THAN IS NECESSARY TO TAKE A READING IN THE "G₁" POSITION.

THE SAME DISCUSSION AS ABOVE APPLIES TO METER SENSITIVITY FOR POWER TRANSISTOR GAIN READINGS IN "G₂" POSITION. (NO LEAKAGE READINGS ARE TAKEN FOR POWER TRANSISTORS)

* * * * *

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 660 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, I_{CB0} AND GAIN, IT IS UNLIKELY THAT OTHER PARAMETERS WILL GO OUT OF SPECIFICATION IN A JUNCTION TYPE TRANSISTOR.

A. I_{EB0} TEST (SOMETIMES LISTED AS I_{EO})

THIS TEST MEASURES THE REVERSE CURRENT BETWEEN EMITTER AND BASE WITH COLLECTOR OPEN, JUST AS I_{CB0} MEASURES REVERSE CURRENT BETWEEN COLLECTOR AND BASE WITH EMITTER OPEN. THE I_{EB0} 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 I_{EBO} TEST IN THE MODEL 660 IS AS FOLLOWS:-

1. SET "D" SWITCH ON "I_{CBO}" POSITION (NPN FOR NPN TYPE TRANSISTOR, PNP FOR PNP TYPE TRANSISTOR).
2. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR BASE CONNECTION TO "BASE" ROW.
3. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR EMITTER CONNECTION TO "COLLECTOR" ROW.
4. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR COLLECTOR CONNECTION TO "TETRODE" OR "OPEN" ROW.
5. ALL OTHER LEVERS SHOULD REMAIN IN "EMITTER" (NORMAL) ROW.
6. SET UP TEST VOLTAGE WITH "B" SWITCH AND METER SENSITIVITY WITH "C" CONTROL IN ACCORD WITH LIMITS SPECIFIED ON MANUFACTURER'S TRANSISTOR DATA SHEET. THE TABLES BELOW INDICATE AVAILABLE MODEL 660 TEST VOLTAGES AND METER SENSITIVITIES IN THE "I_{CBO}" POSITION.

"B" SWITCH POSITION	TEST VOLTAGE IN "I _{CBO} " POSITION
1	-
2	-
3	-
4	-
5	2.8
6	3.5
7	4.0
8	5.3
9	7.0
10	8.0
11	10.5
12	14
13	18
14	20
15	22
16	24
17	31
18	38
19	38
20	64
21	88
22	135

"C" CONTROL SETTING	FULL SCALE METER CURRENT IN "I _{CBO} " POSITION
50	120 μA
31	240 μA
18	600 μA
11	1.2 MA.
7	2.4 MA.
0	24 MA.

FOR EXAMPLE: THE MANUFACTURER'S SPECIFICATIONS FOR A TRANSISTOR STATE THAT I_{EBO} AT V_E (EMITTER VOLTAGE) OF 12V SHALL BE NO MORE THAN 5μA. THE MODEL 660 "B" SWITCH WOULD BE SET AT 12 AND THE "C" CONTROL SET AT 50. THE CURRENT WOULD BE READ IN MICRO-AMPERES DIRECTLY ON THE 0-120 SCALE OF THE MODEL 660.

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 I_{EBO} WOULD THEN BE 3 x 5μA = 15μA OR GREATER.

IF MANUFACTURER'S SPECIFICATIONS ARE NOT AVAILABLE, APPROXIMATE TEST VALUES FOR I_{EBO} ARE AS FOLLOWS:-

RF TYPES HAVING A RATED COLLECTOR VOLTAGE OF 12V OR MORE SHOULD HAVE A MAXIMUM I_{EBO} OF 50μA AT AN EMITTER-TO-BASE VOLTAGE OF 3 VOLTS.

AUDIO TYPES HAVING A RATED COLLECTOR VOLTAGE OF 20V OR MORE SHOULD HAVE A MAXIMUM I_{EBO} OF 100μA AT AN EMITTER-TO-BASE VOLTAGE OF 3 VOLTS.

7. DEPRESS "READ METER" BUTTON TO READ I_{EBO} CURRENT.

* * * * *

B. Icbs Test

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 660 IS AS FOLLOWS:-

1. SET "D" SWITCH IN "Icbo" POSITION (NPN OR PNP ACCORDING TO TRANSISTOR TYPE).
2. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR BASE CONNECTION TO "BASE" ROW.
3. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR EMITTER CONNECTION TO "BASE" ROW.
4. THROW NUMBERED LEVER CORRESPONDING TO TRANSISTOR COLLECTOR CONNECTION TO "COLLECTOR" ROW.
5. ALL OTHER LEVERS SHOULD REMAIN IN "EMITTER" ROW.
6. SET UP TEST VOLTAGE WITH "B" SWITCH; AND METER SENSITIVITY WITH "C" CONTROL IN ACCORD WITH LIMITS SPECIFIED BY MANUFACTURER. (SEE PRECEDING TABLES FOR "B" AND "C" 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 660 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.

* * * * *

C. CRYSTAL DIODE TEST PROCEDURE

CONNECT CRYSTAL DIODE BETWEEN PIN JACKS "2" AND "3" MARKED "CRYSTAL DIODES". CATHODE (+) SIDE OF CRYSTAL GOES TO "3", NEGATIVE SIDE OF CRYSTAL GOES TO 2. SET LEVER 2 TO "BASE" ROW AND LEVER 3 TO "COLLECTOR" ROW.

NOTE: IT IS EXTREMELY IMPORTANT THAT DIODE POLARITY AND LEVER SETTINGS BE CORRECT, OTHERWISE DAMAGE TO THE DIODE AND THE TESTER CAN RESULT. SEE FIG. 11 BELOW.

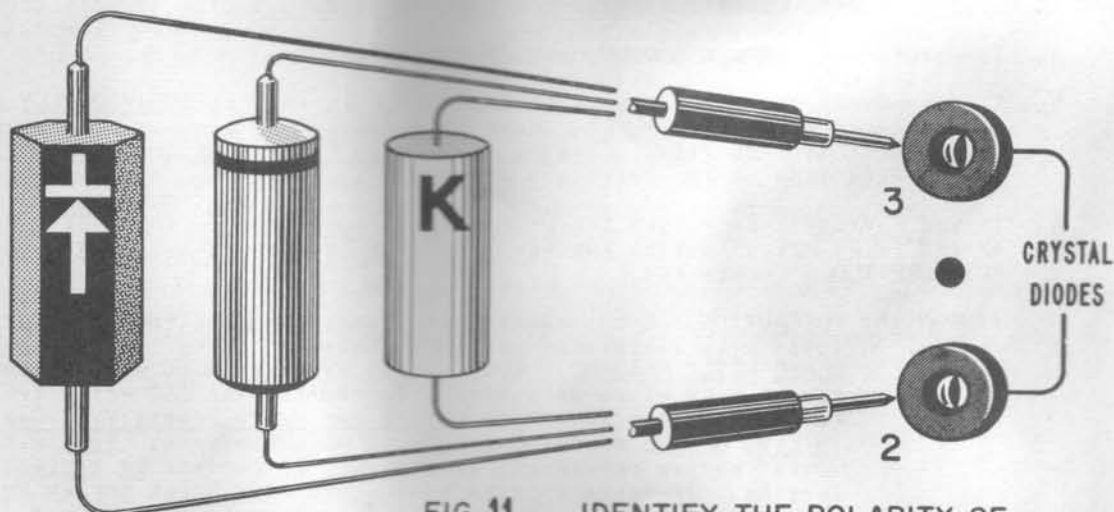


FIG. 11 IDENTIFY THE POLARITY OF CRYSTAL DIODE AND CONNECT TO 660 FOR TEST AS ABOVE.

DIODE FORWARD TEST

1. SET SWITCH "D" IN POSITION 6 ("D_F")
2. SET "B" SWITCH AND "C" CONTROL AS INDICATED IN "FORWARD CURRENT" TEST FOR DIODE.
3. DEPRESS "READ METER" BUTTON AND READ FORWARD CURRENT ON "TRANSISTORS AND CRYSTAL DIODES" ARC. IF DIODE READS ABOVE MINIMUM CURRENT SPECIFIED ON THE DATA SHEET SUPPLIED WITH YOUR MODEL 660, THEN THE DIODE IS OK ON FORWARD CURRENT:- PROCEED TO DIODE REVERSE TEST.

DIODE REVERSE TEST

LEAVE DIODE CONNECTIONS AND LEVER SETTINGS AS INDICATED ABOVE, AND PROCEED AS FOLLOWS:-

1. SET SWITCH "D" IN POSITION 7 ("D_R")
2. SET "B" SWITCH AS INDICATED IN "REVERSE CURRENT" TEST FOR DIODE, AS LISTED ON THE DATA SHEET SUPPLIED WITH 660.
3. SET "C" CONTROL TO "0" AND DEPRESS "READ METER" BUTTON.
4. WITH "READ METER" BUTTON DEPRESSED, ROTATE "C" CONTROL UP FROM ZERO TO THE SETTING INDICATED UNDER "REVERSE CURRENT" TEST ON THE DATA SHEET AND READ REVERSE CURRENT ON "TRANSISTORS AND CRYSTAL DIODES" ARC. NOTE THAT THE "0" SETTING OF THE "C" CONTROL GIVES MAXIMUM PROTECTION FOR THE METER. THEREFORE, IF THE METER REACHES FULL SCALE AS THE "C" CONTROL IS BEING ROTATED UP TO THE SETTING INDICATED FOR THE DIODE BEING TESTED, THE DIODE REVERSE CURRENT IS TOO HIGH, AND THE DIODE SHOULD BE REJECTED.

* * * * *

E. PICTURE TUBE "BEAM CURRENT" TESTS

PRECISION MODEL PTA "PICTURE TUBE ADAPTER" CABLE IS A SEPARATE ACCESSORY WHICH CAN BE PROCURED FROM YOUR FAVORITE DISTRIBUTOR OR DIRECT FROM THE SERVICE DEPARTMENT OF PRECISION APPARATUS COMPANY, INC. THIS CABLE IS USED TO CONNECT PICTURE TUBES TO THE 660 FOR BEAM CURRENT TESTS.

THE TEST PROCEDURE IS LISTED AS FOLLOWS:-

1. SET "A" LEVER, AND "B", "C", AND "D" KNOBS OF THE 660 AS FOLLOWS:-

A	B	C	D
1	9	20	5
2. PLUG ADAPTER CABLE INTO THE OCTAL SOCKET OF MODEL 660 AND CONNECT THE CABLE TO THE PICTURE TUBE. CONNECT ADAPTER'S ALLIGATOR CLIP TO PICTURE TUBE'S SECOND ANODE.
3. TURN THE POWER TO THE 660 ON, AND "ADJUST LINE".
4. PERFORM SHORT TEST BY THROWING LEVERS 2, 4, 6, AND 7, INDIVIDUALLY UP TO "TEST" ROW AND THEN BACK TO "NORMAL". NEON LAMP SHOULD NOT GLOW AS EACH LEVER IS THROWN INTO THE "TEST" POSITION. (IGNORE QUICK NEON FLASHES AS THE LEVERS ARE THROWN. STEADY NEON GLOW IS AN INDICATION OF SHORTS).
5. IF THE PICTURE TUBE PASSES THE SHORT TEST, THROW LEVER 6 TO "TEST" POSITION. *PRESS "READ METER" BUTTON AND READ RELATIVE BRIGHTNESS ON THE 3-COLORED "PICTURE TUBES" METER ARC.

*IMPORTANT PRECAUTION: OCCASIONALLY THE TECHNICIAN WILL ENCOUNTER NEW PICTURE TUBES WITH ESPECIALLY HIGH BEAM CURRENT, WHICH COULD PRODUCE AN OFF-SCALE METER READING. (USED TUBES WITH GAS WILL ALSO PRODUCE EXCESSIVELY HIGH METER READINGS). TO PROTECT THE 660 METER IT IS THEREFORE A WISE PRECAUTION TO ROTATE THE METER SENSITIVITY CONTROL "C" TO ZERO BEFORE PRESSING THE "READ METER" BUTTON. THEN WITH THE "READ METER" BUTTON DEPRESSED, ROTATE THE "C" CONTROL UP TOWARDS THE #20 SETTING. IF METER POINTER APPROACHES FULL SCALE BEFORE 20 IS REACHED, STOP THE TEST AND CONSIDER THAT AN OFF-SCALE READING WAS OBTAINED. USE THE NOTES ON THE FOLLOWING PAGE AS A GUIDE TO READINGS OBTAINED.

GUIDE TO RELATIONSHIP BETWEEN METER READINGS AND PICTURE TUBE CONDITION

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 660 READINGS BETWEEN APPROXIMATELY 65 TO 120 ON THE 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 DETE-
RIORATION.

IT IS IMPORTANT TO NOTE, HOWEVER, THAT USED CR TUBES WHICH PRODUCE READINGS ABOVE APPROXI-
MATELY 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 35, CAN BE CONSIDERED QUITE SATISFACTORY FOR CONTINUED USE, WITH THE FOLLOWING QUALIFICATION: WITHIN THE RANGE BETWEEN APPROXIMATELY 45 DOWN TO 35, 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 RE-
DUCTION 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 RE-
DUCTION 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 LATI-
TITUDE OF PEAK WHITES THEY ACCEPT AS DESIRABLE.

THE NEXT PORTION OF THE METER SCALE TO BE CONSIDERED IS YELLOW SECTOR (15 TO 35 ON THE 0-120 SCALE). AS THE METER READING PROGRESSES FROM 35 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 SEC-
TOR 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.

F. BALLAST TESTING

THE NEON SHORT CHECK CIRCUIT, IN CONJUNCTION WITH THE NUMBERED LEVER-DISTRIBUTION 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 RETMA BALLAST CODING SYSTEMS. 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 RETMA CODE. THEREFORE, PRIVATELY NUMBERED BALLASTS SHOULD BE REFERRED TO BALLAST MANUFACTURERS' REPLACEMENT MANUALS FOR IDENTIFICATION OF THE BALLAST IN TERMS OF THE STANDARD RETMA CODE.

BALLAST RESISTOR CODE:

A SAMPLE AND INTERPRETATION OF THE CODE APPEARING ON STANDARD OCTAL TYPE AND REPLACEMENT TYPE BALLASTS ARE AS FOLLOWS:-

RETMA 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, INDICATE 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 NUMERALS) 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 BALLAST 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 BALLAST TEST PROCEDURE).

FOR STANDARD RETMA 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.

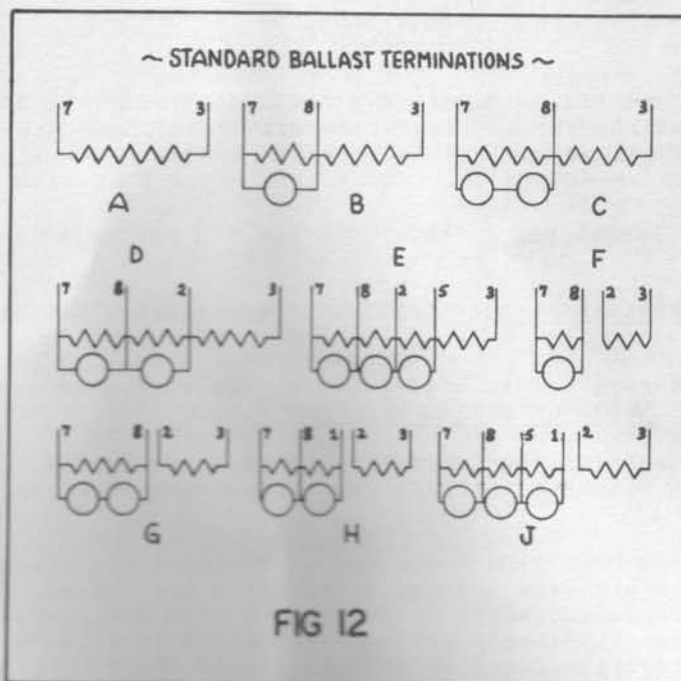
BALLAST TEST PROCEDURE:

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 "D" TO #1 POSITION
SET CONTROL "B" TO #24 POSITION
SET CONTROL "C" TO 0 POSITION
THROW ALL LEVERS TO "NORMAL POSITION"

2. TURN INSTRUMENT ON AND ADJUST FOR "ADJUST-LINE" INDICATION ON THE METER. INSERT THE BALLAST.
3. CLASSIFY THE BALLAST UNIT TO BE TESTED ACCORDING TO ITS RETMA BASE WIRING. REFER TO FIG. 12 ON THE NEXT PAGE AND DETERMINE THE APPLICABLE BASE PIN NUMBERS. THEN INDIVIDUALLY THROW THE LEVERS CORRESPONDING TO THE BASE PIN NUMBERS TO "TEST" POSITION AND THEN BACK TO "NORMAL" POSITION. A NEON GLOW SHOULD BE OBTAINED AS EACH LEVER IS THROWN TO "TEST" POSITION.



FOR EXAMPLE, BALLAST TYPE BK86A IS AN "A" TYPE BASE WIRED UNIT. IT IS CHECKED BY REFERRING TO DIAGRAM "A" OF FIG. 12, WHICH REVEALS THAT LEVER 3 MUST BE THROWN TO "TEST" POSITION AND THEN BACK TO "NORMAL" POSITION. LEVER 7 MUST THEN BE SIMILARLY ACTUATED.

NEON LAMP SHOULD GLOW AS EACH OF THESE 2 LEVERS IS THROWN TO "TEST" POSITION. 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 LEVER 4 IS THROWN TO "TEST" POSITION.

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

4. A CONTINUOUS NEON LAMP GLOW, AS EACH NUMBERED LEVER (CALLED FOR) IS THROWN TO "TEST" POSITION, 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 LEVER IS THROWN TO "TEST" POSITION.

IT IS ADVISABLE TO TAP THE BALLAST UNIT WHILE EACH LEVER (CALLED FOR) IS BEING ACTUATED. 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 ACTUATE LEVER 5, IN ADDITION TO THE LEVERS REQUIRED FOR THE BASE WIRING CODE "A".

LEAKAGE TESTS:

TESTS FOR LEAKAGES BETWEEN SECTIONS OF MULTI-SECTION BALLAST UNITS HAVING BASE WIRING DESIGNATIONS "F", "G", "H" OR "J" ARE ACCOMPLISHED BY THROWING BOTH LEVERS 2 AND 3 TO "TEST" POSITION (SIMULTANEOUSLY), WITH ALL OTHER LEVERS REMAINING IN THE "NORMAL" POSITION. A NEON LAMP GLOW (IF OBTAINED) WILL INDICATE LEAKAGE OR SHORT BETWEEN THE TWO INDEPENDENT SECTIONS, AND THE BALLAST UNIT SHOULD BE REJECTED AS DEFECTIVE.

IF ANY SPECIAL BALLAST RESISTORS ARE EVER ENCOUNTERED (WHICH CANNOT BE IDENTIFIED WITH ANY STANDARD RETMA CODED BASING), THEN MERELY DETERMINE THE INTERNAL WIRING FROM A SERVICE MANUAL SCHEMATIC AND PROCEED AS OUTLINED FOR ALL BALLAST CONTINUITY CHECKS.

* * * * *

SERVICE DATA

THE PRECISION MODEL 660 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 660 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 INTERNALLY MOUNTED 3AG, 1 AMPERE FUSE. IF BLOWN, REPLACE WITH SAME SIZE AND TYPE FUSE ONLY IF THE CAUSE FOR BLOWING OF FUSE IS KNOWN AND HAS BEEN REMEDIATED.

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 "D" SWITCH SETTING DO NOT PROVIDE METER MERIT INDICATIONS.
 - a) THE LOAD RESISTOR ASSOCIATED WITH THE PARTICULAR "D" 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" ADJUSTMENT IS ERRATIC.
 - a) EXAMINE LINE POTENTIOMETER, SCHEMATIC PART NO. R-13, 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 660 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.

GENERAL NOTES AND INFORMATIONNEW TUBE TEST DATA:

IN LINE WITH "PRECISION'S" DESIRE TO EXTEND UTMOST SERVICE TO USERS OF "PRECISION" TEST EQUIPMENT, NEW TUBE 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 WARRANTY 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 \$2.00 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 \$1.00 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:

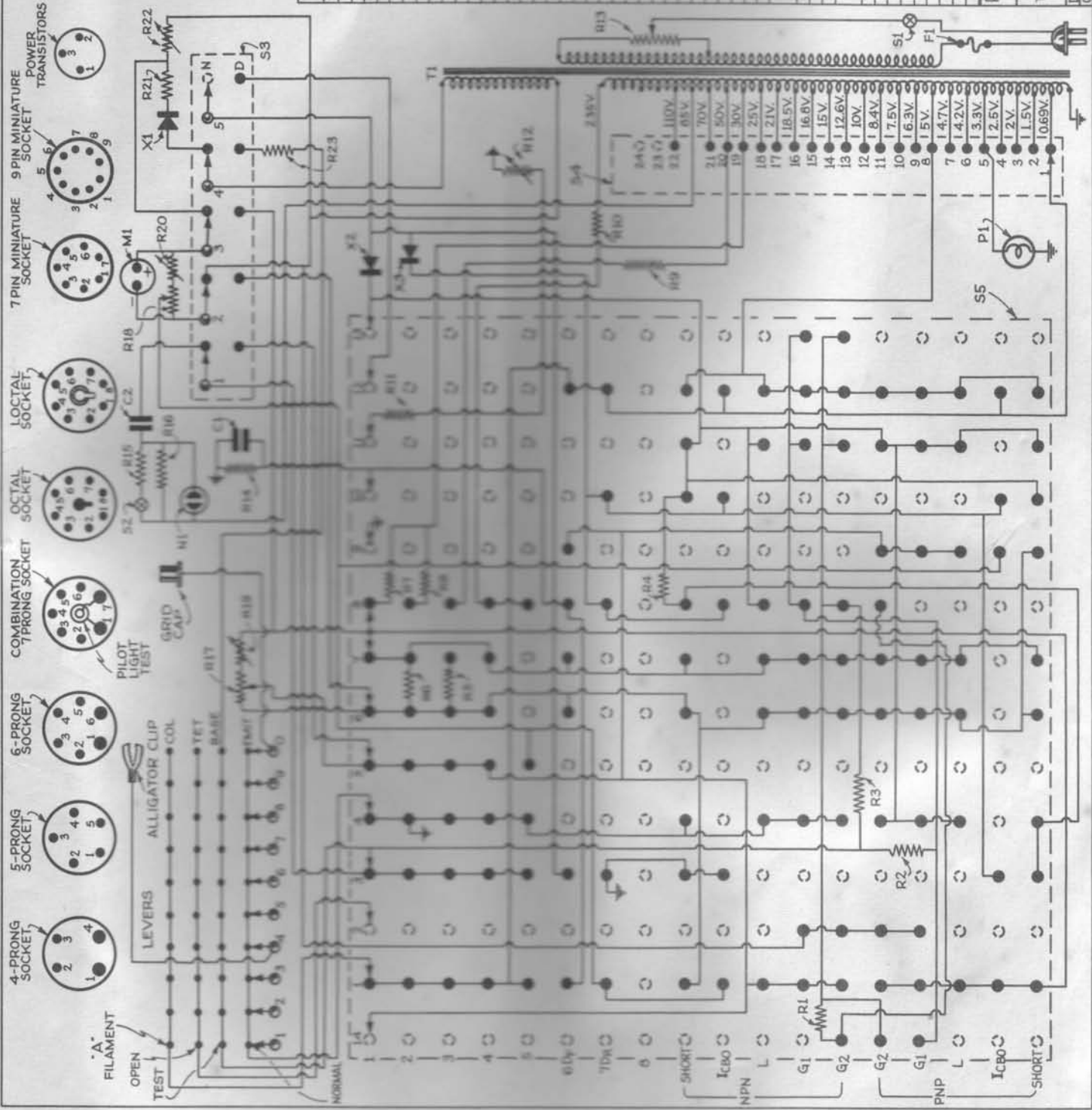
- 1 - TRANSISTOR ADAPTER CABLE

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3. PRINCIPLES OF TRANSISTOR CIRCUITS. R. F. SHEA.
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4. TRANSISTORS THEORY AND PRACTICE. RUFUS P. TURNER.
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N. Y. 1950.

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PRECISION APPARATUS COMPANY, INC.
70-31 - 84TH STREET
GLENDALE 27, L. I., N. Y.
U. S. A.



NOTE: = CIRCUIT COMMON, NOT CHASSIS GROUND.

PART NO.	SPECIFICATION
R23	470 Ω
R22	60 Ω
R21	100 Ω
R20	50 Ω
R19	40 Ω
R18	8K Ω - °C CONTROL
R17	300 Ω - °C CONTROL
R16	1.8 MEG Ω
R15	2.2K Ω
R14	300 Ω - LINE ADJ.
R13	2.00 Ω
R12	2K Ω
R11	5K Ω
R10	1K Ω
R9	1K Ω
R8	3.3 Ω
R7	101 Ω
R6	150 Ω
R5	300 Ω
R4	300 Ω
R3	19.5K Ω
R2	0.367 Ω
R1	PILOT LAMP
T2	0.47 MFD 300V
T1	100 MFD 150V
F1	LAMP FUSE
M1	100 MA - 160 MV
N1	NEON BULB - TUBE SHORT CHECK
S5	LOAD SELECTOR SW "D"
S4	FILAMENT SELECTOR SW "B"
S3	READ METER SWITCH - NORMAL POS. DEPRESSED
S2	HIGH STD SWITCH
S1	OFF-ON POWER SWITCH
T1	POWER TRANSFORMER
X3	30 MA RECTIFIER
X2	500 MA RECTIFIER
X1	METER RECTIFIER

PRECISION APPARATUS CO. INC.
 GLENDALE 27 L.L.N.Y.
 MODEL 660
 TITLE: TUBE & TRANSISTOR CHECKER

DRAWN BY: WM. KADLECZEK-B.
 CHECKED BY: M. A. DATE: 1-26-57