1. Summary

Hickok Model 1890M In-circuit Transistor Tester, S.N. 60947-3.

Original condition is good. Chassis marked 5941 0092.

NSN 6625-00-993-3389. TEST SET, SEMICONDUCTOR DEVICE
NIIN: 00-993-3389
DESIGN CONTROL REFERENCE: 902-353 MANUFACTURERS CODE: 28569
Instruction/service manual is T.O. 33A1-3-206-1 (air force)

Technical Manual T.O. 33A1-3-206-1 dated 28/9/1988 provided by Jason Schnell (toasterfire2@gmail.com). Does not include full circuit schematic.

Similar unit built under AF contract AF 36(600)-13288. Stock number 6625-731-5716

UTC HVC-4 Variductor 0.1H -70/+200%, 30mADC
UTC TF4RX13YY
UTC DO-T11 transistor transformer 10K:2K CT
Industrial transformer corp 3250-84 10Hy 10mA 135Ω DCR
Astron ED-100uF 50V 6418
EKC RN7 resistors
Electrolytic marked 6304
Bourns trimpot

Power interface socket J1: M1-14F. 14 pins marked A to R (G,I,0,Q not marked). 5 pins not used (L,M,N,P,R).

BT1: Red-**J** (+), Purple-**K** (-) = 22.5V (eg. ER763 or Burgess 4156 battery). Red & purple twisted pair to 100uF 50V can to battery switch S1 (pur to wafer 6; red to wafer 1,2).

BT2: White/yell-**C** (+0V), White/Orange-**B** (-3V), Yellow/black-**A** (-4.5) (eg. ER 761-T or Burgess 2370). 0V yel/blk to battery switch S1 wafer 5. Wh/or to circuit impedance S5 wafer 1. Wh/yel to battery switch S1 wafer 4.

BT3: White/red-**D** (+0), Brown-**E** (-1.5V), Orange-**F** (-3V), Yellow-**H** (-4.5V) (eg. ER 761-T or Burgess 2370). Used for Collector Volts selection circuit. -4.5V yel to collector volts switch S3. -3V or to collector volts switch S3. -1.5V br to collector volts switch S3. +0 yel/rd to collector volts switch S3 and battery switch S1 wafer 4. Collector volts switch output to battery test S1 wafer 3 (operate to collector EUT terminal). Max Ic test current is 100mA for any voltage tapping.

Some circuitry differences to the Hickok 890.

Issues:
The Operating manual is missing pages 3-4, and does not include a full schematic.

Meter restoration
Original meter had a bearing alignment or stiction problem – appears to be close to the zero setting (tapping the meter returns the needle to zero, or moves the needle to final resting place). The meter is marked 'sealed – do not open'. The front cover has a rolled lip that needs to be pressed around the perimeter to 'unroll' the edge. The front cover glass is hermetically sealed, and the rear terminals have a rubber boot and are riveted in place.

- Meter was removed and the cover and glass removed.
- No debris of any kind seen between horseshoe pole faces, and coil former, and internal concentrator slug.
- The rear hairspring had a misplaced internal section around a fitting – not sure if this was accidently done during inspection, or prior – returned to nominal position.
- The two accessible seal slots of the internal rod and external bearing had IPA carefully added by syringe/needle, with the aim of flushing any debris from the bearing.
- Front glass and cover reinstated, but the outer cover lip could not be rolled to form a single module, so care would be required if the meter was removed again, as the front cover and glass is not mechanically held to the meter body once the mounting bolts are loosened.
- The meter returns consistently to zero when the front panel is horizontal.
  - If the front panel is vertical then the cal setting is changed, and there may not be enough hair-spring tension to force the needle back to zero all the time without a gentle tap.

Battery restoration
3 isolated batteries with multiple voltage taps, replaced by three external plugpacks and a DB9 interface and internal regulators.

External plug-pack adaptor assembly:

- 3 separate plugpacks feed a single small pcb that is wired to a DB9 male socket.
- 2x 12Vdc 1.2A output plugpacks are wired directly through to the DB9 connector.
- 1x 24Vac 0.3A plugpack is rectified and filtered on the small pcb and the DC output wired to the DB9 connector.

Internal regulated supply pcb in tester:

- External DB9 female connector feeds the three isolated DC supplies into the pcb fitted in the rear of the tester.
- Each isolated DC supply is regulated to provide the single BT1 supply, the two BT2 supplies, and the three BT3 supplies. All output supplies connect to the 14-pin power interface female plug that plugs in to the male socket on the tester chassis.
- See Figure 8 of Manual, and schematic of regulators.

Testing:

- Plug-pack for BT1 powered on.
  - Select position 1 on the Function Selector to read BT1. Front panel must be horizontal, and meter calibrated to zero. Front panel BATT TEST push to hold knob.
    - Position 1 = Icbo position.
    - Only load is a 3k3 resistor.
    - 22.7V battery = 89 on the CALSET top scale (this is in the middle part of the green ‘GOOD’ section of the scale).
    - BT1 feeds the oscillator and amplifier circuitry.
- Plug-pack for BT2 and BT3 powered on.
  - Select position 2 on the Function Selector to read BT2 + BT3 FS levels
    - Position 2 = Ic position:
    - 4.5V + 4.5V battery = 91 on the CALSET top scale.
    - BT2 1.5V feeds the DUT base with Circuit Impedance switch set for Normal.
    - BT2 4.5V feeds the DUT base with Circuit Impedance switch set for Low.
    - BT3 feeds the DUT COLLECTOR VOLTS switch, with switched positions of 0V, 1.5V. 3.0V, 4.5V.

1.1 Circuitry description

Transformer T1 is under smaller lid on Terminal Board TB3. It connects to front panel Beta Cal pot.

L1 is TVC-4 which includes 1 tap.

OM section 56 – Audio Oscillator Calibration

- No schematic – see sketch.
- Q1 and Q2 on TB3 (but not identified in Fig 32).
- Q1 and Q2 DCV in Fig 22.
- Q1 collector drives L1 and should have an ACV of 11Vp-p (+/-1.3V). [5Vrms, 3.9%THD]
- T1 output (Grn to Yel) with Beta Cal pot at Max should have ACV of 1.4Vp-p (+/- 0.2V) [0.58Vrms]
- Sinewave levels a bit higher due to 22.2V supply (ref level is 20.9V). But this is allowed for by Beta Cal pot setting.
- With TB3 lid on, the sinewave can be sensed across Beta Cal pot.

OM section 57 – Amplifier Calibration

- 0.5mVpp to 15Vpp gain (gain = x30,000, or +90dB) to Q5 collector, for FS meter reading.
    - OM has a typo in section 10, as it refers to 0.5uVpp input.
- Replaced C8 and C12 electrolytics.
- Tuned C9 for peak 1kHz response using REW sweep.
- 1kHz gain from input to Q3C ~+36dB; Q3C to Q4C ~+21dB; Q4C to Q5C ~+37.5dB;
    - 0.353Vrms input to 2000:1 divider = 0.176mVrms input to Q5C ~+94dB for 8.6Vrms
    - This was gain trimmed to 6Vrms on Q5C to give meter FSD.
    - Output sinewave had about 22% THD from 2nd and 3rd harmonics, which would have affected Vpp level (15Vpp=5.3Vrms for sinewave with no distortion)

OM section 58-59 – Z ohms Calibration

- Only schematic is the OM Fig.5. Bridge measurement configuration, with meter sensing bridge null.
- Pots and switch were suspect, so opened and contact cleaned with spray. The 100k pot (large knob) has some variable resistance due to shaft tilt.
- Calibration is difficult due to shaft tilt/pressure varying that bridge arm's resistance, as a particular tilt pressure may be needed to get the nominal arm resistance.
- Also only having BT1 connected removes some noise/flutter from meter movement.

OM section 60 – Rin Calibration

- Only schematic is the OM Fig.6. Bridge measurement configuration, with meter sensing bridge null.
- Pot was suspect, so opened and contact cleaned with spray.
- Only having BT1 connected removes some noise/flutter from meter movement.

Output transformer primary winding impedance can be calculated by placing resistive load on secondary winding and measuring primary impedance using Zoh or Rin.

Bipolar Transistor testing

- Use the Atmel tester to identify EBC terminals

Bipolar transistor beta (hfe) is measured at a set collector current, and set collector volts:

- Ic is set first (eg. 1mA based on x10 current and meter reading of 0.1mA).
- Then Beta Cal is set for dial at CAL SET or at 100.
- Then Beta Read gives dial reading either on top scale or next lower scale.
- This allows the hfe characteristic to be checked at a few Ic levels.

Collector volts is measured with a DCV connected to terminal posts E and C:

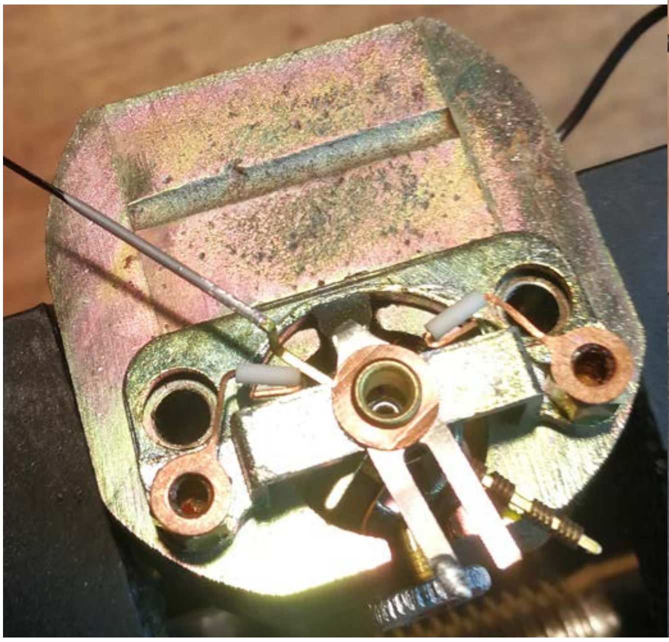
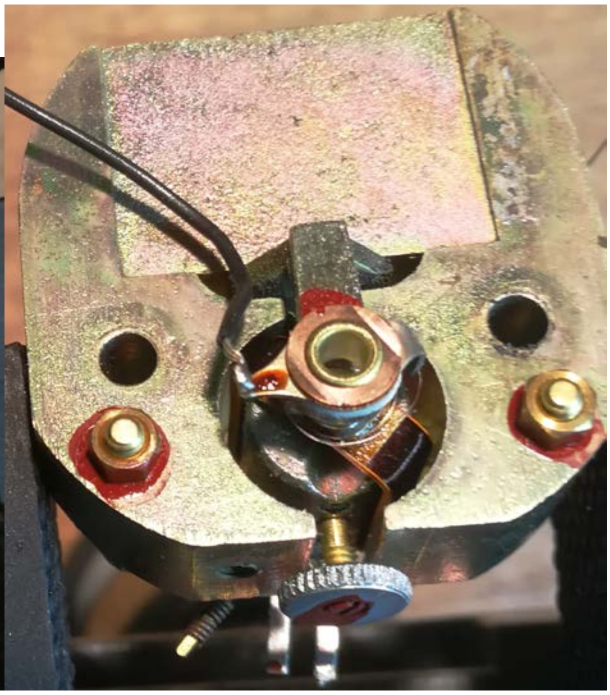
- 1.5V setting = 1.49V
- 3V setting = 2.96VV
- 4.5V setting = 4.52V

Vbe is measured with a DCV connected to terminal posts E and B:

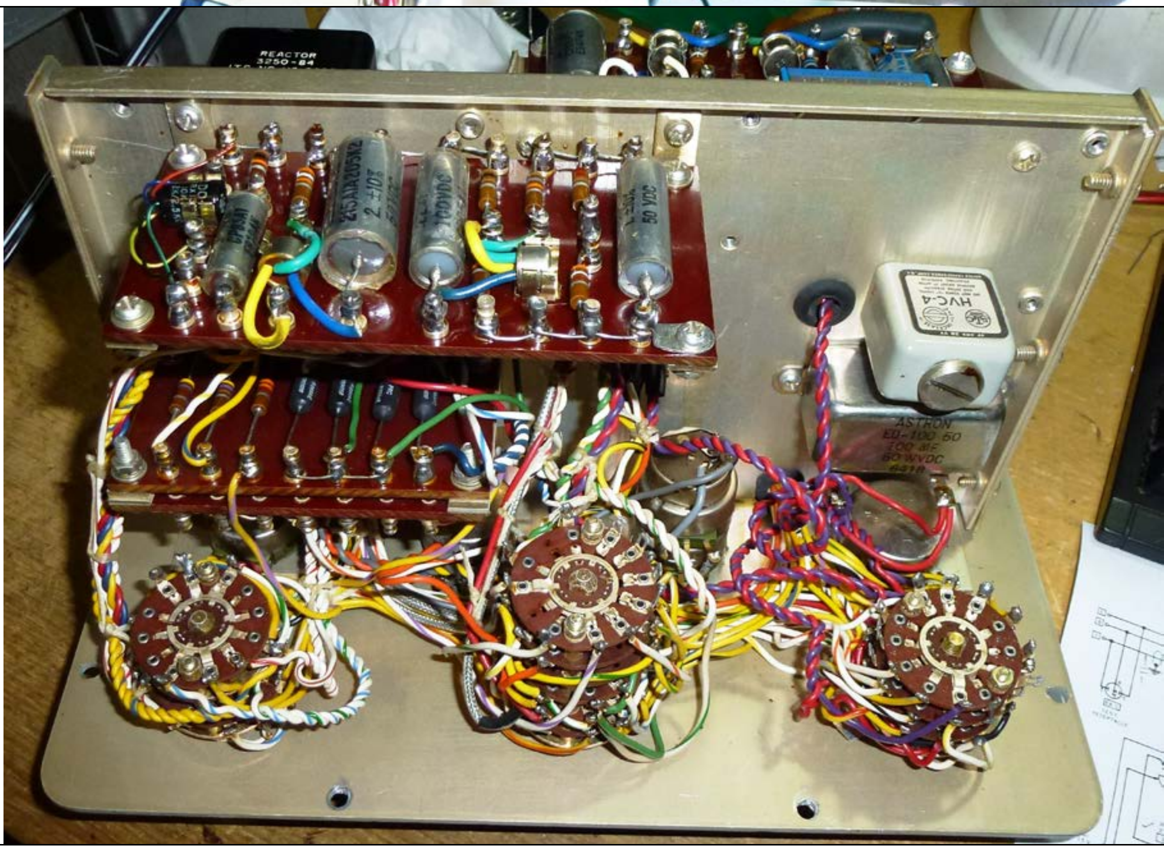
- Ic setting is increased to the desired Ic mA reading on the dial (using the multiplier).
  - For a power bjt, the collector current can be set and read up to 100mA (1mA FSD and x100 multiplier).
- This increases the DC base current, for the set collector voltage.
- With Beta Cal set to zero there is no AC base current applied.

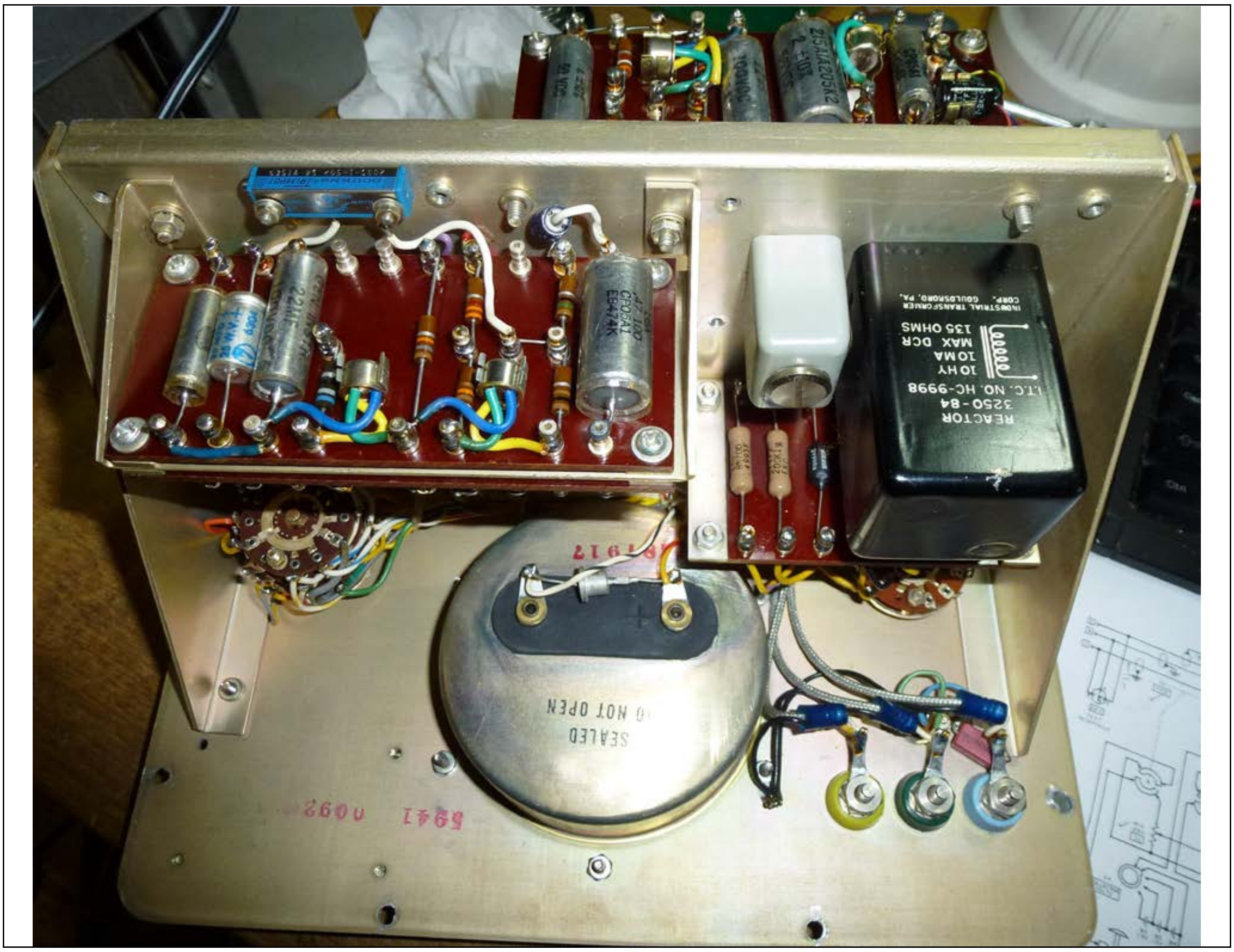
Diode testing with junction voltage measured with a DCV connected to terminal posts B and C:

- Diode current setting is increased to the desired Ic mA reading on the dial (using the multiplier).
  - the diode current can be set and read up to about 0.88mA (0.88mA FSD and x1 multiplier) with NORMAL Circuit Impedance setting.
  - the diode current can be set and read up to a bit more than 10mA (1mA FSD and x10 multiplier or 0.1mA and x100 multiplier) with LOW Circuit Impedance setting.
- With Beta Cal set to zero there is no AC diode current applied.
- Accuracy versus Aneng AN8009 is pretty close across the scale for all multipliers and Circuit Impedance settings.


MODEL 1890M
SERIAL NO.
IN-CIRCUIT TRANSISTOR TESTER
CALIBRATION SYSTEM
DATE CAL
CAL DUE
NAME
HICKOK
CAL SET
BETA
PNP
NPN
DIODE
TYPE
COLLECTOR V
EB C
VERNIER
OUT OF CIRCUIT
CIRCUIT
TRANSISTOR
BETA CAL
CIRCUIT IMPEDANCE
LOW
NORMAL
OFF
OPERATE
BATT. TEST
BETA READ
X 1
X 10
X 100
FUNCTION SELECTOR


REACTOR
3250-84
HYC-4
ASTRON
50 VDC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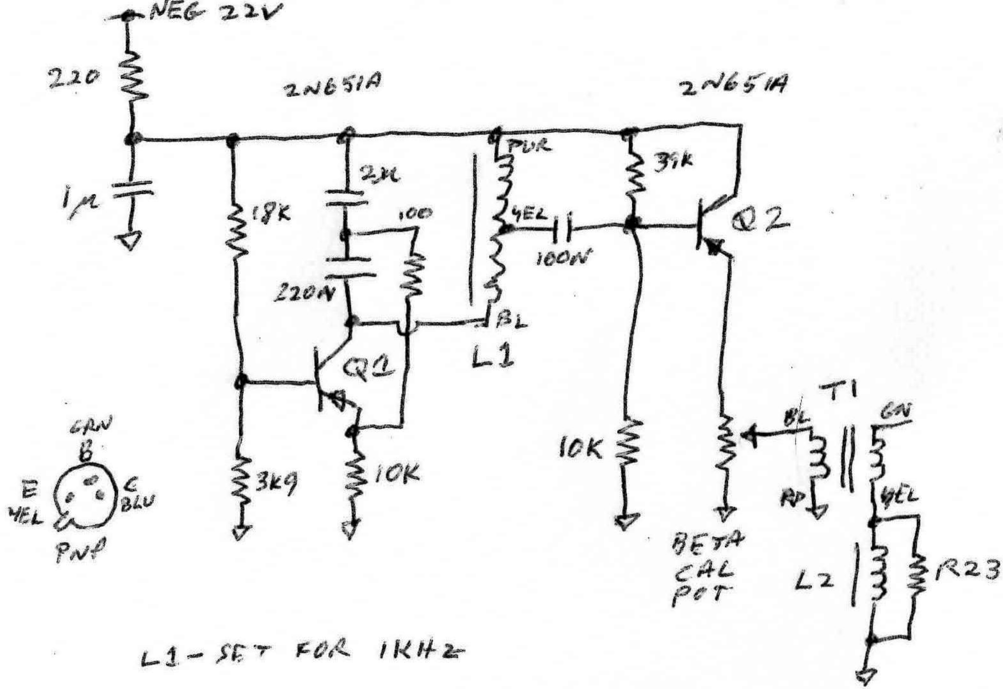
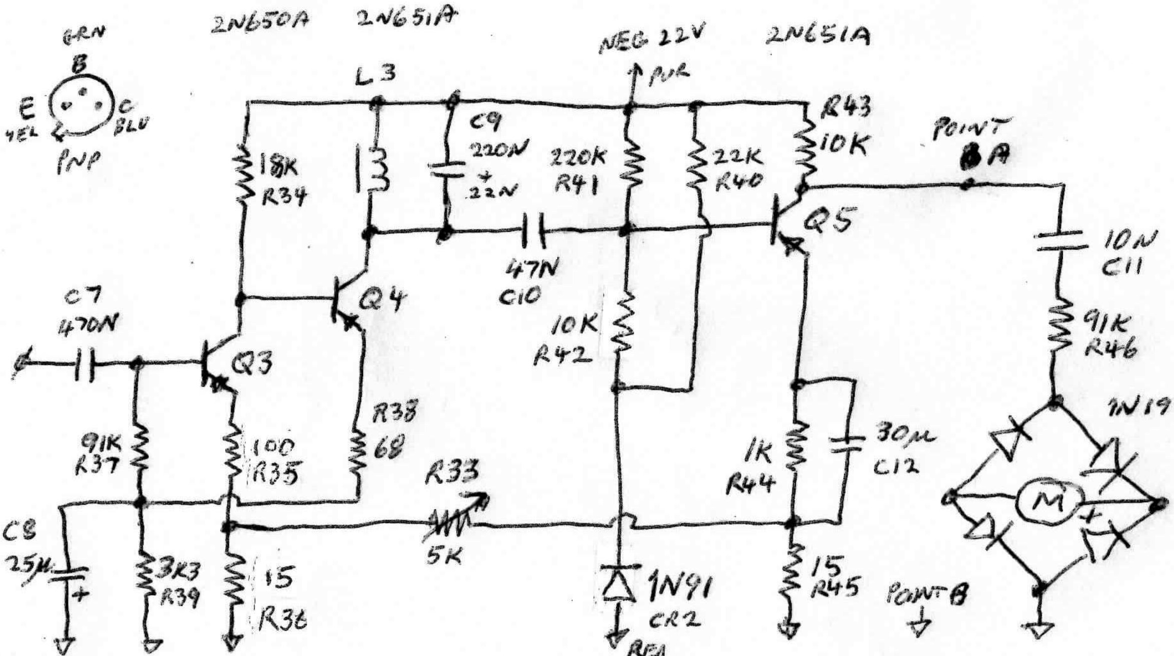
I.T.C. NO. HC-9998
10 HY
10 MA
MAX DCR
135 OHMS
SEALED



L1 - SET FOR 1KHZ

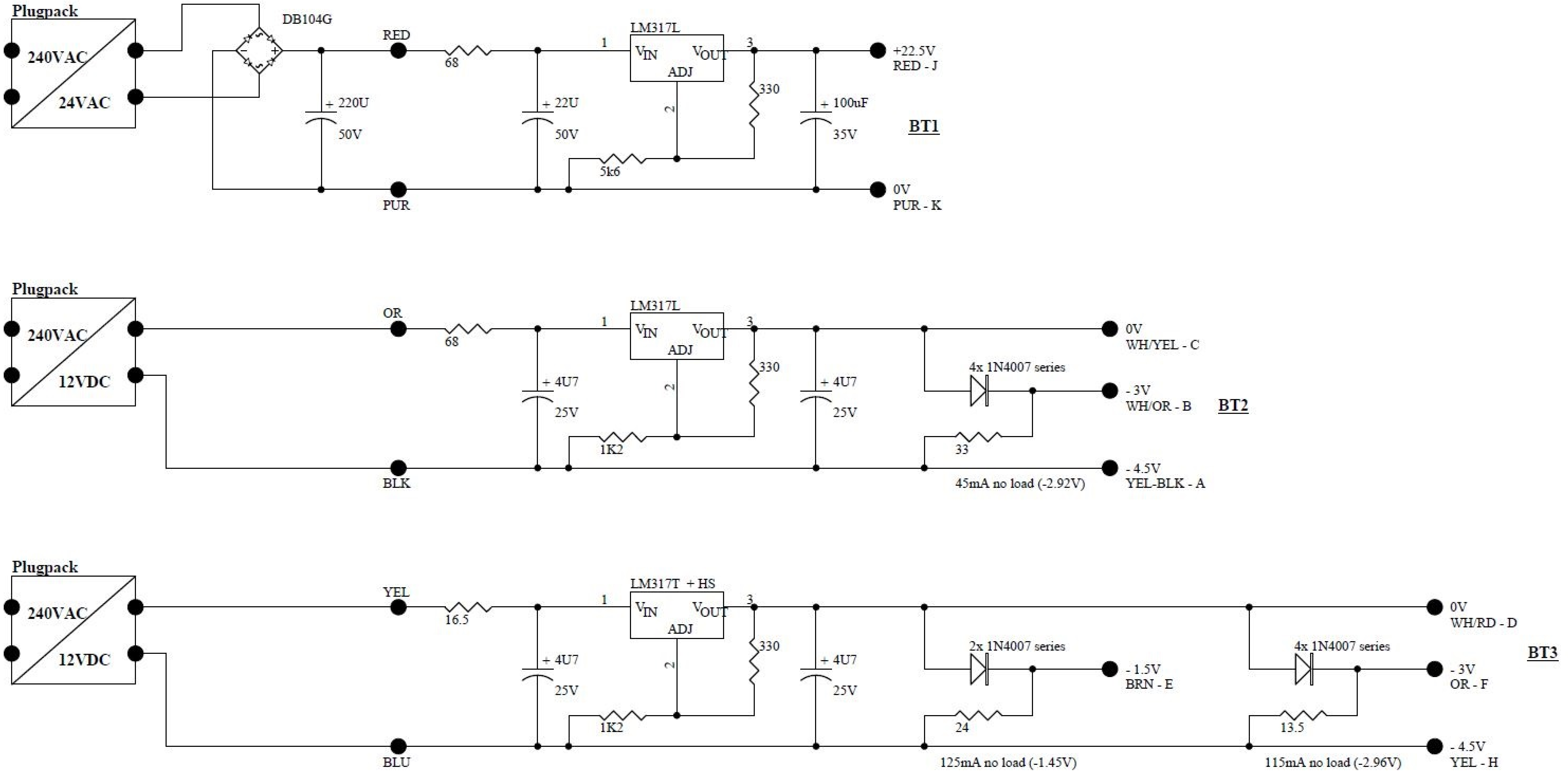
HICKOK 1890M IN-CIRCUIT TRASISTOR TESTER

AUDIO OSCILLATOR - TB3



HICKOK 1890M IN-CIRCUIT TRANSISTOR TESTER

1KHZ 90dB GAIN AMPLIFIER – TB1 AND TB2


Plugpack
240VAC
24VAC
DB104G
RED
68
LM317L
1
VIN
VOUT
3
ADJ
2
+22.5V
RED - J
+ 220U
50V
+ 22U
50V
330
+ 100uF
35V
BT1
5k6
PUR
0V
PUR - K
Plugpack
240VAC
12VDC
OR
68
LM317L
1
VIN
VOUT
3
ADJ
2
0V
WH/YEL - C
+ 4U7
25V
330
+ 4U7
25V
4x 1N4007 series
- 3V
WH/OR - B
BT2
1K2
33
BLK
- 4.5V
YEL-BLK - A
45mA no load (-2.92V)
Plugpack
240VAC
12VDC
YEL
16.5
LM317T + HS
1
VIN
VOUT
3
ADJ
2
0V
WH/RD - D
+ 4U7
25V
330
+ 4U7
25V
2x 1N4007 series
- 1.5V
BRN - E
4x 1N4007 series
- 3V
OR - F
BT3
1K2
24
13.5
BLU
- 4.5V
YEL - H
125mA no load (-1.45V)
115mA no load (-2.96V)

TECHNICAL MANUAL

INSTRUCTIONS AND PARTS BREAKDOWN

IN-CIRCUIT TYPE TRANSISTOR TESTER

MODEL
1890M

SEP 28 1988

6

(HICKOK ELECTRICAL INSTRUMENT COMPANY)

AF36(600)-13288

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26AA - 26AL	5
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26BA - 26BP Deleted	5
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SECTION I
USE AND MAINTENANCE

1. INTRODUCTION.

2. SCOPE OF MANUAL. This technical manual covers installation, operation, maintenance and parts breakdown of In-Circuit Type Transistor Tester Model 1890M (figure 1), Federal Stock Number 6625-993-3389, hereafter referred to as tester. The tester is manufactured by The Hickok Electrical Instrument Company, Cleveland, Ohio.

3. PURPOSE AND FEATURES OF EQUIPMENT. The tester is designed to test all small and medium power transistors and diodes directly in or out of their circuits. A portable aluminum case houses the complete equipment. Access to the control panel is provided by the detachable top case in which the test lead assembly is stored.

4. SPECIFICATIONS. Principle features and characteristics of the tester are listed below.

Batteries required (not supplied)	1 - 22.5-volt No. 763 Eveready 2 - 4.5-volt No. 2370 ST Burgess
Meter scales	
I_{CBO} Ranges	0-50 ua, 0-500 ua and 0-5 ma
I_C Ranges	0-1.0 ma, 0-10 ma and 0-100 ma
Beta Ranges	0-50, 0-100, 0-200 and 0-400
Beta Test Accuracy	± 5% for Circuit Impedances above 25 ohms on the 0-100 Beta
Meter sensitivity	50 ua, 100 mv
AC test signal	
Signal	1000 cps sine wave, with a variable amplitude
Calibration setting	5 ua Base Current for the 0-100 Beta Range
Transistor input resistance Range	50-10,000 ohms
Circuit input impedance Range	25-100,000 ohms
Collector voltages	0, 1.5V, 3V, 4.5V

Transistor complement

	Type	Function
Q1, Q2	2N651A	1000 cps Oscillator
Q3	2N650A	A. C. Meter Amplifier - 1st Stage
Q4, Q5	2N651A	A. C. Meter Amplifier - 2nd Stage and 3rd Stage

5. DESCRIPTION.

6. GENERAL. Six major circuits are incorporated in the tester to provide the means to accomplish the basic tests listed below. The circuits are briefly described in paragraphs 7 through 20.

a. I_{CBO} (collector leakage current).

b. I_C (collector current).

c. Z ohms (external input impedance).

d. R_{IN} (dynamic input impedance).

e. Beta (current gain of a transistor in the common emitter configuration).

7. POWER SUPPLY CIRCUIT. (See figure 2).

a. The tester and its associated circuitry for testing a transistor is energized in the OPERATE position of the Battery switch S1. The BATT. TEST position of this switch will be explained in conjunction with the FUNCTION SELECTOR switch S4 (paragraph 12) because they are interrelated. The Battery switch is a three-position, momentary contact, center OFF spring return in both directions - that is, to the left and right. The switch always returns to the center position after it has been released.

b. The internal power requirements of the audio oscillator, the A. C. amplifier and meter circuit are supplied by a 22.5-volt battery BT1.

c. The collector voltage for the transistor under test is obtained from a tapped 4.5-volt battery BT3. The collector voltage can be varied from 0 to 4.5 volts in 1.5-volt steps by changing the position of the COLLECTOR VOLTS switch S3.

d. The collector current can be varied from 0 - 1 ma, 0 - 10 ma and 0 - 100 ma, depending upon external circuitry conditions, by varying the current into the base of the transistor under test. This is accomplished by using I_C potentiometer (R24) across

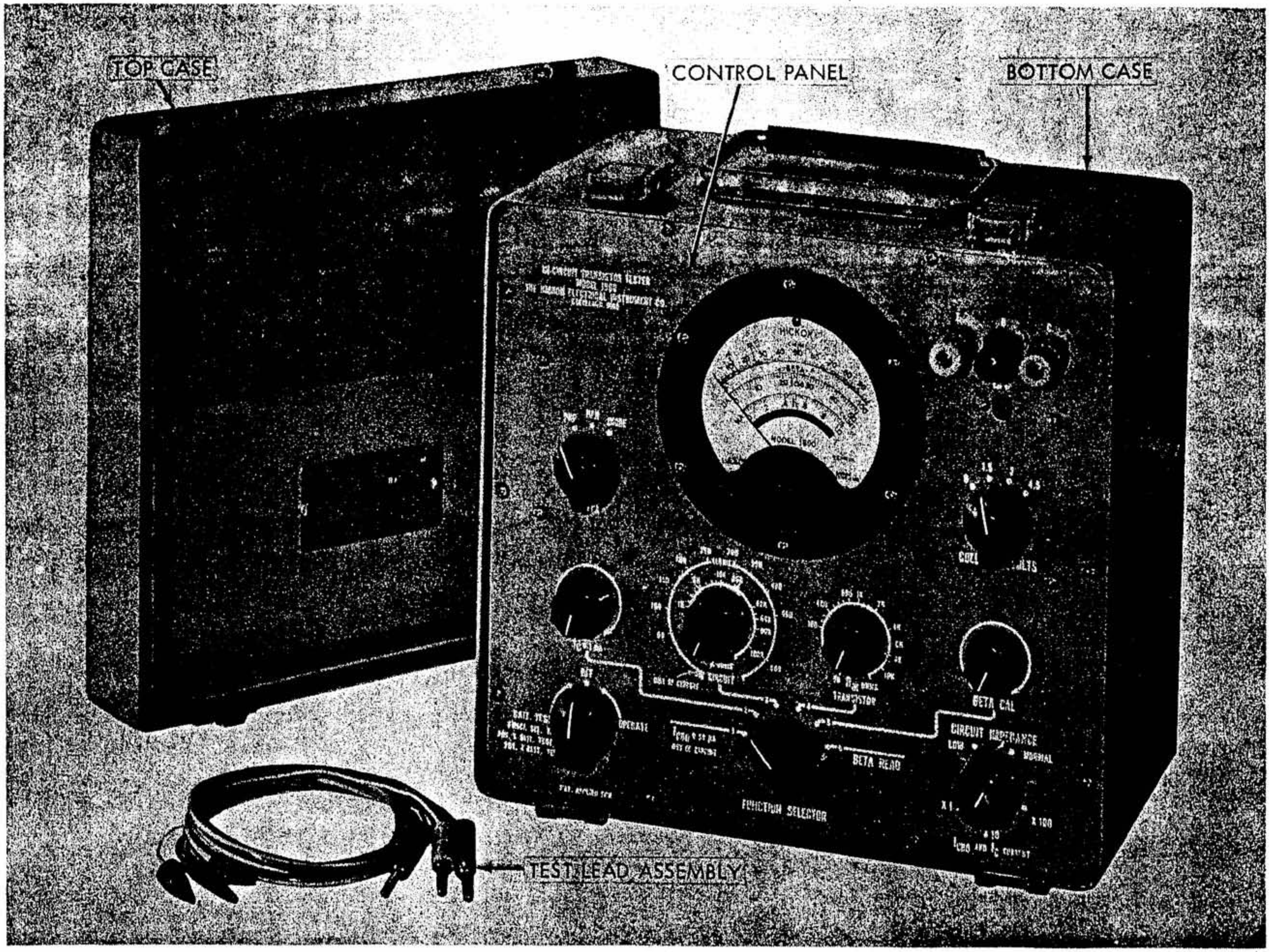

Figure 1. In-Circuit Type Transistor Tester Model 1890M

the 1.5-volt tap of battery BT2 when the CIRCUIT IMPEDANCE switch S5 is in the NORMAL position, and across the 4.5-volt tap of battery BT2 when the CIRCUIT IMPEDANCE switch S5 is in the LOW position. This arrangement gives a variable biasing network for the base to emitter circuit of the transistor under test.

8. AUDIO OSCILLATOR. (See figure 2). A 1000 cps Colpitts Oscillator consisting of a tuned circuit, transistor Q1 and its associated biasing and feedback networks, is used to generate the A.C. test signal. The output of the oscillator is A.C. coupled into an emitter follower Q2 whose output is then coupled into the step-down transformer T1 by means of the BETA CAL potentiometer R8 located in the emitter circuit of the amplifier. The output of T1 is connected to the variable resistance bridge (paragraph 9) through the FUNCTION SELECTOR switch S4. The amplitude of the test signal is controlled by the BETA CAL potentiometer R8.

9. VARIABLE RESISTANCE BRIDGE CIRCUIT. (See figure 2).

a. One leg of the bridge circuit is the base to emitter input impedance of the transistor under test. This input impedance can be the parallel combination of the external circuitry impedance of the transistor under test and its dynamic input resistance. The balancing leg is provided by the tester; it consists of one dual potentiometer Z OHMS CIRCUIT (R9 and R11) and a single potentiometer R_{IN} TRANSISTOR R10 which is connected in parallel with the dual potentiometer in the last three positions of the FUNCTION SELECTOR switch S4. The dual potentiometer is used to null out the external circuit impedance of the transistor under test. If an "out of circuit" test is performed, this dual potentiometer must be removed from the circuit. A SPST switch, which is an integral part of potentiometer R9, is provided to accomplish this condition. The single potentiometer (R_{IN} TRANSISTOR R10) is used to null out the dynamic input resistance of the transistor.

b. The functions of the CIRCUIT IMPEDANCE switch S5 are to change the circuit constants in the bridge and also to change the applied battery voltages to the forward biasing network which is used to adjust the collector current of the transistor under test. In the LOW position, the circuit constants are given low resistance values in order to present a low driving impedance to the external circuitry and transistor under test. However, in the NORMAL position, the circuit constants are given nominal values, thus presenting a normal driving impedance to the external circuitry and transistor under test. The setting of the CIRCUIT IMPEDANCE switch S5 to LOW or NORMAL will depend upon the impedance of the external circuitry and transistor under test.

c. In transistor power amplifiers where the external circuitry and transistor impedances are normally low or in any circuit where the impedance is under 500 ohms, the LOW position of CIRCUIT IMPEDANCE switch S5 is selected. In small signal RF-IF and audio amplifiers where the external circuitry and transistor impedances are above 500 ohms, the NORMAL position is selected.

d. When estimating the external circuit impedance at 1000 cps, only the circuitry between the base and emitter is considered. If there is any doubt as to which position to use, the NORMAL position is selected.

CAUTION

In either position of the CIRCUIT IMPEDANCE switch, the transistor must be tested below its maximum collector dissipation.

10. A.C. VOLTMETER CIRCUIT. (See figure 2). The A.C. voltmeter circuit consists of a three-stage amplifier (Q3, Q4, Q5) which is highly degenerative to provide excellent stability, and a crystal diode bridge detector. The input sensitivity of the amplifier is 0.5 uv P-P or 0.176 uv RMS for full scale deflection of the meter.

11. TYPE SELECTOR SWITCH CIRCUIT. (See figure 2). The TYPE selector switch S2 is a three-position switch which changes the polarity of the applied voltages to the transistor or diode under test. The three positions of the switch are PNP, NPN and DIODE. The position of the switch is determined by the circuit element to be tested, that is, an NPN or PNP transistor, or a diode.

12. TEST CIRCUITS. The various test circuits are set up by the FUNCTION SELECTOR switch. Following is an explanation of these circuits.

13. I_{CBO} TEST CIRCUIT. (See figure 3). In the I_{CBO} test, a reverse voltage is applied across the collector-base diode of the transistor. The emitter is open-circuited. (The transistor must be removed from its circuit for this test.) The collector cutoff current is read directly on the 0-50 ua scale of the meter and the appropriate multiplier of the CIRCUIT IMPEDANCE switch S5 is used, that is, X1, X10, or X100. The meter M1 is connected in series with a limiting resistor (R17 in this case) to the applied voltage (battery BT2) and the transistor under test.

14. BATTERY TEST CIRCUIT #1. (See figure 2). By placing the Battery switch S1 to the BATT. TEST position, the tester and its associated circuitry is de-energized and the 22.5-volt battery BT1 is tested under a fixed load of 3.3K. The quality of the battery is read from the meter scale, which is in two colors, red and green. The red portion of the scale indicates that the battery is low, while the green portion of the scale indicates that the battery is good.

15. I_C TEST CIRCUIT. (See figure 4). The I_C control adjustment is made in the following manner when testing transistors "in circuit": The I_C potentiometer R24 is set to "zero" or its minimum position. Note the shunt leakage current on the 0-1.0 ma scale of the meter and the appropriate multi-

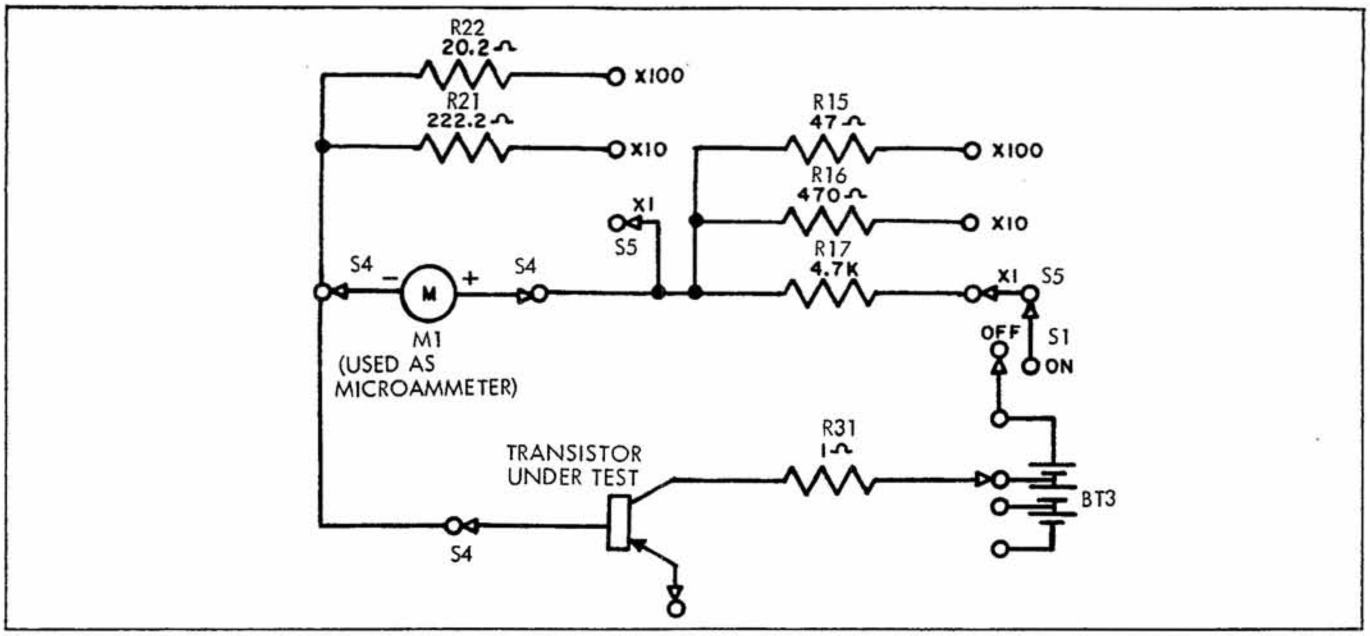

Figure 3. I_{CBO} Test Circuit

plier of the Current Range switch S5A and S5B should be used, that is, X1, X10 or X100. Under these circumstances the meter is reading the stray leakage current flowing in the external circuitry due to the collector supply voltage. The I_C potentiometer is then adjusted for one additional milliampere over the previously noted reading. With this setting one milliampere of collector current will flow through the transistor which is considered standard for a small signal beta test. If a larger collector current is desired, the I_C potentiometer can be adjusted to the desired value.

16. BATTERY TEST CIRCUIT #2. (See figure 2). When the Battery Switch S1 is placed in the BATT. TEST position, the quality of the two 4.5-volt batteries BT2 and BT3 is determined by reading the dual colored scale of the meter. If the pointer of the meter is in the red portion of the scale the batteries are low; if it is in the green portion of the scale the batteries are good.

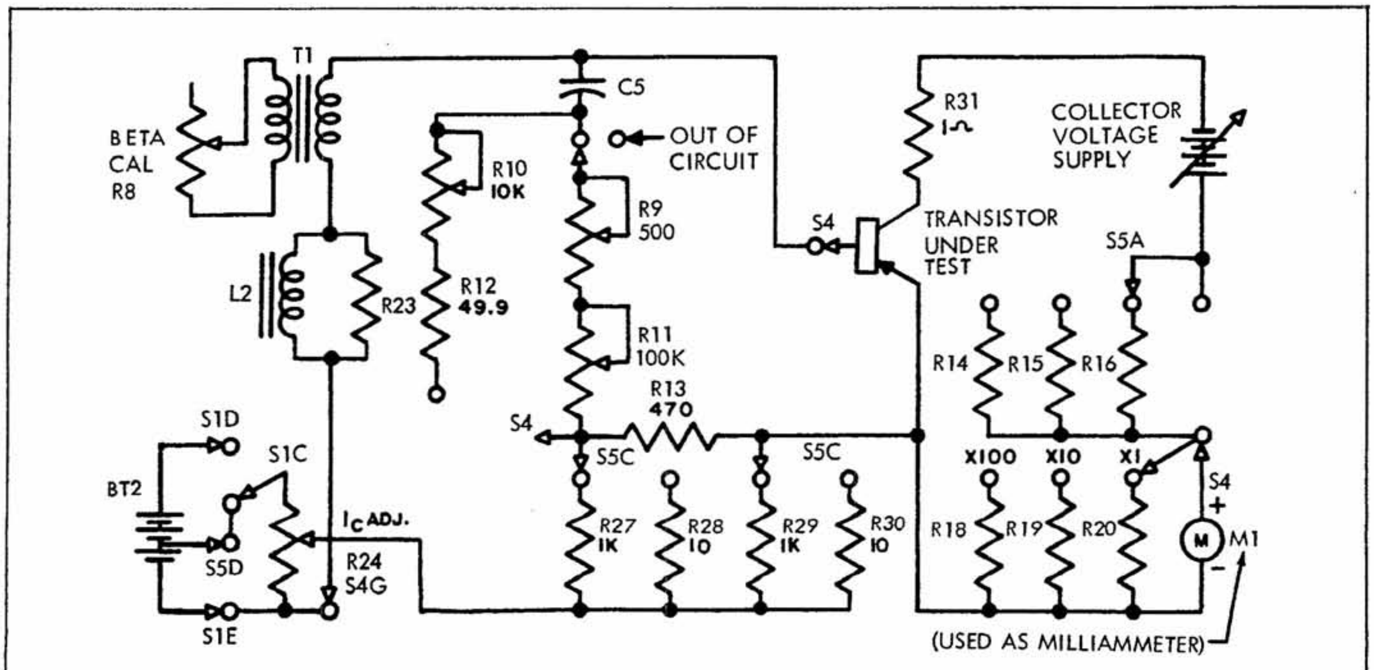

Figure 4. I_C Test Circuit

17. Z OHMS CIRCUIT. (See figure 5).

a. To determine the Z ohms circuit input impedance, it is necessary to separate the external input circuit impedance from the transistor input resistance. This is accomplished by reversing the bias on the transistor so that it is cut off, thus separating the external input circuit impedance from the transistor input resistance.

b. The external input circuit impedance forms one leg of the bridge circuit and its value is determined by varying the Z OHMS CIRCUIT potentiometers R9 and R11 until a null is indicated on the sensitive a-c voltmeter tied across the bridge. The value of this external input circuit impedance can be read directly from the calibrated dials of the Z OHMS CIRCUIT potentiometers. This null must be made very carefully because it can affect the next test, which is the R_{IN} of the transistor.

c. If the transistor is "out of circuit" the external input impedance is almost infinite. Therefore the Z OHMS CIRCUIT potentiometers must be removed from the bridge circuit. This is accomplished with a SPST switch (an integral part of R9) which is ganged to the shaft of the small knob of the Z OHMS CIRCUIT potentiometer. This switch must be placed to the OUT OF CIRCUIT position to remove the Z OHMS CIRCUIT potentiometers from the bridge circuit.

18. R_{IN} TRANSISTOR CIRCUIT. (See figure 6). The dynamic input resistance of the transistor is determined by using the same technique used in determining the external input circuit impedance (paragraph 17). However, in this test the transistor is biased in the forward direction, and the previous settings (paragraph 17) of the Z OHMS CIRCUIT potentiometers R9 and R11 are retained. The value of the dynamic input resistance is determined by varying the R_{IN} TRANSISTOR potentiometer R10 until a null is indicated on the meter M1. The value of the dynamic input resistance can be read directly from the calibrated dial of the R_{IN} TRANSISTOR potentiometer.

19. BETA CAL AND BETA READ CIRCUITS. Circuits set up by the BETA CAL and BETA READ positions of FUNCTION SELECTOR switch S4 are the same as that shown in figure 6, except for location of the meter M1. Beta is the current gain of a transistor in the common emitter configuration which is the ratio of the a-c collector current to the a-c base current. To measure both of these currents, a monitoring resistor of 49.9 ohms (R12) is placed in the bridge circuit and another monitoring resistor of 1 ohm (R31) in the collector circuit. The meter M1 monitors the voltage drops across these resistors and the AC Beta can be determined. Placing the FUNCTION SELECTOR switch S4 to the BETA CAL position, meter M1 monitors the voltage drop across the 49.9-ohm resistor; the BETA CAL potentiometer R8 is adjusted until the meter reads 1/2 scale or CAL SET. Under this condition there is 5 ua of current flowing in the base circuit. The FUNCTION SELECTOR switch is then placed to the BETA position. This switches the meter across the 1-ohm monitoring resistor and the meter reads AC Beta directly.

20. DIODE TEST CIRCUIT. (See figure 7). The circuitry used to perform the diode tests is essentially the same as that used for the transistor tests. The only difference between the circuitry is the functions performed by the TYPE selector switch S2. This switch performs three different functions, the first of which is to reverse the meter M1 in the IC

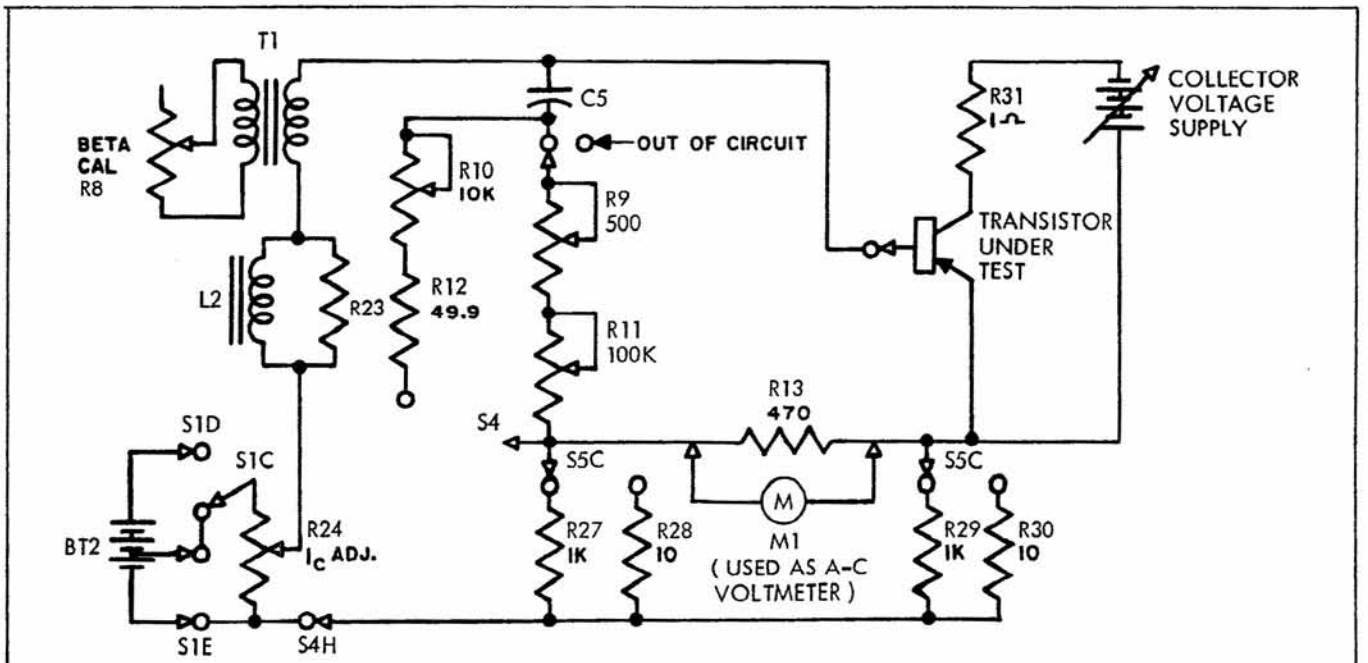

Figure 5. Z Ohms Test Circuit

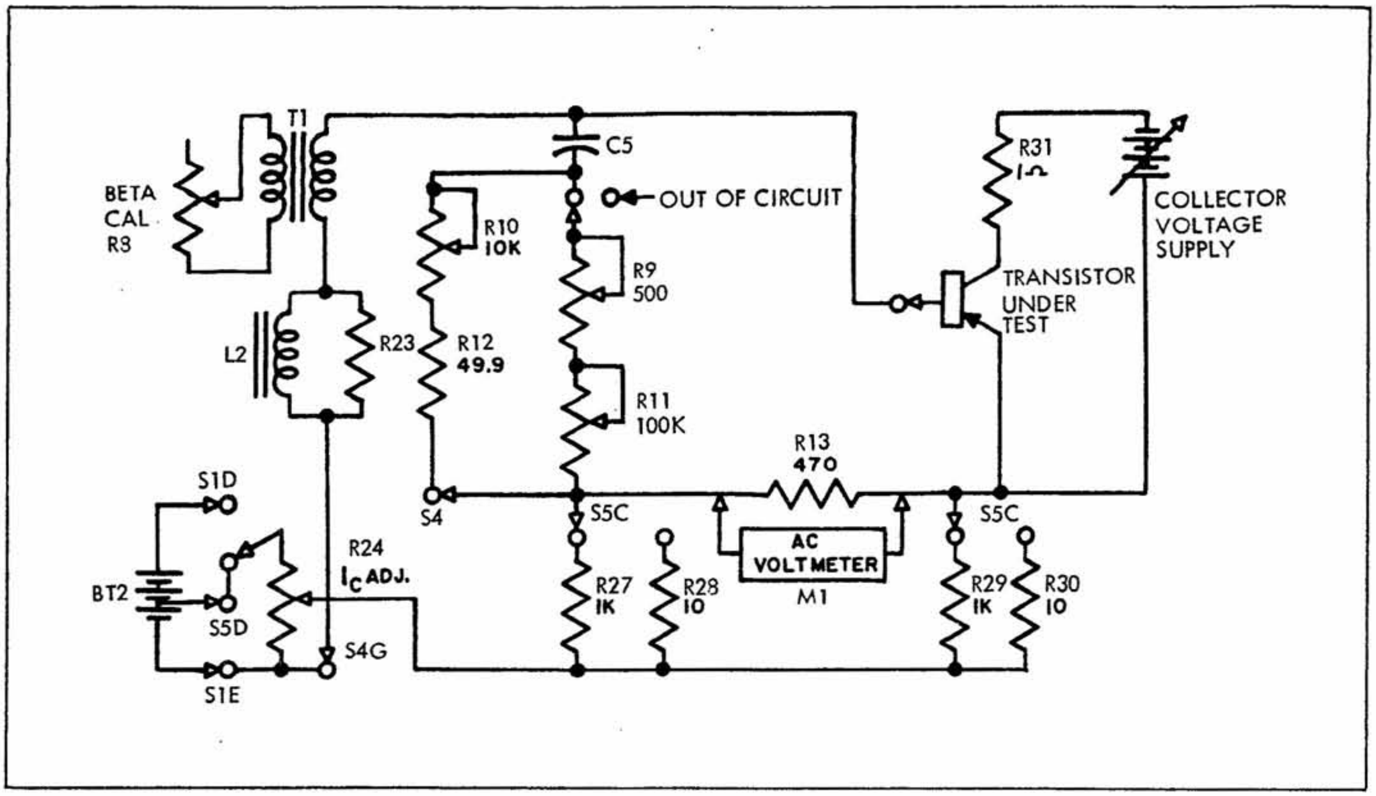

Figure 6. R_{IN} Test Circuit

position of the FUNCTION SELECTOR switch S4, so that the total current drawn by the diode and its external circuitry can be measured. Secondly it shorts out the current limiting resistors (R21 and R22) in the collector circuit, which are used to protect the meter if a shorted transistor is tested and lastly it removes the collector voltage supply in the last 5 positions of the FUNCTION SELECTOR switch. Compare figure 7 with figure 4 and note the differences.

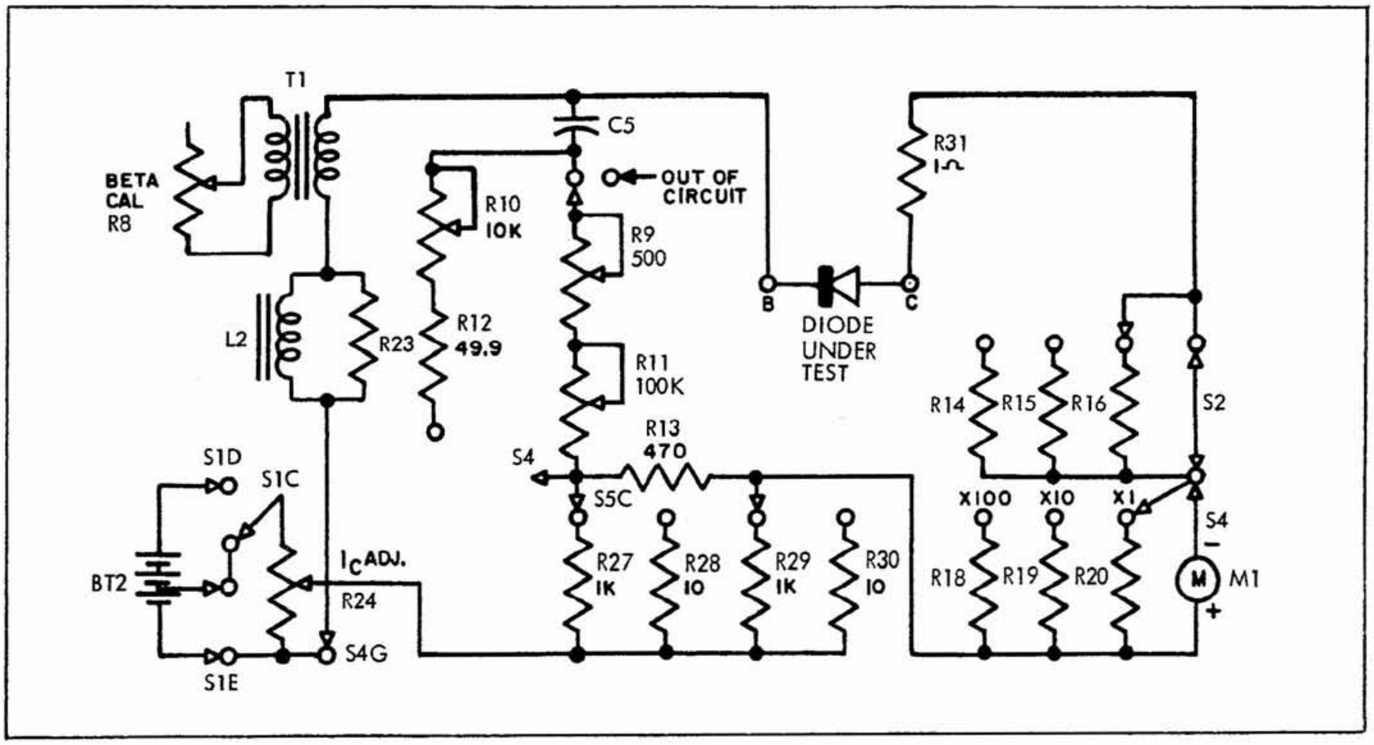

Figure 7. Diode Test Circuit

21. PREPARATION FOR USE. (See figure 8). The tester is not supplied with batteries because batteries deteriorate with age. The following complement of batteries should be installed as explained below.

Symbol	Quantity	Type
BT2 and BT3	2	No. 2370 ST Burgess
BT1	1	No. 763 Eveready

a. Remove ten screws located near outer edge of control panel.

b. Gently lift panel assembly out of its case and disconnect cable assembly from the panel assembly chassis.

c. Remove eight screws that hold battery brackets to case.

d. Place the smaller of the two brackets around battery BT1 and the other bracket around batteries BT2 and BT3.

Note

When installing batteries in their brackets, there should be sufficient clearance between the lip of the bracket and the battery studs. When installing Military Batteries BA-2 and BA-27, reverse the mounting brackets so that the bracket flanges will be opposite the battery terminal end. Use pressboard or cardboard to insure a snug fit for battery BT-1 when installing Military Battery BA-2.

e. Place battery assemblies in case and secure them to case with the eight screws that were removed.

f. Connect the various leads to their proper batteries. The wires are color-coded and are soldered to lugs. Figure 8 shows the color of the leads and where they should be placed. Tighten each lug securely to its stud.

g. Reconnect the cable assembly to the chassis.

h. Carefully insert panel assembly back into the case and secure with the ten screws.

22. OPERATING INSTRUCTIONS.

23. GENERAL. Consult the manufacturer's specification sheets for values of the transistors to be tested. The tests performed by the tester are I_{CBO}, I_C, Z ohms, R_{IN}, and BETA. These tests must be performed carefully and in the sequence indicated. Test procedures are categorized by "in circuit" transistor tests, "out of circuit" transistor tests, "in circuit" diode tests, "out of circuit" diode tests, and additonal tests.

Note

The I_{CBO} test (collector leakage current) is performed only as an "out of circuit" test.

24. OPERATING CONTROLS AND INDICATORS. The operating controls and indicators are all located on the front of the tester. Figure 9 shows the location and figure 10 lists the controls and indicators and the function of each one of their positions.

25. TRANSISTOR LEAD IDENTIFICATION. For the purpose of quick reference, bottom views of the most common types of transistors are shown in figure 11.

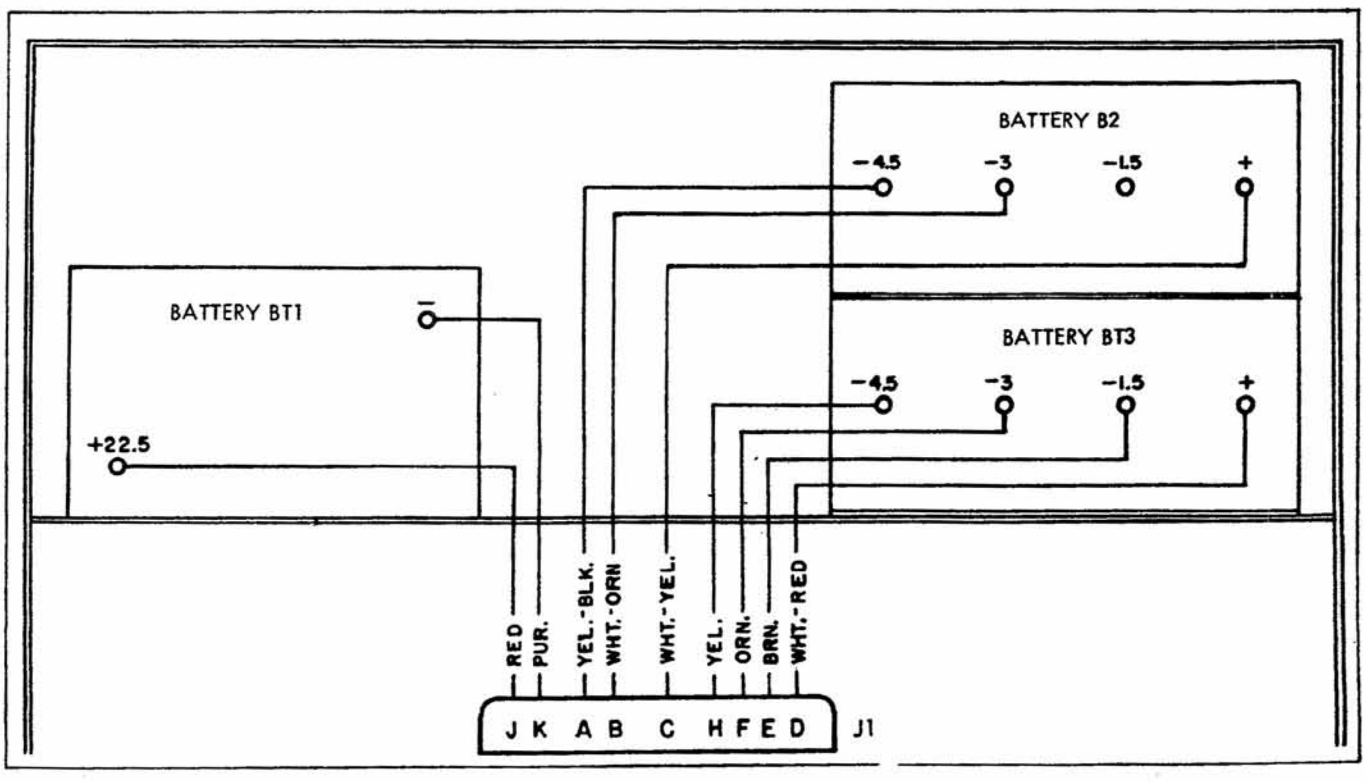

Figure 8. Battery Wiring Diagram

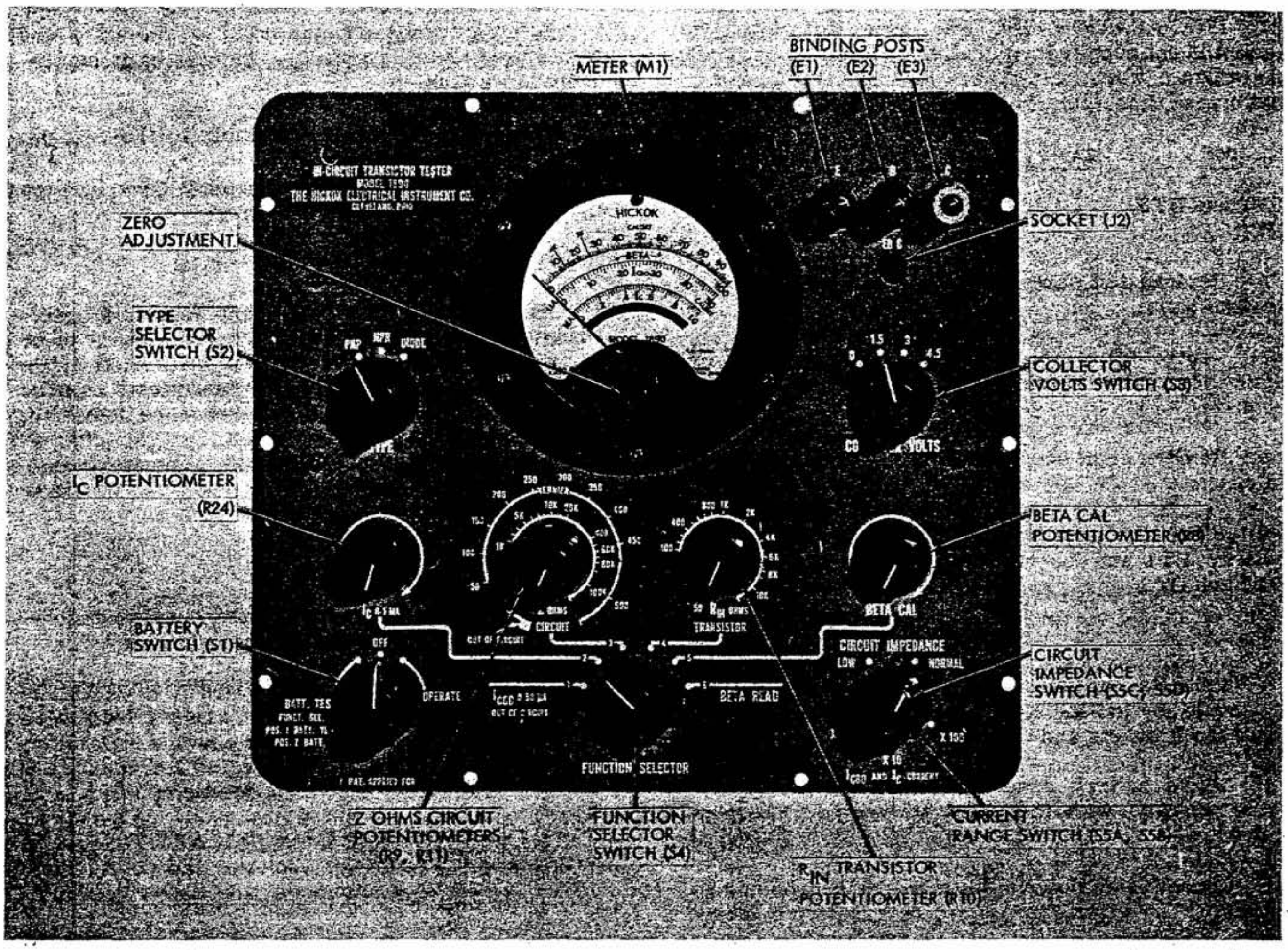

Figure 9. Operating Controls and Indicators.

26. PRELIMINARY ADJUSTMENTS AND CONTROL SETTINGS. Before attempting to test any transistor or diode do the following.

a. Place FUNCTION SELECTOR switch to I_{CBO}. Rotate Battery switch to BATT. TEST and monitor the meter; meter should read on green portion (GOOD).

b. Place FUNCTION SELECTOR switch to I_C. Rotate Battery switch to BATT. TEST and monitor the meter; meter should read on green portion (GOOD).

c. Rotate the I_C and BETA CAL potentiometers to their minimum positions.

CAUTION

If the I_C and BETA CAL potentiometers are not set at their minimum positions, possible damage could be incurred to the transistor or diode to be tested.

d. Using a screwdriver on the Zero Adjustment, zero the meter.

27. "IN CIRCUIT" TRANSISTOR TESTS. The test procedure for the "in circuit" transistor test is as follows.

a. Connect the three colored banana plugs of the test lead assembly to their respective binding posts (E, B and C) located on the tester control panel. Then connect the other end of the test leads to transistor to be tested. The yellow lead is connected to emitter, green lead to base and blue lead to collector.

b. Set the TYPE selector switch to either the PNP or NPN position, depending upon which type of transistor is to be tested.

c. Turn I_C and BETA CAL potentiometers to "zero", or minimum, positions.

d. Set CIRCUIT IMPEDANCE switch to NORMAL if circuit impedance is above 500 ohms or to LOW if circuit impedance is below 500 ohms.

e. Set the COLLECTOR VOLTS switch to the collector voltage desired for testing the transistor (1.5, 3, 4.5).

CONTROL or INDICATOR	POSITION or SCALE	FUNCTION
Battery switch S1	OPERATE	Energizes tester circuitry for testing a transistor.
	BATT. TEST	With FUNCTION SELECTOR switch S4 in position 1 (I_{CBO}), the tester and its associated circuitry is de-energized and the 22.5-volt battery BT1 is tested under a fixed load of 3.3K.
		With FUNCTION SELECTOR switch S4 in position 2 (I_C), the two 4.5-volt batteries BT2 and BT3 are tested.
	OFF	De-energizes the tester.
TYPE selector switch S2	PNP	Sets the correct polarity of the applied voltages to the PNP transistor under test.
	NPN	Sets the correct polarity of the applied voltages to the NPN transistor under test.
	DIODE	With FUNCTION SELECTOR switch S4 at I_C, meter M1 is reversed.
		Shorts out current limiting resistors R14, R15 and R16.
		Removes collector voltage supply in positions 2 to 6 of FUNCTION SELECTOR switch S4.
COLLECTOR VOLTS switch S3	0	De-energizes the 4.5-volt battery BT3 potential to the collector of the transistor under test.
	1.5, 3, 4.5	Applies voltage to collector of the transistor from battery BT3 in 1.5-volt steps.
FUNCTION SELECTOR switch S4	1 - I_{CBO}	With the Battery switch S1 to BATT. TEST position, the tester and its associated circuitry is de-energized and the 22.5-volt battery BT1 is tested under a fixed load of 3.3K.
		In the I_{CBO} test (Battery switch S1 in OPERATE position), a reverse voltage is applied across the collector-base diode and the emitter is open-circuited in this test. Meter M1 and the appropriate limiting resistor are placed in series with the circuit.
	2 - I_C	With the Battery switch S1 to BATT. TEST position, the two 4.5-volt batteries BT2 and BT3 are tested.

Figure 10. Functions of Operating Controls and Indicators (Sheet 1 of 3)

CONTROL or INDICATOR	POSITION or SCALE	FUNCTION
		In the I_C test (Battery switch S1 in OPERATE position), the I_C potentiometer R24 is energized, meter M1 and appropriate limiting resistor are switched into the collector circuit and the variable resistance bridge into the circuit.
	3 - Z OHMS CIRCUIT	Reverses bias on the transistor under test and switches meter M1 across the bridge circuit.
	4 - R_{IN} OHMS TRANSISTOR	Switches R_{IN} OHMS TRANSISTOR potentiometer R10 into the bridge circuit. Forward biases on the transistor under test and retains meter M1 across the bridge.
	5 - BETA CAL	Places meter M1 across monitoring resistor R12 (49.9 ohms) in the bridge circuit.
	6 - BETA READ	Places meter M1 across monitoring resistor R31 (1 ohm) in the collector circuit for a Beta reading on meter M1.
CIRCUIT IMPEDANCE switch S5C and S5D	LOW	Places I_C potentiometer R24 across the 4.5-volt tap of battery BT2.
		Switches the two 10-ohm resistors (R28 and R30) into the bridge circuit and shorts out resistor R11.
	NORMAL	Places I_C potentiometer R24 across the 1.5-volt tap of battery BT2.
		Places resistors R27 and R29 into the bridge circuit.
CURRENT RANGE switch S5A and S5B	X1, X10, X100	Connects the appropriate meter shunt resistor into the circuit which determines the multiplier used when reading meter M1.
		Inserts a limiting resistor in series with the meter.
I_C potentiometer R24	---	With the FUNCTION SELECTOR switch S4 in position 2, the I_C potentiometer R24 is used to adjust collector current flow of the transistor under test.
Z OHMS CIRCUIT potentiometers R9 and R11	Any position except OUT OF CIRCUIT	With the FUNCTION SELECTOR switch S4 in position 3, the Z OHMS CIRCUIT potentiometers are adjusted to provide the balancing leg of the bridge circuit. It also provides direct reading of the external input impedance.

Figure 10. Functions of Operating Controls and Indicators (Sheet 2 of 3)

CONTROL or INDICATOR	POSITION or SCALE	FUNCTION
	OUT OF CIRCUIT	Removes Z OHMS CIRCUIT potentiometers R9 and R11 from the bridge circuit during "out of circuit" transistor tests.
R_{IN} TRANSISTOR potentiometer R10	---	With the FUNCTION SELECTOR switch S4 in position 4, the R_{IN} TRANSISTOR potentiometer is used to balance the bridge circuit and provide direct reading of the dynamic input resistance of the transistor under test.
BETA CAL potentiometer R8	---	With the FUNCTION SELECTOR switch S4 in position 5, the BETA CAL potentiometer R8 is used to adjust meter M1 to read CAL SET permitting 5 ua of current to flow in the base circuit of the transistor under test.
Meter M1	BATTERY LOW-GOOD	With the Battery switch S1 at BATT. TEST and the FUNCTION SELECTOR switch S4 in position 1, condition of battery BT1 is indicated.
		With the Battery switch S1 at BATT. TEST and the FUNCTION SELECTOR switch S4 in position 2, condition of the two 4.5-volt batteries BT2 and BT3 is indicated.
	I_C 0-1 MA.	Indicates collector current flow when the I_C potentiometer R24 is used to forward bias the transistor under test.
	ICBO 0-50 UA.	Indicates Beta of transistor under test for full scale calibration of the meter.
	0-100	Indicates Beta of transistor under test for 1/2, 1/4 and 1/8 scale calibration of the meter.
Binding Posts E1, E2, E3	E, B, C	Connects to respectively colored banana plugs of lead assembly for "in circuit" transistor tests.
Socket J2	---	Provides connection to transistor for "out of circuit" tests.
Zero ADJUSTMENT	---	Used to "zero" meter M1.

Figure 10. Functions of Operating Controls and Indicators (Sheet 3 of 3)

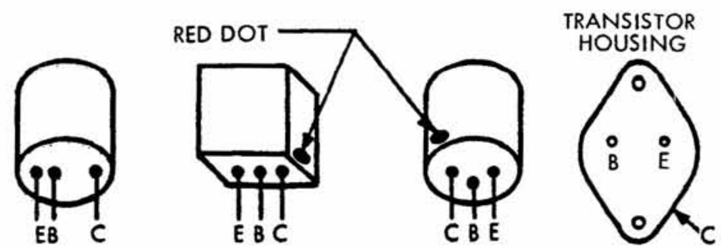

Figure 11. Transistor Lead Identification

f. Place FUNCTION SELECTOR switch to I_C position and Current Range switch to X10. Turn Battery switch to OPERATE. This energizes the tester.

g. Observe the shunt leakage current on the 0-1 MA. scale of the meter and apply its proper multiplier (X10 in this case) to determine current flow.

Note

Under these circumstances the meter is reading the stray leakage current flowing in the external circuitry due to the collector supply voltage.

h. Adjust the collector current with I_C potentiometer for one additional milliampere over the previously noted reading. If the stray leakage current is high (3, 4 or 5 MA), set collector current to at least twice the noted stray leakage current, by adjusting I_C potentiometer.

Note

Power type transistors, used in the final audio output stages of transistor radios, should be checked with 5 or 10 MA. of collector current.

CAUTION

Do not change current multipliers while the tester is energized.

i. Rotate the VERNIER of the Z OHMS potentiometer to approximately 250 ohms, or mid position.

j. Place FUNCTION SELECTOR switch to the Z OHMS CIRCUIT position and turn the Battery switch to the right.

k. Increase amplitude of audio oscillator by turning BETA CAL potentiometer until meter reads approximately half scale. Balance the bridge by first varying the large control of Z OHMS CIRCUIT potentiometer to obtain an approximate null; adjust VERNIER to obtain a precise null as indicated on meter. Value of external input impedance can now be read directly from the calibrated dials of Z OHMS CIRCUIT potentiometers.

l. Place FUNCTION SELECTOR switch to R_{IN} TRANSISTOR; turn Battery switch to the right and increase amplitude of audio oscillator. Adjust RIN TRANSISTOR potentiometer to balance the bridge circuit. A null will be indicated on the meter when the bridge is balanced. The value of the dynamic input resistance of the transistor is read directly from the calibrated dial of the R_{IN} TRANSISTOR potentiometer.

m. Place FUNCTION SELECTOR switch to BETA CAL. Turn Battery switch to the right and adjust BETA CAL potentiometer until meter reads 1/2 scale or CAL SET. Then place FUNCTION SELECTOR switch to the BETA READ and read Beta directly on the meter. If the Beta of the transistor is higher than 100, recalibrate meter to 1/4 scale and multiply meter reading by 2. If Beta of the transistor is higher than 200, recalibrate meter to 1/8 scale and multiply meter reading by 4. If the beta of the transistor is below 50, and an accurate value of Beta is required, recalibrate meter to full scale and read Beta directly on 0-50 scale of meter.

28. "OUT OF CIRCUIT" TRANSISTOR TESTS. The test procedure for the "out of circuit" test condition is almost identical to that of the "in circuit" test procedure. The only difference is that the I_{CBO} test is performed and the Z Ohms test is omitted. When omitting the Z Ohms test, the Z OHMS CIRCUIT potentiometer must be switched to the OUT OF CIRCUIT position. The test procedure for the "out of circuit" transistor test is as follows.

a. Remove transistor which is to be tested from its circuit. Either plug it into socket located on control panel (identified as EB C) or perform step a of paragraph 27.

b. Switch Z OHMS CIRCUIT potentiometer to OUT OF CIRCUIT position.

c. Perform steps b through e, paragraph 27.

d. Place FUNCTION SELECTOR switch to I_{CBO} and Current Range switch to X100.

e. Turn Battery switch to the right and monitor the I_{CBO} scale of the meter for leakage current. If current reading is low, release Battery switch and place Current Range switch to X10 or X1, depending upon what current is measured.

f. Perform steps f, g, h, l, and m, paragraph 27.

29. "IN CIRCUIT" DIODE TESTS. Perform the following procedure for the "in circuit" diode test.

a. Connect the three colored banana plugs of the test lead assembly to their respective colored binding posts (E, B and C) on the tester. Then connect the other end of the test leads to the diode to be tested. The green lead is connected to cathode end, blue lead to anode and the yellow lead is left open-circuited.

b. Set the TYPE selector switch to DIODE and set the I_C and BETA CAL potentiometers to their minimum positions.

c. Place CIRCUIT IMPEDANCE switch to LOW or NORMAL, depending on circuit impedance; set Current Range switch to X10.

Note

The setting of the COLLECTOR VOLTS switch is immaterial in this test because this supply is not used in an "in circuit" diode test.

d. Place the FUNCTION SELECTOR switch to I_C, and turn Battery switch to the right, energizing the tester.

e. Adjust I_C potentiometer until the meter reads 0.1 MA. Under this condition the meter is actually reading 1 MA.

f. Turn FUNCTION SELECTOR switch to Z OHMS CIRCUIT and increase the amplitude of the audio oscillator by turning BETA CAL potentiometer until meter reads half scale. Then vary the Z OHMS CIRCUIT potentiometers until null is obtained on the meter. Read the value of external impedance from calibrated dial of the Z OHMS CIRCUIT potentiometers. If null occurs near zero or some low value, the diode can be assumed to be shorted or leaky.

g. Place the FUNCTION SELECTOR switch to R_{IN} TRANSISTOR and increase amplitude of the audio oscillator until meter reads half scale. Then balance the bridge by varying R_{IN} TRANSISTOR potentiometer until null is indicated on the meter. Read the value of the diode's dynamic forward resistance from the dial of the R_{IN} TRANSISTOR potentiometer. Normal values of 50-500 ohms can be expected. If a high value of resistance is obtained, the diode can be assumed to be open circuited or the external circuitry which shunts the diode is extremely low. If the external circuitry is low, adjust the I_C potentiometer until the meter reads 2 to 5 MA. and then null the diode's dynamic resistance. Variations in the dynamic forward resistance of a diode is a function of the d-c current flowing through the diode.

30. "OUT OF CIRCUIT" DIODE TESTS. The test porcedure for the "out of circuit" diode test is as follows.

a. Connect the three colored banana plugs of the test lead assembly to their respective colored binding posts (E, B and C) on the tester. Then connect the other end of the test leads to the diode to be tested. The green lead is connected to the cathode end, blue lead to anode and the yellow lead is left open-circuited.

b. Set the TYPE selector switch to DIODE and set the I_C and BETA CAL potentiometers to their minimum positions.

c. Place CIRCUIT IMPEDANCE switch to NORMAL and Current Range switch to X10.

d. Set COLLECTOR VOLTS switch to 1.5.

e. Place FUNCTION SELECTOR switch to I_{CBO} and turn Battery switch to the right. Now read the leakage current of the diode on the meter; then release the Battery switch. If the meter reading is high the diode is shorted or very leaky.

f. Place FUNCTION SELECTOR switch to I_C and turn Battery switch to the right. Adjust the I_C potentiometer until the meter reads 0.1 MA. Under this condition the meter is actually reading 1 MA.

g. Place Z OHMS CIRCUIT potentiometers to their OUT OF CIRCUIT position.

h. Place FUNCTION SELECTOR switch to R_{IN} TRANSISTOR and turn Battery switch to the right. Increase the amplitude of the audio oscillator by varying the BETA CAL potentiometer until the meter reads half scale. Then balance the bridge by varying the R_{IN} TRANSISTOR potentiometer until null is indicated on the meter. The value of the diode's dynamic forward resistance is read from the dial of the R_{IN} TRANSISTOR potentiometer.

31. ADDITIONAL TESTS.

32. GENERAL. The tester is also capable of performing certain other less common tests. Procedures for these additional tests are explained below.

33. "OUT OF CIRCUIT" I_{CEO} TEST FOR SMALL SIGNAL TYPES. I_{CEO} is the collector leakage current with the collector reverse-biased and the base open-circuited. In general the I_{CEO} leakage current is considerably larger than I_{CBO}. The test is performed in the following manner.

a. Place TYPE selector switch to either NPN or PNP, depending upon the type of transistor.

b. Place COLLECTOR VOLTS switch to 1.5.

c. Place FUNCTION SELECTOR switch to I_{CBO}.

d. Connect collector to the blue lead and emitter to green lead of lead assembly and leave the base open-circuited.

e. Place the Current Range switch to X100 and then turn Battery switch to the right. Read the leakage current on the 0-50 ua scale of the meter. If reading is low, place the Current Range switch to X10 or X1, depending upon how much leakage current is being measured.

34. "OUT OF CIRCUIT" I_{EBO} TEST FOR SMALL SIGNAL TYPES. I_{EBO} is the emitter leakage current with reverse-bias applied to the emitter and the collector open circuited. The test is as follows.

a. Place TYPE selector switch to NPN or PNP.

b. Place COLLECTOR VOLTS switch to 1.5.

c. Place FUNCTION SELECTOR switch to I_{CBO}.

d. Connect base to the green lead, emitter to blue lead of the lead assembly; the collector is left open-circuited.

e. Place Current Range switch to X100 and then turn Battery switch to the right. Read the leakage current on the 0-50 ua scale of the meter. If the reading is low, place Current Range switch to X10 or X1, depending upon how much leakage current is being measured. However, release Battery switch when changing current multipliers.

35. IMPEDANCE RATIO OF AUDIO TRANSFORMER. The impedance ratio of an audio transformer can be determined in the following manner.

a. Connect primary of transformer to the yellow and green leads of the lead assembly.

b. Place I_C potentiometer to its minimum position.

c. Place FUNCTION SELECTOR switch to Z OHMS CIRCUIT and be sure that the Z OHMS CIRCUIT potentiometers are in the circuit.

d. Place a resistive load across the secondary.

e. Turn Battery switch to the right and increase the BETA CAL potentiometer until the meter reads full scale. Then vary the Z OHMS CIRCUIT potentiometers until null is indicated on the meter. Release the Battery switch. Read the value of reflected impedance on dial of Z OHMS CIRCUIT potentiometer. Knowing the reflected impedance and the secondary load, the impedance ratio can be determined. Also, knowing the impedance ratio, the turns ratio can also be determined. The turns ratio is the square root of the impedance ratio. The formula is as follows:

$$TR = \sqrt{\frac{Zp}{Zs}}$$

36. TESTER LIMITATIONS.

37. GENERAL. As with all instruments, there are limitations to which this tester can be used. Therefore, this section will help the user of the tester to overcome some of its pitfalls by altering the external circuitry of the transistor to be tested or by using a slightly different test procedure when required. Various types of circuits with their specific difficulties in testing them, as well as special techniques used to overcome these difficulties, are explained in paragraphs 38 through 42. The following general considerations should be noted.

a. While following the regular test procedure for an "in circuit" test on a circuit which has a low external input impedance, it is possible that the transistor input resistance cannot be nulled out. Under these circumstances, it is necessary to increase the collector current of the transistor under test to decrease its input resistance. The limitations to the above solution are the collector dissipation of the transistor under test and the shunting effects of the external input circuitry impedance.

b. The maximum ratio of the transistor input resistance to the external input impedance which can be detected by the bridge circuit is 10 to 1. Therefore, under the lowest limit of external input impedance (25 ohms), the maximum detectable value of the transistor input resistance is 250 ohms.

c. There are external circuit conditions under which it is impossible to reverse bias the transistor under test when performing a Z ohm test. This is due to extremely low values of self-biasing networks. When this condition exists, reduce the collector voltage to zero. This will reverse bias the transistor under test, and the external circuitry impedance can be measured as outlined in paragraph 27. After the Z Ohm test has been made, return the COLLECTOR VOLTS switch to its previous position.

d. In some special circuits, where the external input circuitry of the transistor being tested exhibits a large capacitance (0.5 uf or larger) across its base to emitter leads, disconnect one side of this capacitor before performing the tests.

38. R-F AND I-F STAGE. In some R-F and I-F AVC stages, which have both the base and the low side of the collector tank heavily bypassed, it is possible, even under these adverse conditions that the Z OHM CIRCUIT potentiometers can still null out the external circuit impedance. However, the value of this impedance will be very low, almost a short circuit. When these circumstances exist, open one side of these bypass capacitors. This will remove the low impedance from the emitter-base circuit. Then the stage can be tested in the usual manner.

39. AUDIO DRIVER STAGE. When testing an audio ouput driver stage of a radio, set the volume control to approximately 1/2 of its maximum resistance. This will eliminate an a-c short between the base and the emitter of the transistor being tested.

40. DETECTOR STAGE. Figure 12 shows a detector stage in which a slightly different test procedure is required. Place the Z OHMS CIRCUIT potentiometer to the OUT OF CIRCUIT position, omit the Z Ohm test and then proceed to test the transistor as outlined in paragraph 27. From figure 12 one can see that the diode isn't conducting when the transistor is forward biased by the tester. Therefore the Z Ohm test should be omitted because the Z Ohm test reverses the forward biasing voltage applied to the transistor under test. In this

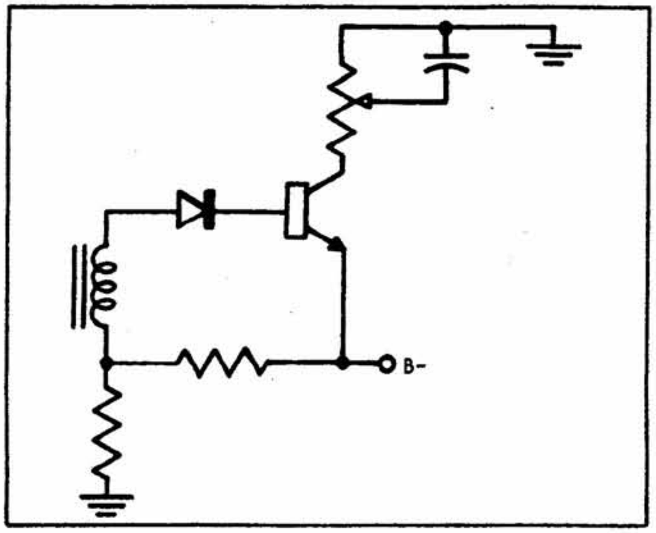

Figure 12. Typical Detector Circuit

case it also makes the diode conduct, which produces an erroneous input impedance measurement.

41. DIRECT COUPLED CIRCUIT. Directly coupled PNP to NPN circuits require a slightly different test procedure. Preset the Z OHMS CIRCUIT potentiometers to the approximate value of the external input impedance. Then omit the Z Ohm test and continue with the other tests. The reason for this deviation is that the Z Ohm test reverse biases the transistor under test, however at the same time it acts as a collector supply voltage for the previous transistor, which then shunts the input impedance of the transistor under test.

42. SWITCHING CIRCUITS.

a. When performing a Z Ohm test on a transformer diode gate circuit (figure 13) or on a circuit which uses a diode to limit the reverse bias that can be applied to the emitter base junction, preset Z OHMS CIRCUIT potentiometers and omit the Z Ohm test. The potentiometer setting will depend upon the circuitry involved. If the diode is conducting when the transistor is forward biased, set the Z OHMS CIRCUIT potentiometers to the approximate value of the impedance between the base and emitter. If the diode is cut off when the transistor is forward biased, set the Z OHMS CIRCUIT potentiometer to the approximate value of impedance between base and emitter (in some cases an open circuit). If the latter is the case, place the Z OHMS CIRCUIT potentiometer to OUT OF CIRCUIT.

b. Figure 14 shows a circuit in which the diode doesn't conduct when the transistor is forward biased; the external input impedance is determined by its biasing network and the impedance of the previous stage. Follow the procedure outlined in paragraph a, above, or an erroneous input impedance measurement will be obtained. This is due to the fact that the Z Ohm test reverses the forward biasing voltage of the transistor under test and at the same time it also reverses the voltage applied to the diode in the external circuitry which might cause it to conduct or to become cut off depending upon the polarity of the voltage. Check the circuitry before attempting to test the transistor.

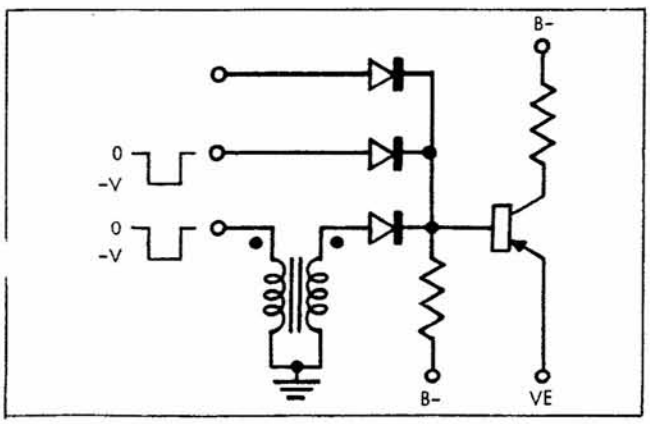

Figure 13. Typical Transformer Diode Gate Circuit

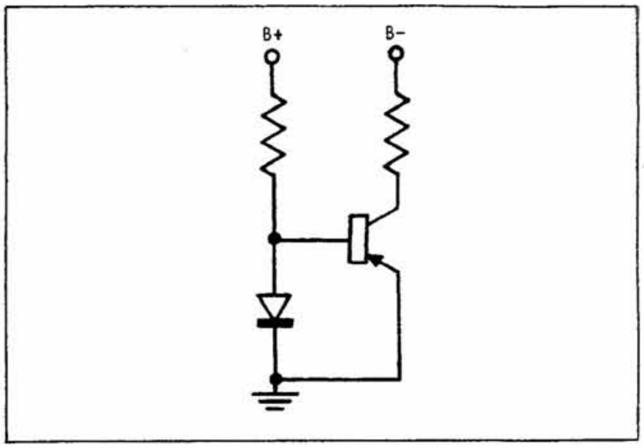

Figure 14. Typical Switching Circuit

c. A Schmitt trigger (figure 15) is another circuit in which some difficulties may arise when checking the second transistor of the circuit. The forward biasing network of the tester, which is used to adjust the collector current of the transistor under test, can also act as a collector supply for the first transistor. Eliminate this difficulty by placing a short between the collector and the emitter of the first transistor; then proceed to test the second transistor as outlined in paragraph a.

d. Figure 16 is a directly coupled monostable multivibrator. To test the three transistors of the circuit, open lead A for all of the tests and test transistor Q3 in the usual manner. If lead A is not opened when the tests on transistor Q3 are performed, the collector voltage supply will be short circuited through the emitter base diode of transistor Q2. When testing transistor Q1, short the emitter and base of transistor Q2; when testing transistor Q2, short the emitter and base of transistor Q1. If this isn't done, one could mistake the leakage current I_{CEO} of the transistor not under test for a shorted or leaky transistor. Then test the transistors as outlined in paragraph a.

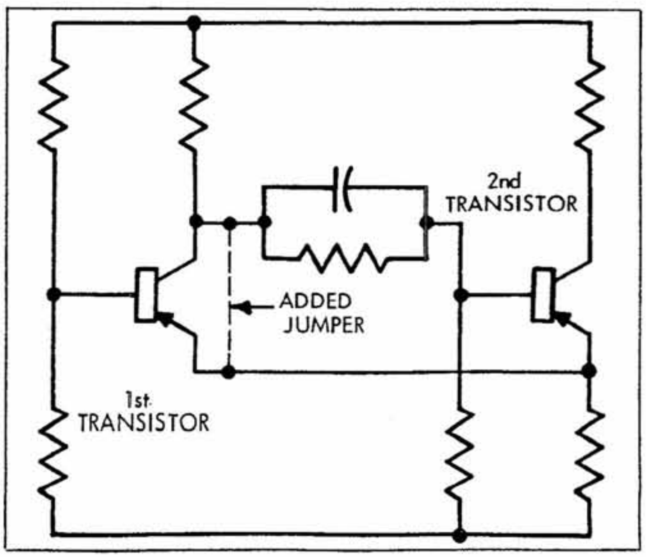

Figure 15. Schmitt Trigger Circuit

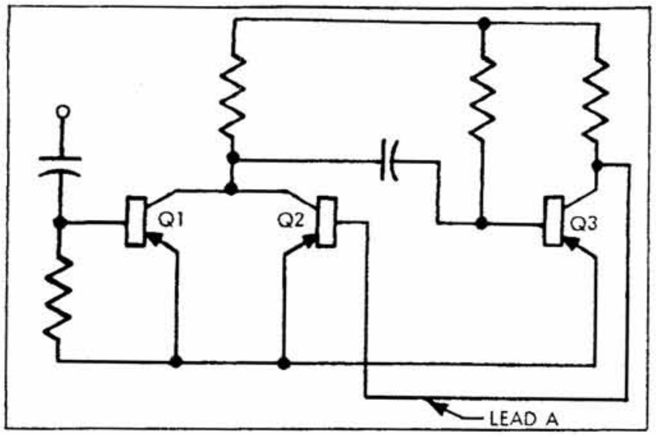

Figure 16. Directly Coupled Monostable Multivibrator

43. MAINTENANCE INSTRUCTIONS.

44. GENERAL. Maintenance of the tester consists of periodic cleaning, periodic inspection, disassembly, trouble shooting, repair or replacement of parts, and periodic calibration. No lubrication is required.

45. CLEANING.

WARNING

Perform all solvent cleaning operations in an approved cleaning cabinet or in a well ventilated area. Avoid prolonged breathing of vapors. Avoid eye and repeated skin contact. Keep solvents away from sparks and flames. Use approved personal protective equipment (goggles/face shield) when using compressed air. Provide protection from flying particles. Do not direct airstream towards self or other personnel.

a. Clean the exterior of the tester as required, using a lint-free cloth soaked with cleaning solvent conforming to Federal Specification P-D-680, Type II. Exercise catuion to avoid removing any identification markings. Dry with compressed air at not more than 30 psi.

46. INSPECTION.

a. Prior to use, perform the inspection procedure outlined below.

(1) Place FUNCTION SELECTOR switch to I_{CBO}.

(2) Turn Battery switch to BATT. TEST and monitor the meter. The meter should read in the green (GOOD) portion of the battery test scale.

(3) Place FUNCTION SELECTOR switch to I_C.

(4) Turn Battery switch to BATT. TEST and monitor meter. The meter should read in the green (GOOD) portion of the battery test scale.

47. TROUBLE SHOOTING.

48. GENERAL. In case of malfunction of the tester, investigate and remedy the trouble immediately to prevent damage to the equipment. Under no circumstances should the equipment be operated if it does not function properly. See figure 17 for indication of trouble, probable causes, and remedial action to be taken to restore equipment to the required standards. See figure 2 for the schematic wiring diagram.

49. DISASSEMBLY.

50. GENERAL. The tester is disassembled only to the extent necessary for inspection (paragraph 46), troubleshooting (paragraph 47), repair or replacement of parts (paragraph 51), and calibration (paragraph 52). Refer to section II of this manual for the parts breakdown, which includes parts location and parts descriptions. General disassembly instructions are given below.

a. Remove the ten screws located near the outer edge of the control panel.

b. Gently lift panel assembly out of its case.

c. Disconnect jack J1 from plug P1.

d. To remove a switch or potentiometer proceed as follows:

TROUBLE	PROBABLE CAUSE	REMEDIAL ACTION
No deflection of meter when all batteries are tested.	All three batteries are completely dead	Replace defective batteries.
	Open circuit	Check continuity and repair defective wiring.
	Shorted crystal CR1	Replace defective crystal.
	Defective meter M1	Replace meter.
	Defective Battery switch S1	Replace defective switch.
	Defective FUNCTION SELECTOR switch S4	Replace defective switch.
No deflection of meter when 22.5-volt battery BT1 is tested.	Dead battery BT1	Replace defective battery.
	Shorted capacitor C6	Replace defective capacitor.
	Open circuit	Check continuity and repair defective wiring.
	Defective Battery switch S1	Replace defective switch.
	Defective FUNCTION SELECTOR switch S4	Replace defective switch.
	Shorted resistor R25	Replace defective resistor.
	Open resistor R26	Replace resistor.
No deflection of meter when the two 4.5-volt batteries BT2 and BT3 are tested.	Both batteries are completely dead	Replace defective batteries.
	Open circuit	Check continuity and repair defective wiring.
	Defective Battery switch S1	Replace defective switch.
	Defective FUNCTION SELECTOR switch S4	Replace defective switch.
	Open resistor R32	Replace defective resistor.
Meter deflects to the extreme right when 22.5-volt battery BT1 is tested.	Open resistor R25 or R26 shorted	Replace defective resistor.

Figure 17. Troubleshooting Chart (Sheet 1 of 3)

TROUBLE	PROBABLE · CAUSE	REMEDIAL ACTION
Meter deflects to the extreme right when the two 4.5-volt batteries BT2 and BT3 are tested.	Shorted resistor R32	Replace defective resistor.
No power, or defective power to audio oscillator.	Defective battery BT1	Replace defective battery.
	Open circuit	Check continuity and repair defective wiring.
	Defective Battery switch S1	Replace defective switch.
No power, or defective power to A.C. amplifier.	Defective battery BT1	Replace defective battery.
	Open circuit	Check continuity and repair defective wiring.
	Defective Battery switch S1	Replace defective switch.
No power, or defective collector voltage.	Defective battery BT3	Replace defective battery
	Open circuit	Check continuity and repair defective wiring.
	Defective COLLECTOR VOLTS switch S3	Replace defective switch.
	Defective Battery switch S1	Replace defective switch.
	Defective TYPE selector switch S2	Replace defective switch.
Defective base current.	Defective battery BT2	Replace defective battery.
	Open circuit	Check continuity and repair defective wiring.
	Defective battery switch S1	Replace defective switch.
	Defective CIRCUIT IMPEDANCE switch S5	Replace defective switch.
	Defective I_C potentiometer R24	Replace defective potentiometer.
	Defective FUNCTION SELECTOR switch S4	Replace defective switch.

Figure 17. Troubleshooting Chart (Sheet 2 of 3)

TROUBLE	PROBABLE CAUSE	REMEDIAL ACTION
Power circuits check out but switching circuit is manfunctioning	Refer to figure 18 and check voltages at the binding posts. When an incorrect reading is obtained, isolate the trouble to the defective component in the circuit set up by the particular combination of switch settings. Then replace the defective component and calibrate the tester as outlined in paragraph 52.	
Power checks out but audio oscillator is malfunctioning	Refer to figure 19 and perform voltage and resistance measurements at the points indicated. If an incorrect reading is obtained, isolate the trouble and replace defective component. If this fails to correct the malfunction, calibrate the audio oscillator as outlined in paragraph 52. In either case, re-calibration of the audio oscillator will be necessary.	
Power checks out but amplifier is malfunctioning	Refer to figure 20 and perform voltage and resistance measurements at the points indicated. If an incorrect reading is obtained, isolate the trouble and replace defective component. If this fails to correct the malfunction, calibrate the amplifier as outlined in paragraph 52. In either case, re-calibration of the amplifier will be necessary.	

Figure 17. Troubleshooting Chart (Sheet 3 of 3)

(1) Unsolder or cut leads from terminals.

(2) Tag leads.

(3) Remove knob and locking nut from front of control panel.

(4) Remove switch or potentiometer from inside.

e. To remove meter M1, unsolder leads from crystal CR1 at rear of meter. Unscrew nuts from mounting studs at rear, and extract meter from the front of the control panel.

f. To remove binding posts, unscrew nuts from mounting studs at rear, disconnect terminals and extract binding post from the front of the control panel.

g. To remove bracket mounted capacitors or chokes, unsolder and tag leads. Remove attaching parts and lift out the component.

h. When removing or replacing a transistor, or a component near a transistor, observe the following.

CAUTION

Do not apply excessive heat to the transistors, or they will be damaged. Use an adequate heat sink to the leads when soldering or unsoldering. Cut leads if necessary.

51. REPAIR OR REPLACEMENT. Individual components of the tester are not to be repaired if defective; replace defective components. Paragraph 49 gives removal instructions for the replaceable items. Section II (Parts Breakdown) gives information to facilitate ordering of replacement parts. Repair should consist only of routine maintenance such as repairing defective wiring, connections, etc.

52. CALIBRATION.

53. GENERAL. This section contains step-by-step procedures which will enable the operator to check definitely the reliability of the indications or readings provided by the tester. These instructions further outline the steps required to restore the original accuracy of such indications or readings. Calibration procedures which are explained in the following paragraphs are audio oscillator calibration, amplifier calibration, Z OHMS CIRCUIT potentiometer knobs, R_{IN} TRANSISTOR knob, and final check.

54. FREQUENCY OF CALIBRATION CHECKS. Perform calibration only when the tester is suspected of being defective/repaired.

55. TEST EQUIPMENT. Test equipment required for calibration of the tester is listed in figure 21.

56. AUDIO OSCILLATOR CALIBRATION. Calibrate the audio oscillator as follows:

a. Remove the ten screws located near outer edge of control panel and gently lift panel assembly out of its case. Leave the cable assembly connected to the case.

b. Turn Battery switch to the right and rotate BETA CAL potentiometer to its maximum position.

TYPE Selector Switch	CIRCUIT IMPEDANCE Switch Position	COLLECTOR VOLTS Switch Position	I_C Pot. Position	FUNCTION SELECTOR SWITCH																	
				I_{CBO}			I_C			Z OHMS			R_{IN}			BETA CAL			BETA READ		
				+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B
PNP	NORMAL	0	Min.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	1.5	Min.	+1.5	0	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0
	NORMAL	3.0	Min.	+3.0	0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0
	NORMAL	4.5	Min.	+4.5	0	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0
	NORMAL	0	Min. -Max	0	0	0	-1.5	0	+1.5	+1.5	0	-1.5	-1.5	0	+1.5	-1.5	0	+1.5	-1.5	0	+1.5
	LOW	0	Min. -Max	0	0	0	-4.5	0	+4.5	+4.5	0	-4.5	-4.5	0	+4.5	-4.5	0	+4.5	-4.5	0	+4.5
				+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B
NPN	NORMAL	0	Min.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	1.5	Min.	+1.5	0	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0	+1.5	+1.5	0
	NORMAL	3.0	Min.	+3.0	0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0	+3.0	+3.0	0
	NORMAL	4.5	Min.	+4.5	0	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0	+4.5	+4.5	0
	NORMAL	0	Min. -Max	0	0	0	-1.5	0	+1.5	+1.5	0	-1.5	-1.5	0	+1.5	-1.5	0	+1.5	-1.5	0	+1.5
	LOW	0	Min. -Max	0	0	0	-4.5	0	+4.5	+4.5	0	-4.5	-4.5	0	+4.5	-4.5	0	+4.5	-4.5	0	+4.5
				+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B	+ B-C	+ E-C	+ E-B
DIODE	NORMAL	0	Min.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	1.5	Min.	+1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	3.0	Min.	+3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	4.5	Min.	+4.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NORMAL	0	Min. -Max	0	0	0	-1.5	0	+1.5	+1.5	0	-1.5	-1.5	0	+1.5	-1.5	0	+1.5	-1.5	0	+1.5
	LOW	0	Min. -Max	0	0	0	-4.5	0	+4.5	+4.5	0	-4.5	-4.5	0	+4.5	-4.5	0	+4.5	-4.5	0	+4.5

NOTE: This table shows where the various switches should be placed and what voltages are to be read at the binding posts of E-C, E-B and B-C. The plus lead of the d-c voltmeter is indicated by a +sign over the pair of binding posts being measured.

Figure 18. Table of Switching Circuit D-C Voltages

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q1	10K 4.2V DC 0.75V P-P	1800 3.9V DC ---	3800 ohms 20.9V DC 11V P-P
Q2	10K 4V DC 3.1V P-P	2700 ohms 4.1V DC 3.1V P-P	3800 ohms 20.9V DC ---
Note: Perform all measurements with respect to ground. Place the positive lead of the ohmmeter to ground.			

Figure 19. Table of Audio Oscillator Circuit's Voltage and Resistance Values

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q3	100 ohms 0.15V DC ---	300 ohms 0.3V DC ---	1600 ohms 2.9V DC 0.018V P-P
Q4	3000 ohms 2.8V DC 0.012V P-P	1600 ohms 2.9V DC 0.018V P-P	3800 ohms 22.5V DC 0.13V P-P
Q5	900 ohms 0.92V DC 0.025V P-P	1100 ohms 0.92V DC 0.094V P-P	12K 12.5V DC 14.5V P-P
Note: Perform all measurements with respect to ground. Place the positive lead of the ohmmeter to ground.			

Figure 20. Table of A.C. Amplifier Circuit's Voltage and Resistance Values

c. Using Multimeter Hickok Model 456, check the d-c voltages of transistors Q1 and Q2 with respect to ground. See figure 22 for nominal voltage values.

d. Using the Oscilloscope Model 1805A, observe the output waveform of the audio oscillator at the top of choke L1 (figure 26); it should be a sine wave. To check the frequency, connect Oscillator Model 202C (set to 1000 cps) to the External sweep circuit of the oscilloscope; make sure the oscilloscope's Horizontal display switch is in the External position and the magnifier is in the 5X position. If the audio oscillator of the tester is tuned to 1000 cps, a single Lissajous pattern will be obtained. If the audio oscillator is not properly tuned vary the slug of choke L1 (figure 26) until a single Lissajous pattern is obtained.

e. An alternate method of testing the audio oscillator is to connect Electronic Counter Model 523B to the vertical signal output jack of the oscilloscope. The oscilloscope's Horizontal display switch should be in the Main sweep normal position and the magnifier on 1X position. The input signal to the oscilloscope should be from the top of choke L1. Then measure the frequency directly with the electronic counter. If the audio oscillator needs adjustment, vary the slug of choke L1 until the electronic

NOMENCLATURE	PART NUMBER OR MODEL	APPLICATION	RANGE	ACCURACY
Oscilloscope	Hickok Model 1805A or 1805	Peak to peak voltage measurement	dc to 30 mc	Vertical frame 3 db down at 30 mc
Electronic Counter	Hewlett-Packard Model 523B	Frequency measurement	10 cps to 1.1 mc	±1 count
Vacuum Tube Voltmeter	Hickok Model 1602	Calibration of amplifier. Measures input voltage across divider	1 mv to 300v	1% between 50 cps and 500 kc
Multimeter	Hickok Model 456	D-c measurement and resistance measurement	0-3, 15 and 60v	±3%
Oscillator	Hewlett-Packard Model 202C	Calibration source	1 cps - 100 kc	±2%

Figure 21. Calibration Test Equipment

TRANSISTOR	D-C VOLTAGE		
	EMITTER	BASE	COLLECTOR
Q1	4.2	3.9	20.9
Q2	4	4.1	20.9

Figure 22. Voltmeter D-C Voltages for Audio Oscillator Transistors

counter reads 1000 cps.

f. Place the oscilloscope's Horizontal display switch to the Main sweep normal position and measure the output voltage at the collector of transistor Q1 (figure 32). The voltage should be 11 volts P-P ± 1.3 volts. Then measure the voltage across the secondary winding of transformer T1 (figure 32); the voltage should be 1.4 volts P-P ± 0.2 volts. If the voltage is low, decrease the value of resistor R4 by paralleling it with a resistor which is larger in value than R4; recheck the voltage across the secondary winding of transformer T1.

57. AMPLIFIER CALIBRATION. Calibrate the amplifier as follows:

a. Turn Battery switch to the OPERATE position.

b. Using Multimeter Model 456, check the d-c voltages of transistors Q3, Q4 and Q5 with respect to ground. See figure 23 for nominal voltage values.

c. Disconnect the shielded wire (figure 24) from the input of the amplifier and connect a precision divider consisting of a 20K, 1% resistor and a 10-ohm 1% resistor to a variable frequency oscillator. Connect the input of the amplifier across the 10-ohm resistor. Set the frequency of the oscillator to 1000 cps and then using the VTVM or oscilloscope, adjust the voltage across the precision divider to 1 volt P-P. This will give the amplifier a 0.5 mv input signal.

d. Rotate the Battery switch to the right. Monitor meter of the tester and vary the frequency of the variable frequency oscillator. If the meter doesn't peak at 1000 cps adjust the slug of choke L3 (figure 26) until it does peak at 1000 cps. Then check the frequency response of the amplifier from 20 cps to approximately 200 kc. There should be only one peak and this should occur at 1000 cps. If the amplifier peaks at a low frequency (150 to 400 cps), replace transistor Q4 (figure 29) with a different 2N651A transistor.

e. Connect the output of the third stage of the amplifier to the oscilloscope, as shown in figure 24, and measure the a-c voltage. The peak to peak voltage should be within 14.5 volts P-P to 15.5 volts P-P which is sufficient to drive the meter to full scale. Set Function Selector to position #3.

TRANSISTOR	D-C VOLTAGE		
	EMITTER	BASE	COLLECTOR
Q3	0.15	0.3	2.9
Q4	2.8	2.9	22.5
Q5	0.92	0.92	12.5

Figure 23. Voltmeter D-C Voltages for Amplifier Transistors

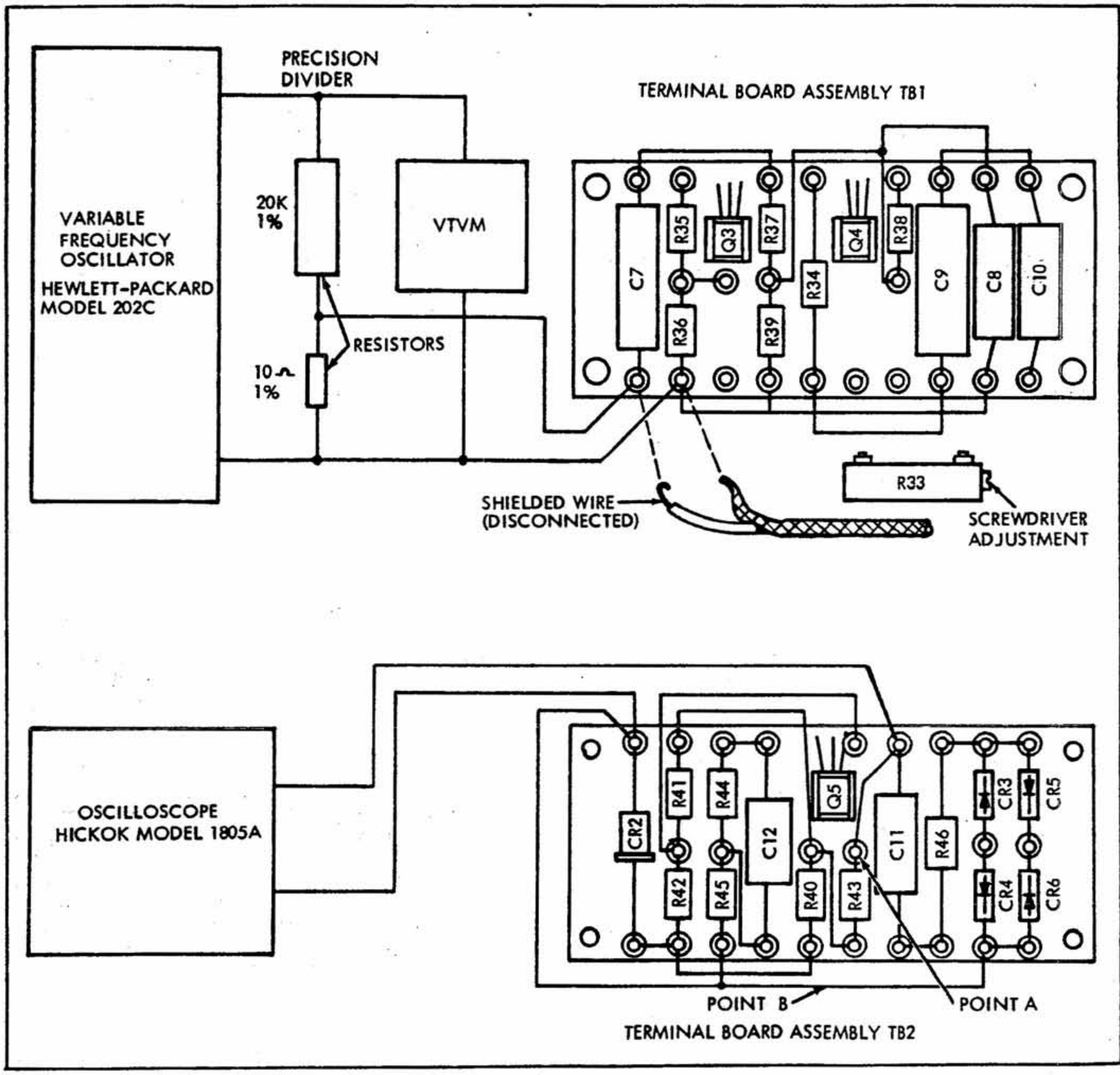

Figure 24. Amplifier Calibration Test Set Up

If the output voltage is higher than 15.5 volts P-P, adjust the negative feedback resistor R33 by rotating the screwdriver adjustment counterclockwise to a smaller value. If the output voltage is less than 14.5 volts P-P, adjust the negative feedback resistor R33 by rotating the screwdriver adjustment clockwise to a higher value.

f. Check the d-c voltage at the collector of the third stage (point B is ground, figure 24) the voltage should be at least -10 volts dc. If it is less negative, remove resistor R41 (220K) and replace it with a 270K resistor. Re-check the d-c voltage.

g. With the oscilloscope connected as shown in figure 24 (output of 14.5 volts P-P to 15.5 volts P-P), check the waveform. The waveform should not be clipped or bottomed. If the waveform is distorted, replace resistor R41 with resistors of other values until the waveform is not distorted.

Note

Don't change the ohmic value of resistor R42 below 10K because this will load the second stage and shunt the input of the third stage.

h. If all the preceding requirements are met and the meter is still reading low, decrease the value of R46 (figure 24) in the detector circuit by paralleling it with another resistor; the total parallel resistance should not be less than 86K. If the meter still reads low, check the diodes (CR3 to CR6) in the bridge circuit. After adjusting the value of resistor R46, the meter should be within ± 2% of full scale.

58. LARGE KNOB OF Z OHMS CIRCUIT POTENTIOMETER (R11). Calibrate the large knob 1K to 100K) .of the Z OHMS CIRCUIT potentiometer as follows:

a. Place a 10K, 1% resistor between the Binding Posts E and B, using the test lead assembly.

b. Set FUNCTION SELECTOR switch to Z OHMS CIRCUIT.

c. Switch the smaller knob (R9) of the Z OHMS CIRCUIT potentiometer to In Circuit and then rotate it counterclockwise to its minimum position.

d. Place the CIRCUIT IMPEDANCE switch to NORMAL.

e. Turn the Battery switch to the right and increase the signal by turning BETA CAL potentiometer until the meter reads approximately 1/2 scale.

f. Vary the Z OHMS CIRCUIT potentiometer (large knob only) until a null is indicated.

g. Release the Battery switch. Loosen setscrews of large know and set the indicator line of the knob to the 10K point on the inner dial of the Z OHMS CIRCUIT potentiometers. Then tighten the setscrews.

59. SMALL KNOB OF Z OHMS CIRCUIT POTENTIOMETER (R9). Calibrate the small knob (50 to 500 ohms) of the Z OHMS CIRCUIT potentiometer as follows:

a. Set the large knob the Z OHMS CIRCUIT potentiometer to its minimum position.

b. Place a 200-ohm, 1% resistor between Binding Posts E and B, using the test lead assembly.

c. Place FUNCTION SELECTOR switch to Z OHMS CIRCUIT.

d. Turn Battery switch to the right and increase the signal by turning BETA CAL potentiometer until the meter reads approximately 1/2 scale.

e. Vary the small knob of the Z OHMS CIRCUIT potentiometer until null is indicated on the meter.

f. Release the Battery switch. Loosen set screw of small knob and set the indicator line of the knob to the 200-ohm point on the outer dial of the Z OHMS CIRCUIT potentiometer. Then tighten the setscrew.

60. KNOB OF R_{IN} TRANSISTOR POTENTIOMETER (R10). Calibrate the knob (100 ohms to 10K) of the R_{IN} TRANSISTOR potentiometer as follows:

a. Place FUNCTION SELECTOR switch to R_{IN} TRANSISTOR.

b. Switch Z OHMS CIRCUIT potentiometer to OUT OF CIRCUIT position.

c. Place a 1K, 1% resistor between the Binding Posts E and B, using the test lead assembly.

d. Turn Battery switch to the right and increase the signal by turning BETA CAL potentiometer until the meter reads approximately 1/2 scale.

e. Vary the R_{IN} TRANSISTOR potentiometer until null is indicated on the meter.

f. Release the Battery switch. Loosen setscrews and set the indicator line of the knob to the 1K point on dial of the R_{IN} TRANSISTOR potentiometer. Then tighten the setscrews.

61. FINAL TEST. Perform an "out of circuit" transistor test as explained in paragraph 28 and note its Beta. Place the same transistor in a functionable circuit and perform an "in circuit" transistor test as explained in paragraph 27 and note its Beta. Compare these Beta readings to the listed Betas in the transistor manufacturer's literature. If this test is satisfactory, it can be assumed that the tester is working properly.

61A. USE OF TRANSISTOR REFERENCE CHART

The transistor Reference Chart is to be used as a guide in evaluating the quality of transistors. In an effort to simplify the Chart as much as possible, only the pertinent information necessary for testing is given. For any additional information the transistor manufacturer's literature should be consulted.

To explain the use of the Transistor Reference Chart each colum of the chart is described, as follows:

Type

This column specifies the type of transistor PNP or NPN. The Type Selector switch should be set accordingly.

Max. Icbo

This column specifies the maximum allowable leakage current. If the leakage current of the transistor under test exceeds this value it can be considered out of tolerance, or defective. The Collector Voltage used for this test should be 4.5V, unless otherwise noted. This test must be performed out of circuit. See I_{CBO} test procedure in the manual of operating instructions for the Model 890.

Vce

This is the Collector to Emitter voltage specified for the Beta test In or Out of Circuit. The Collector Voltage Selector Switch should be set accordingly.

Ic

This column gives the Ic current in milliamperes. The Beta Test should be made at or near this level. The Ic control adjusts this level when the Function Selector is set to the Ic position. This adjustment can be made In or Out of Circuit.

Beta

Beta values are given in three columns -- Minimum, Typical, and Maximum. In some cases only Typical Values are listed. This is because the Transistor Manufacturer only lists the Typical Value in his specification sheets.

Notes

Notes 1 through 9 are listed on page 26C. These notes are self-explanatory and used in specific cases where deviation from conventional test procedure is required.

MODEL 1890M

TRANSISTOR REFERENCE CHART

NOTES:

Note 1: Perform "Icer" test. Reverse the emitter and base leads. Connect a 30 ohm resistor between the emitter and base terminals.

Note 2: Perform "Icer" test. Reverse the emitter and base leads. Connect a 200 ohm resistor between the emitter and base terminals.

Note 3: Perform "Icer" test. Reverse the emitter and base leads. Connect a 10K ohm resistor between the emitter and base terminals.

Note 4: Connect B1 and B2 to the base terminal and test as triode.

Note 5: Perform "Icer" test. Short emitter and base binding posts and test as for "Icbo". Remove jumper for "Beta" test.

Note 6: Indicated value for "Icbo" is typical, not maximum.

Note 7: Set Collector Volts (Vcb) to 1.5.

Note 8. Set Collector Volts (Vcb) to 3.0.

Note 9. No "Beta" condition listed.

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N29	NPN	005.0	4.5	01.0		049		
2N34	PNP	016.0	4.5	01.0		075		
2N35	NPN	016.0	4.5	01.0	025		125	
2N43	PNP	005.0	4.5	01.0	030	042		
2N43A	PNP	005.0	4.5	01.0	030	042	066	
2N44,A	PNP	005.0	4.5	01.0		025		
2N45	PNP	005.0	4.5	01.0	009	012	016	
2N47	PNP	003.0	4.5	01.0		039		NOTE 6
2N49	PNP	003.0	4.5	01.0		039		NOTE 6
2N59	PNP	007.0	4.5	10.0		110		
2N59A,B,C	PNP	007.0	4.5	10.0		110		
2N60,A,B,C	PNP	007.0	4.5	10.0		090		
2N61,A,B,C	PNP	007.0	4.5	10.0		065		
2N63	PNP	006.0	4.5	01.0		022		NOTE 6
2N64	PNP	006.0	4.5	01.0		045		NOTE 6
2N65	PNP	006.0	4.5	01.0		090		NOTE 6
2N68	PNP	002.5MA	4.5	99.9		035		NOTE 2
2N76	PNP	010.0	4.5	01.0	009	019	099	
2N77	PNP	006.0	4.5	00.7		055		
2N78,A	NPN	001.5	4.5	01.0	032	058	200	
2N81	PNP	006.0	4.5	01.0	020		060	
2N94,A	NPN	014.0	4.5	01.0	020		080	NOTE 3
2N95	NPN	002.5MA	4.5	99.9		035		NOTE 2
2N97,A	NPN	002.0	4.5	00.5		013		
2N98,A	NPN	010.0	4.5	01.0		040		
2N99	NPN	010.0	4.5	01.0		040		
2N101	PNP	002.5MA	4.5	99.9		035		NOTE 2
2N102	NPN	002.5MA	4.5	99.9		035		NOTE 2
2N104	PNP	006.0	4.5	01.0		044		
2N105	PNP	003.0	4.5	00.7		055		
2N106	PNP	012.0	1.5	00.5	025			NOTE 8
2N107	PNP	006.0	4.5	01.0		020		
2N109	PNP	006.0	1.5	50.0		060		
2N111	PNP	001.0	4.5	01.0		040		NOTE 6
2N112	PNP	001.0	4.5	01.0		040		NOTE 6
2N113	PNP	001.0	4.5	01.0		045		NOTE 6
2N114	PNP	001.0	4.5	01.0		065		NOTE 6
2N117	NPN	000.8	4.5	01.0	009	012	020	
2N118	NPN	000.8	4.5	01.0	018	024	040	
2N118A	NPN	000.8	4.5	01.0	018	039	090	
2N119	NPN	000.8	4.5	01.0	036	049	090	
2N120	NPN	000.8	4.5	01.0	076	099	332	
2N123	PNP	003.0	4.5	01.0	031	090		
2N125	NPN	002.0	4.5	01.0		036		
2N126	NPN	002.0	4.5	01.0		074		
2N128	PNP	003.0	3.0	00.5	019	040	066	NOTE 8
2N129	PNP	003.0	3.0	00.5	012	021	039	
2N130,A	PNP	006.0	4.5	01.0		022		
2N131,A	PNP	006.0	4.5	01.0		045		
2N132,A	PNP	006.0	4.5	01.0		090		
2N133	PNP	012.0	1.5	00.5	025			
2N135	PNP	005.0	4.5	01.0		020		
2N136	PNP	005.0	4.5	01.0		040		
2N137	PNP	005.0	4.5	01.0		060		
2N138	PNP	006.0	4.5	01.0		140		NOTE 6
2N139	PNP	004.0	4.5	01.0	022	048	110	
2N140	PNP	004.0	4.5	01.0	022	048	110	
2N141	PNP	002.0MA	1.5	99.9		015		NOTE 2
2N142	NPN	002.0MA	1.5	99.9		015		NOTE 2
2N143	PNP	002.0MA	1.5	99.9		015		NOTE 2
2N144	NPN	002.0MA	1.5	99.9		015		NOTE 2
2N145	NPN	003.0	4.5	01.0	030			
2N146	NPN	003.0	4.5	01.0	033			
2N147	NPN	003.0	4.5	01.0	036			
2N156	PNP	400.0	1.5	99.9		055		
2N158	PNP	300.0	1.5	99.9		045		
2N158A	PNP	250.0	1.5	99.9		045		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N160,A	NPN	002.0	4.5	01.0	009	013	019	
2N161,A	NPN	002.0	4.5	01.0	019	024	039	
2N162,A	NPN	002.0	4.5	01.0	039			
2N163,A	NPN	002.0	4.5	01.0	039	099		
2N164A	NPN	000.5	4.5	01.0		040		NOTE 6
2N165	NPN	002.5	4.5	01.0		050		NOTE 6
2N167,A	NPN	000.8	4.5	01.0	020	066	200	
2N168	NPN	000.5	4.5	01.0		040		NOTE 6
2N169	NPN	000.5	1.5	01.0		072		NOTE 6
2N169A	NPN	002.5	4.5	01.0		050		
2N170	NPN	003.0	4.5	01.0		020		
2N174,A	**PNP**	**008.0**	**2.0**	**01.2**		**055**		
2N175	PNP	005.0	4.5	00.5		065		
2N185	PNP	007.0	4.5	02.0		040		
2N186	PNP	006.0	1.5	50.0		030		
2N186A	PNP	006.0	1.5	50.0		030		
2N187	PNP	006.0	1.5	50.0		045		
2N187A	PNP	006.0	1.5	50.0		045		
2N188	PNP	006.0	1.5	50.0		060		
2N188A	PNP	007.0	1.5	10.0		060		
2N189	PNP	006.5	4.5	01.0		032		
2N190	PNP	006.5	4.5	01.0		042		
2N191	PNP	006.5	4.5	01.0		067		
2N192	PNP	006.5	4.5	01.0		090		
2N193	NPN	015.0	4.5	01.0		040		NOTE 3
2N194A	NPN	015.0	4.5	01.0		040		NOTE 3
2N195	PNP	003.0	4.5	01.0	100	180	300	NOTE 8
2N200	PNP	002.0	4.5	01.0	030	045	060	NOTE 6
2N204	PNP	002.0	4.5	01.0	050	080	120	NOTE 6
2N205	PNP	002.0	4.5	01.0	015	025	035	NOTE 6
2N206	PNP	004.0	4.5	01.0		047		
2N207	PNP	009.0	4.5	01.0	035	100		
2N207A,B	PNP	006.0	4.5	01.0	035	100		
2N211	NPN	013.0	4.5	01.0	010			NOTE 3
2N212	NPN	015.0	4.5	01.0		020		NOTE 3
2N213	NPN	016.0	4.5	01.0	070		250	
2N213A	NPN	016.0	4.5	01.0	100		250	
2N214A	PNP	006.5	1.5	10.0		080		
2N215	PNP	006.0	~~4.5~~	01.0		044		
2N216	NPN	025.0	4.5	01.0		045		NOTE 3
2N217	PNP	002.5	4.5	01.0	050		100	
2N218	PNP	004.0	4.5	01.0	022	048	110	
2N219	PNP	004.0	4.5	01.0	022	048	110	
2N220	PNP	007.0	4.5	00.5		065		
2N223	PNP	014.0	4.5	01.0	070	110	150	
2N224	PNP	015.0	4.5	10.0		080		
2N225	PNP	PAIR OF 2N224 WITH BETA MATCHED TO WITHIN 20%						
2N226	PNP	010.0	4.5	10.0		070		
2N227	PNP	PAIR OF 2N226 WITH BETA MATCHED TO WITHIN 20%						
2N228	NPN	054.0	4.5	10.0	055		100	
2N229	NPN	065.0	4.5	01.0	025	075		NOTE 3
2N232	PNP	006.0	3.0	00.5	009		039	
2N233A	NPN	015.0	4.5	01.0	010			NOTE 3
2N233	NPN	033.0	4.5	01.0	010			NOTE 3
2N238	PNP	010.0	4.5	02.0		040		
2N240	PNP	010.0	3.0	00.5	016	030		
2N241	PNP	006.0	1.5	50.0		070		
2N241A	PNP	006.0	1.5	50.0		070		
2N243	NPN	000.4	4.5	05.0		016		
2N244	NPN	000.4	4.5	05.0		031		
2N247	PNP	004.0	4.5	01.0		060		
2N248	PNP	010.0	4.5	00.5		020		
2N264	NPN	000.5	4.5	10.0	020		055	
2N265	PNP	006.5	4.5	01.0		110		
2N269	PNP	003.0	4.5	01.0		135		
2N274	PNP	007.0	4.5	01.0		060		
2N279	PNP	012.0	1.5	00.5	020	030	040	
2N280	PNP	012.0	1.5	03.0	030	047	075	

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N281	PNP	006.0	4.5	10.0		070		
2N282	PNP	PAIR OF 2N281 WITH BETA MATCHED TO WITHIN 30%						
2N283	PNP	006.0	4.5	00.5		040		
2N284A	PNP	006.0	4.5	10.0	045			
2N284	PNP	006.0	4.5	10.0	045			
2N292	NPN	000.5	1.5	01.0		025		NOTE 6
2N293	NPN	000.5	1.5	01.0		025		NOTE 6
2N299	PNP	003.0	3.0	00.5	050	065	090	
2N300	PNP	003.0	3.0	00.5	050	065	090	
2N306	NPN	009.0	4.5	01.0	025		125	
2N311	PNP	025.0	1.5	10.0		050		
2N312	NPN	003.0	1.5	01.0		050		NOTE 7
2N315A	PNP	002.0	4.5	01.0		070		
2N316	PNP	002.0	1.5	50.0		050		
2N317	PNP	002.0	1.5	50.0		120		
2N316A	PNP	002.0	4.5	01.0		130		
2N317A	PNP	002.0	4.5	01.0		180		
2N319	PNP	006.5	1.5	20.0		034		
2N320	PNP	006.5	1.5	20.0		050		
2N321	PNP	006.5	1.5	20.0		080		
2N322	PNP	008.0	4.5	01.0		045		
2N323	PNP	008.0	4.5	01.0		068		
2N324	PNP	008.0	4.5	01.0	040	085		
2N327A	PNP	040.0NA	4.5	03.0		014		
2N327	PNP	050.0NA	4.5	01.0	009	014	018	
2N327B	PNP	000.4NA	1.5	01.0	006			
2N328A	PNP	040.0NA	4.5	03.0		028		
2N328	PNP	050.0NA	4.5	01.0	018	024	036	
2N328B	PNP	000.4NA	1.5	01.0	009			
2N329A	PNP	040.0NA	4.5	03.0		060		
2N329	PNP	050.0NA	4.5	01.0	036	050	072	
2N329B	PNP	000.4NA	1.5	01.0	014			
2N330A	PNP	000.4	4.5	03.0		025		
2N330	PNP	050.0NA	4.5	01.0	009	030	072	
2N331	PNP	006.0	4.5	01.0	030	050	070	
2N332A	NPN	002.0NA	4.5	01.0	009	016	022	
2N332	NPN	000.8	4.5	01.0	009	015	022	
2N333A	NPN	002.0NA	4.5	01.0	018	030	044	
2N333	NPN	000.8	4.5	01.0	018	030	044	
2N334A	NPN	002.0NA	4.5	01.0	018	038	090	
2N334	NPN	000.8	4.5	01.0	018	039	090	
2N335A,B	NPN	002.0NA	4.5	01.0	037	052	090	
2N335	NPN	000.8	4.5	01.0	037	060	090	
2N336A	NPN	002.0NA	4.5	01.0	076	095	333	
2N336	NPN	000.8	4.5	01.0	076	120	333	
2N337A	NPN	040.0NA	4.5	01.0		050		
2N337	NPN	000.5	4.5	01.0		050		
2N338A	NPN	040.0NA	4.5	01.0		080		
2N338	NPN	000.5	4.5	01.0		080		
2N339A	NPN	000.4	4.5	01.0	015		090	
2N339	NPN	000.4	4.5	05.0	009		090	
2N340A	NPN	000.4	4.5	01.0	015		090	
2N340	NPN	000.4	4.5	05.0	009		090	
2N341A	NPN	000.4	4.5	01.0	015		090	
2N341	NPN	000.4	4.5	05.0	009		090	
2N342,A,B	NPN	000.4	4.5	05.0	009		031	
2N343,B	NPN	000.4	4.5	05.0	028		090	
2N344	PNP	003.0	3.0	00.5	011	022	033	
2N345	PNP	003.0	3.0	00.5	025	035	110	
2N346	PNP	003.0	3.0	00.5	010	035		
2N354	PNP	070.0NA	4.5	01.0	009	018		
2N355	PNP	070.0NA	4.5	01.0	009	018		
2N356A	NPN	005.0	4.5	01.0		060		
2N356	NPN	005.0	4.5	01.0		030		
2N357A	NPN	005.0	4.5	01.0		090		
2N357	NPN	005.0	4.5	01.0		045		
2N358A	NPN	005.0	4.5	01.0		120		

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N358	NPN	005.0	4.5	01.0		060		
2N359	PNP	009.0	4.5	01.0		150		
2N360	PNP	009.0	4.5	01.0		100		
2N361	PNP	009.0	4.5	01.0		070		
2N362	PNP	009.0	4.5	01.0		090		
2N363	PNP	009.0	4.5	01.0		050		
2N364	NPN	004.0	4.5	01.0		015		
2N365	NPN	004.0	4.5	01.0		026		
2N366	NPN	004.0	4.5	01.0		065		
2N367	PNP	008.0	4.5	01.0		015		
2N368	PNP	008.0	4.5	01.0	019	036	049	
2N369	PNP	008.0	4.5	01.0	049	055	142	
2N370	PNP	012.0	4.5	01.0		055		
2N371	PNP	012.0	4.5	01.0		055		
2N372	PNP	012.0	4.5	01.0		055		
2N373	PNP	005.0	4.5	01.0		055		
2N374	PNP	005.0	4.5	01.0		055		
2N377	NPN	004.0	1.5	30.0		030		
2N381	PNP	006.0	4.5	10.0	035	060	085	
2N382	PNP	006.0	4.5	10.0	070	090	135	
2N383	PNP	006.0	4.5	10.0	090	115	155	
2N384	PNP	007.0	4.5	01.5		060		
2N385	NPN	004.0	1.5	30.0		060		
2N385A	NPN	004.0	1.5	30.0		060		
2N388A	NPN	013.0	4.5	01.0		125		
2N388	NPN	004.0	4.5	01.0		125		
2N393	PNP	005.0	3.0	00.5	040	155		
2N394	PNP	004.0	1.5	10.0		070		
2N395	PNP	003.0	1.5	10.0		060		
2N396,A	PNP	003.0	4.5	01.0		070		
2N397	PNP	004.0	1.5	10.0		085		
2N398A	PNP	014.0	4.5	01.0	020			NOTE 8
2N398B	PNP	006.0	4.5	01.0	040			NOTE 8
2N402	PNP	007.0	4.5	01.0		020		
2N403	PNP	007.0	4.5	01.0		032		
2N404,A	PNP	003.0	4.5	01.0		135		
2N405	PNP	008.0	4.5	01.0		035		
2N406	PNP	008.0	4.5	01.0	020	035	080	
2N407	PNP	008.0	1.5	50.0		060		
2N408	PNP	008.0	1.5	50.0		060		
2N409	PNP	008.0	4.5	01.0		048		
2N410	PNP	003.0	4.5	01.0	022	048	110	
2N411	PNP	003.0	4.5	01.0	022		110	
2N412	PNP	003.0	4.5	01.0	022	048	110	
2N413A	PNP	003.0	4.5	01.0	020	050	080	
2N413	PNP	003.0	4.5	01.0	010	030	050	
2N414A	PNP	003.0	4.5	01.0	030	060	090	
2N414	PNP	003.0	4.5	01.0	030		090	
2N416	PNP	003.0	4.5	01.0		080		
2N417	PNP	003.0	4.5	01.0		140		
2N422	PNP	007.0	4.5	01.0	025	050		
2N425	PNP	004.0	1.5	30.0		030		NOTE 7
2N426	PNP	004.0	1.5	40.0		040		NOTE 7
2N427	PNP	004.0	1.5	55.0		055		NOTE 7
2N428	PNP	004.0	1.5	04.0		100		NOTE 7
2N438,A	NPN	004.0	4.5	01.0	015	025		
2N439,A	NPN	004.0	4.5	01.0	015	035		
2N440,A	NPN	004.0	4.5	01.0	015	065		
2N444A	NPN	004.0	4.5	01.0	015	025		
2N444	NPN	004.0	4.5	01.0	010			
2N445A	NPN	004.0	4.5	01.0	035	070		
2N445	NPN	004.0	4.5	01.0	020			
2N446A	NPN	004.0	4.5	01.0	060	120		
2N446	NPN	004.0	4.5	01.0	030			
2N447A	NPN	004.0	4.5	01.0	085	150		
2N447	NPN	004.0	4.5	01.0	050			
2N447B	NPN	004.0	4.5	01.0	150		250	

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N448	NPN	000.5	1.5	01.0	008	025	051	NOTE 6
2N449	NPN	000.5	1.5	01.0		072		NOTE 6
2N450	PNP	004.0	4.5	01.0		130		
2N460	PNP	005.0	4.5	01.0	016		035	
2N461	PNP	005.0	4.5	01.0	032			
2N464	PNP	009.0	4.5	01.0	014			
2N465	PNP	009.0	4.5	01.0	027		066	
2N466	PNP	009.0	4.5	01.0	054		130	
2N467	PNP	009.0	4.5	01.0	110		260	
2N470	NPN	003.0NA	4.5	01.0	010	017	025	
2N471A	NPN	000.2	4.5	01.0	010		025	
2N471	NPN	000.2	4.5	01.0	010	017	025	
2N472A	NPN	150.0NA	4.5	01.0	010		025	
2N472	NPN	150.0NA	4.5	01.0	010	017	025	
2N473	NPN	003.0NA	4.5	01.0	020	035	050	
2N474A	NPN	000.2	4.5	01.0	020		050	
2N474	NPN	000.2	4.5	01.0	020	035	050	
2N475A	NPN	150.0NA	4.5	01.0	020		050	
2N475	NPN	150.0NA	4.5	01.0	020	035	050	
2N476	NPN	003.0NA	4.5	01.0	030	045	060	
2N477	NPN	000.2	4.5	01.0	030	045	060	
2N478	NPN	003.0NA	4.5	01.0	040	060	100	
2N479A	NPN	000.2	4.5	01.0	040		100	
2N479	NPN	000.2	4.5	01.0	040	060	100	
2N480A	NPN	150.0NA	4.5	01.0	040		100	
2N480	NPN	150.0NA	4.5	01.0	040	060	100	
2N481	PNP	006.0	4.5	01.0		050		
2N482	PNP	006.0	4.5	01.0		050		
2N483	PNP	006.0	4.5	01.0		060		
2N484	PNP	006.0	4.5	01.0		090		
2N485	PNP	006.0	4.5	01.0		050		
2N486	PNP	006.0	4.5	01.0		100		
2N495	PNP	000.4	4.5	01.0	015	030		
2N496	PNP	060.0NA	1.5	15.0		012		
2N497,A	NPN	004.0	4.5	30.0		030		
2N498,A	NPN	004.0	4.5	30.0		030		
2N499	PNP	005.0	4.5	02.0		035		
2N501,A	PNP	005.0	4.5	02.0		040		
2N502A	PNP	003.0	4.5	02.0	015	065		
2N502	PNP	003.0	4.5	02.0	009	065		
2N503	PNP	003.0	4.5	02.0	009	045		
2N504	PNP	006.0	4.5	01.0	016			
2N508A	PNP	003.0	4.5	01.0	075	110	180	
2N508	PNP	003.0	4.5	01.0		110		
2N509	PNP	002.5	4.5	01.0		049		
2N515	NPN	002.0	4.5	01.0		028		
2N516	NPN	002.0	4.5	01.0		033		
2N517	NPN	002.0	4.5	01.0		033		
2N518	PNP	004.0	1.5	10.0	060			
2N519,A	PNP	002.0	4.5	01.0	015	025		
2N520A	PNP	002.0	4.5	01.0	040		100	
2N520	PNP	002.0	4.5	01.0	020	040		
2N521	PNP	002.0	4.5	01.0	035	070		
2N521A	PNP	002.0	4.5	01.0	070	150		
2N522	PNP	002.C	4.5	01.0	060	120		
2N522A	PNP	002.0	4.5	01.0	100	200		
2N523	PNP	002.0	4.5	01.0	080	200		
2N523A	PNP	002.0	4.5	01.0	125	300		
2N524	PNP	004.0	4.5	01.0	018	030	041	
2N525	PNP	004.0	4.5	01.0	030	044	064	
2N526,A	PNP	004.0	4.5	01.0	044	064	088	
2N527,A	PNP	004.0	4.5	01.0	060	080	120	
2N534	PNP	005.0	4.5	01.0	035	100		
2N535,A,B	PNP	006.0	4.5	01.0	035	100	200	
2N536	PNP	006.0	1.5	10.0		150		
2N537	PNP	002.5	4.5	10.0	009		200	
2N538,A	PNP	002.0	2.0	02.0		050		
2N541	NPN	000.3	4.5	01.0	080	130	200	

2N232	PNP	6	3.0	0.5	9		39	
2N233	NPN	33	4.5	1.0	10			Note 4
2N233A	NPN	25	4.5	1.0	10			Note 4
2N238	PNP	10	4.5	2.0		40		
2N240	PNP	10	3.0	0.5	16	30		
2N241	PNP	6	1.5	50		70		
2N241A	PNP	6	1.5	50		70		
2N242	PNP	0.15MA	4.5	0.1A		55		Note 7
2N243	NPN	0.4	4.5	10		15		
2N244	NPN	0.4	4.5	10		40		
2N247	PNP	6	4.5	1.0		55		
2N248	PNP	10	4.5	0.5		20		
2N265	PNP	6.5	4.5	1.0		110		
2N269	PNP	3	1.5	24		24		
2N274	PNP	7	4.5	1.0		60		
2N279	PNP	12	1.5	0.5	20	30	40	
2N280	PNP	12	4.5	1.0	30	47	82	
2N281	PNP	6	4.5	10		70		
2N282	PNP	Pair of 2N281 with Beta matched to within 30%						
2N283	PNP	6	4.5	1.0		40		
2N284	PNP	6	4.5	10	47			
2N284A	PNP	6	4.5	10	47			
2N292	NPN	0.5	4.5	1.0		25		Note 6
2N293	NPN	0.5	4.5	1.0		25		Note 6
2N299	PNP	3	3.0	0.5	11	18	33	
2N300	PNP	3	3.0	0.5		18		
2N306	NPN	25	4.5	1.0	16	75		
2N311	PNP	25	1.5	10		50		
2N312	NPN	3	1.5	10		50		Note 7
2N315	PNP	2	1.5	50		25		

2N232	PNP	6	3.0	0.5	9		39	
2N233	NPN	33	4.5	1.0	10			Note 4
2N233A	NPN	25	4.5	1.0	10			Note 4
2N238	PNP	10	4.5	2.0		40		
2N240	PNP	10	3.0	0.5	16	30		
2N241	PNP	6	1.5	50		70		
2N241A	PNP	6	1.5	50		70		
2N242	PNP	0.15MA	4.5	0.1A		55		Note 7
2N243	NPN	0.4	4.5	10		15		
2N244	NPN	0.4	4.5	10		40		
2N247	PNP	6	4.5	1.0		55		
2N248	PNP	10	4.5	0.5		20		
2N265	PNP	6.5	4.5	1.0		110		
2N269	PNP	3	1.5	24		24		
2N274	PNP	7	4.5	1.0		60		
2N279	PNP	12	1.5	0.5	20	30	40	
2N280	PNP	12	4.5	1.0	30	47	82	
2N281	PNP	6	4.5	10		70		
2N282	PNP	Pair of 2N281 with Beta matched to within 30%						
2N283	PNP	6	4.5	1.0		40		
2N284	PNP	6	4.5	10	47			
2N284A	PNP	6	4.5	10	47			
2N292	NPN	0.5	4.5	1.0		25		Note 6
2N293	NPN	0.5	4.5	1.0		25		Note 6
2N299	PNP	3	3.0	0.5	11	18	33	
2N300	PNP	3	3.0	0.5		18		
2N306	NPN	25	4.5	1.0	16	75		
2N311	PNP	25	1.5	10		50		
2N312	NPN	3	1.5	10		50		Note 7
2N315	PNP	2	1.5	50		25		

2N335A, B	NPN	0. 2	4. 5	1. 0	37	52	90	
2N336	NPN	0. 8	4. 5	1. 0	76	120		
2N336A	NPN	0. 2	4. 5	1. 0	76	95		
2N337	NPN	0. 5	4. 5	1. 0	19	55		
2N337A	NPN	. 04	4. 5	1. 0	19	55		
2N338	NPN	0. 5	4. 5	1. 0	39	99		
2N338A	NPN	. 04	4. 5	1. 0	19	55		
2N339	NPN	0. 4	4. 5	10	10			
2N339A	NPN	0. 4	4. 5	5. 0	25		90	
2N340	NPN	0. 4	4. 5	10	10			
2N340A	NPN	0. 4	4. 5	5. 0	25		90	
2N341	NPN	0. 4	4. 5	10	10			
2N341A	NPN	0. 4	4. 5	1. 0	25		90	
2N342	NPN	0. 4	4. 5	10	10			
2N342A	NPN	0. 4	4. 5	10	10			
2N342B	NPN	0. 4	4. 5	1. 0	7		32	
2N343	NPN	0. 4	4. 5	10	25			
2N343B	NPN	0. 4	4. 5	1. 0	20		90	
2N344	PNP	3	3. 0	0. 5	11	22	33	
2N345	PNP	3	3. 0	0. 5	25	35	110	
2N346	PNP	3	3. 0	0. 5	10	20	35	
2N354	PNP	0. 1	4. 5	1. 0	9	18		
2N355	PNP	0. 1	4. 5	1. 0	9	18		
2N356	NPN	5	4. 5	1. 0		30		
2N356A	NPN	5	4. 5	1. 0		60		
2N357	NPN	5	4. 5	1. 0		45		
2N357A	NPN	5	4. 5	1. 0		90		
2N358	NPN	5	4. 5	1. 0		60		
2N358A	NPN	5	4. 5	1. 0		120		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N359	PNP	9	4.5	1.0		150		
2N360	PNP	9	4.5	1.0		100		
2N361	PNP	9	4.5	1.0		70		
2N362	PNP	9	4.5	1.0		120		
2N363	PNP	9	4.5	1.0		50		
2N364	NPN	4	4.5	1.0		15		
2N365	NPN	4	4.5	1.0		26		
2N366	NPN	4	4.5	1.0		65		
2N367	PNP	8	4.5	1.0		15		
2N368	PNP	8	4.5	1.0		36		
2N369	PNP	8	4.5	1.0		55		
2N370	PNP	12	4.5	1.0		55		
2N371	PNP	12	4.5	1.0		55		
2N372	PNP	12	4.5	1.0		55		
2N373	PNP	5	4.5	1.0		55		
2N374	PNP	5	4.5	1.0		55		
2N377	NPN	4	1.5	30		30		
2N381	PNP	6	4.5	10	35	60	85	
2N382	PNP	6	4.5	10	70	90	135	
2N383	PNP	6	4.5	10	90	115	135	
2N384	PNP	7	4.5	1.5	20	60	175	
2N385	NPN	4	1.5	30		60		
2N385A	NPN	4	1.5	30		60		
2N388	NPN	5	1.5	30		100		Note 7
2N388A	NPN	5	1.5	30		100		Note 7
2N393	PNP	5	3.0	0.5	40	155		

2N394	PNP	4	1.5	10		70		
2N395	PNP	3	1.5	10		60		
2N396, A	PNP	3	1.5	10		80		
2N397	PNP	4	1.5	10		85		
2N398	PNP	14	1.5	5.0		60		Note 8
2N398A	PNP	14	1.5	5.0		60		
2N402	PNP	7	4.5	1.0		20		
2N403	PNP	7	4.5	1.0		32		
2N404, A	PNP	3	4.5	1.0		135		
2N405	PNP	8	4.5	1.0		35		
2N406	PNP	8	4.5	1.0		35		
2N407	PNP	8	1.5	50		60		
2N408	PNP	8	1.5	50		60		
2N409	PNP	6	4.5	1.0		48		
2N410	PNP	6	4.5	1.0		48		
2N411	PNP	6	4.5	0.6		75		
2N412	PNP	6	4.5	0.6		75		
2N413	PNP	3	4.5	1.0	20	30		
2N413A	PNP	3	4.5	1.0		25		
2N414	PNP	3	4.5	1.0	30	60	120	
2N414A	PNP	3	4.5	1.0		60		
2N416	PNP	3	4.5	1.0	50	80	200	
2N417	PNP	3	4.5	1.0	70	140		
2N422	PNP	7	4.5	1.0		50		
2N425	PNP	4	1.5	30		30		Note 7
2N426	PNP	4	1.5	40		40		Note 7
2N427	PNP	4	1.5	55		55		Note 7
2N428	PNP	4	1.5	4.0		100		Note 7
2N438	NPN	4	4.5	1.0	15	25		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N438A	NPN	4	4.5	1.0	15	25		
2N439	NPN	4	4.5	1.0	15	35		
2N439A	NPN	4	4.5	1.0	15	35		
2N440	NPN	4	4.5	1.0	15	65		
2N440A	NPN	4	4.5	1.0	15	65		
2N444	NPN	4	4.5	1.0	10	15		
2N444A	NPN	4	4.5	1.0	15	25		
2N445	NPN	4	4.5	1.0	20	35		
2N445A	NPN	4	4.5	1.0	35	70		
2N446	NPN	4	4.5	1.0	30	60		
2N446A	NPN	4	4.5	1.0	60	120		
2N447	NPN	4	4.5	1.0	50	125		
2N447A	NPN	4	4.5	1.0	85	150		
2N448	NPN	0.5	1.5	1.0	8	25	51	Note 6
2N449	NPN	0.5	1.5	1.0		72		Note 6
2N450	PNP	4	4.5	1.0		130		
2N460	PNP	3	4.5	1.0		24		
2N461	PNP	3	4.5	1.0		49		
2N464	PNP	7	4.5	1.0	14	26		
2N465	PNP	7	4.5	1.0	27	45		
2N466	PNP	7	4.5	1.0	56	90		
2N467	PNP	7	4.5	1.0	112	180		
2N470	NPN	5na	4.5	1.0	10	16	25	
2N471	NPN	5na	4.5	1.0	10	16	25	
2N471A	NPN	5na	4.5	1.0	10	16	25	
2N472, A	NPN	5na	4.5	1.0	10	16	25	

2N473	NPN	5na	4.5	1.0	20	30	50	
2N474	NPN	5na	4.5	1.0	20	30	50	
2N474A	NPN	5na	4.5	1.0	20	30	50	
2N475, A	NPN	5na	4.5	1.0	20	30	50	
2N476	NPN	5na	4.5	1.0	30	45	60	
2N477	NPN	5na	4.5	1.0	30	45	60	
2N478	NPN	5na	4.5	1.0	40	60	100	
2N479	NPN	5na	4.5	1.0	40	60	100	
2N479A	NPN	5na	4.5	1.0	40	60	100	
2N480	NPN	5na	4.5	1.0	40	60	100	
2N480A	NPN	5na	4.5	1.0	40	60	100	
2N481	PNP	6	4.5	1.0		50		
2N482	PNP	6	4.5	1.0		50		
2N483	PNP	6	4.5	1.0		60		
2N484	PNP	6	4.5	1.0		90		
2N485	PNP	6	4.5	1.0		50		
2N486	PNP	6	4.5	1.0		100		
2N495	PNP	0.4	4.5	1.0	15	30		
2N496	PNP	.06	1.5	15		12		
2N497, A	NPN	4	4.5	30		30		
2N498, A	NPN	4	4.5	30		30		
2N499	PNP	5	4.5	2.0		35		
2N501	PNP	5	4.5	2.0		40		
2N501A	PNP	5	4.5	2.0		40		
2N502	PNP	3	4.5	2.0	9	65		
2N502A	PNP	3	4.5	2.0	15	65		
2N503	PNP	3	4.5	2.0	9	45		
2N504	PNP	10	4.5	1.0		16		
2N508	PNP	8	4.5	1.0		112		

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N509	PNP	2.5	4.5	1.0		49		
2N515	NPN	25	4.5	0.5	10			Note 4
2N516	NPN	25	4.5	0.5	10			Note 4
2N517	NPN	25	4.5	0.5	10			Note 4
2N518	PNP	4	1.5	10		60		
2N519	PNP	2.5	4.5	1.0		25		Note 7
2N519A	PNP	2	4.5	1.0		25		
2N520	PNP	2	4.5	1.0	20	40		
2N520A	PNP	2	4.5	1.0	40	100		
2N521	PNP	10	4.5	1.0		70		
2N521A	PNP	2	4.5	1.0	70	150		
2N522	PNP	10	4.5	1.0		120		
2N522A	PNP	2	4.5	1.0	100	200		
2N523	PNP	10	4.5	1.0		200		
2N523A	PNP	2	4.5	1.0	125			
2N524, A	PNP	4	4.5	1.0	16	30	41	
2N525, A	PNP	4	4.5	1.0	30	44	64	
2N526, A	PNP	4	4.5	1.0	44	64	88	
2N527, A	PNP	4	4.5	1.0	60	80	120	
2N534	PNP	5	4.5	1.0	35	100		
2N535	PNP	6	4.5	1.0	35	100	200	
2N535A	PNP	6	4.5	1.0	35	100	200	
2N535B	PNP	6	4.5	1.0	35	100	200	
2N536	PNP	6	1.5	10		150		
2N537	PNP	2.5	4.5	10	9		200	
2N541	NPN	5na	4.5	1.0	80	130	200	

2N542, A	NPN	5na	4.5	1.0	80	130	200	
2N543, A	NPN	5na	4.5	1.0	80	130	200	
2N544	PNP	2.5	4.5	1.0		55		
2N545	NPN	4	1.5	100		20		
2N546	NPN	4	1.5	100		20		
2N547	NPN	4	1.5	100		20		
2N548	NPN	4	1.5	100		20		
2N549	NPN	4	1.5	100		20		
2N550	NPN	4	1.5	100		20		
2N551	NPN	4	4.5	50	20	30	80	
2N552	NPN	6	4.5	50	20	30	80	
2N559	PNP	3	4.5	10		50		
2N560	NPN	.05	4.5	10		50		
2N563	PNP	3	4.5	1.0		25		
2N564	PNP	3	4.5	1.0		25		
2N565	PNP	3	4.5	1.0		55		
2N566	PNP	3	4.5	1.0		55		
2N567	PNP	3	4.5	1.0		100		
2N568	PNP	3	4.5	1.0		100		
2N569	PNP	3	4.5	1.0		150		
2N570	PNP	3	4.5	1.0		150		
2N571	PNP	3	4.5	1.0		200		
2N572	PNP	3	4.5	1.0		200		
2N576	NPN	5	4.5	1.0		80		Note 7
2N576A	NPN	5	4.5	1.0		80		Note 7
2N578	PNP	3	1.5	50		50		
2N579	PNP	3	1.5	50		105		
2N580	PNP	3	1.5	50		120		
2N581	PNP	5	1.5	20		30		

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N582	PNP	3	1.5	20		60		
2N583	PNP	5	1.5	20		30		
2N584	PNP	3	1.5	20		60		
2N585	NPN	7	1.5	20		40		
2N587	NPN	3	1.5	50		60		
2N591	PNP	7	4.5	2.0		70		Note 7
2N592	PNP	5	4.5	1.0		25		
2N593	PNP	5	4.5	1.0		35		
2N594	NPN	5	4.5	1.0		50		
2N595	NPN	5	4.5	1.0		75		
2N596	NPN	5	4.5	1.0		100		
2N597	PNP	5	4.5	3.0		70		Note 7
2N598	PNP	5	4.5	3.0		125		Note 7
2N599	PNP	5	4.5	3.0		175		Note 7
2N600	PNP	5	4.5	3.0		125		Note 7
2N601	PNP	5	4.5	3.0		175		Note 7
2N602	PNP	5	4.5	1.0		25		
2N602A	PNP	3	1.5	0.5	20		80	
2N603	PNP	5	4.5	1.0		50		
2N603A	PNP	3	1.5	0.5	30		100	
2N604	PNP	5	4.5	1.0		100		
2N604A	PNP	3	1.5	0.5	40		120	
2N609	PNP	12	4.5	10		110		
2N610	PNP	12	4.5	10		90		
2N611	PNP	12	4.5	10		65		
2N612	PNP	12	4.5	1.0		20		

2N613	PNP	12	4.5	1.0		32		
2N619	NPN	.04	1.5	0.5		15		
2N620	NPN	.04	4.5	1.0		30		
2N621	NPN	.04	4.5	1.0		60		
2N623	PNP	5	4.5	2.0	10	35		
2N624	PNP	10	4.5	1.0		30		
2N625	NPN	50	1.5	50		50		Note 7
2N631	PNP	9	4.5	1.0		150		
2N632	PNP	9	4.5	10		175		
2N633	PNP	9	4.5	10		60		
2N634	NPN	5	1.5	10	15			
2N634A	NPN	4	1.5	10		55		
2N635	NPN	5	1.5	10	25			
2N635A	NPN	4	1.5	10		100		
2N636	NPN	5	1.5	10	35			
2N636A	NPN	4	1.5	10		190		
2N640	PNP	3	4.5	1.0		55		
2N641	PNP	4	4.5	1.0		55		
2N642	PNP	4	4.5	1.0		55		
2N643	PNP	10	4.5	5.0		45		
2N644	PNP	10	4.5	5.0		45		
2N645	PNP	10	4.5	5.0		45		
2N647	NPN	6	1.5	50		80		
2N649	NPN	9	1.5	50		80		
2N650	PNP	4	4.5	1.0	30	49	70	
2N650A	PNP	4	4.5	1.0	30	60	70	
2N651	PNP	4	4.5	1.0	50	80	120	
2N651A	PNP	4	4.5	1.0	50	100	120	
2N652	PNP	4	4.5	1.0	100	130	225	

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N652A	PNP	4	4.5	1.0	100	150		
2N653	PNP	6	4.5	1.0	30	49	70	
2N654	PNP	6	4.5	1.0	50	80	125	
2N655	PNP	6	4.5	1.0	100	130		
2N656, A	NPN	4	4.5	30		60		
2N657, A	NPN	4	4.5	30		60		
2N658	PNP	3	4.5	1.0		55		
2N659	PNP	3	4.5	1.0		75		
2N660	PNP	3	4.5	1.0		110		
2N661	PNP	3	4.5	1.0		160		
2N662	PNP	3	4.5	1.0		65		
2N670	PNP	25	1.5	100		100		Note 7
2N671	PNP	25	1.5	100		100		Note 7
2N672	PNP	25	1.5	100		100		Note 7
2N673	PNP	25	1.5	100		100		Note 7
2N674	PNP	27	1.5	100		190		
2N679	NPN	10	1.5	30	20			
2N694	PNP	3	4.5	2.0	9	19	200	
2N695	PNP	3	1.5	10		40		
2N696	NPN	0.4	1.5	50		30		
2N697	NPN	0.4	1.5	50		60		
2N698	NPN	0.7	4.5	1.0	15			
2N699	NPN	0.7	4.5	1.0	35		100	
2N699B	NPN	2na	4.5	1.0	35		100	
2N700, A	PNP	2	4.5	2.0	4	10		
2N702	NPN	0.3	4.5	10		50		

2N703	NPN	0.3	4.5	10		70		
2N705, A	PNP	3	1.5	30		80		
2N706	NPN	0.3	1.5	10		40		
2N706A, B	NPN	0.3	1.5	10		40		
2N706C	NPN	10na	1.5	10		40		
2N707	NPN	2.5	4.5	10		12		
2N707A	NPN	0.4	1.5	10	9		50	
2N708	NPN	11na	4.5	10		50		
2N709	NPN	50na	1.5	10		50		
2N710, A	PNP	3	1.5	10	25			
2N711	PNP	3	1.5	10	20			
2N711A	PNP	1.5	1.5	10	25		150	
2N711B	PNP	1.0	1.5	10	35		150	
2N715	NPN	0.4	4.5	10		30		
2N716	NPN	0.4	4.5	10		24		
2N717	NPN	0.4	1.5	50		30		
2N718	NPN	0.4	4.5	1.0	30	70		
2N718A	NPN	3na	4.5	1.0	30		100	
2N719	NPN	0.5	4.5	1.0	15			
2N719A	NPN	.24	4.5	1.0	15			
2N720	NPN	0.5	4.5	1.0	30		90	
2N720A	NPN	.21	4.5	1.0	30		100	
2N721	PNP	0.4	4.5	1.0	15		50	
2N722	PNP	0.4	4.5	1.0	25		75	
2N725	PNP	3	1.5	10	20			
2N726	PNP	4	1.5	10		30		
2N728	NPN	2.5	4.5	10		40		
2N729	NPN	2	4.5	10		40		
2N730	NPN	0.4	4.5	50		35		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N731	NPN	0. 4	4. 5	50		70		
2N734	NPN	0. 3	4. 5	5. 0	20		50	
2N735	NPN	0. 3	4. 5	5. 0	40		100	
2N735A	NPN	1. 5na	4. 5	1. 0	30		100	
2N736	NPN	0. 3	4. 5	5. 0	80		200	
2N736A	NPN	. 16	4. 5	5. 0	80		200	
2N736B	NPN	1. 5na	4. 5	1. 0	60		150	
2N738	NPN	0. 3	4. 5	5. 0	20		50	
2N739	NPN	0. 3	4. 5	5. 0	40		100	
2N739A	NPN	1. 1na	4. 5	1. 0	30		100	
2N740	NPN	0. 3	4. 5	5. 0	80		200	
2N740A	NPN	1. 1na	4. 5	1. 0	60		200	
2N741, A	PNP	3	4. 5	5. 0	20			
2N742	NPN	. 05	1. 5	10	25			
2N743	NPN	0. 5	1. 5	10		40		Note 1
2N744	NPN	0. 5	1. 5	10		80		Note 1
2N745	NPN	0. 5	4. 5	1. 0		55		
2N746	NPN	0. 5	4. 5	1. 0		99		
2N747	NPN	0. 1	4. 5	10		50		
2N748	NPN	0. 1	4. 5	10		25		
2N749	NPN	. 25	4. 5	1. 0		15		
2N750	NPN	. 25	4. 5	1. 0		15		
2N751	NPN	0. 8	4. 5	1. 0		15		
2N752	NPN	. 04	4. 5	1. 0	40		120	
2N753	NPN	0. 3	1. 5	10		80		
2N754	NPN	0. 3	4. 5	1. 0		40		

2N755	NPN	0.2	4.5	1.0		40		
2N756	NPN	.08	4.5	1.0	12		22	
2N756A	NPN	.04	4.5	1.0	12		22	
2N757	NPN	.08	4.5	1.0	18		40	
2N757A	NPN	.04	4.5	1.0	18		40	
2N758	NPN	.08	4.5	1.0	18		90	
2N758A	NPN	.04	4.5	1.0	18		90	
2N758B	NPN	1.5na	4.5	1.0	18		90	
2N759	NPN	.08	4.5	1.0	36		90	
2N759A	NPN	.04	4.5	1.0	36		90	
2N759B	NPN	1.5na	4.5	1.0	36		90	
2N760	NPN	.08	4.5	1.0	76		333	
2N760A	NPN	.04	4.5	1.0	76		333	
2N760B	NPN	1.5na	4.5	1.0	76		333	
2N761	NPN	.09	4.5	1.0		35		
2N762	NPN	.09	4.5	1.0		70		
2N768	PNP	3	1.5	2.0		60		
2N769	PNP	3	1.5	10		70		
2N770	NPN	0.4	4.5	10		30		
2N771	NPN	0.4	4.5	10		60		
2N772	NPN	0.3	4.5	10		25		
2N773	NPN	0.4	4.5	2.0	5	10	16	
2N774	NPN	0.4	4.5	2.0	10	18	32	
2N775	NPN	0.4	4.5	2.0	25	44	80	
2N776	NPN	0.4	4.5	2.0	5	10	16	
2N777	NPN	0.4	4.5	2.0	10	18	32	
2N778	NPN	0.4	4.5	2.0	25	44	80	
2N779	PNP	3	1.5	10		80		
2N779A, B	PNP	3	1.5	10		130		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N780	NPN	3na	4.5	1.0		125		
2N781	PNP	3	1.5	10	25			
2N782	PNP	3	1.5	10	20			
2N783	NPN	.10	1.5	10	20		60	
2N784	NPN	.10	1.5	10	25			
2N784A	NPN	10na	1.5	10	25			
2N789	NPN	0.8	4.5	1.0	9		20	
2N790	NPN	0.8	4.5	1.0	18		40	
2N791	NPN	0.8	4.5	1.0	18		90	
2N792	NPN	0.8	4.5	1.0	36		88	
2N793	NPN	0.8	4.5	1.0	78		330	
2N794	PNP	3	3.0	10	40		120	
2N795	PNP	3	3.0	10	40		120	
2N796	PNP	3	3.0	10	60		130	
2N797	NPN	0.7	1.5	10		75		
2N799	PNP	3	4.5	1.0		135		
2N799A, B	PNP	3	1.5	10		125		
2N800	PNP	3	4.5	1.0		135		
2N801	PNP	4	1.5	2.0		50		Note 7
2N802	PNP	4	1.5	2.0		50		Note 7
2N803	PNP	4	1.5	2.0		80		Note 7
2N804	PNP	4	1.5	2.0		80		Note 7
2N805	PNP	4	1.5	4.0		100		Note 7
2N806	PNP	4	1.5	4.0		100		Note 7
2N807	PNP	3	1.5	20		60		
2N808	PNP	3	1.5	20		60		

2N809	PNP	3	4.5	1.0		60		
2N810	PNP	3	4.5	1.0		60		
2N811	PNP	3	4.5	1.0		80		
2N812	PNP	3	4.5	1.0		80		
2N813	PNP	3	4.5	1.0		140		
2N814	PNP	3	4.5	1.0		140		
2N815	NPN	5	1.5	30		100		Note 7
2N816	NPN	5	1.5	30		100		Note 7
2N817	NPN	4	4.5	1.0	15	25		
2N818	NPN	4	4.5	1.0	15	25		
2N819	NPN	4	4.5	1.0	15	35		
2N820	NPN	4	4.5	1.0	15	35		
2N821	NPN	4	4.5	1.0	15	65		
2N822	NPN	4	4.5	1.0	15	65		
2N823	NPN	3	1.5	24		24		
2N824	NPN	3	4.5	1.0		135		
2N825	PNP	3	1.5	10		80		
2N826	PNP	3	1.5	10		80		
2N828	PNP	3	1.5	10		40		
2N834	NPN	0.2	1.5	10	25	40		
2N835	NPN	0.2	1.5	10	25	40		
2N839	NPN	0.3	4.5	1.0	20		45	
2N840	NPN	0.3	4.5	1.0	40		90	
2N841	NPN	0.3	4.5	1.0	80		330	
2N842	NPN	0.3	4.5	1.0	20			
2N843	NPN	0.3	4.5	1.0	40			
2N844	NPN	0.3	4.5	1.0		80		
2N845	NPN	0.2	4.5	1.0		80		
2N846	PNP	3	1.5	10		45		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N846A, B	PNP	3	1.5	20		50		
2N849	NPN	0.3	1.5	10	20		60	
2N850	NPN	0.3	1.5	10	40		120	
2N851	NPN	0.5	1.5	10	20		60	Note 1
2N852	NPN	0.5	1.5	10	40		120	Note 1
2N858	PNP	.06	4.5	1.0	15	33	75	
2N859	PNP	.06	4.5	1.0	30	65	120	
2N860	PNP	.06	4.5	1.0	15	33	45	
2N861	PNP	.06	4.5	1.0	30	65	100	
2N862	PNP	.06	4.5	1.0	20	33	60	
2N863	PNP	.06	4.5	1.0	40	65	120	
2N864	PNP	.06	4.5	1.0	25	65	125	
2N865	PNP	.06	4.5	1.0	100	150	350	
2N869	PNP	5na	4.5	10	20			
2N870	NPN	2.4na	4.5	1.0	30		100	
2N871	NPN	2.4na	4.5	1.0	50		200	
2N902	NPN	0.8	4.5	1.0	9	15	22	
2N903	NPN	0.8	4.5	1.0	18	30	44	
2N904	NPN	0.8	4.5	1.0	18	39	90	
2N905	NPN	0.8	4.5	1.0	36	60	90	
2N906	NPN	0.8	4.5	1.0	76	120		
2N907	NPN	0.5	4.5	1.0	19	55		
2N908	NPN	0.5	4.5	1.0	39	99		
2N909	NPN	0.4	4.5	1.0	40			
2N910	NPN	6na	4.5	1.0	76		200	
2N911	NPN	6na	4.5	1.0	36		90	

2N912	NPN	6na	4.5	1.0	18		50	
2N914	NPN	12na	4.5	20	3			
2N915	NPN	3na	4.5	1.0	40		200	
2N916	NPN	5na	1.5	10	50		200	
2N917	NPN	0.5na	1.5	3.0	20	50		
2N918	NPN	5na	1.5	3.0	20	50		
2N919	NPN	0.3	1.5	10		40		
2N920	NPN	0.3	1.5	10		80		
2N921	NPN	0.3	1.5	10		40		
2N922	NPN	0.3	1.5	10		80		
2N923	PNP	10na	4.5	1.0	12		30	
2N924	PNP	10na	4.5	1.0	24		70	
2N925	PNP	10na	4.5	1.0	10		24	
2N926	PNP	10na	4.5	1.0	20		55	
2N927	PNP	10na	4.5	1.0	8		22	
2N928	PNP	10na	4.5	1.0	18		50	
2N929	NPN	3na	4.5	1.0	60			Note 1
2N929A	NPN	0.6na	4.5	1.0	60		350	
2N930	NPN	3na	4.5	1.0	150			Note 1
2N930A	NPN	0.3na	4.5	1.0	150		600	
2N935	PNP	.04	4.5	3.0		14		
2N936	PNP	.04	4.5	3.0		28		
2N937	PNP	.04	4.5	3.0		60		
2N938	PNP	9na	4.5	1.0	9	15	22	
2N939	PNP	9na	4.5	1.0	18	30	44	
2N940	PNP	9na	4.5	1.0	36	60	88	
2N941	PNP	25na	4.5	1.0	25	50		
2N942	PNP	25na	4.5	1.0	25	50		
2N943	PNP	10na	4.5	1.0	30		60	Note 6

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N944	PNP	10na	4.5	1.0	20		35	Note 6
2N945	PNP	10na	4.5	1.0	18		30	Note 6
2N946	PNP	10na	4.5	1.0	18		30	Note 6
2N947	NPN	0.5	4.5	1.0	50		200	
2N955, A	NPN	5	1.5	30		50		
2N956	NPN	3na	4.5	1.0	50		200	
2N957	NPN	2	4.5	1.0	45			
2N958	NPN	0.3	4.5	10		40		
2N959	NPN	0.3	4.5	10		80		
2N960	PNP	3	1.5	50	20	55		
2N961	PNP	3	1.5	50	20	55		
2N962	PNP	3	1.5	50	20	55		
2N963	PNP	5	1.5	10	20			
2N964	PNP	3	1.5	50	40	95		
2N965	PNP	3	1.5	50	40	95		
2N966	PNP	3	1.5	50	40	95		
2N967	PNP	5	1.5	10	40			
2N968	PNP	3	1.5	10	17	35		
2N969	PNP	3	1.5	10	17	35		
2N970	PNP	3	1.5	10	17	35		
2N971	PNP	10	1.5	10	17	35		
2N972	PNP	3	1.5	10	40	75		
2N973	PNP	3	1.5	10	40	75		
2N974	PNP	3	1.5	10	40	75		
2N975	PNP	10	1.5	10	40	75		
2N976	PNP	3	1.5	20		52		

2N978	PNP	3	4.5	30	10			
2N979	PNP	3	1.5	10		120		
2N982	PNP	3	1.5	10		100		
2N983	PNP	3	1.5	10		85		
2N984	PNP	5	1.5	10		70		
2N985	PNP	3	1.5	10	40			
2N987	PNP	8	4.5	1.0	40	100	250	
2N990	PNP	8	4.5	1.0	40	150		Leads= B-E-C
2N991	PNP	8	4.5	1.0	40	150		Leads= B-E-C
2N992	PNP	8	4.5	1.0	40	150		Leads= B-E-C
2N993	PNP	8	4.5	1.0	40	150		Leads= B-E-C
2N995	PNP	3na	1.5	20	35		140	
2N996	PNP	3na	1.5	20	35		75	
2N1000	NPN	5	1.5	10		40		
2N1008	PNP	6	4.5	10	40	90	150	
2N1008A	PNP	4	4.5	10	40	90	150	
2N1008B	PNP	4	4.5	10	40	90	150	
2N1010	NPN	7	3.0	0.3		35		
2N1012	NPN	5	1.5	50		50		
2N1017	PNP	0.4	1.5	50		150		Note 7
2N1021	PNP	150	1.5	100		80		
2N1022	PNP	150	1.5	100		80		
2N1023	PNP	7	4.5	1.5		60		
2N1024	PNP	12na	4.5	1.0	9	15		
2N1025	PNP	12na	4.5	1.0	9	15	22	
2N1026	PNP	12na	4.5	1.0	18	30	44	
2N1026A	PNP	12na	4.5	1.0	36	60	88	
2N1027	PNP	12na	4.5	1.0	18	30		
2N1028	PNP	16na	4.5	1.0	9			

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N1034	PNP	0. 4	4. 5	1. 0	9	15	22	
2N1035	PNP	0. 4	4. 5	1. 0	18	30	42	
2N1036	PNP	0. 4	4. 5	1. 0	34	60	88	
2N1037	PNP	0. 4	4. 5	1. 0	9	25	42	
2N1038	PNP	60	1. 5	50		70		
2N1039	PNP	60	1. 5	50		70		
2N1040	PNP	60	1. 5	50		70		
2N1041	PNP	60	1. 5	50		70		
2N1042	PNP	60	1. 5	50		83		
2N1043	PNP	60	1. 5	50		83		
2N1044	PNP	60	1. 5	50		83		
2N1045	PNP	60	1. 5	50		83		
2N1047, A	NPN	6	4. 5	30		15		
2N1048, A	NPN	6	4. 5	30		15		
2N1049, A	NPN	6	4. 5	30		25		
2N1050, A	NPN	6	4. 5	30		25		
2N1051	NPN	. 04	4. 5	5. 0	30		100	
2N1052	NPN	0. 5	4. 5	20		35		Note 1
2N1053	NPN	0. 5	4. 5	20		35		Note 1
2N1054	NPN	1	4. 5	20		35		Note 1
2N1056	PNP	6	4. 5	1. 0		25		
2N1057	PNP	5	1. 5	20		60		
2N1058	NPN	25	4. 5	1. 0	10	25		Note 4
2N1059	NPN	16	1. 5	35		75		
2N1060	NPN	0. 1	4. 5	1. 0		30		
2N1065	PNP	5	4. 5	1. 0		25		

2N1066	PNP	7	4. 5	1. 5		60		
2N1072	NPN	0. 1	4. 5	1. 0		40		
2N1074	NPN	0. 4	4. 5	5. 0	9	15	22	
2N1075	NPN	0. 4	4. 5	5. 0	18	28	44	
2N1076	NPN	0. 4	4. 5	5. 0	36	60	88	
2N1077	NPN	0. 4	4. 5	5. 0	9	25	44	
2N1086	NPN	3	1. 5	1. 0		40		
2N1086A	NPN	3	1. 5	1. 0		40		
2N1087	NPN	3	1. 5	1. 0		40		
2N1090	NPN	5	1. 5	20		50		
2N1091	NPN	5	1. 5	20		50		
2N1093	PNP	2	4. 5	1. 0		125		
2N1094	PNP	2	4. 5	4. 0	24	49	199	
2N1095	NPN	1. 5	4. 5	5. 0	9	49		
2N1096	NPN	1. 5	4. 5	5. 0	9	24		
2N1097	PNP	8	4. 5	1. 0		55		
2N1098	PNP	8	4. 5	1. 0		45		
2N1101	NPN	25	4. 5	1. 0	20			
2N1102	NPN	16	4. 5	1. 0	20			
2N1107	PNP	6	4. 5	0. 5		50		
2N1108	PNP	6	4. 5	0. 5		45		
2N1109	PNP	6	4. 5	0. 5		10		
2N1110	PNP	6	4. 5	0. 5		28		
2N1111	PNP	6	4. 5	0. 5		18		
2N1111A	PNP	6	4. 5	0. 5		28		
2N1111B	PNP	6	4. 5	0. 5		28		
2N1114	NPN	12	1. 5	20	40		180	
2N1115	PNP	3	1. 5	10		50		Note 4
2N1118	PNP	0. 4	4. 5	1. 0	15	30		

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N1118A	PNP	0.4	4.5	1.0	15	25	35	
2N1119	PNP	.06	1.5	10		16		
2N1121	NPN	0.5	1.5	1.0	32	72		Note 6
2N1122	PNP	5	3.0	1.0	35			
2N1122A	PNP	5	3.0	1.0	35			
2N1123	PNP	5	4.5	3.0		80		Note 7
2N1124	PNP	30	4.5	10	40	100		
2N1125	PNP	25	1.5	10		150		
2N1126	PNP	30	4.5	10	40			
2N1128	PNP	14	4.5	2.0	70	120	150	
2N1129	PNP	10	4.5	10		190		
2N1130	PNP	10	4.5	10		130		
2N1131	PNP	0.4	4.5	1.0	15		50	
2N1131A	PNP	.15	4.5	1.0	15		50	
2N1132	PNP	0.4	4.5	1.0	25		100	
2N1132A	PNP	.15	4.5	1.0	25		75	
2N1132B	PNP	3na	4.5	1.0	25		75	
2N1139	NPN	2.5	4.5	10		40		
2N1140	NPN	15	4.5	1.0	20			
2N1141	PNP	3	4.5	10		49		
2N1142	PNP	3	4.5	10		49		
2N1143	PNP	3	4.5	10		49		
2N1144	PNP	8	4.5	1.0		55		
2N1145	PNP	8	4.5	1.0		45		
2N1149	NPN	0.8	4.5	1.0	9	13	20	
2N1150	NPN	0.8	4.5	1.0	18	24	40	

2N1151	NPN	0.8	4.5	1.0	18	39	90	
2N1152	NPN	0.8	4.5	1.0	36	49	90	
2N1153	NPN	0.8	4.5	1.0	76	99		
2N1154	NPN	1.5	4.5	5.0	9	15		
2N1155	NPN	1	4.5	5.0	9	15		
2N1156	NPN	1.5	4.5	5.0	9	15		
2N1158	PNP	3	4.5	3.0	5	50		
2N1158A	PNP	3	4.5	3.0	8	50		
2N1169	NPN	6	1.5	50		40		
2N1170	NPN	5	1.5	50		40		
2N1171	PNP	3	1.5	50		50		
2N1175	PNP	5	4.5	1.0	60	80	120	
2N1175A	PNP	5	4.5	1.0	60	80	120	
2N1176	PNP	16	4.5	10	20			
2N1176A	PNP	12	4.5	10	20			
2N1176B	PNP	12	4.5	10	20			
2N1177	PNP	7	4.5	1.0		90		
2N1178	PNP	7	4.5	1.0		35		
2N1179	PNP	7	4.5	1.0		70		
2N1180	PNP	7	4.5	1.0		70		
2N1185	PNP	4	4.5	1.0	190	260	400	
2N1186	PNP	3	4.5	1.0	30	49	70	
2N1187	PNP	3	4.5	1.0	50	80	120	
2N1188	PNP	3	4.5	1.0	100	130	225	
2N1191	PNP	6	4.5	1.0	30	40	70	
2N1192	PNP	6	4.5	1.0	50	75	125	
2N1193	PNP	6	4.5	1.0	100	160		
2N1194	PNP	6	4.5	1.0	190	280	500	
2N1195	PNP	2.5	4.5	10	26	49	200	

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta Min.	Beta Typ.	Beta Max.	Notes
2N1196	PNP	. 12	4. 5	2. 0	6	10		
2N1197	PNP	. 12	4. 5	2. 0	6	10		
2N1198	NPN	0. 8	4. 5	1. 0	20	66	200	
2N1199, A	NPN	0. 4	4. 5	10		35		
2N1204, A	PNP	7	4. 5	10		150		
2N1205	NPN	. 25	4. 5	2. 0	10			
2N1206	NPN	0. 4	4. 5	5. 0	25		90	
2N1207	NPN	0. 4	4. 5	5. 0	25		90	
2N1217	NPN	0. 8	1. 5	2. 0		60		
2N1218	NPN	100	1. 5	100	40		160	Note 7
2N1219	PNP	. 07	1. 5	5. 0	18			
2N1220	PNP	. 07	1. 5	5. 0	9			
2N1221	PNP	. 07	4. 5	1. 0	18			
2N1222	PNP	. 07	4. 5	1. 0	9			
2N1223	PNP	. 07	4. 5	1. 0	6	10		
2N1224	PNP	7	4. 5	1. 5		60		
2N1225	PNP	7	4. 5	1. 5		60		
2N1226	PNP	7	4. 5	1. 5		60		
2N1228	PNP	. 06	4. 5	1. 0	14		32	
2N1229	PNP	. 06	4. 5	1. 0	28		65	
2N1230	PNP	. 04	4. 5	1. 0	14		32	
2N1231	PNP	. 04	4. 5	1. 0	28		65	
2N1232	PNP	. 03	4. 5	1. 0	14		32	
2N1233	PNP	. 03	4. 5	1. 0	28		65	
2N1234	PNP	. 02	4. 5	1. 0	14		32	
2N1238	PNP	. 06	4. 5	1. 0	14		32	

2N1239	PNP	.06	4.5	1.0	28		65	
2N1240	PNP	.04	4.5	1.0	14		32	
2N1241	PNP	.04	4.5	1.0	28		65	
2N1242	PNP	.03	4.5	1.0	14		32	
2N1243	PNP	.03	4.5	1.0	28		65	
2N1244	PNP	.02	4.5	1.0	14		32	
2N1247	NPN	5na	3.0	0.1		70		
2N1248	NPN	.01	3.0	0.1		38		
2N1251	NPN	25	4.5	1.0	70	150	250	
2N1252	NPN	5	4.5	50		35		
2N1253	NPN	5	4.5	50		70		
2N1254	PNP	0.1	4.5	2.0		10		
2N1255	PNP	0.1	4.5	2.0		40		
2N1256	PNP	.08	4.5	2.0		10		
2N1257	PNP	.08	4.5	2.0		40		
2N1258	PNP	.06	4.5	2.0		10		
2N1259	PNP	.06	4.5	2.0		40		
2N1264	PNP	25	4.5	1.5	15			
2N1265	PNP	70	4.5	1.0		50		Note 4
2N1266	PNP	70	4.5	1.0	10	48		Note 4
2N1267	NPN	0.4	4.5	2.0	5	10	16	
2N1268	NPN	0.4	4.5	2.0	10	18	32	
2N1269	NPN	0.4	4.5	2.0	25	44	80	
2N1270	NPN	0.4	4.5	2.0	5	10	16	
2N1271	NPN	0.4	4.5	2.0	10	18	32	
2N1272	NPN	0.4	4.5	2.0	25	44	80	
2N1273	PNP	8	1.5	50		50		
2N1274	PNP	8	1.5	50		50		
2N1275	PNP	0.3	4.5	1.0		14		

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N1276	NPN	0.4	4.5	1.0	9	14	22	
2N1277	NPN	0.4	4.5	1.0	18	33	44	
2N1278	NPN	0.4	4.5	1.0	37	66	90	
2N1279	NPN	0.4	4.5	1.0	76	101	333	
2N1280	PNP	7	1.5	20		60		
2N1281	PNP	7	1.5	20		90		
2N1282	PNP	7	1.5	20		100		
2N1284	PNP	2.5	1.5	10	30	90	150	
2N1285	PNP	7	4.5	1.5	30		100	
2N1288	NPN	5	1.5	10		150		
2N1289	NPN	3	4.5	1.0		125		
2N1299	NPN	4	1.5	50	35		110	
2N1300	PNP	3	3.0	10	40		120	
2N1301	PNP	3	3.0	10	40		120	
2N1302	NPN	2.5	1.5	10		50		
2N1303	PNP	2.5	1.5	10		50		
2N1304	NPN	2.5	1.5	10		70		
2N1305	PNP	2.5	1.5	10		70		
2N1306	NPN	2.5	1.5	10		100		
2N1307	PNP	2.5	1.5	10		100		
2N1308	NPN	2.5	1.5	10		150		
2N1309	PNP	2.5	1.5	10		150		
2N1310	NPN	7	4.5	1.0		35		
2N1311	NPN	7	4.5	1.0		30		
2N1312	NPN	7	4.5	1.0		40		
2N1316	PNP	3	1.5	10		50		

2N1317	PNP	4	1.5	10		50		
2N1318	PNP	5	1.5	10		50		
2N1335	NPN	1	4.5	30		10		
2N1336	NPN	1	4.5	30		10		
2N1337	NPN	1	4.5	30		10		
2N1338	NPN	1	4.5	30		10		
2N1339	NPN	1	4.5	30		10		
2N1340	NPN	1	4.5	30		10		
2N1341	NPN	1	4.5	30		10		
2N1343	PNP	3	1.5	50		25		
2N1344	PNP	5	1.5	20		90		
2N1345	PNP	4	4.5	1.0		66		
2N1346	PNP	5	4.5	1.0		137		
2N1347	PNP	4	1.5	10		80		
2N1349	PNP	6	1.5	10		115		
2N1350	PNP	8	1.5	10		95		
2N1351	PNP	6	1.5	10		65		
2N1352	PNP	2	4.5	1.0		70		
2N1353	PNP	4	1.5	10		70		
2N1354	PNP	4	1.5	10		70		
2N1355	PNP	4	1.5	10		80		
2N1356	PNP	3	1.5	10		80		
2N1357	PNP	4	1.5	10		85		
2N1370	PNP	3	1.5	50		80		Notes 6, 7
2N1371	PNP	3	1.5	50		80		Notes 6, 7
2N1372	PNP	3	4.5	1.0		45		Notes 6, 7
2N1373	PNP	3	4.5	1.0		45		Notes 6, 7
2N1374	PNP	3	4.5	1.0		70		Notes 6, 7
2N1375	PNP	3	4.5	1.0		70		Notes 6, 7

Transistor	Type	Max. Icbo µa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N1376	PNP	3	4.5	1.0		95		Notes 6, 7
2N1377	PNP	3	4.5	1.0		95		Notes 6, 7
2N1378	PNP	7	4.5	1.0		200		Notes 6, 7
2N1379	PNP	5	4.5	1.0		200		Notes 6, 7
2N1380	PNP	7	4.5	1.0		100		Notes 6, 7
2N1381	PNP	5	4.5	1.0		100		Notes 6, 7
2N1382	PNP	7	4.5	1.0		80		
2N1383	PNP	7	4.5	1.0		50		
2N1384	PNP	10	1.5	100		60		Note 8
2N1386	NPN	0.1	4.5	10		45		
2N1387	NPN	0.1	4.5	10		30		
2N1388	NPN	.25	4.5	1.0		15		
2N1389	NPN	.25	4.5	1.0		15		
2N1390	NPN	0.8	4.5	1.0		15		
2N1395	PNP	7	4.5	1.5		90		
2N1396	PNP	7	4.5	1.5		90		
2N1397	PNP	7	4.5	1.5		90		
2N1405	PNP	3	4.5	2.0	10			
2N1406	PNP	3	4.5	2.0	10			
2N1407	PNP	3	4.5	2.0	10			
2N1408	PNP	7	4.5	1.0	10	25		
2N1409, A	NPN	5	4.5	100		30		
2N1410. A	NPN	5	4.5	100		30		
2N1411	PNP	5	1.5	50		75		
2N1413	PNP	5	4.5	1.0	20	29	41	
2N1414	PNP	5	4.5	1.0	30	42	64	

Model 1890 M. Test Data For Burroughs Devices

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
DS-100291	PNP	030.0	4.5	1.0	28		65	
GVL-20121	PNP	003.0	1.5	10.0	25			
GVL-20301	NPN	013.0	4.5	10.0	25			
GVL-20122	NPN	012.0	1.5	10.0		55		
GVL-20078	PNP	005.0	1.5	10.0		125		
GVL-20072		006.0						NOTE 9
GVL-20076	PNP	009.0						NOTE 9
GVL-20228	NPN	00.9						NOTE 9
GVL-20229	PNP	00.4						NOTE 9
GVL-20287 Dual Transistor, cannot be tested.								
The following Transistors cannot be tested (Too High Powered)								
DS-100444								
DS-100445								
DS-100447								
DS-100448								
GVL-20077								
GVL20108								
GVL20114								
DS-100446 Controlled Rectifier, cannot be tested.								
DS-100023								
(Diode Testing) See instruction book, page 16 and 17.								

Deleted

Transistor	Type	Max. Icbo μa	Vce	Ic ma	Beta			Notes
					Min.	Typ.	Max.	
2N1479	NPN	4	4.5	5.0		50		
2N1480	NPN	4	4.5	5.0		50		
2N1481	NPN	4	4.5	5.0		50		
2N1482	NPN	4	4.5	5.0		50		
2N1491	NPN	6	4.5	15		50		
2N1492	NPN	6	4.5	15		50		
2N1493	NPN	6	4.5	15		50		
2N1494	PNP	7	4.5	10		150		
2N1499A	PNP	3	1.5	10		75		
2N1500	PNP	5	1.5	10		90		
2N1507	NPN	0.4	4.5	50		150		
2N1510	NPN	2	1.5	1.0		30		
2N1515	PNP	13	4.5	1.0	20	100		
2N1516	PNP	13	4.5	1.0	20	100		
2N1517	PNP	13	4.5	1.0	20	100		
2N1524	PNP	10	4.5	1.0		55		
2N1525	PNP	10	4.5	1.0		55		
2N1526	PNP	10	4.5	1.0		115		
2N1527	PNP	10	4.5	1.0		115		
2N1528	NPN	1	4.5	1.0	10		100	
2N1564	NPN	0.3	4.5	5.0	20		50	
2N1565	NPN	0.3	4.5	5.0	40		100	
2N1566	NPN	0.3	4.5	5.0	80		200	
2N1566A	NPN	0.16	4.5	5.0	80		200	
2N1572	NPN	0.3	4.5	5.0	20		50	
2N1573	NPN	0.3	4.5	5.0	40		100	

SECTION II
PARTS BREAKDOWN

62. INTRODUCTION.

63. SCOPE.

a. This section contains parts lists and illustrations (figures 25 through 33), which are used to identify and describe parts of the tester to facilitate ordering replacement parts. Vendor information and reference designations are also included in this section.

64. ORDERING REPLACEMENT PARTS. A replacement part is ordered as follows:

a. Locate the part on the figure, and determine the index number.

b. Locate the index number found in the first column on the parts list pertaining to that figure. Then determine the complete description and part number of the part for ordering.

65. VENDOR'S CODE.

66. PURPOSE AND USE.

a. The vendor's code is used to facilitate ordering replacement parts other than those manufactured by the Hickok Electrical Instrument Company.

b. The vendor's code number, enclosed in parenthesis, follows the description of the part in the parts list. The code numbers are in accordance with the Federal Supply Code for Manufacturers, Cataloging Handbook H4-1. The name and address of each vendor and the corresponding code number are listed below.

CODE	VENDOR'S NAME AND ADDRESS
03508	Semi-Conductor Products Department of Electronic Components Division of Electronic, Atomic and Defense Systems Group General Electric Co. Syracuse, New York
04713	Motorola, Inc. Semi-Conductor Products Division Phoenix, Arizona
12059	Superior Electronics Corp. Clifton, New Jersey
14370	Continental Rubber Works Erie, Pennsylvania
71590	Centralab Division of Globe Union, Inc. Milwaukee, Wisconsin
75376	Kurz-Kasch, Inc. Dayton, Ohio
76149	Mallory Electric Corp. Detroit, Michigan
76545	Mueller Electric Co. Cleveland, Ohio
78189	Shakeproof Division of Illinois Tool Works Elgin, Illinois
80095	Burgess Battery Co. Battery Division Chicago, Illinois
81483	International Rectifier Corp. El Segundo, California
82376	Astron Co. East Newark, New Jersey
83330	Herman H. Smith, Inc. Brooklyn, New York
83740	Eveready Division of National Carbon Division of Union Carbide Corp. New York, N. Y.
88419	Cornell-Dubilier Electric Corp. Fuquay Springs, North Carolina
89307	Sprague Engineering Corp. Gardena, California
89665	United Transformer Co. Chicago, Illinois
91662	Elco Corp. Philadelphia, Pennsylvania
97954	U. S. Components, Inc. New York, New York

67. REFERENCE DESIGNATIONS.

68. PURPOSE AND USE.

a. Reference designations are used to identify electronic components in the text of this technical manual, on the schematic wiring diagram (figure 2), and on figures 3 to 9, 19, 20, and 22 to 24. The reference designations are listed below in alpha-numeric sequence. The "Figure and Index No." column contains the figure and index numbers of those parts in the parts lists which have reference designations. The "Part No." column contains the corresponding part numbers of these parts.

b. To find a part on the parts location illustrations (figures 25 to 33) when the reference designation is known, proceed as follows:

(1) Refer to the list of reference designations below, find the reference designation, and note the figure and index number.

(2) Turn to the parts list and locate the figure and index number found in step (1) above.

(3) On the proper illustration, find the index number of step (2) above.

REFERENCE DESIGNATION	FIGURE & INDEX NO.	PART NUMBER
BT1	33-4	763
BT2	33-9	2370ST
BT3	33-9	2370ST
CR1	26-9	SD91
CR2	28-1	IN91
CR3	28-8	JAN IN198
CR4	28-8	JAN IN198
CR5	28-8	JAN IN198
CR6	28-8	JAN IN198
C1	32-2	MQZFP.5-1M-10
C2	32-7	MQZFP.5-2M-10
C3	32-6	CP05A1EB224K
C4	32-8	CP05A1EB104K
C5A	30-4	TE1162
C5B	30-4	TE1162
C6	26-41	BSX-5100
C7	29-1	CP05A1EC474K
C8	29-9	NLW25-25
C9	29-8	CP05A1EB224K
C10	29-10	CP05A1EC473K
C11	28-6	CP05A1EE103K
C12	28-4	NLW-30-25
E1	26-4	DF31BLC

REFERENCE DESIGNATION	FIGURE & INDEX NO.	PART NUMBER
E2	26-5	DF31GNC
E3	26-6	DF31YC
J1	33-6	M1-14F
J2	26-3	3301
L1	26-20	TVC4
L2	26-21	3250-84
L3	26-40	HVC-4
M1	26-10	481-917
P1	26-12	M1-14M
Q1	32-4	2N651A
Q2	32-4	2N651A
Q3	29-3	2N650A
Q4	29-6	2N651A
Q5	28-5	2N651A
R1	32-13	RC20GF221K
R2	32-12	RC20GF183K
R3	32-3	RC20GF392K
R4	32-5	RC20GF103K
R5	32-11	RC20GF101K
R6	32-10	RC20GF393K
R7	32-5	RC20GF103K
R8	26-29	16925-391
R9	26-25	16925-393
R10	26-27	16925-391
R11	26-25	16925-393
R12	30-3	RN70B49R9F
R13	31-5	RC20GF471K
R14	27-6	RC32GF4R7K
R15	27-7	RC20GF470K
R16	27-8	RC20GF471K
R17	27-9	RC20GF472K
R18	31-1	RB55AE1R000F

REFERENCE DESIGNATION	FIGURE & INDEX NO.	PART NUMBER	REFERENCE DESIGNATION	FIGURE & INDEX NO.	PART NUMBER
R19	31-3	RB55AE10R05F	R39	29-11	RC20GF332K
R20	31-2	RB55AE105R3F	R40	28-10	RC20GF223K
R21	27-5	RB55AE222R2F	R41	28-2	RC20GF224K
R22	27-4	RB55AE20R20F	R42	28-12	RC20GF103K
R23	31-6	RC20GF472K	R43	28-9	RC20GF103K
R24	26-22	RV4NAYSD251A	R44	28-3	RC20GF102K
R25	31-4	RC20GF332K	R45	28-11	RC20GF150K
R26	27-2	RN70B4993F	R46	28-7	RC20GF913J
R27	30-1	RN70B1001F	S1	26-23	19912-467
R28	30-2	RB55AE10R00F	S2	26-11	19912-456
R29	30-1	RN70B1001F	S3	26-2	19912-458
R30	30-2	RB55AE10R00F	S4	26-26	19912-457
R31	31-1	RB55AE1R000F	S5	26-28	19912-455
R32	27-3	RN70B2003F	TB1	29-, 26-18	2420-505
R33	26-19	20-9316	TB2	26-15, 28-	2420-506
R34	29-5	RC20GF183K	TB3	26-36, 32-	2420-507
R35	29-2	RC20GF101K	TB4	26-34, 31-	2420-508
R36	29-12	RC20GF150K	TB5	26-31, 30-	2420-509
R37	29-4	RC20GF913J	TB6	26-1, 27-	2420-516
R38	29-7	RC20GF680K	T1	32-9	TF4RX13YY, DO-T11

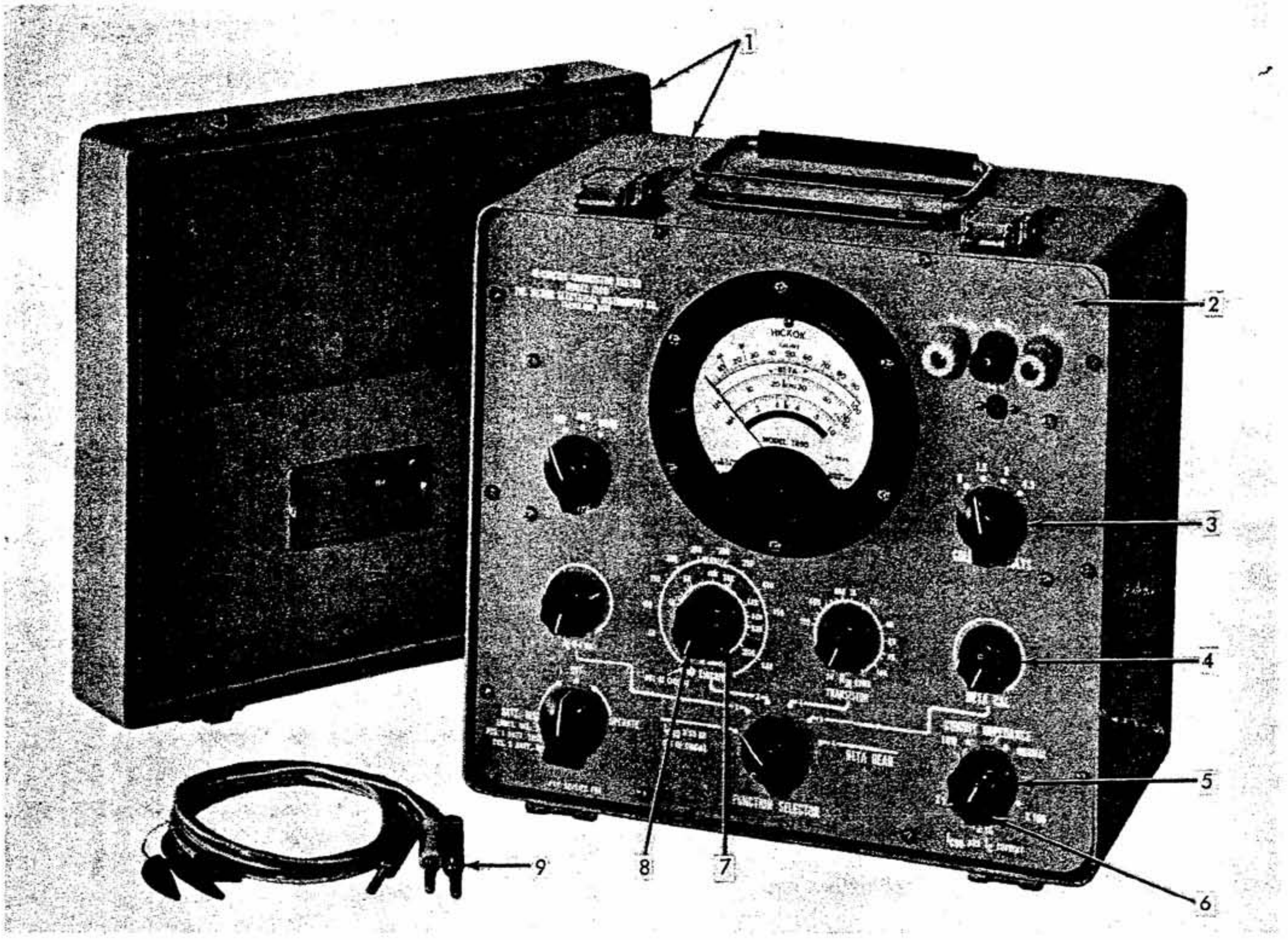

Figure 25. In-Circuit Transistor Tester Model 1890M

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		IN-CIRCUIT TRANSISTOR TESTER MODEL 1890M		
25-	902-353	TRANSISTOR TESTER, IN-CIRCUIT	1	
-1	3145-560	. CASE ASSEMBLY, Portable (See figure 33 for breakdown) .	1	
-2	No Number	. PANEL AND CHASSIS ASSEMBLY (See figure 26 for . . . . breakdown)	1	
-3	S-657-3L-BB	. KNOB, INDICATOR (Mfd by 75376)	4	
-4	S-647-3L-BB	. KNOB, INDICATOR (Mfd by 75376)	3	
-5	S-645-5L-BB	. KNOB, INDICATOR (Mfd by 75376)	1	
-6	S-656-3L-BB	. KNOB, INDICATOR (Mfd by 75376)	1	
-7	11505-116	. KNOB, INDICATOR.	1	
-8	11505-115	. KNOB, INDICATOR.	1	
-9	12450-356	. LEAD ASSEMBLY, TEST	1	
	211	. . CONNECTOR, PLUG, ELECTRICAL, green (Mfd by . . 83330)	1	
	211	. . CONNECTOR, PLUG, ELECTRICAL, yellow (Mfd by . . 83330)	1	
	211	. . CONNECTOR, PLUG, ELECTRICAL, blue (Mfd by . . . 83330)	1	
	36	. . INSULATOR (Mfd by 76545)	3	
	34	. . CLIP, Minigator (Mfd by 76545)	3	

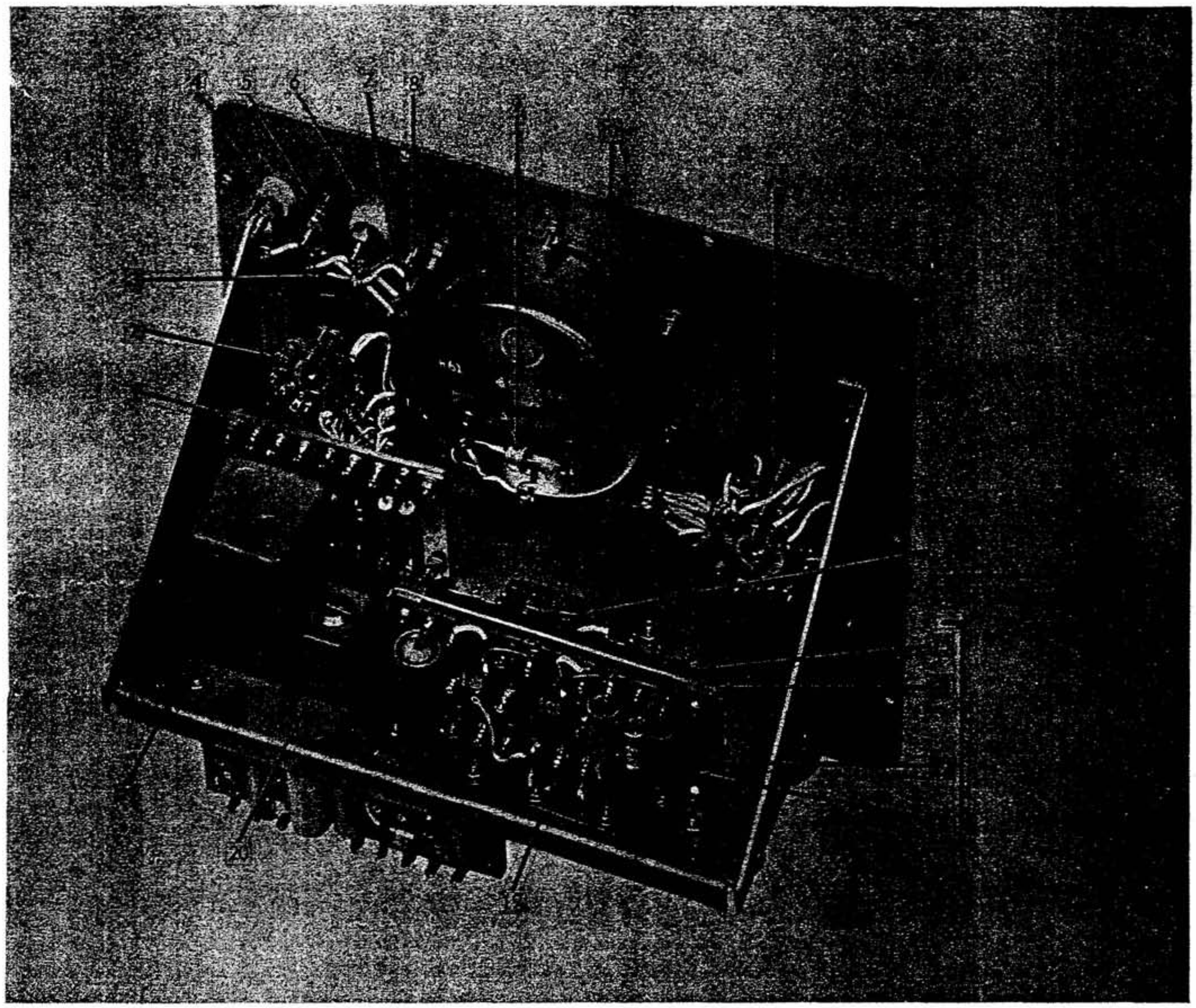

Figure 26. Panel and Chassis Assembly (Sheet 1 of 2)

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		PANEL AND CHASSIS ASSEMBLY		
26-	No Number	PANEL AND CHASSIS ASSEMBLY (See item 2, figure 25 for next higher assembly)	Ref	
-1	2420-516	. TERMINAL BOARD ASSEMBLY (See figure 27 for breakdown)	1	
-2	19912-458	. SWITCH, ROTARY, 1 section, 4 position	1	
-3	3301	. SOCKET, TRANSISTOR, mica filled, beryllium copper, silver pl contacts (Mfd by 91662)	1	
-4	DF31BLC	. POST, BINDING, blue (Mfd by 12059)	1	
-5	DF31GNC	. POST, BINDING, green (Mfd by 12059)	1	
-6	DF31YC	. POST, BINDING, yellow (Mfd by 12059)	1	
-7	10	. LUG, TERMINAL (Mfd by 78189)	3	
-8	2102-6HT	. LUG, TERMINAL (Mfd by 78189)	1	
-9	SD91	. SEMICONDUCTOR DEVICE, DIODE (Mfd by 81483)	1	
-10	481-917	. METER, INDICATOR, 50 ua, 2K ohms, 100 uv	1	

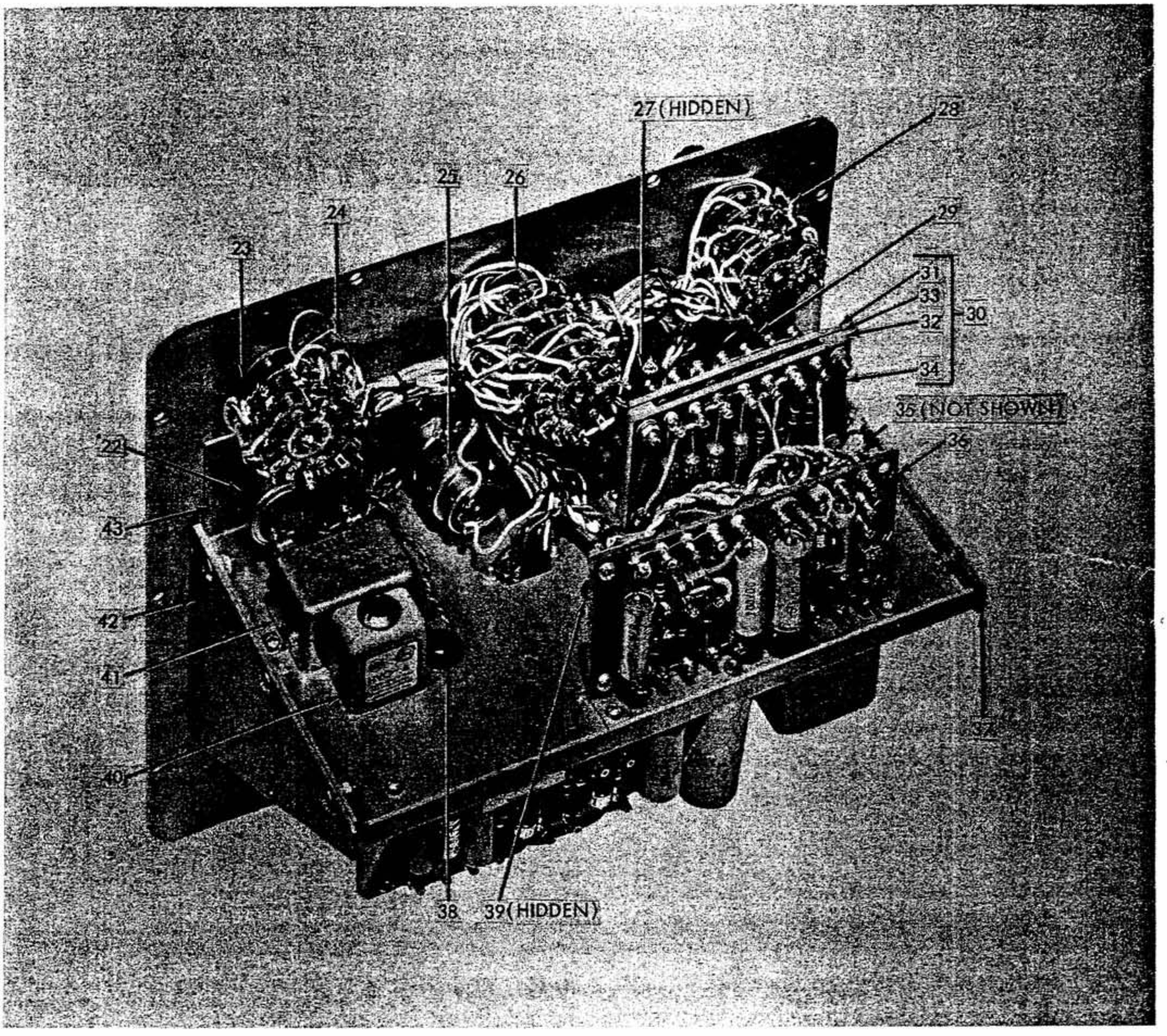

Figure 26. Panel and Chassis Assembly (Sheet 2 of 2)

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		PANEL AND CHASSIS ASSEMBLY (Cont)		
26-11	19912-456	. SWITCH, ROTARY, 3 section, 3 position	1	
-12	M1-14M	. CONNECTOR, RECEPTACLE, ELECTRICAL (Mfd by . . . 97954)	1	
-13	3825-334	. COVER, Amplifier	1	
-14	2420-510	. BOARD ASSEMBLY, Component, amplifier	1	
-15	2420-506	. . TERMINAL BOARD ASSEMBLY (See figure 28 for . . . . breakdown)	1	
-16	19370-310	. . SPACER, Terminal board	4	
-17	2660-905	. . BRACKET, Terminal board	1	
-18	2420-505	. . TERMINAL BOARD ASSEMBLY (See figure 29 for . . . . breakdown)	1	

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		PANEL AND CHASSIS ASSEMBLY (Cont)		
26-19	20-9316	. RESISTOR, Variable, 5K ohms, 1/4 w (Mfd by 71590) . . .	1	
-20	TVC4	. CHOKE, Variductor (Mfd by 89665)	1	
-21	3250-84	. CHOKE, Reactor, 10 henry, 10 ma, 135 ohms	1	
-22	RV4NAYSD251A	. RESISTOR, VARIABLE, 250 ohm, 10%, 2w (MIL-R-94) . .	1	
-23	19912-467	. SWITCH, ROTARY, 3 section, 3 position	1	
-24	16-030-1206	. LUG, TERMINAL (Mfd by 71590)	1	
-25	16925-393	. RESISTOR, VARIABLE, CONCENTRIC, front section 1K . ohms, 10%, Z taper; rear section 500 ohms, 10% linear taper with SPST switch	1	
-26	19912-457	. SWITCH, ROTARY, 6 section, 6 position	1	
-27	16925-391	. RESISTOR, VARIABLE, 10K ohms, 10%, 2w, Z taper . . .	1	
-28	19912-455	. SWITCH, ROTARY, Dual concentric, front section, 1 section, 3 position; rear section, 1 section, 2 position	1	
-29	16925-391	. RESISTOR, VARIABLE, 10K ohms, 10%, 2 w, 7 taper . . .	1	
-30	2420-511	. BOARD ASSEMBLY, Component	1	
-31	2420-509	. . TERMINAL BOARD ASSEMBLY (See figure 30 for . . . breakdown)	1	
-32	19370-310	. . SPACER, Terminal board	2	
-33	2660-906	. . BRACKET, Terminal board	2	
-34	2420-508	. . TERMINAL BOARD ASSEMBLY (See figure 31 for . . . breakdown)	1	
-35	3825-333	. COVER, Oscillator	1	
-36	2420-507	. TERMINAL BOARD ASSEMBLY (See figure 32 for break- . down)	1	
-37	2660-904	. BRACKET, Chassis, right	1	
-38	3013	. GROMMET, RUBBER, 5/16 in. ID, 5/8 in. OD, 9/32 in. . thk (Mfd by 14370)	4	
-39	7859	. GROMMET, RUBBER, 3/16 in. ID, 5/8 in. OD, 3/16 in. . thk (Mfd by 14370)	1	
-40	HVC-4	. CHOKE, Variductor (Mfd by 89665)	1	
-41	BSX-5100	. CAPACITOR, FIXED, ELECTROLYTIC, 100 uf, 50 v dc . (Mfd by 76149)	1	
-42	2660-903	. BRACKET, Chassis, left	1	
-43	3225-391	. CHASSIS, Tester	1	

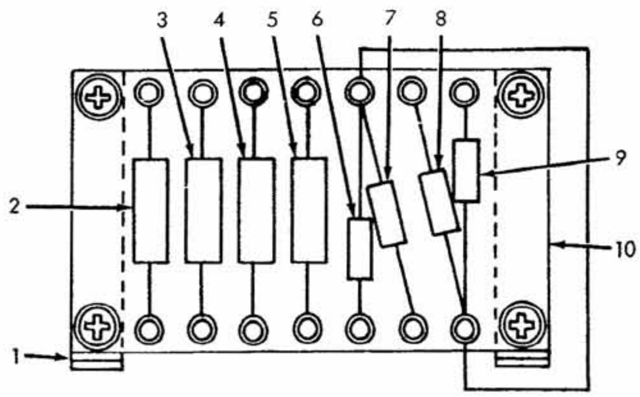

Figure 27. Terminal Board Assembly TB6

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB6		
27-	2420-516	TERMINAL BOARD ASSEMBLY (See item 1, figure 26 for . . next higher assembly)	Ref	
-1	2660-906	. BRACKET, Terminal board	2	
-2	RN70B4993F	. RESISTOR, FIXED, FILM, 499 K ohms, 1%, 1/2 w . . . . (MIL-R-10509)	1	
-3	RN70B2003F	. RESISTOR, FIXED, FILM, 200 K ohms, 1%, 1/2 w . . . . (MIL-R-10509)	1	
-4	RB55AE20R20F	. RESISTOR, FIXED, WIREWOUND, 20.2 ohms, 1%, 0.15 w. (MIL-R-93)	1	
-5	RB55AE222R2F	. RESISTOR, FIXED, WIREWOUND, 222.2 ohms, 1%, . . . 0.15 w (MIL-R-93)	1	
-6	RC32GF4R7K	. RESISTOR, FIXED, COMPOSITION, 4.7 ohms, 10% . . . 1 w (MIL-R-11)	1	
-7	RC20GF470F	. RESISTOR, FIXED, COMPOSITION, 47 ohms, 10%, 1/2 w. (MIL-R-11)	1	
-8	RC20GF471K	. RESISTOR, FIXED, COMPOSITION, 470 ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-9	RC20GF472K	. RESISTOR, FIXED, COMPOSITION, 4.7 K ohms, 10% . . . 1/2 w (MIL-R-11)	1	
-10	2420-502	. BOARD, Terminal, staked	1	

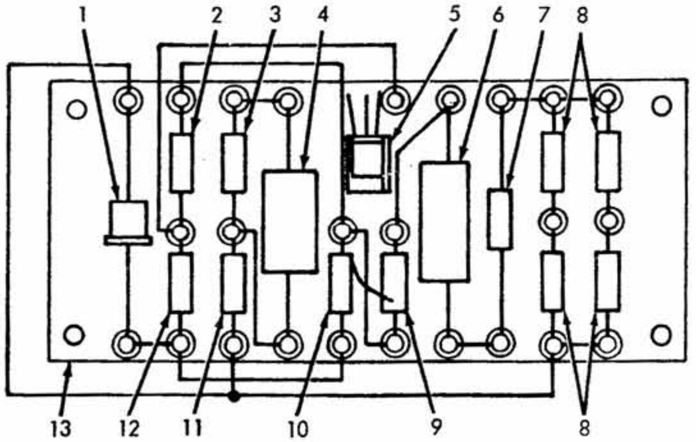

Figure 28. Terminal Board Assembly TB2

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB2		
28-	2420-506	TERMINAL BOARD ASSEMBLY (See item 15, figure 26. . . . for next higher assembly)	Ref	
-1	IN91	. SEMICONDUCTOR DEVICE, DIODE, Germanium (Mfd by . 03508)	1	
-2	RC20GF224K	. RESISTOR, FIXED, COMPOSITION, 220K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB2 (Cont)		
28-3	RC20GF102K	. RESISTOR, FIXED, COMPOSITION, 1 K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-4	NLW-30-25	. CAPACITOR, FIXED, ELECTROLYTIC, 30 uf, 25 v . . . (Mfd by 88419)	1	
-5	2N651A	. TRANSISTOR (Mfd by 04713)	1	
-6	CP05AIEE103K	. CAPACITOR, FIXED, PAPER, DIELECTRIC, 0.01 uf, . . 10%, 400 v	1	
-7	RC20GF913J	. RESISTOR, FIXED, COMPOSITION, 91 K ohms, 5%, 1/2 w (MIL-R-11)	1	
-8	JAN IN198	. SEMICONDUCTOR DEVICE, DIODE, Germanium	4	
-9	RC20GF103K	. RESISTOR, FIXED, COMPOSITION, 10 K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-10	RC20GF223K	. RESISTOR, FIXED, COMPOSITION, 22 K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-11	RC20GF150K	. RESISTOR, FIXED, COMPOSITION, 15 ohms, 10%, 1/2 w (MIL-R-11)	1	
-12	RC20GF103K	. RESISTOR, FIXED, COMPOSITION, 10 K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-13	2420-502	. BOARD, Terminal, staked	1	

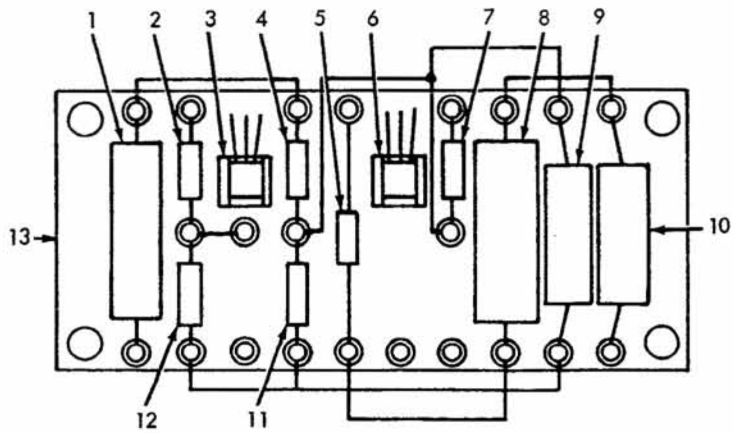

Figure 29. Terminal Board Assembly TB1

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB1		
29-	2420-505	TERMINAL BOARD ASSEMBLY (See item 18, figure 26 for . . next higher assembly)	Ref	
-1	CP05AIEB474K	. CAPACITOR, FIXED, PAPER DIELECTRIC, 0.47 uf, 10% 100 v (MIL-C-25)	1	
-2	RC20GF101K	. RESISTOR, FIXED, COMPOSITION, 100 ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-3	2N650A	. TRANSISTOR (Mfd by 04713)	1	
-4	RC20GF913J	. RESISTOR, FIXED, COMPOSITION, 91 K ohms, 5%. . . . 1/2 w (MIL-R-11)	1	

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB1 (Cont)		
29-5	RC20GF183K	. RESISTOR, FIXED, COMPOSITION, 18 K ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-6	2N651A	. TRANSISTOR (Mfd by 04713)	1	
-7	RC20GF680K	. RESISTOR, FIXED, COMPOSITION, 68 ohms, 10%, 1/2 w. (MIL-R-11)	1	
-8	CP05AIEB224K	. CAPACITOR, FIXED, PAPER DIELECTRIC, 0.22 uf, 10%, 100 v (MIL-C-25)	1	
-9	NLW25-25	. CAPACITOR, FIXED, ELECTROLYTIC, 25 uf, 25 v (Mfd . by 88419)	1	
-10	CP05AIEC473K	. CAPACITOR, FIXED, PAPER DIELECTRIC, 0.047 uf, 10%, 200 v (MIL-C-25)	1	
-11	RC20GF332K	. RESISTOR, FIXED, COMPOSITION, 3.3 K ohms, 10%,. . . 1/2 w (MIL-R-11)	1	
-12	RC20GF150K	. RESISTOR, FIXED, COMPOSITION, 15 ohms, 10%, ... 1/2 w (MIL-R-11)	1	
-13	2420-504	. BOARD, Terminal, staked	1	

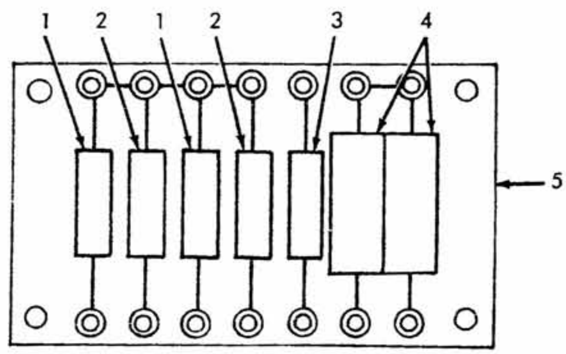

Figure 30. Terminal Board Assembly TB5

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB5		
30-	2420-509	TERMINAL BOARD ASSEMBLY (See item 31, figure 26 for . . next higher assembly)	Ref	
-1	RN70B1001F	. RESISTOR, FIXED, FILM, 1 K ohms, 1%, 1/2 w. . . . . . (MIL-R-10509)	2	
-2	RB55AE10R00F	. RESISTOR, FIXED, WIREWOUND, 10 ohms, 1%, 0.15 w . (MIL-R-93)	2	
-3	RN70B49R9F	. RESISTOR, FIXED, FILM, 49.9 ohms, 1%, 1/2 w . . . . . (MIL-R-10509)	1	
-4	TE1162	. CAPACITOR, FIXED ELECTROLYTIC, 100 uf, 15 w. . . . (Mfd by 89307)	2	
-5	2420-501	. BOARD, TERMINAL, Staked	1	

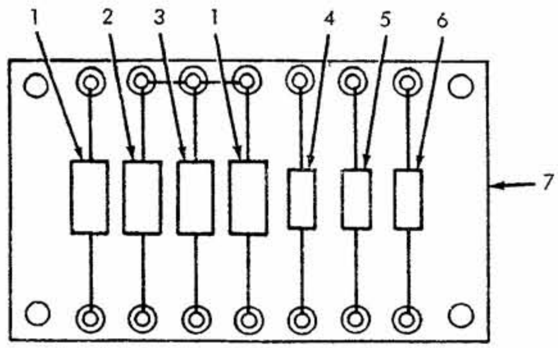

Figure 31. Terminal Board Assembly TB4

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB4		
31-	2420-508	TERMINAL BOARD ASSEMBLY (See item 34, figure 26 for . . next higher assembly)	Ref	
-1	RB55AEIR000F	. RESISTOR, FIXED, WIREWOUND, 1 ohm, 1%, 0.15 w . . (MIL-R-93)	2	
-2	RB55AE105R3F	. RESISTOR, FIXED, WIREWOUND, 105.3 ohms, 1%, ... 0.15 w (MIL-R-93)	1	
-3	RB55AE10R05F	. RESISTOR, FIXED, WIREWOUND, 10.05 ohms, 1%, ... 0.15 w (MIL-R-93)	1	
-4	RC20GF332K	. RESISTOR, FIXED, COMPOSITION, 3.3 K ohms, 10% . . . 1/2 w (MIL-R-11)	1	
-5	RC20GF471K	. RESISTOR, FIXED, COMPOSITION, 470 ohms, 10%, . . . 1/2 w (MIL-R-11)	1	
-6	RC20GF472K	. RESISTOR, FIXED, COMPOSITION, 4.7 K ohms, 10% . . . 1/2 w (MIL-R-11)	1	
-7	2420-501	. BOARD, Terminal, staked	1	
		TERMINAL BOARD ASSEMBLY TB3		
32-	2420-507	TERMINAL BOARD ASSEMBLY (See item 36, figure 26 for . next higher assembly)	Ref	
-1	2660-907	. BRACKET, Terminal board	1	
-2	MQZFP.5-1M-10	. CAPACITOR, FIXED, PAPER DIELECTRIC, 1 uf, 10%, . . 50 v dc (Mfd by 82376)	1	
-3	RC20GF392K	. RESISTOR, FIXED, COMPOSITION, 3.9 K ohm, 10%, . . . 1/2 w (MIL-R-11)	1	
-4	2N651A	. TRANSISTOR (Mfd by 04713)	2	
-5	RC20GF103K	. RESISTOR, FIXED, COMPOSITION, 10 K ohms, 10%, . . . 1/2 w (MIL-R-11)	2	

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		TERMINAL BOARD ASSEMBLY TB3 (Cont)		
32-6	CP05AIEB224K	. CAPACITOR, FIXED, PAPER DIELECTRIC, 0.22 uf, 10%, 100 v (MIL-C-25)	1	
-7	MQZFP.5-2M-10	. CAPACITOR, FIXED, PAPER DIELECTRIC, 2 uf, 10% 50 v dc (Mfd by 82376)	1	
-8	CP05AIEB104K	. CAPACITOR, FIXED, PAPER DIELECTRIC, 0.1 uf, 10% 100 v (MIL-C-25)	1	
-9	TF4RX13YY, DO-T11	. TRANSFORMER, Driver (Mfd by 89665)	1	
-10	RC20GF393K	. RESISTOR, FIXED, COMPOSITION, 39 K ohms, 10%, 1/2 w (MIL-R-11)	1	
-11	RC20GF101K	. RESISTOR, FIXED, COMPOSITION, 100 ohms, 10%, 1/2 w (MIL-R-11)	1	
-12	RC20GF183K	. RESISTOR, FIXED, COMPOSITION, 18 K ohms, 10%, 1/2 w (MIL-R-11)	1	
-13	RC20GF221K	. RESISTOR, FIXED, COMPOSITION, 220 ohms, 10%, 1/2 w (MIL-R-11)	1	
-14	2420-503	. BOARD, Terminal, staked	1	

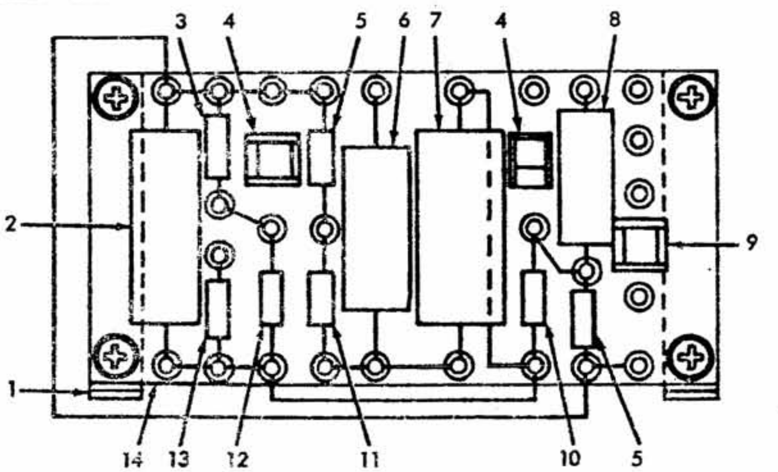

Figure 32. Terminal Board Assembly TB3

FIG. & INDEX NO.	PARTS NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY PER ASSY	USABLE ON CODE
		PORTABLE CASE ASSEMBLY		
33-	3145-560	CASE ASSEMBLY, Portable (See figure 25 for next higher assembly)	Ref	
-1	No Number	. CASE, Portable, cover	1	
-2	No Number	. CASE, Portable, bottom	1	
-3	8825-138	. HOLDER, Battery	1	
-4	763	. BATTERY, 22.5 v (Mfd by 83740)	1	
-5	3030-60	. ELECTRICAL CABLE ASSEMBLY	1	
-6	M1-14F	. . CONNECTOR, RECEPTACLE, ELECTRICAL (Mfd by 97954)	1	
-7	2106-08-00	. . LUG, Terminal (Mfd by 78189)	9	
-8	8825-141	. HOLDER, Battery	1	
-9	2370	. BATTERY, 4.5 v (Mfd by 80095)	2	

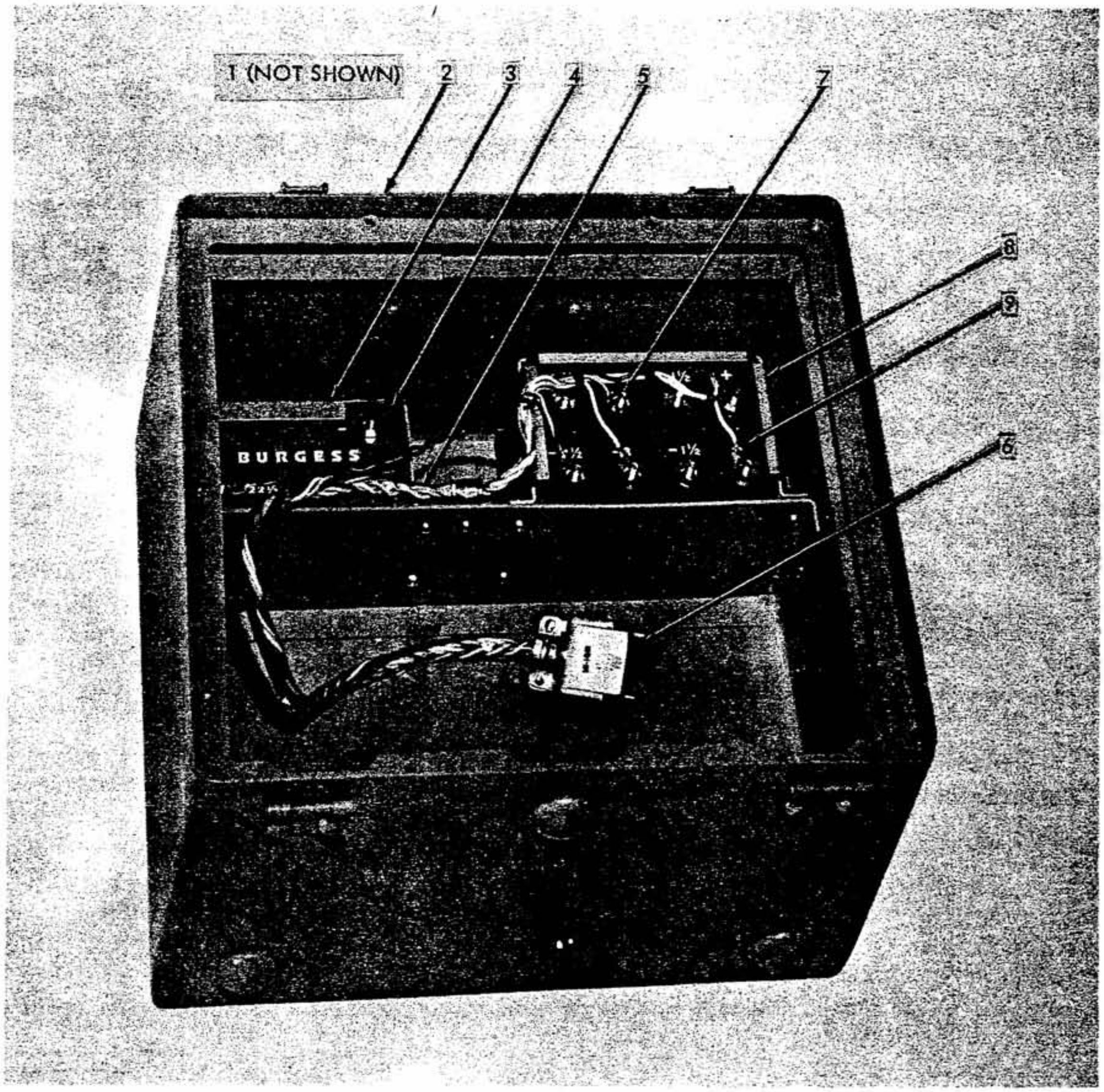

Figure 33. Portable Case Assembly

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