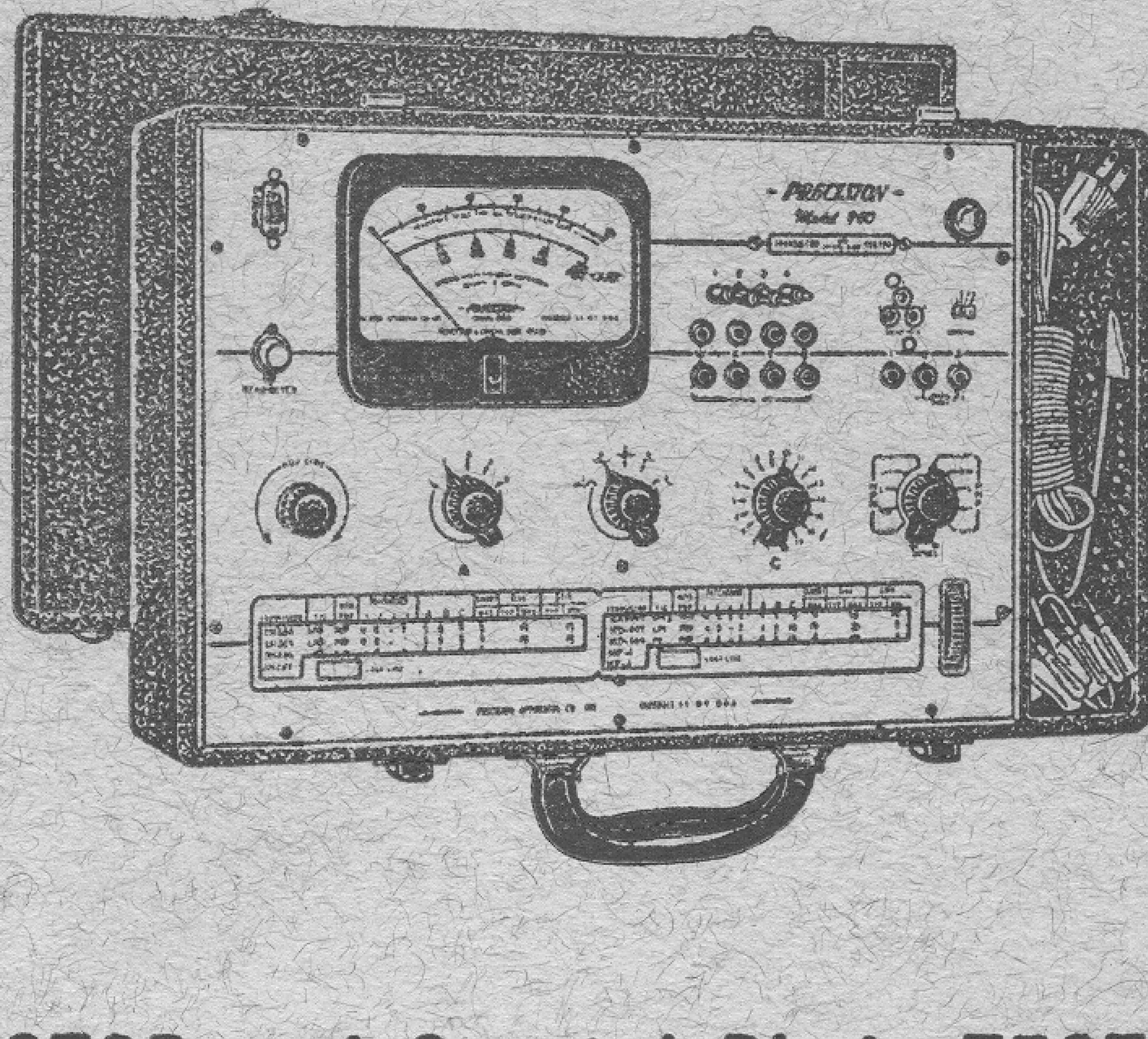
OPERATING INSTRUCTIONS FOR

PRECISION



MODEL 960

TRANSISTOR and Crystal Diode TESTER

PRECISION
TEST EQUIPMENT
Standard of Accuracy

PRECISION APPARATUS COMPANY, INC.

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

EXPORT DIVISION: 458 BROADWAY, NEW YORK CITY, U.S.A. CABLES: MORHANEX

CANADIAN SALES DIVISION: ATLAS RADIO CORP., LTD., 560 KING STREET W., TORONTO 28, ONTARIO

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MODEL 960

The Model 960 Semiconductor Tester, intended for Laboratory and Service applications, is specifically engineered to comprehensively test Low Power, Medium Power and Power Transistors. In addition, Model 960 includes flexible facilities for testing crystal diodes in direct comparison with diode manufacturers' specifications.

The Model 960 sequentially examines transistors for the following characteristics:-

1. Collector to Emitter and/or Base shorts.
2. Direct and comparative Icbo, in terms of Collector Current.
3. "Leakage" check (to be used for obtaining maximum accuracy in Transistor gain readings).
4. Direct reading Beta measurements (Gain).

EXPANSION OF 960 FEATURES:-

1. 17 DC Collector voltages are available for test of Icbo to insure most accurate comparison with manufacturers' specifications. Five meter ranges from 100 microamperes full scale to 50 milliamperes full scale insure complete coverage for all types of transistors.

2. Direct reading Beta (Gain) is covered in two ranges, 0-100 and 0-500. Five individual values of Base Current Injection are provided. This eliminates all possibilities of obsolescence due to the development of new transistors which may locate between the existing three classes (Low Power, Medium Power and Power types). The roller chart test data for transistors automatically provides a specific value of Base Current Injection for Gain tests when testing transistors.

   In the case of Power Transistors, the Base Injection Current has been selected to insure sufficiently heavy Collector currents so that these Power Transistors will be tested in the relatively flat region of the Gain-versus-Collector-Current characteristic. This latter feature is quite important inasmuch as a test of good Power Transistors at low Collector currents can yield erroneous gain measurements.

3. Transistor socket terminations are distributed to the 960 test circuits through a master patchcord distribution system. In addition, dual panel jacks for each patchcord permits paralleling of individual circuits for special test purposes. This patchcord system insures utmost flexibility for accommodation of future transistor releases.

4. A universal flexible-lead adapter cable is supplied with your Model 960 to permit connection to unusual types which are not adaptable to standard sockets. This cable also permits connection of new types of transistors yet to be released which may not mate with panel sockets.

5. All crystal diodes are checked for reverse current directly in accordance with the diode manufacturers' data. The test limits for Forward Current have been correlated against manufacturers' limits and are specifically listed on the diode data sheet accompanying your Model 960.

6. All transistor test data is completely listed on the 960 Roller Chart. Specific Short, Icbo and Gain figures are listed for each transistor type. In those cases where specific limits are available from the transistor manufacturer, they are listed under the "Max" or "Min" column on the roller chart. In those cases, where the manufacturer has not yet set a specific field reject limit, "Typ" values for Icbo and Gain are listed for guidance.

7. All test potentials are compensated for variations in line voltage by means of a heavy duty continuously variable panel mounted line voltage control.

8. IMPORTANT. All roller chart data is related directly to the top 0-100 linear meter scale. For rapid checking of transistors, therefore, Icbo readings on this scale (except for "B" switch position 1)

will be relative readings. If the operator so chooses, he may quickly and conveniently determine the Icbo current in terms of microamperes or milliamperes by reading the lower triple numbered meter scale which bears direct reference to the Icbo range as indicated by the range identification on the 960 "B" Selector Switch. This special facility has been included to combine rapidity of test for quantity testing of transistors with the accuracy required in analysis of individual transistor types.

9. LARGE, EASY-TO-READ, rugged, double-jeweled "PACE" Meter, accurately balanced and factory-calibrated to within 2%. 100 microamperes full scale sensitivity.

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

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

12. TEST CIRCUITS COMPLETELY TRANSFORMER ISOLATED FROM POWER LINE.

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DESCRIPTION OF PANEL CONTROLS AND SWITCHES

1. "Adj Line" Control compensates for varying line voltage conditions.

2. Switch "A" is the Base Current Injection Selector (for Gain tests) for all classes of transistors.

Position 1 . . .	50 Microamperes	Injection	(Low Power types)
Position 2 . . .	200 "	"	(Medium Power and miscellaneous types)
Position 3 . . .	500 "	"	(" " " " ")
Position 4 . . .	2 Milliamperes	"	(" " " " ")
Position 5 . . .	5 "	"	(Power types)

3. Switch "B" is the Meter Sensitivity Selector with full scale ranges indicated for direct reading of Icbo ranges for all classes of transistors.

4. Switch "C" is the Collector Voltage Selector for Icbo readings. It provides 17 predetermined values of Collector voltage from .5 volts DC to 100 volts DC.

5. The Right Hand Function Selector Switch provides sequential test positions for Short, Icbo, Leakage and Gain for both NPN and PNP types. Two Gain ranges are selectable through use of this switch: the Gx1 position provides direct Gain readings from 0-100, the Gx5 position gives direct Gain readings from 0-500.

6. Power Transistors of "Top Hat" type can be inserted into Socket #1; the black miniature alligator lead emerging from the tool compartment will be used to connect to the shell of this type of transistor. Transistors with heavy solid leads can also be inserted into Socket #1.

7. Miniature transistors with 3 or 4 pin in line leads can be inserted into Socket #2. Transistors whose leads are not in line, can also be inserted into Socket #2, provided the leads are thin and long enough to be flexible.

8. All miscellaneous types not adaptable to either one of these two sockets, will be connected through use of the cable adapter provided with your 960.

9. All Crystal Diodes are to be tested using Pin Jacks #2 and #3 with polarity as indicated.

10. The Patchcord Plugs are inserted into Jacks "W", "X", "Y" and "Z", in accordance with the roller chart data for transistors. The patchcord plug numbers relate directly to the socket numbering as indicated on Socket #1, #2, and the three panel pin jacks. (For example, if Plugs #2 and #3 are plugged into the two jacks labeled "X", then Transistor Terminals 2 and 3 will be connected together into the circuit indicated by Jack "X"). For all crystal diodes, Plug #2 is inserted into "X" and Plug #3 into "Z". Plugs 1 and 4 may be left disconnected or plugged into any jack as desired.

TRANSISTOR TESTING

In order to more clearly acquaint the technician with the function of the Model 960 Transistor Tester, it may be helpful to review a few of the more pertinent characteristics of transistors and their relation to the operating equipment. The scope of this Instruction Manual prohibits a complete discussion of the principles of transistors. It must be assumed that the technician has familiarized himself with these basic principles through a study of technical literature such as listed in the bibliography on the last page of this Instruction Manual.

Because of the relative newness of the transistor field itself, a variety of test procedures and limits have thus far been advanced for field checking of transistors. One parameter however has been found to be superior to most others in the determination of transistor quality. This parameter labeled "Icbo" (to be discussed further on in this Instruction Manual) is a reliable indication of the original quality of the transistor in the manufacturing process and can be successfully used as a yardstick for determining deterioration of the transistor after it has been installed and used in commercial equipment. The reading to be taken on an "Icbo" test is usually in the order of microamperes and therefore requires a sensitive indicator in the test instrument. Many inexpensive types of commercial transistor testers have been designed away from this important "Icbo" test because of this meter sensitivity problem and, as a result, rely upon other less revealing characteristics to determine transistor condition. The Model 960, therefore, is one of the few service type instruments which can be used in direct comparison with laboratory type transistor test equipment.

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

1. Icbo - This symbol indicates the current flowing between the Collector and Base with the Emitter open. See Fig. 2, second illustration. It will be noticed therefore that the first two symbols after the "I" indicate the circuit in which the current is to be measured: the symbol missing in this particular example is the "E" (Emitter). The "O" at the end of the symbol indicates that the missing symbol ("E" in this case) is open-circuited for this particular type of test. In other words, if we had a case where the test required a measurement of current flowing between the Emitter and the Base, with the Collector open, the symbol would read "Iebo". In fact, "Iebo" is a characteristic used by the transistor manufacturer for some types of tests. (See "Special Tests for Transistors", page 9).

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

3. Beta - "Beta" is the description for Current Gain and is analogous to amplification factor in a receiving tube. Specifically it is defined as the Current Gain from Collector to Base with the output shorted and with a constant DC collector voltage. Beta can refer to either AC or DC Current Gain. A pulsating DC signal is used in the Model 960. In the Model 960, Beta or Gain is indicated by first observing a reading of Emitter to Collector Current with Base open; then obtaining a second reading with a predetermined value of current injected into the Base to produce an increased Collector Current reading. The increase in Collector Current will be an indication of the Gain or Beta of the transistor. Extensive tests have yielded results which show close correlation between AC and DC Beta readings under these conditions.

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

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The schematic representation of a transistor is illustrated in Fig. 1, Page 4 . Figure 1 shows the relationship between the schematic representation and actual physical structure of the transistor. The two indium pellets which constitute the Emitter and Collector terminations of the transistor are spaced quite

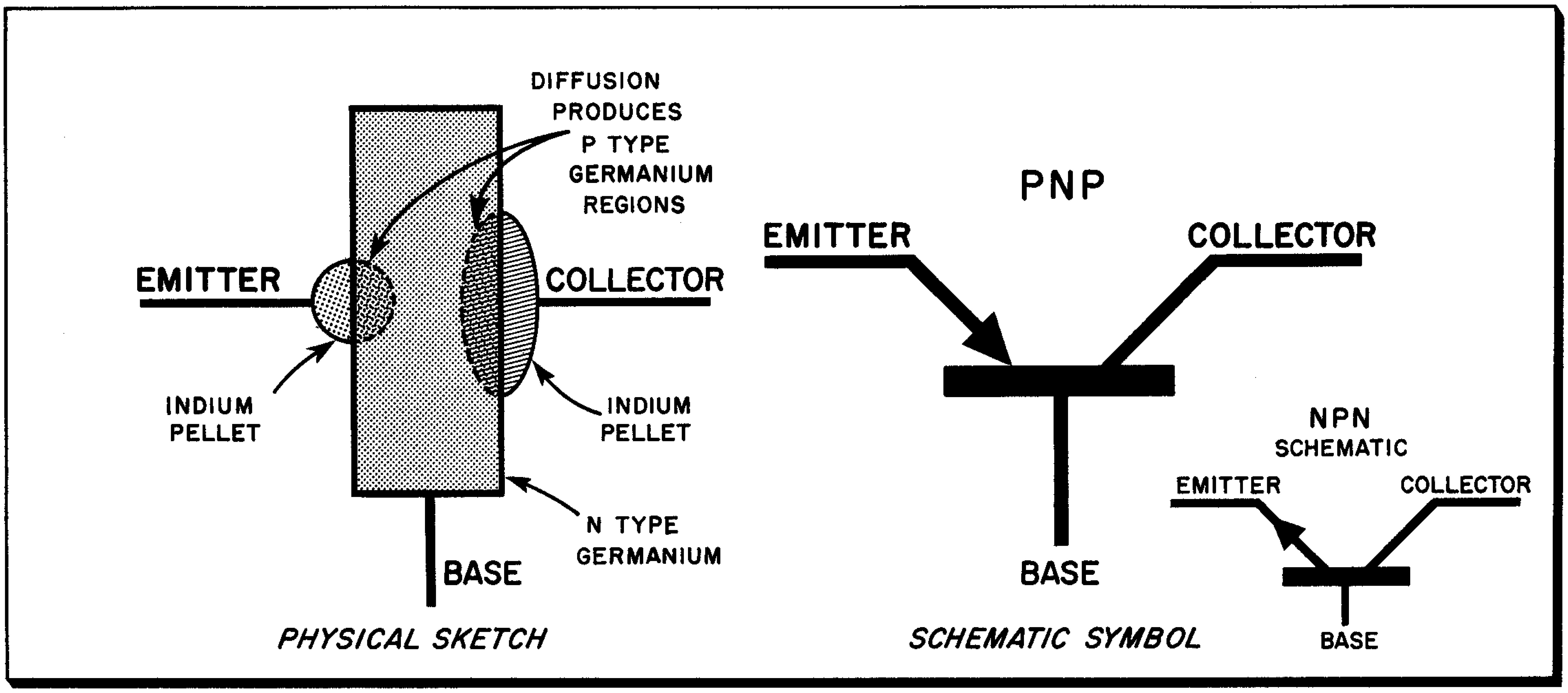


FIG. 1 DIFFUSED JUNCTION PNP TRANSISTOR

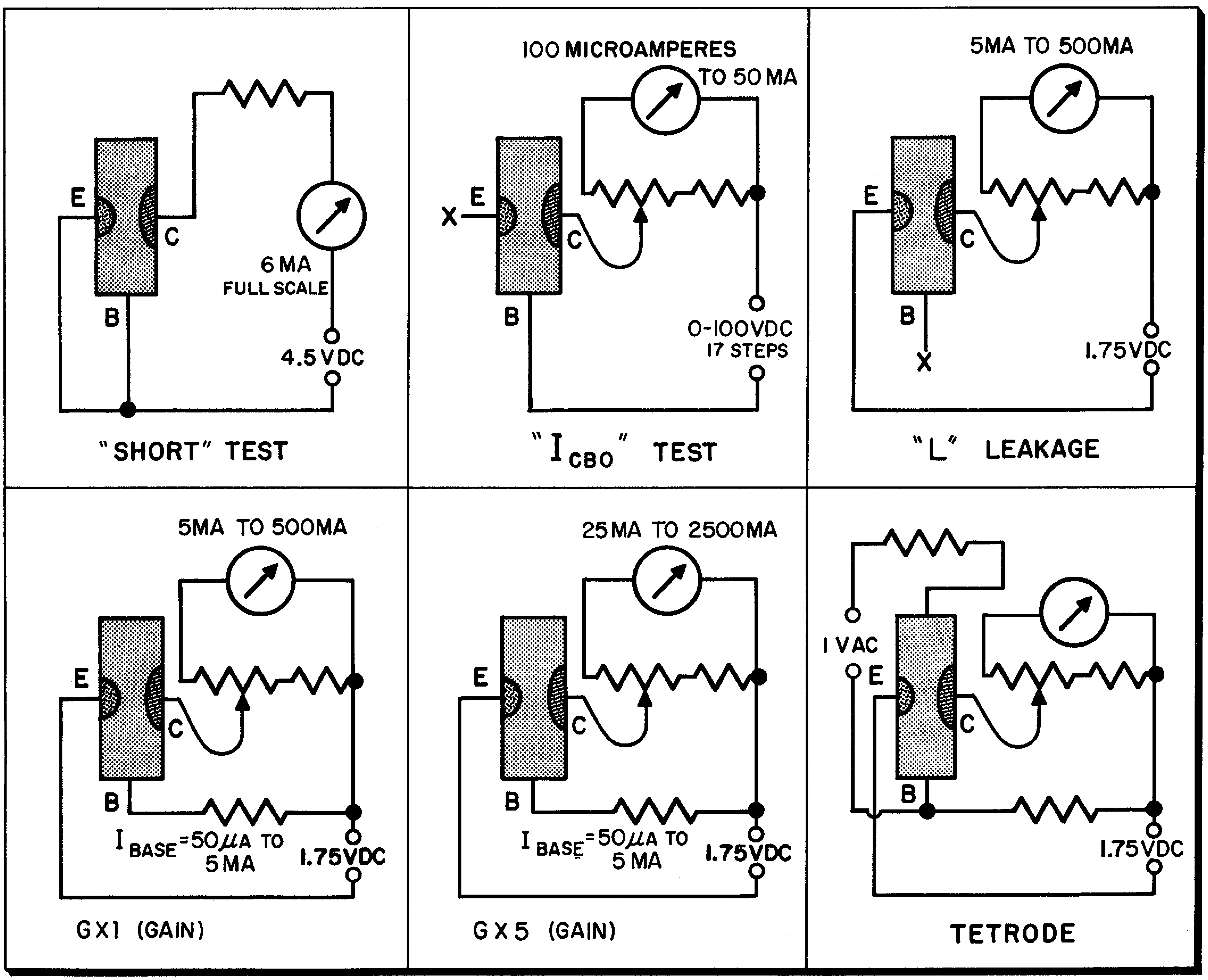


FIG. 2 BASIC CIRCUITS • 960 TRANSISTOR TESTS

closely to each other and create diffused regions, separated only by an extremely thin wall of crystal material. It becomes obvious therefore that shorts may occur between Emitter and Collector: the "Short" position of the transistor test facilities of the Model 960 is therefore the first important test. See Fig. 2, "Short Test". A shorted or low resistance transistor should be rejected without further testing, since damage to the meter can result should the next sequence of tests be attempted.

As noted previously, Icbo (Collector Cut-off Current), which is measured per Fig. 2, second illustration, is the basic transistor test parameter, and is the second test performed on all transistors by the 960.

The third transistor test is designated as "L" or Leakage. The basic circuit for this Leakage test is indicated in Fig. 2, third illustration, and provides a meter reading which is essentially the Icbo of the transistor multiplied by the Beta (Gain). Test position "L" on the right-hand Function Selector Switch of the 960 sets up the instrument for this Leakage test. This Leakage test in itself is of no special significance insofar as the condition of the transistor is concerned. IT MERELY SERVES AS AN INITIAL READING TO BE SUBTRACTED FROM THE NEXT TEST WHICH IS DESIGNATED ON THE PANEL AS "Gx1" FOR "GAIN". SEE FIG. 2, FOURTH ILLUSTRATION.

The Beta or Gain of a transistor is simply determined on the 960 by subtraction of the "L" reading from the "G" reading to yield an actual Gain number.

It is interesting to note that in the case of a transistor where the Icbo is normal (a low value) and the Beta is also normal, the Leakage reading will be quite small and, in many cases, negligible. For example, if a transistor has a Gain (Beta) of 50 and the Icbo is inherently quite low, multiplication of a very low Icbo times Beta of 50 will yield a very small Leakage number as compared to the second reading (Gain) and could almost be ignored. On the other hand, if the Icbo is quite high, the Leakage reading will become significant and should not be ignored in obtaining the Gain reading.

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

ONE MAJOR DIFFERENCE BETWEEN RECEIVING TUBE TESTING AND TRANSISTOR TESTING LIES IN THE FACT THAT TRANSISTORS ARE QUITE TEMPERATURE SENSITIVE. A test performed upon a transistor at normal room temperature (approximately 70° Fahrenheit) may yield noticeably different results as compared to the same test performed in direct sunlight, for example at 95° Fahrenheit, or in a cold room at 40 to 50° Fahrenheit. The operator must therefore bear in mind that any unusual results obtained when testing transistors at temperatures which vary considerably from 70° Fahrenheit must be verified by repeating the test at room temperature. Sensitivity to temperature is such that different readings can be obtained if the operator holds the transistor in his fingertips while performing the test as compared to a test where the hand is removed from the transistor. These precautions regarding temperature are most important when questionable current readings are obtained during transistor tests. The limits on transistor tests in many cases are critical enough to result in rejection of a good transistor simply because this temperature factor was not observed.

Transistors are classified as PNP or NPN type. The only difference, so far as testing of the transistor is concerned, between these two classes is the polarity of the applied test voltage and of the metering circuit. In other words, all tests on a PNP transistor are the same as would be performed on the NPN with the exception that the right-hand Function Selector Switch of the Model 960 applies test voltages of the correct polarity to the transistor. A PNP transistor will have a negative potential applied to its Collector: a NPN transistor will have a positive potential applied to its Collector.

The above basic principles of transistor testing apply to Low Power, Medium Power and Power types of transistors. The major difference between the operation and test of Power types as compared to the Medium and Low Power types is in the heavier current capabilities of the Power Transistor.

CRYSTAL DIODE TESTS

Crystal Diodes are an important factor in modern TV and communication circuits. The most reliable accepted test for Crystal Diodes is a comparison with manufacturers' specifications on the basis of forward and reverse current at specified test voltages. The usual forward and reverse resistance check (using ohmmeter type circuits) are useful only in those cases where relatively large deterioration of the crystal has occurred. In the case of your Model 960, the forward and reverse current characteristics of the crystal can be correlated with manufacturers' specifications. The wide variety of DC test potentials available in the Model 960 (0 to 100V DC) in 17 steps assures availability of test voltages exactly equal or closely similar to manufacturers' test voltages for reverse current.

* * * * * * * * *

OPERATING INSTRUCTIONS FOR TRANSISTOR TESTS

A duplicate set of transistor basing illustrations, Pages 14 and 15, have been slipped into this manual for your convenience. These extra sheets may either be attached to the inside cover of your Model 960 or to a convenient area above the work bench to facilitate reference to transistor basing identification.

ALL TEST READINGS ARE ACCURATE ONLY WHEN THE SURROUNDING TEMPERATURE IS IN THE REGION OF 70° FAHRENHEIT.

NOTE: It is important that the meter be checked for an accurate mechanical zero adjustment. To do this, set the instrument in the position in which it will be used (horizontal, vertical, or at an angle). With the Power off, rotate the meter's bakelite zero adjuster with the proper sized screw driver till the meter pointer is aligned with the "O" calibration on the 0-100 meter scale.

Step 1. From the roller chart data supplied with your Model 960, set the patchcord plugs into the "W", "X", "Y" and "Z" jacks as indicated.

Step 2. Set Switches "A", "B" and "C" in accordance with the data.

Step 3. From the data, determine whether the transistor is "PNP" or "NPN" type and set the "NPN" - "PNP" right hand Selector Switch to "Short" position accordingly.

Step 4. Throw the "Power" Slide Switch to "ON" and set the "Adj Line" Control so that the meter pointer lines up with the "Adj Line" meter calibrations.

Step 5. Plug the transistor into the appropriate socket, or use the Adapter Cable if the transistor type cannot be accommodated by either Socket #1 or Socket #2. Note the polarization and identification of the transistor leads as shown on Page 14 or 15. If the transistor to be tested has four terminals and cannot be accommodated by Socket #2, you will use the Adapter Cable and the Alligator Lead emerging from the tool compartment. Figures 3 and 4 are examples of typical transistor connections.

Step 6. Depress the "Read Meter" Button and read the upper 0-100 Transistor Scale for Short Test as listed under "SHORT" on the roller chart. A good transistor will read lower than the "Max" value listed on the roller chart. (A full scale reading indicates a direct short). If the transistor does not pass the "Short Test", no further tests should be performed inasmuch as a shorted transistor can cause excessive Meter current to flow in subsequent tests.

Step 7. Rotate the Function Selector Switch to "Icbo," depress the "Read Meter" Button and read the comparative Icbo on the top "0-100" scale in accordance with the roller chart data. Icbo for GOOD transistors will read anywhere between Zero and the "Max" reading listed on the roller chart. If a "TYP" reading is indicated on the roller chart, its value does not represent a maximum limit: it does represent a TYPICAL value for the transistor and is listed in this fashion because absolute field limits are not yet available from the manufacturer.

NOTE 1: In some cases, the Icbo reading may increase as the "Read Meter" Button is held down. If the Icbo reading doubles in a period of 10 seconds, the transistor should be rejected. However, if the Icbo reading is within limits and goes down within a lapse of time, it is of course good.

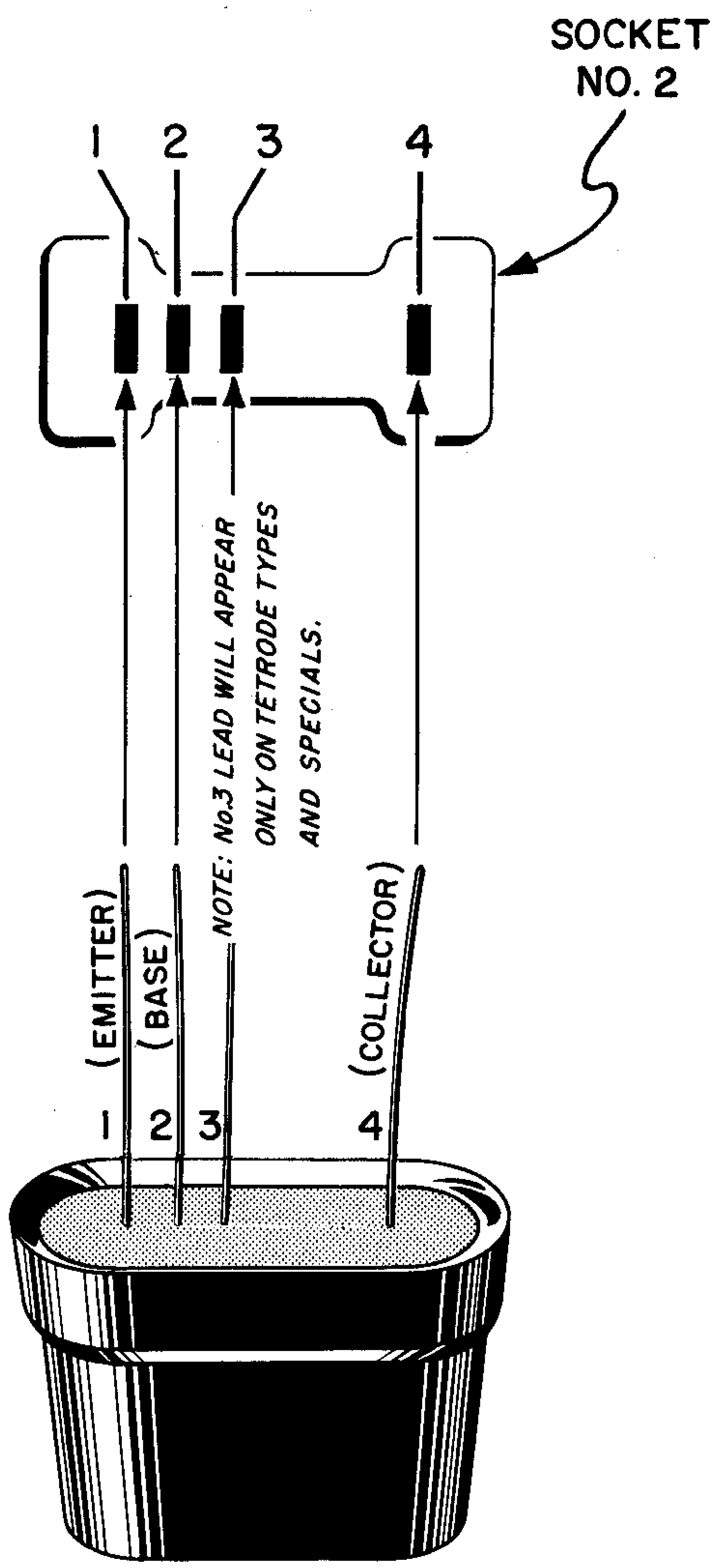


FIG. 3 PLUG-IN TYPE
LOW POWER TRANSISTOR

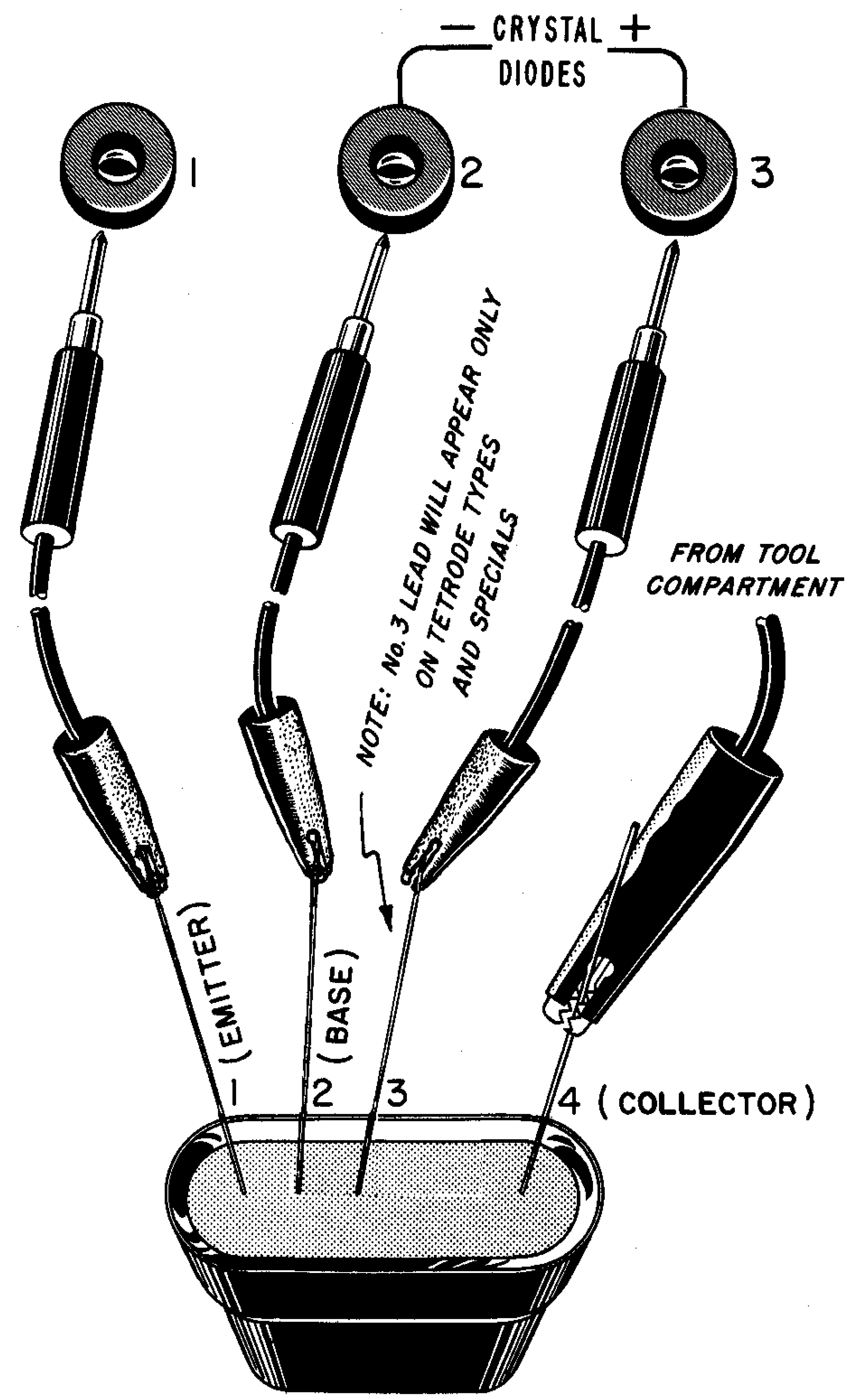


FIG. 4 INTERCONNECTION OF LOW POWER TRANSISTOR TO PANEL JACKS, USING ADAPTER CABLE.

"TOP HAT" TYPE TRANSISTOR

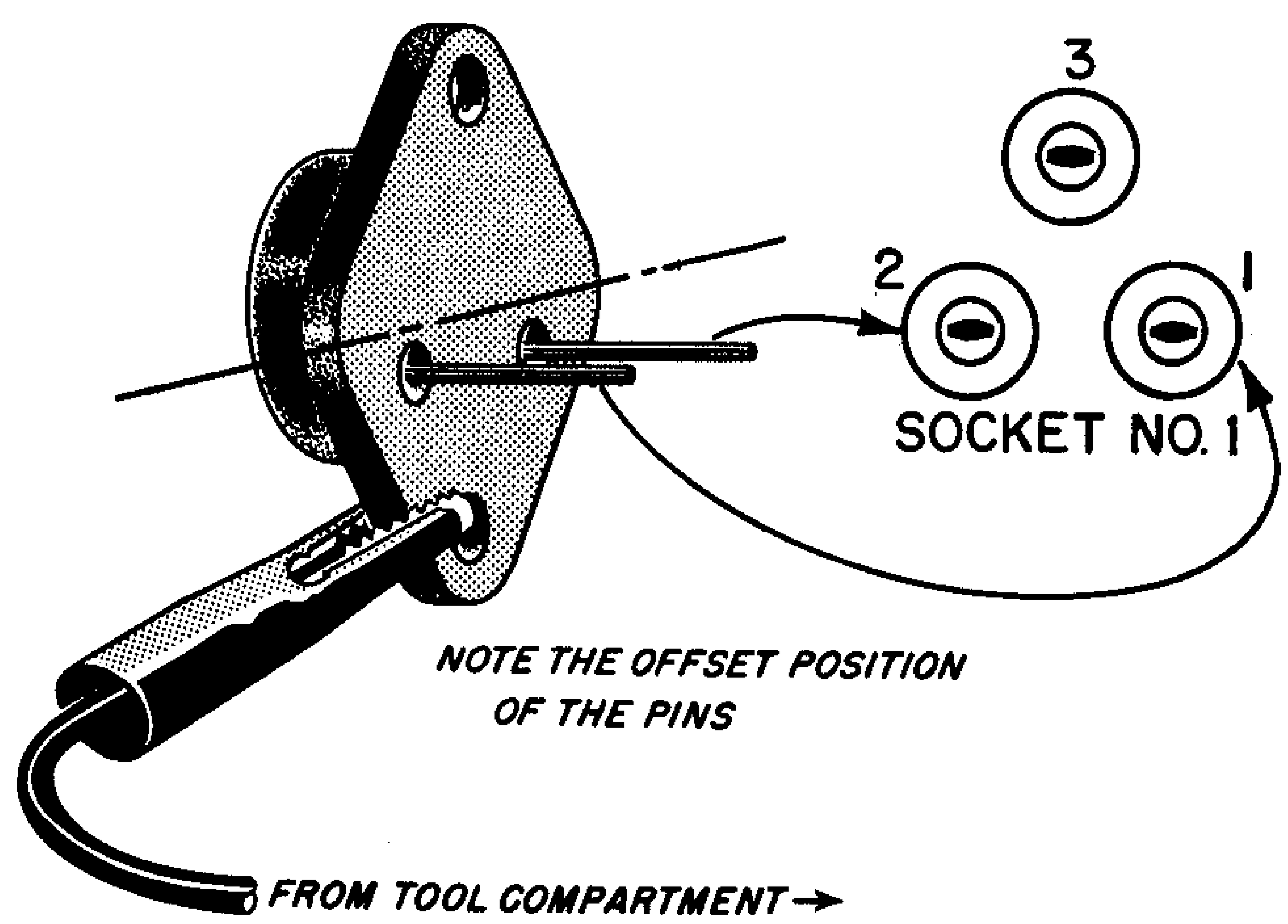


FIG. 5

CYLINDRICAL TYPE TRANSISTOR

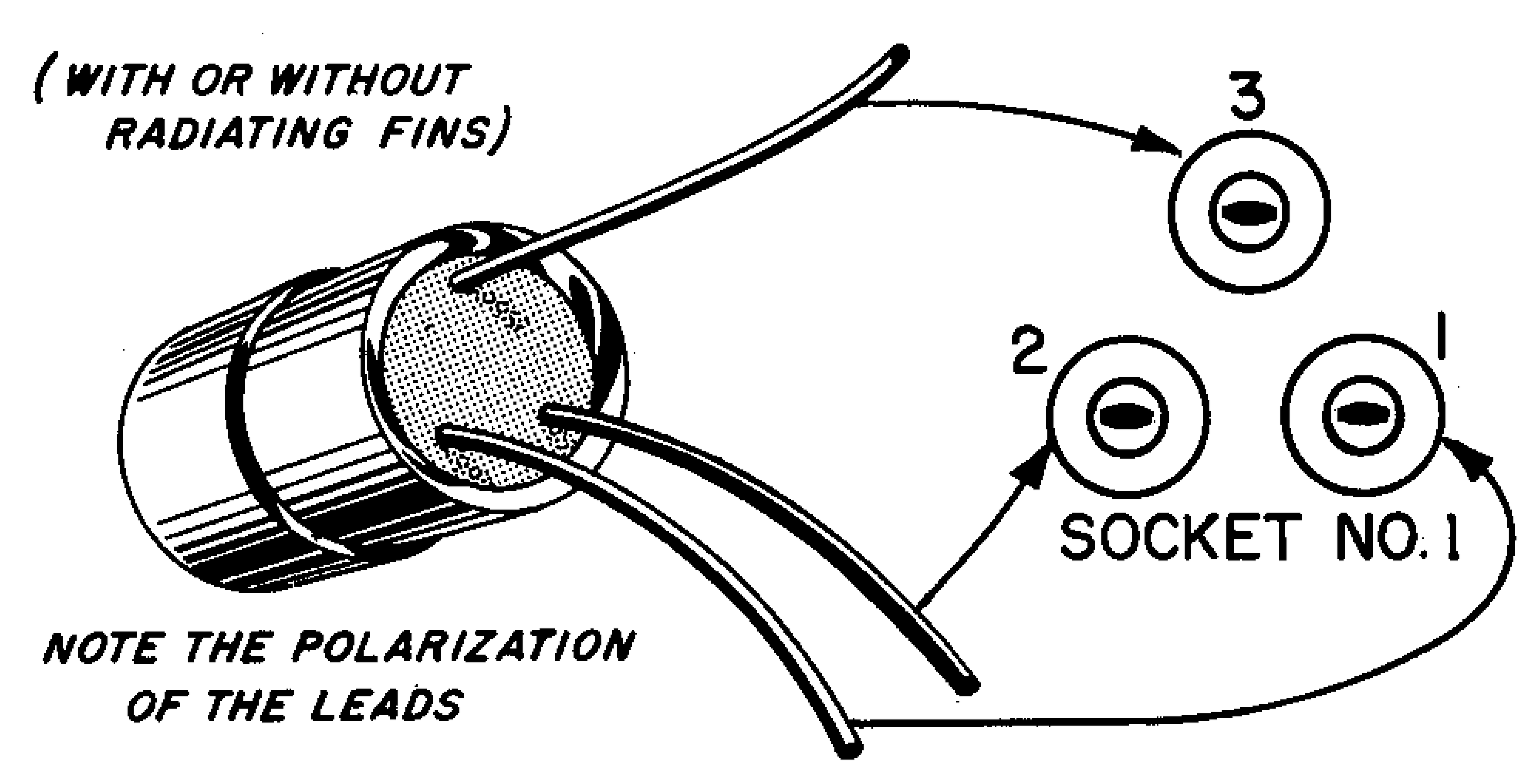


FIG. 6

NOTE 2: Icbo readings are particularly sensitive to temperature variations. Many manufacturers note that Icbo will double for a 10°C. (18°F.) rise in temperature. Since all Icbo limits listed on the roll chart are based on tests at 70° F., the room temperature must be taken into consideration in evaluating Icbo test results.

NOTE 3: Readings taken on the "0-100" top scale of the meter may, in some cases, be arbitrary readings set up for maximum speed in testing. If the operator wishes to obtain an actual Icbo reading in direct terms of microamperes or milliamperes of Collector current, he may first refer to the setting of the "B" Switch which indicates the full scale Icbo range for which the 960 has been set up. If, for example, the "B" Switch had been set to Position #2 (500 microamperes) then the meter will be indicating a range of 0-500 microamperes. The operator then will read the special lower scale on the meter for this 0-500 microamperes range. The same procedure applies to all other "B" Switch settings, ie: the "B" Switch setting indicates the range to be read on the special lower scale of the 960 meter. The lower scale is direct reading for the first three "B" Switch ranges (100 microamperes, 500 microamperes and 2500 microamperes). For Position #4 of the "B" Switch (10 milliamperes range) read the 0-100 arc of the special scale as 0-10ma. For Position #5 of the "B" Switch (50 milliamperes range) read the 0-500 arc of the special scale as 0-50ma.

Step 8. Rotate the Function Selector Switch to "L" (Leakage). Depress the "Read Meter" Button and read the top "0-100" scale and make a note of the reading. This "L" or Leakage reading is to be arithmetically subtracted from the forthcoming Gain (Gx1 or Gx5) reading to yield a final accurate Gain value. This is the only significant use for the "L" reading. It is not to be used as a direct indication of a transistor characteristic.

Step 9. Rotate the Function Selector Switch to either the "Gx1" or the "Gx5" position as indicated on the roll chart and press the "Read Meter" Button. If the "Gx1" position was used, Gain will be read directly on the top "0-100" scale. If the "Gx5" position was used, the operator will read the top "0-100" scale and multiply his reading by five.

NOTE: Due to wide variations in Gain for some transistor types, the meter may go above 100 in some isolated cases where the "Gx1" position is specified. This indicates a high Gain transistor. Should the operator desire, he may then use the "Gx5" position to obtain the actual Gain figure. Conversely, if reading is below 20 on the "0-100" scale when using the "Gx5" position, the operator may then use the "Gx1" position, if he wishes.

Step 10. The operator will subtract the "L" or Leakage reading obtained in Step 8 from the Gain reading. The net result is the Gain of the transistor.

NOTE: Do not keep the "Read Meter" Button depressed any longer than necessary to take a reading in either the "Gx1" or "Gx5" positions. Most transistors will increase in reading if the button is held down, due to the heating of the Collector Junction. However, the initial reading is the correct one to use.

Step 11. If the transistor has a tetrode connection, proceed as follows:-

After the Gain test (Gx1 or Gx5) has been completed, pull out the patchcord plug indicated on the roll chart and plug into "Y" jack. Then press the "Read Meter" Button and watch for a reading LOWER than the "Gx1" or "Gx5" reading. If the reading does not differ from the "Gx1" or "Gx5" reading, then the condition of the tetrode connection of the transistor is to be questioned.

* * * * * * *

PRECAUTIONARY NOTES:-

1. Always check the patchcord insertions before going on with the setting of the "A", "B" and "C" control. The patchcord setup may be the same for a great variety of transistors. However, these positions do change for a reasonable number of types of transistors.

2. Always perform the "Short" test before going on to "Icbo" or "Gain". If the "Short" test is bypassed, a shorted transistor can cause damage to the meter in subsequent tests.

SPECIAL TESTS FOR TRANSISTORS

Transistor manufacturers sometimes list additional tests on their data sheets for a transistor type and recommend that these parameters be checked when the transistor is used in certain applications. The versatility of the Model 960 system of testing and multiple voltages available enables the user to perform these special tests as is indicated below. Note that these tests are mainly SUPPLEMENTARY tests for those interested in examining further characteristics of a transistor. IF THE TRANSISTOR CHECKS GOOD ON SHORT, Icbo AND GAIN, IT IS UNLIKELY THAT OTHER PARAMETERS WILL GO OUT OF SPECIFICATION IN A JUNCTION TYPE TRANSISTOR.

A. Iebo Test (sometimes listed as Ieo)

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

The procedure for making the Iebo test in the Model 960 is as follows:-

1. Set the Function Selector Switch to the "Icbo" position (NPN for NPN type transistor, PNP for PNP type transistor).
2. Remove all patchcord plugs from the "W", "X", "Y" and "Z" jacks.
3. Insert transistor into socket or connect to adapter cable as shown in appropriate figure on Page 14 or 15.
4. Insert patchcord plug #2 (corresponding to the transistor base) into the "X" jack.
5. Insert patchcord plug #1 (corresponding to transistor emitter connection) into the "Z" jack.
6. The remaining plugs should be inserted into the "W" jack or left unconnected, as desired.
7. The transistor manufacturers' data will list a specific test voltage for the "Iebo" test. This voltage can be closely duplicated in the Model 960 by setting the "C" Switch to the value indicated in the table below. The meter sensitivity for the "Iebo" test can be directly selected through use of the 960 "B" Switch.

"C" Switch Position	DC Volts For Icbo Position
1	.5V
2	1.5V
3	2.3V
4	3V
5	4.5V
6	6V
7	9V
8	12V
9	15V

"C" Switch Position	DC Volts For Icbo Position
10	20V
11	25V
12	30V
13	40V
14	50V
15	60V
16	80V
17	100V

For example: The manufacturer's specifications for a transistor state that Iebo at Ve (Emitter Voltage) of 12V shall be no more than 5 microamperes. The Model 960 "C" Switch would then be set at 8 and the "B" Switch would be set to Position #1 (100 microamperes). The current would then be read in microamperes directly on the lower 0-100 scale of the Model 960.

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

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

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

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

8. Depress "Read Meter" Button to read Iebo current.

* * * * * * *

B. Icbs Test

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

The procedure for making the Icbs test in the Model 960 is as follows:-

1. Set the Function Selector Switch in the Icbo position (NPN or PNP according to transistor type).

2. Remove all patchcord pin plugs from their jacks.

3. Insert transistor into socket or connect to adapter cable as shown in appropriate figure on Page 14 or 15.

4. Insert patchcord plug #2 (corresponding to transistor base connection) to "X" jack.

5. Insert patchcord plug #1 (corresponding to transistor emitter connection) to "X" jack.

6. Insert the appropriate numbered plug (transistor collector) listed on the roll chart into "Z" jack.

7. Insert the remaining patchcord plug into "W" jack or leave unconnected, as desired.

8. Set up the "Icbs" test voltage using the 960 "C" Switch (see preceding tables for "C" Switch settings).

9. Set the "B" Switch to the appropriate meter current range.

10. Depress the "Read Meter" Switch and read Icbs current on the appropriate lower scale corresponding to the "B" Switch setting.

OPERATING INSTRUCTIONS FOR CRYSTAL DIODE TESTS

Connect crystal diode between pin jacks "2" and "3" marked "Crystal Diodes". Cathode (+) side of crystal goes to "3", negative side of crystal goes to "2". Patchcord Plug #2 is inserted into "X" jack, Plug #3 into "Z" jack. Remaining patchcord plugs can be left unconnected or plugged into any jack, as desired.

NOTE: It is extremely important that diode polarity and insertion of patchcord plugs 2 and 3 be correct, otherwise damage to the diode and tester can result.

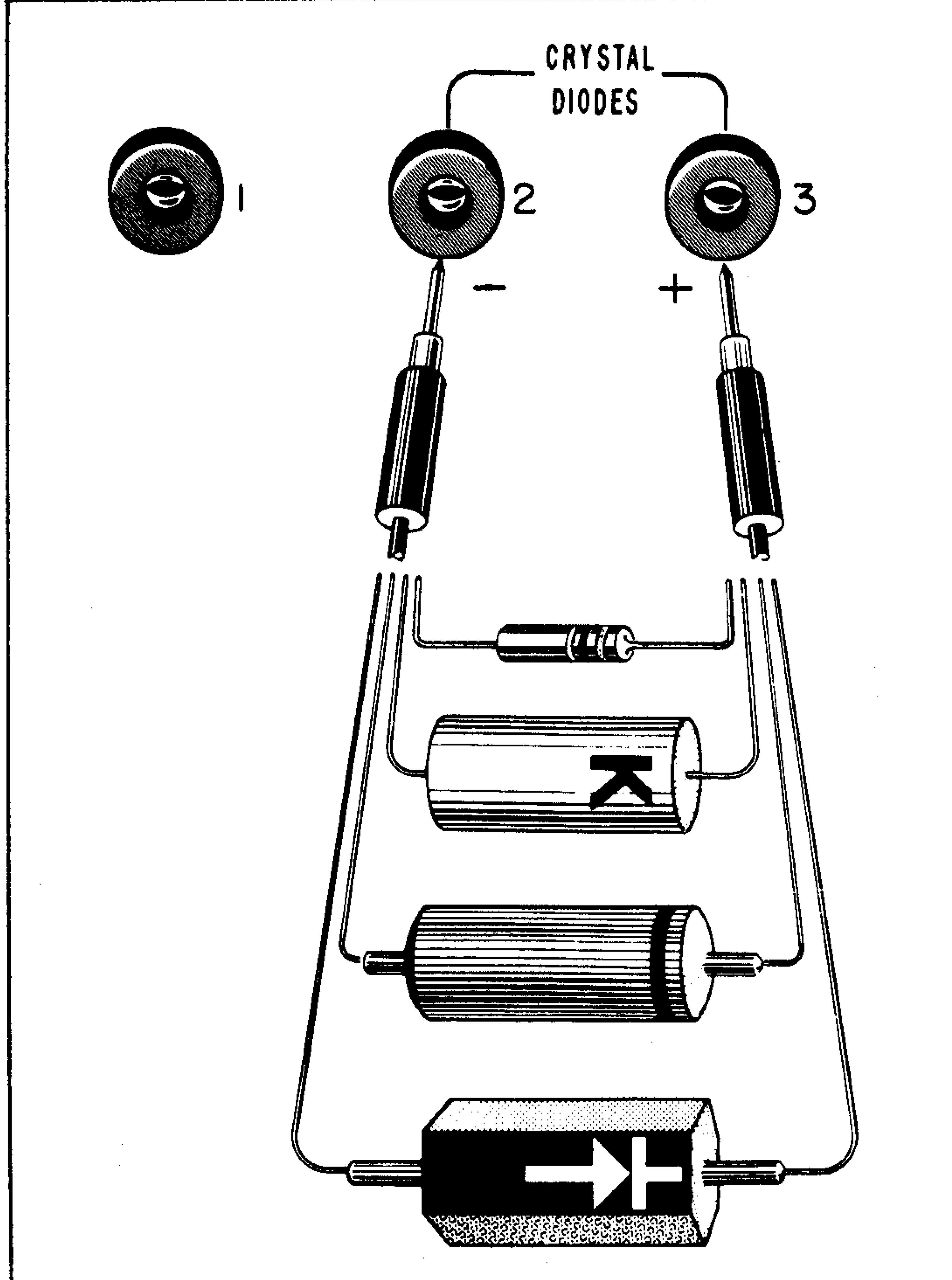


FIGURE 7

Diode Forward Test

1. Set (Right-hand) Function Selector Switch in "Df" position.

2. Set "A" and "C" switches as indicated on test data sheets for "Forward Current" for diode.

3. Depress "Read Meter" Button and note reading on upper 0-100 scale. If diode reading is OK, proceed to Diode Reverse Test.

Diode Reverse Test

Leave diode connections and patchcord settings as above and proceed as follows:-

1. Set (Right-hand) Function Selector Switch in "Dr" position.

2. Set "B" and "C" switches as indicated on test data sheet for Diode Reverse Test.

3. Depress "Read Meter" Button and note reading on 0-100 scale. Reading should be below that specified under Diode Reverse Current. (If the operator wishes to know the actual diode reverse current, he may read it directly on the appropriate lower scale corresponding to the "B" Switch setting.)

* * * * * * * *

SERVICE DATA

The PRECISION Model 960 has not only been designed as an accurate Test Instrument, but has also been constructed to withstand the abuses of general field use. All components have been exhaustively sample-tested by Precision's Test Engineering Laboratory and have been approved for general long-life usage. Generous mechanical design is a major Precision precept.

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

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

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

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

IMPORTANT NOTE: Your PRECISION Model 960 is a relatively complex instrument, and has been carefully inspected and calibrated by Precision's Performance-Test Department. - - DO NOT attempt repairs or modifications other than those listed below unless upon specific recommendation by Precision's SERVICE DEPARTMENT.

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

   Remove internally mounted 3AG, 1 ampere fuse. If blown, replace with same size and type fuse only if the cause for blowing of fuse is known and has been remedied.

2. "Line" adjustment is erratic.

   Examine "Line Adjust" potentiometer for shorted, open or worn turns. Unsolder the three leads and check for continuity with an ohmmeter. If defective, contact Precision's Service Department.

3. Apparent defective operation of the instrument meter.

   Repair and recalibration of the meter of a Model 960 is a delicate and highly specialized operation. DO NOT ATTEMPT TO REPAIR AN INOPERATIVE METER. Always contact Precision's Service Department should your meter appear defective or damaged.

SPECIAL NOTES RE REPAIR SERVICE

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

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

ATT: Service Division

FRAGILE label should appear on at least four sides of the carton.

NEVER return an instrument unless it is accompanied by full explanation of difficulties encountered. The more explicit the details, the more rapidly your instrument can be handled and processed.

GENERAL NOTES AND INFORMATION

NEW TEST DATA:

In line with "PRECISION's" desire to extend utmost service to users of "PRECISION" test equipment, new Transistor and Diode Test Data is now being made available on a special subscription basis.

This plan entitles the subscriber to receive, automatically, 2 up-to-date roll charts and a minimum of 2 additional supplements during a one year subscription period.

NOTE FOR NEW OWNERS:

The first year's subscription is entered FREE OF CHARGE upon our receipt of your registration-subscription card covering the purchase of a new Model 960 Tester. It is important that this registration-subscription card be completely filled-in and returned to us immediately, in order that you may receive the full benefits of this special service.

PLEASE NOTE:

Upon our receipt of your registration-subscription card, we will respond with two separate cards:-

a) One card acknowledges warranty registration of your new Instrument.

b) The other card, (which will follow a few days later), confirms your one year FREE Test Data subscription.

Upon expiration of the first one year's FREE subscription, you will have the opportunity to renew the same efficient service for the nominal charge of only $2.50 per year. Adequate advance notice of end of subscription is sent to all subscribers. For those who may not wish to renew this automatic service, charts will be available, upon request, at the nominal cost of $1.25 each. It is very important that such separate roll chart requests list the following information:-

a) Model No. of your Instrument (Model 960 in this case).

b) Serial No. of your Instrument.

c) Form No. of your present chart (printed in upper left-hand corner of chart).

This information permits our Test Data Department to respond with the correct charts for your particular tester.

SPECIAL NOTE:- Paid subscription service applies only to Continental U. S. A., Canada and U. S. possessions.

ACCESSORIES SUPPLIED:

1 - Transistor Adapter Cable

* * * * * * *

BIBLIOGRAPHY

1. Modern Theory of Solids. Frederick Seitz. McGraw-Hill Book Co., Inc., New York, N. Y.

2. The ABC's of Germanium. J. P. Jordan. Electrical Engineering. July 1952.

3. Principles of Transistor Circuits. R. F. Shea. John Wiley and Sons, Inc., New York, N. Y.

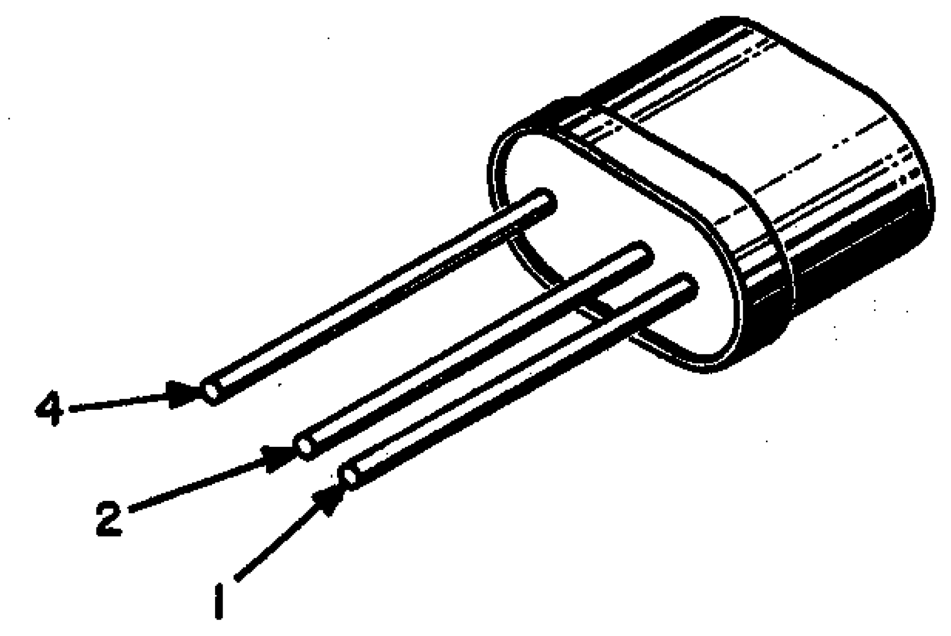
4. Transistors Theory and Practice. Rufus P. Turner. Gernsback Library, New York, N. Y.

5. Electrons and Holes in Semiconductors. William Shockley. D. van Nostrand Co., Inc., New York, N. Y. 1950.

* * * * * * *

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

LOW POWER TRANSISTORS



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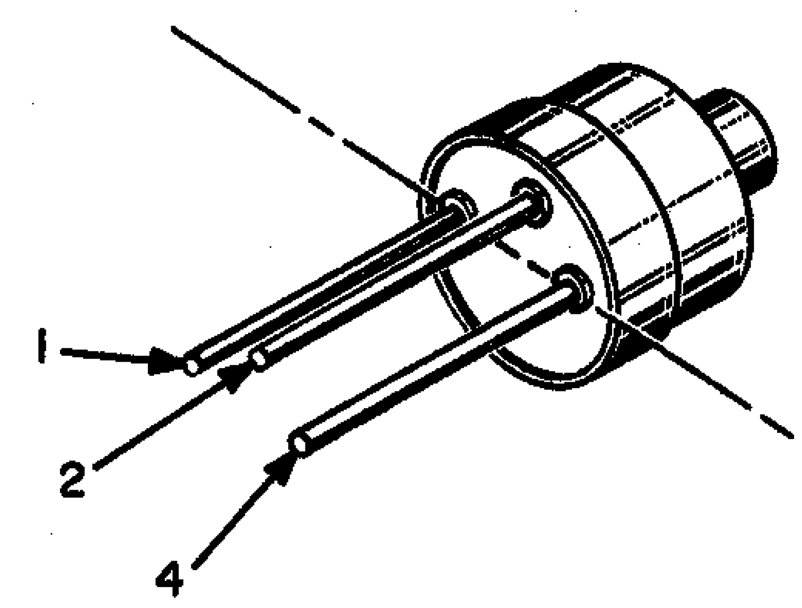

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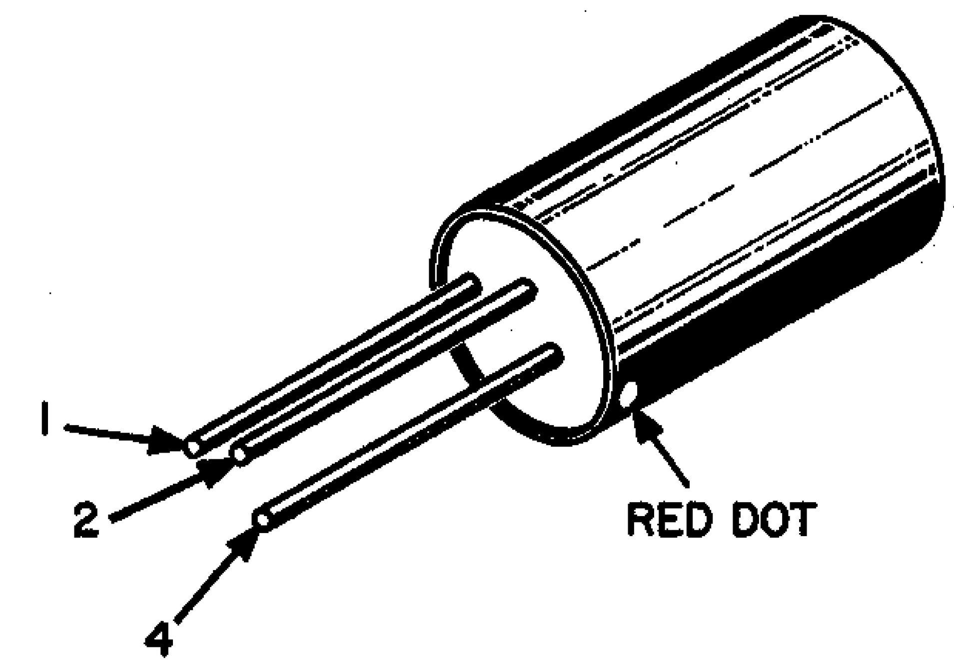

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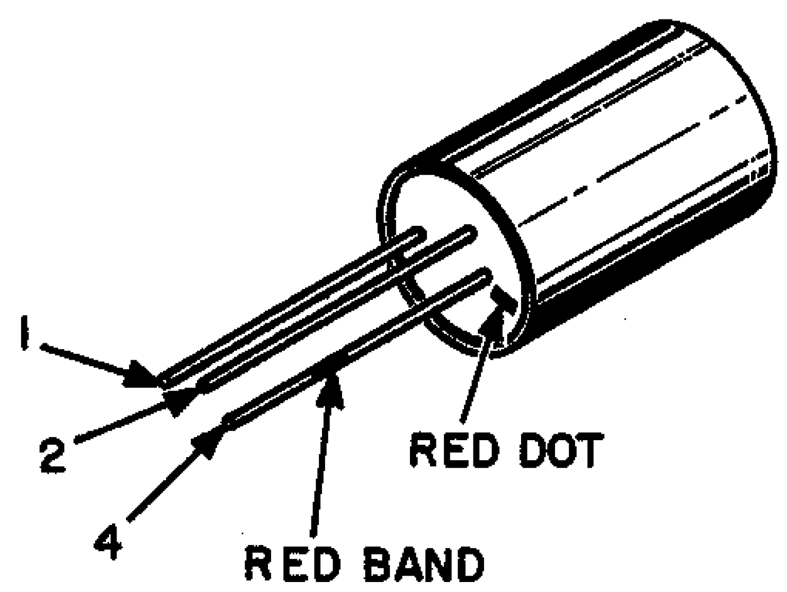

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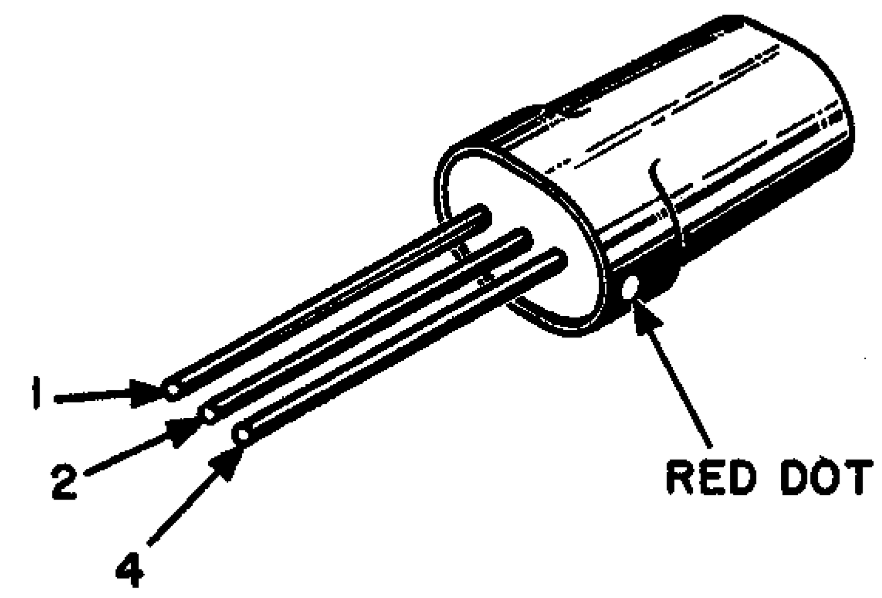

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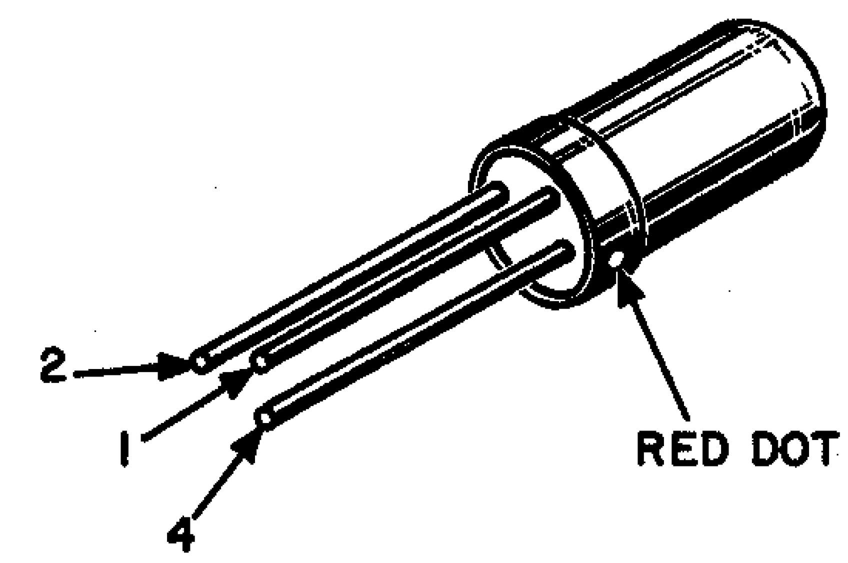

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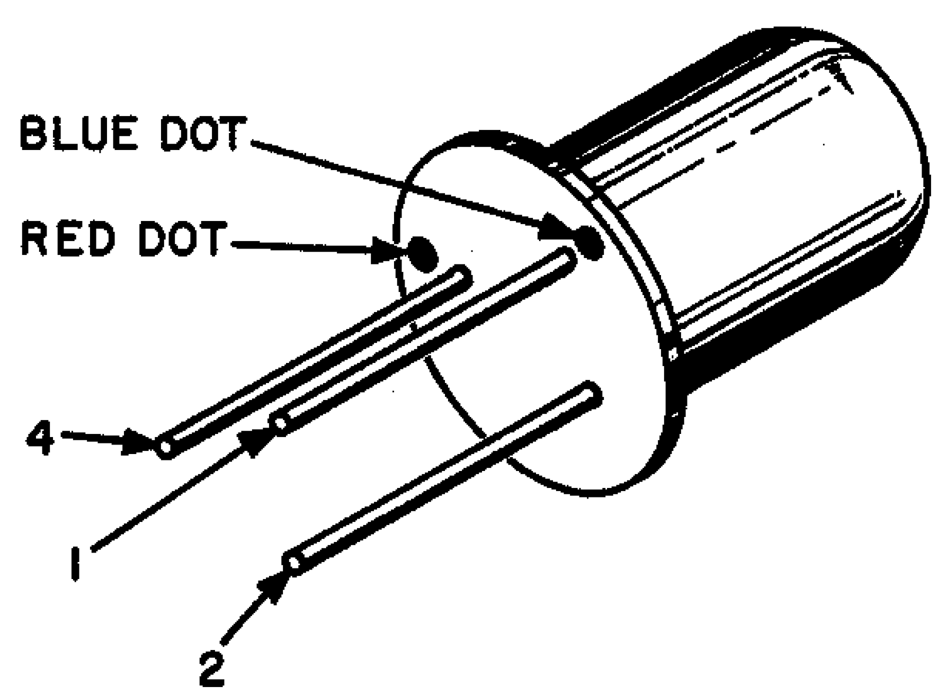

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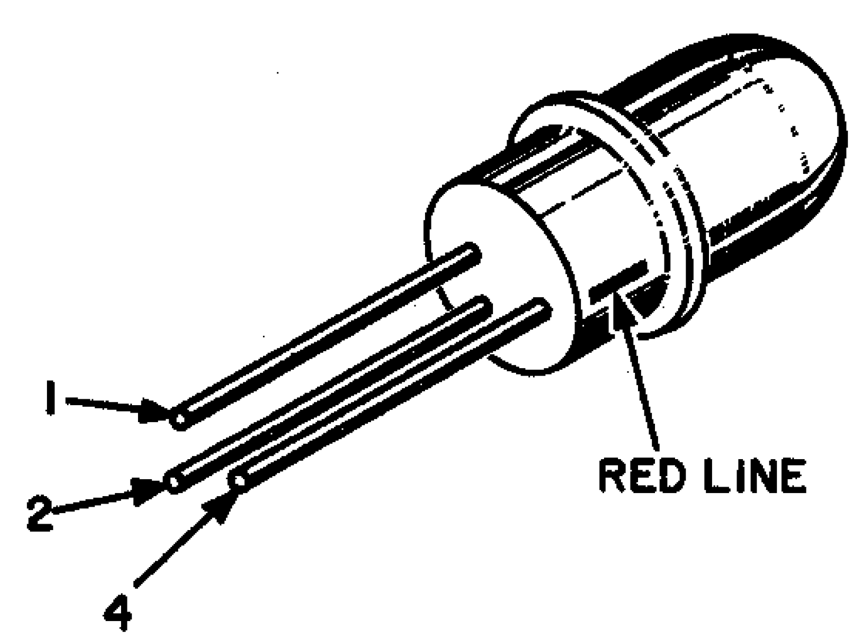

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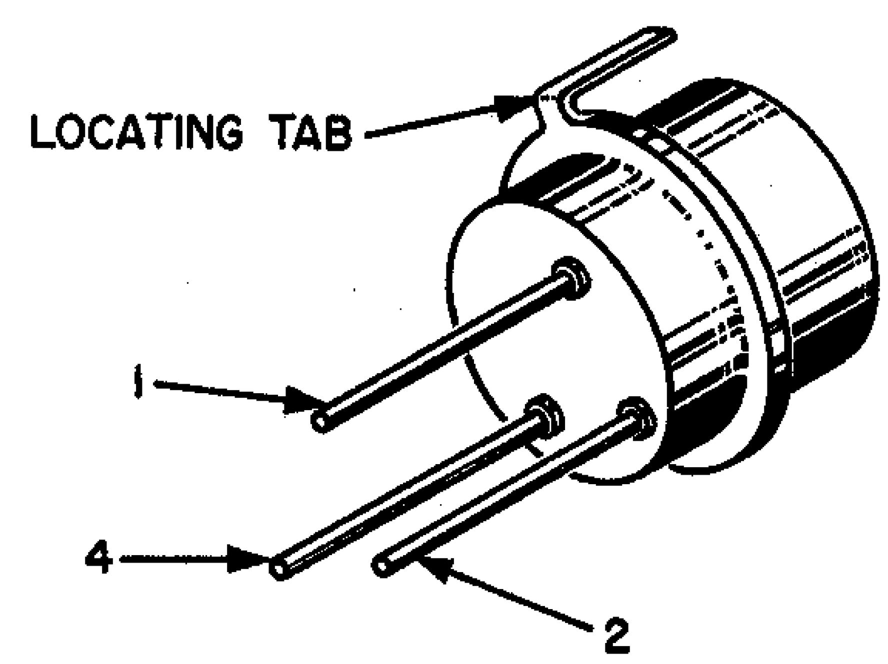

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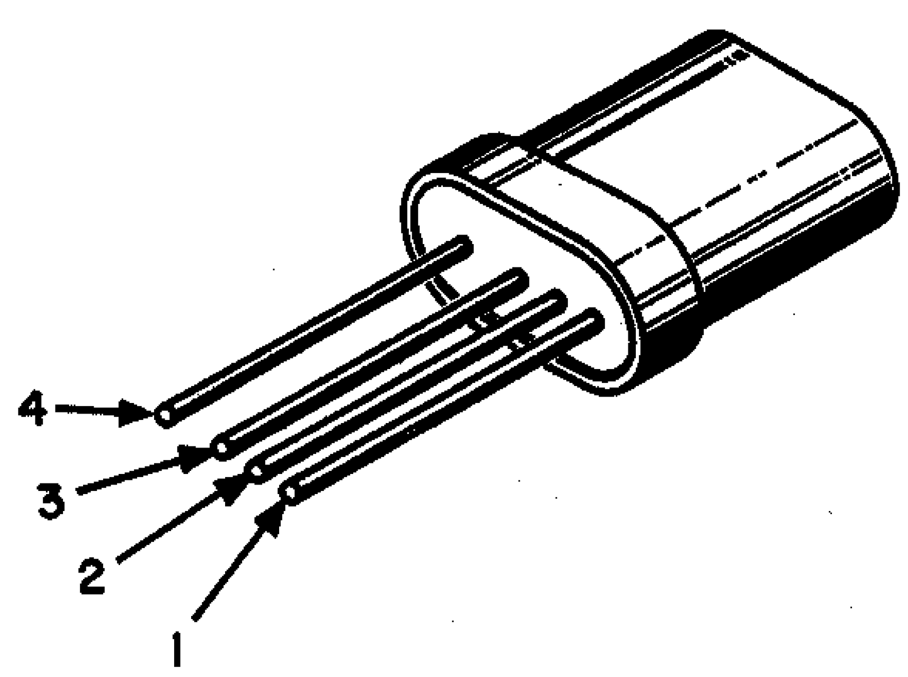

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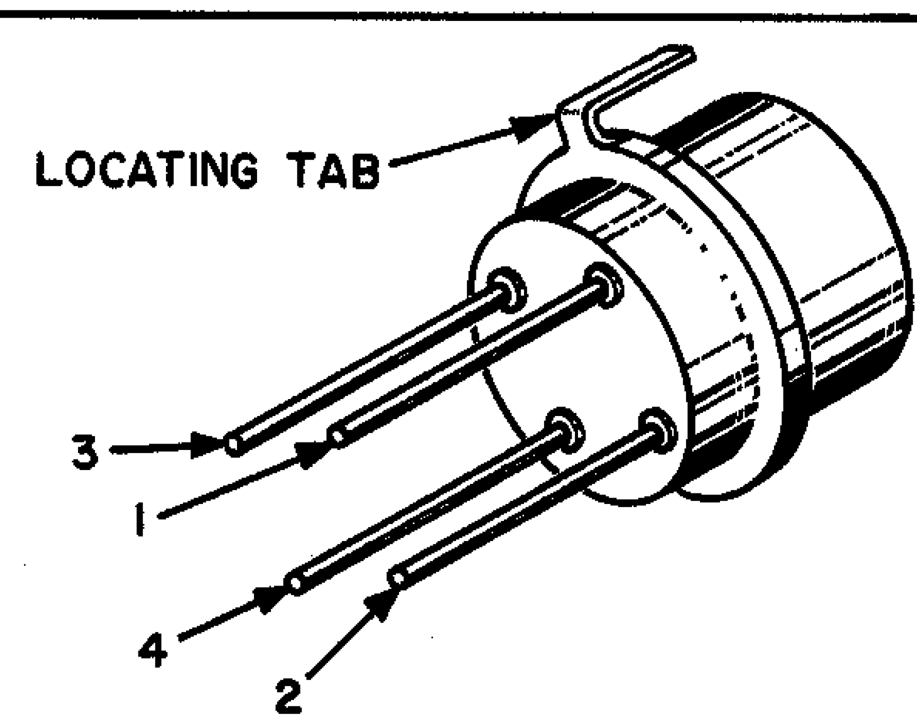

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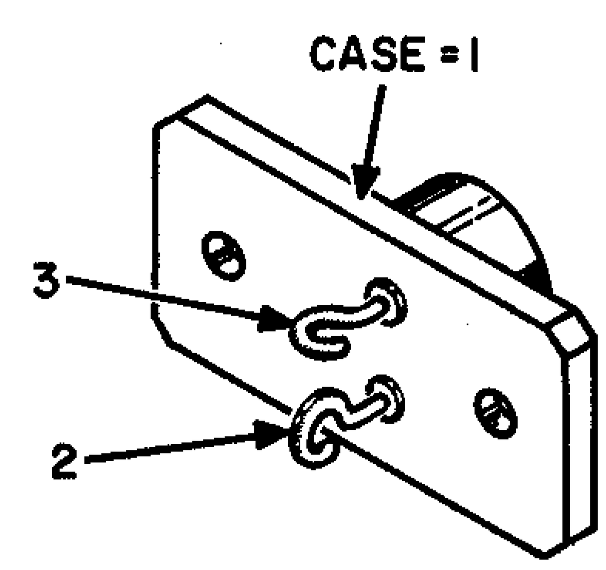

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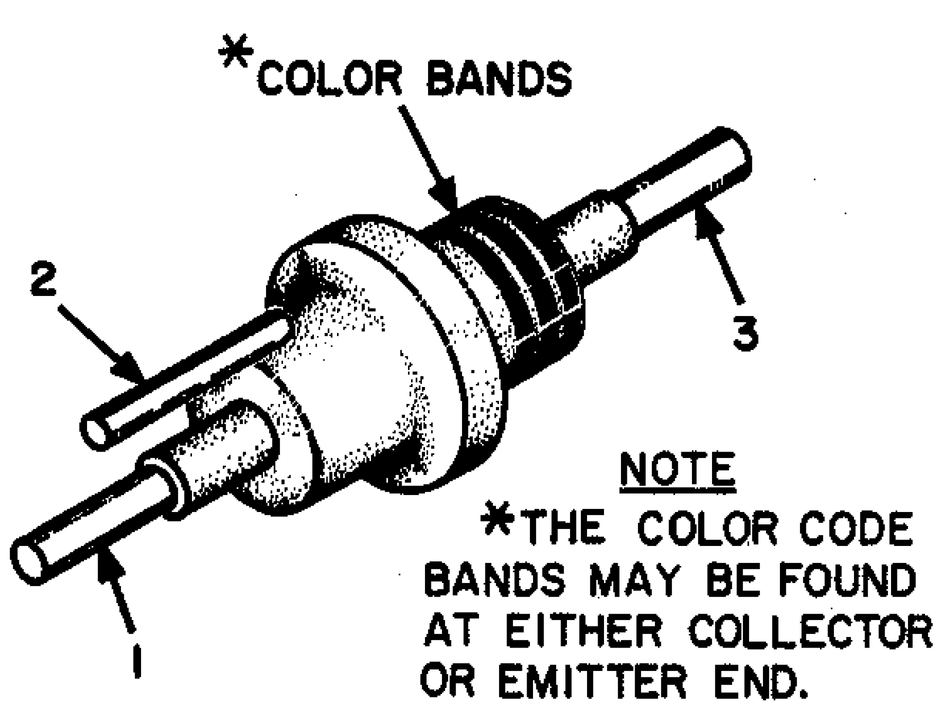

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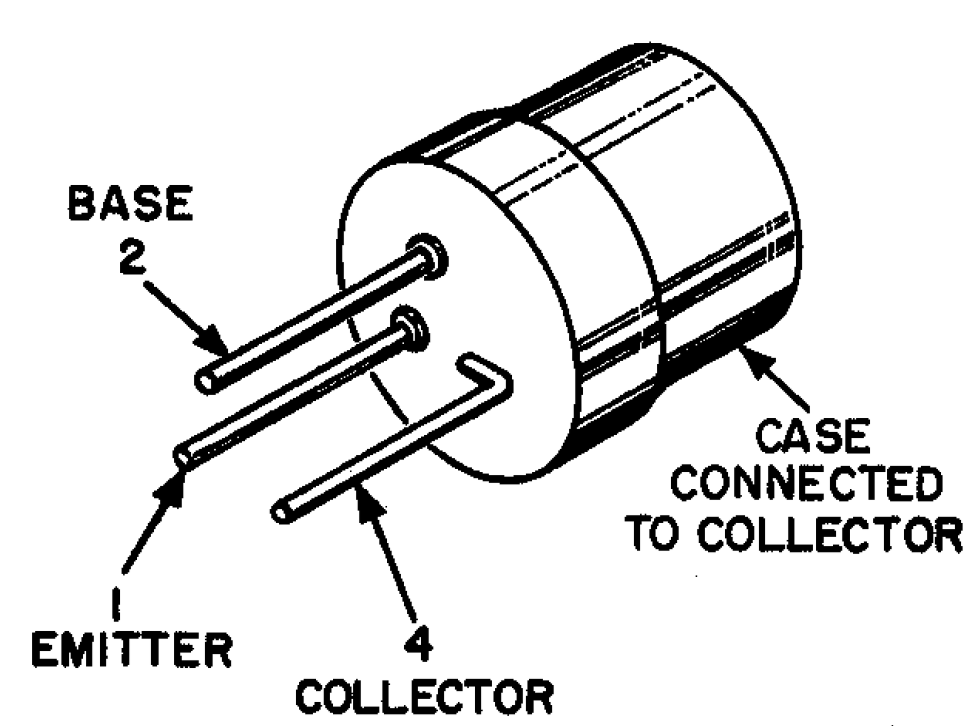

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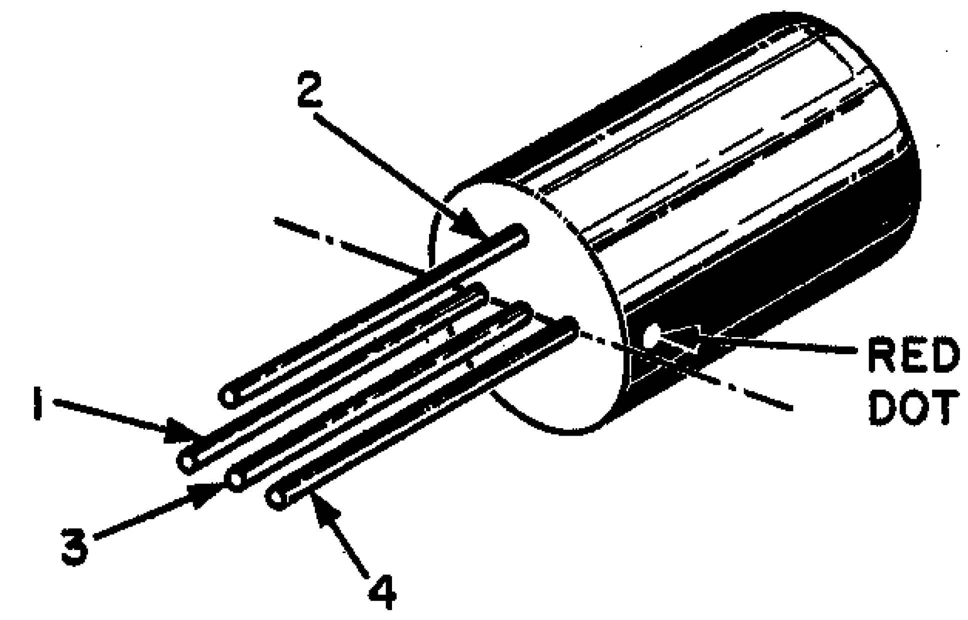

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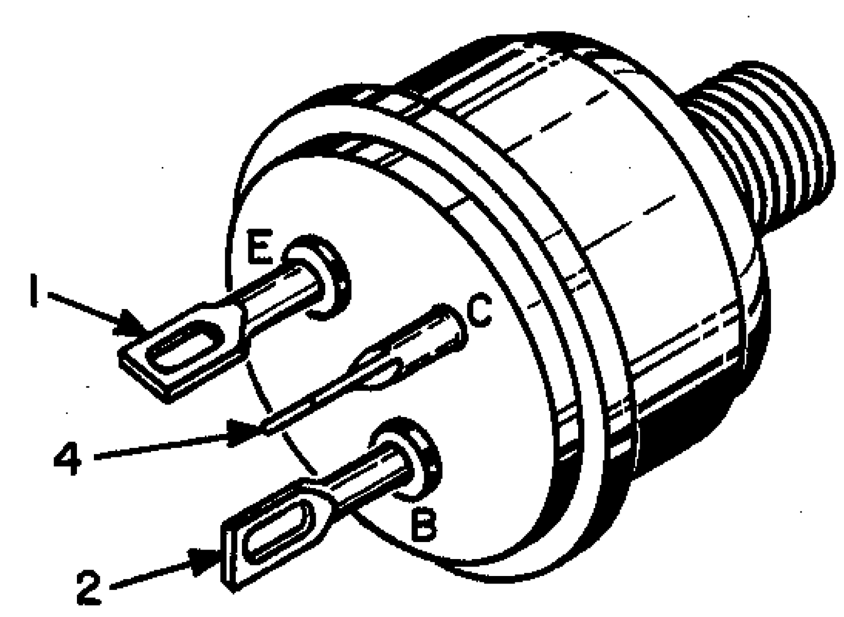
POWER TRANSISTORS



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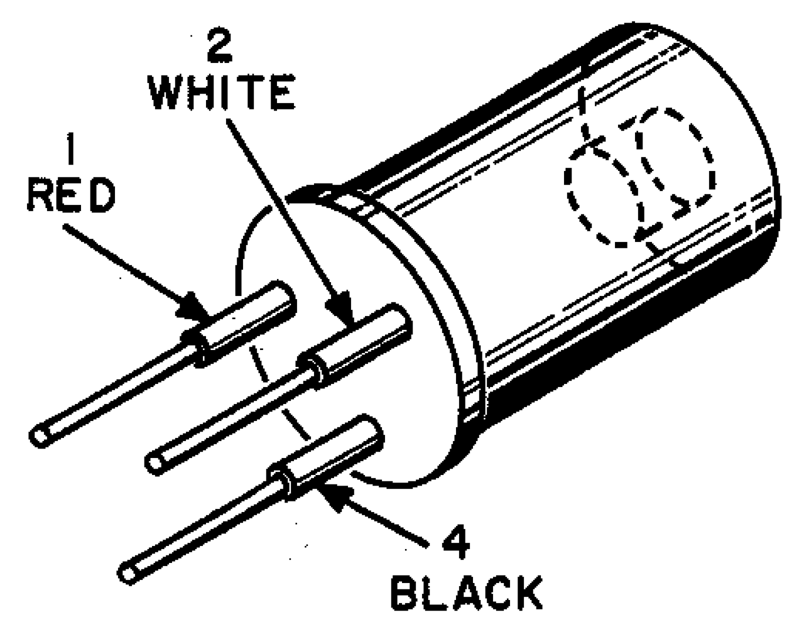

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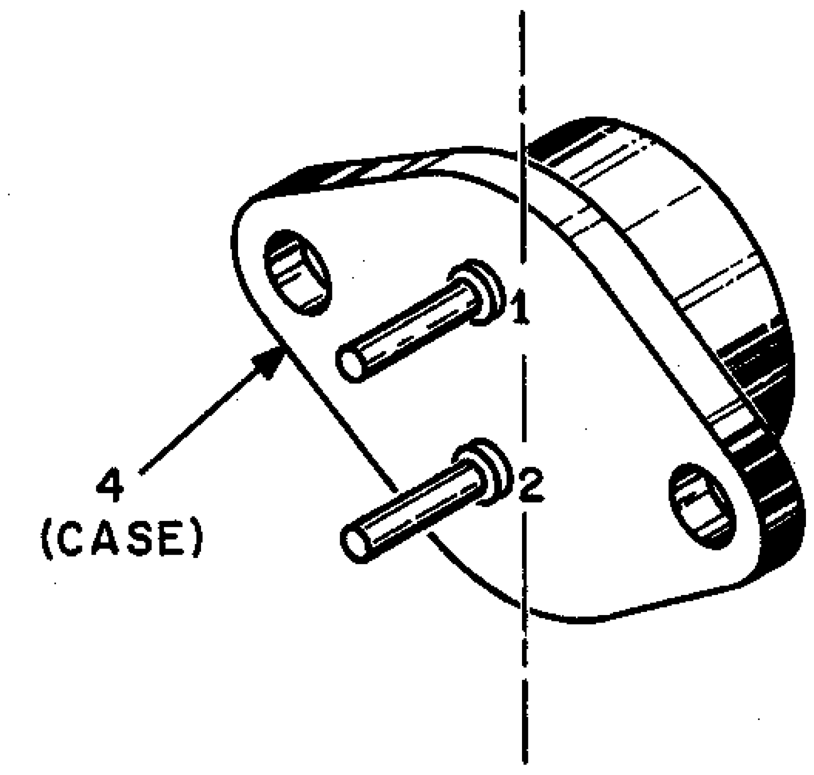

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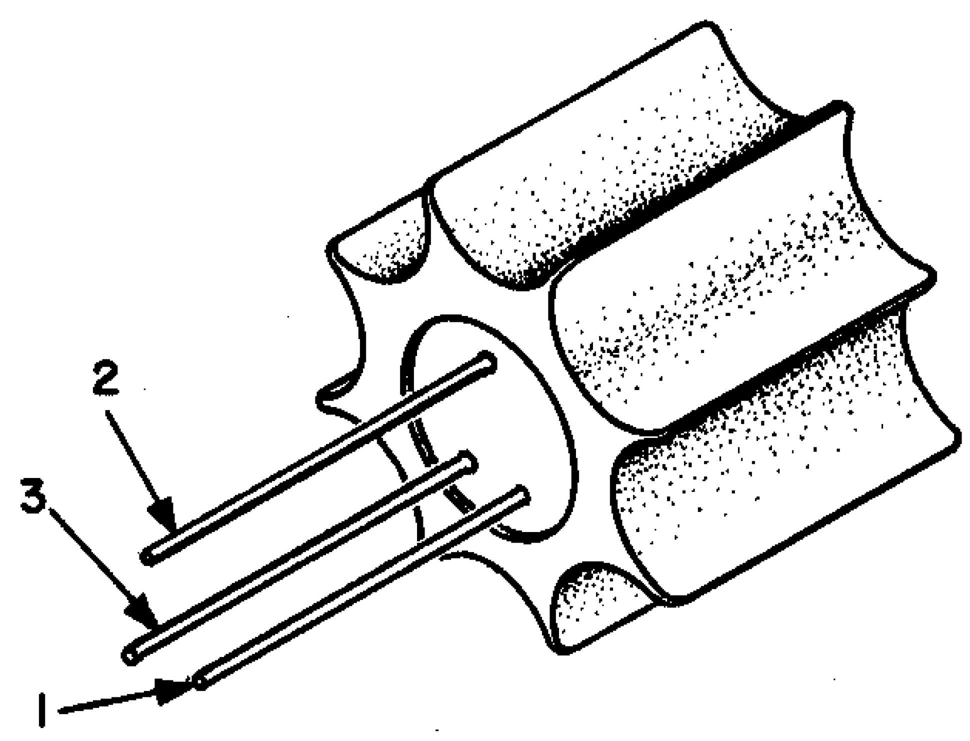

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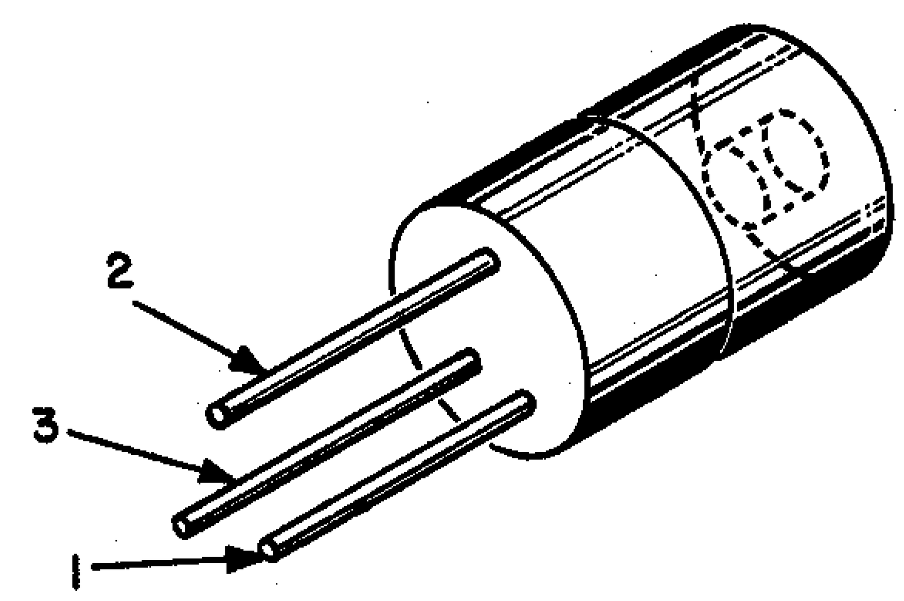

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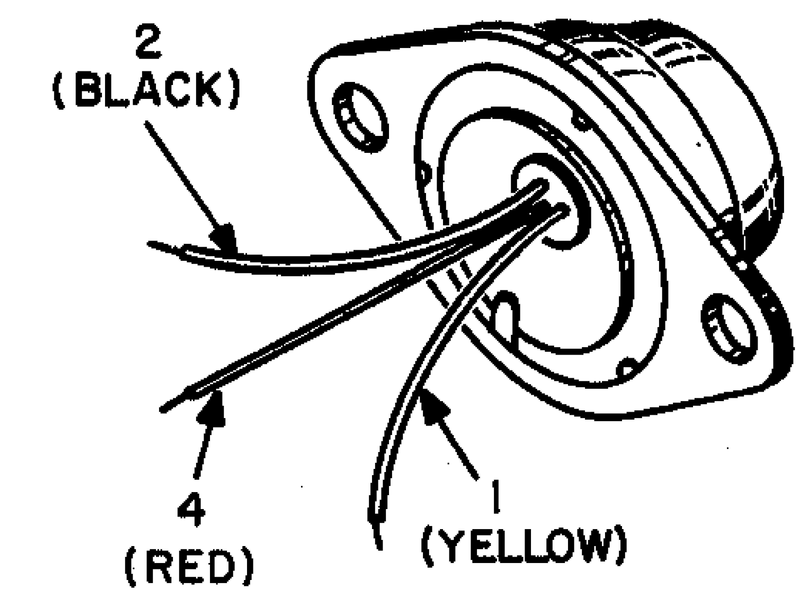

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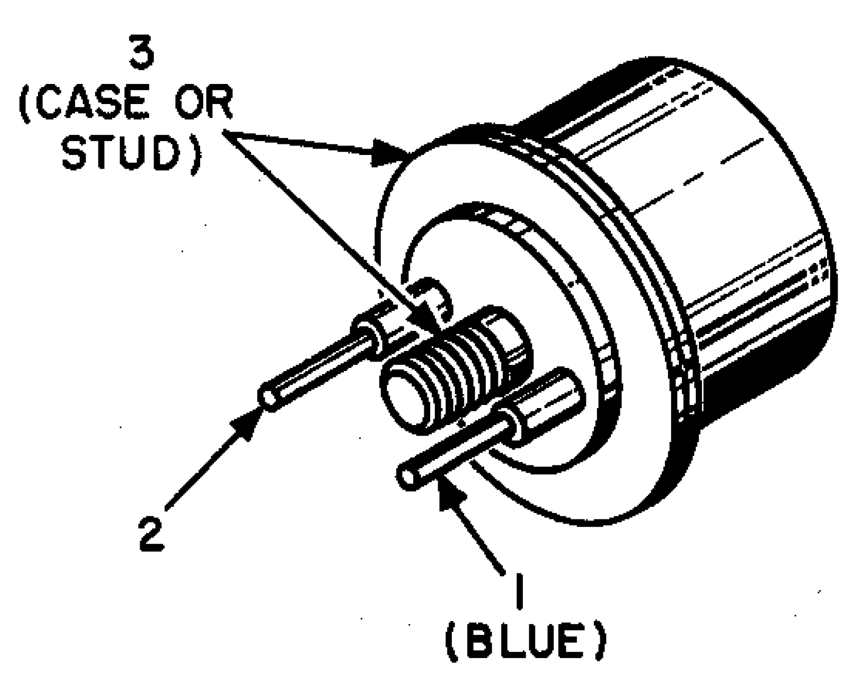

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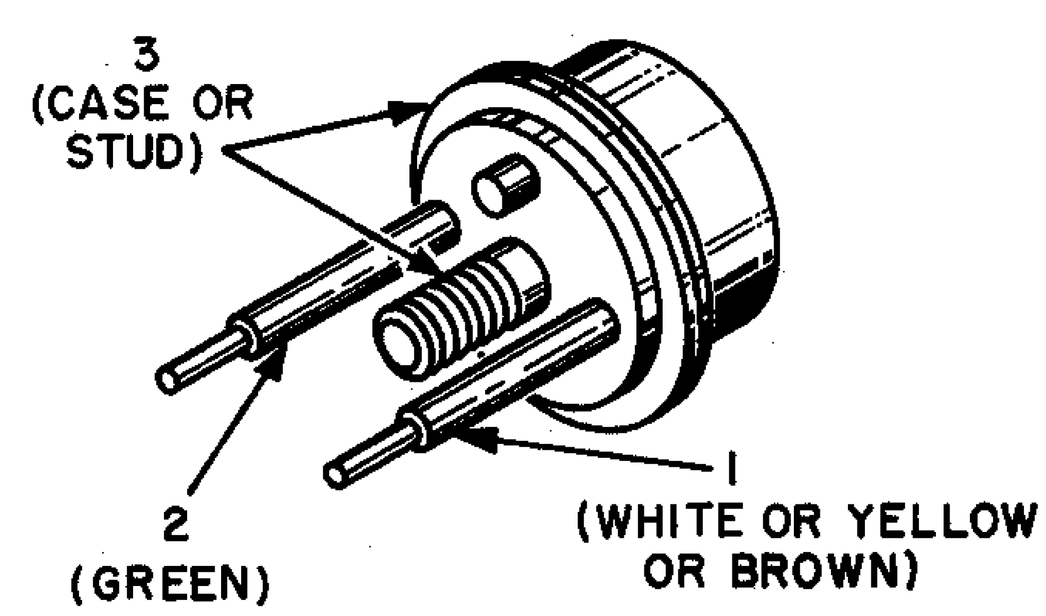

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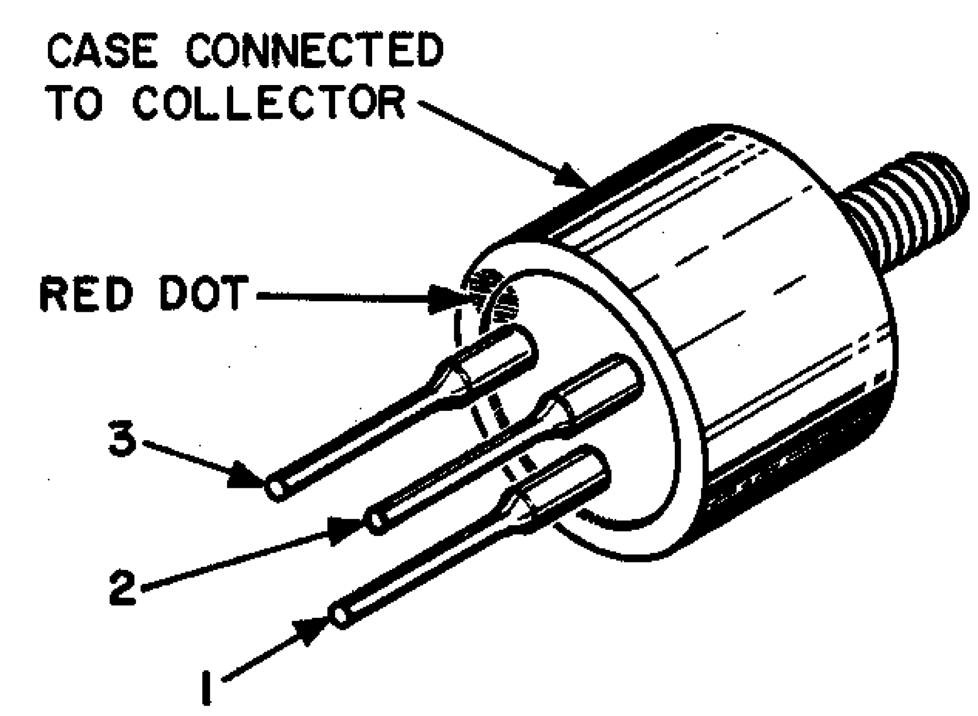

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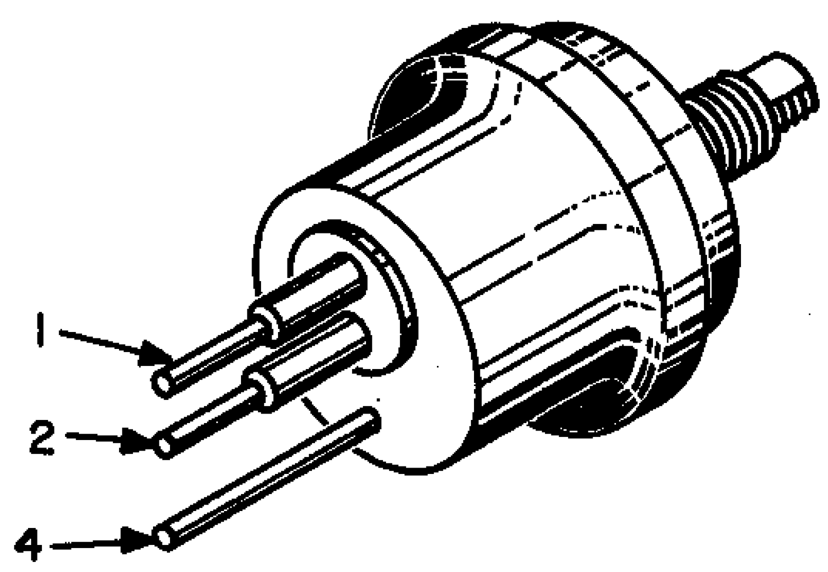

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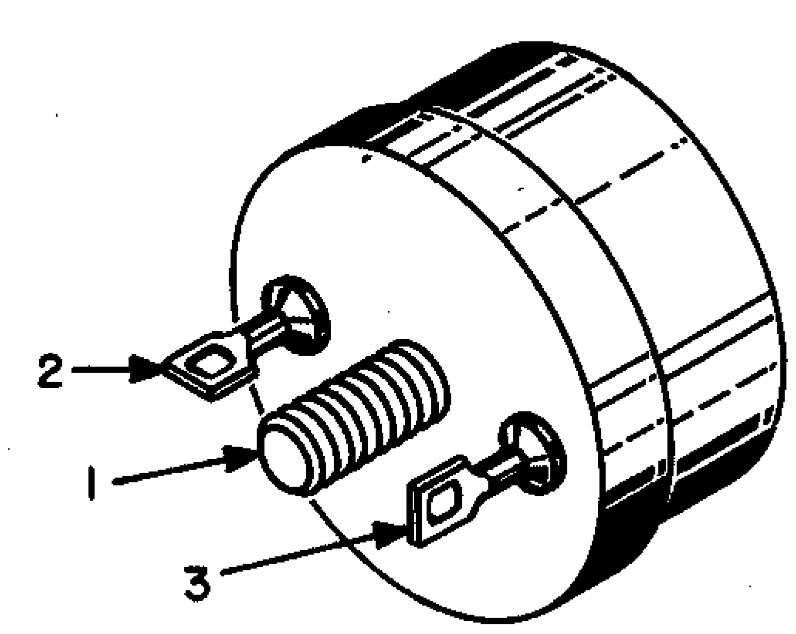

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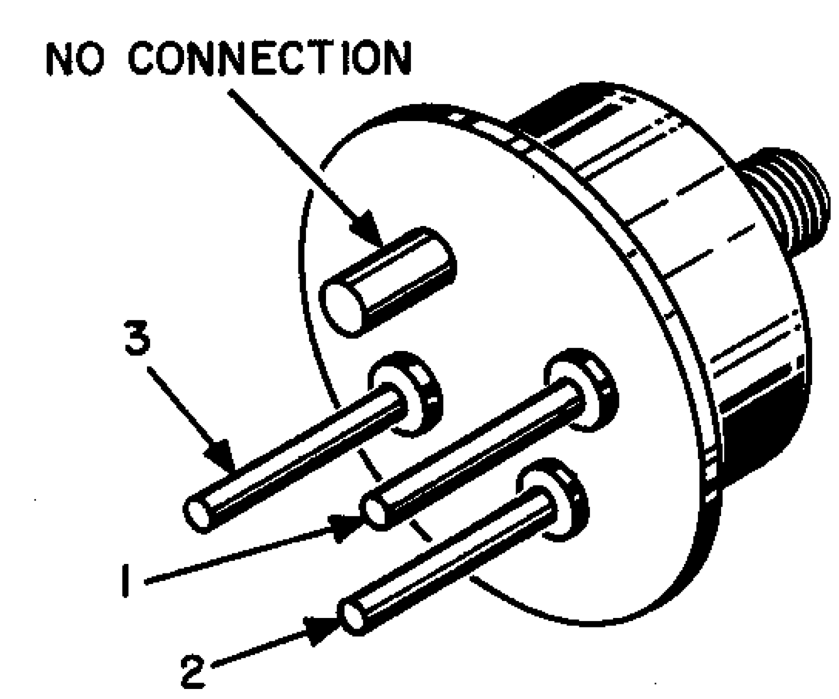

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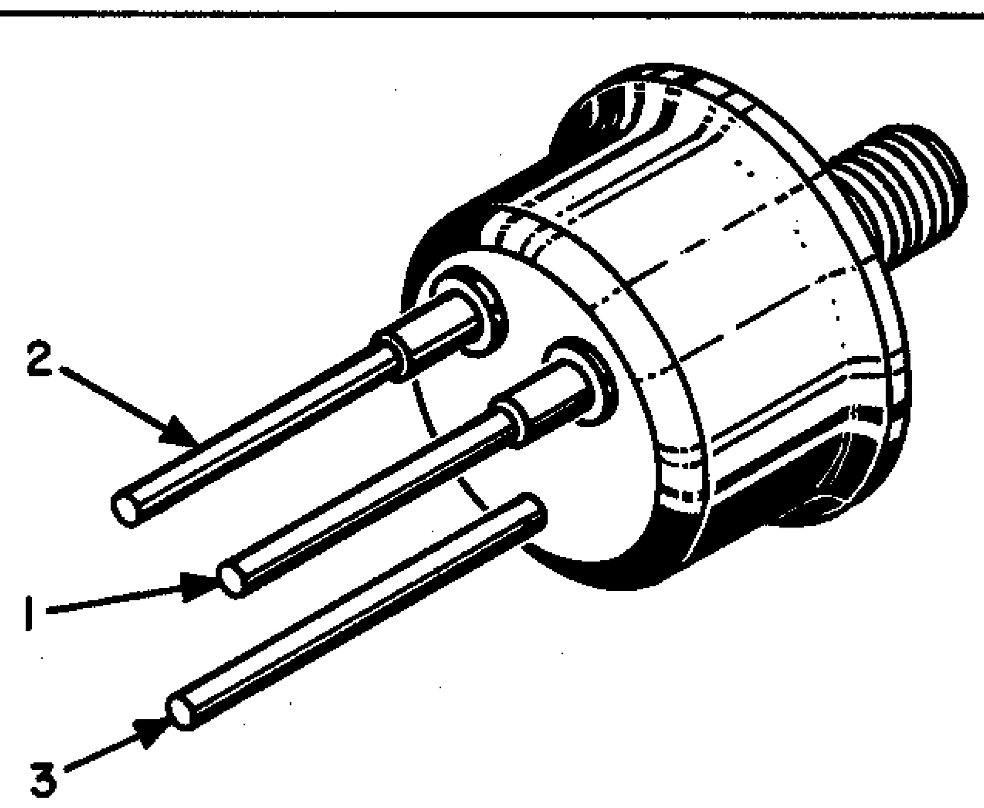

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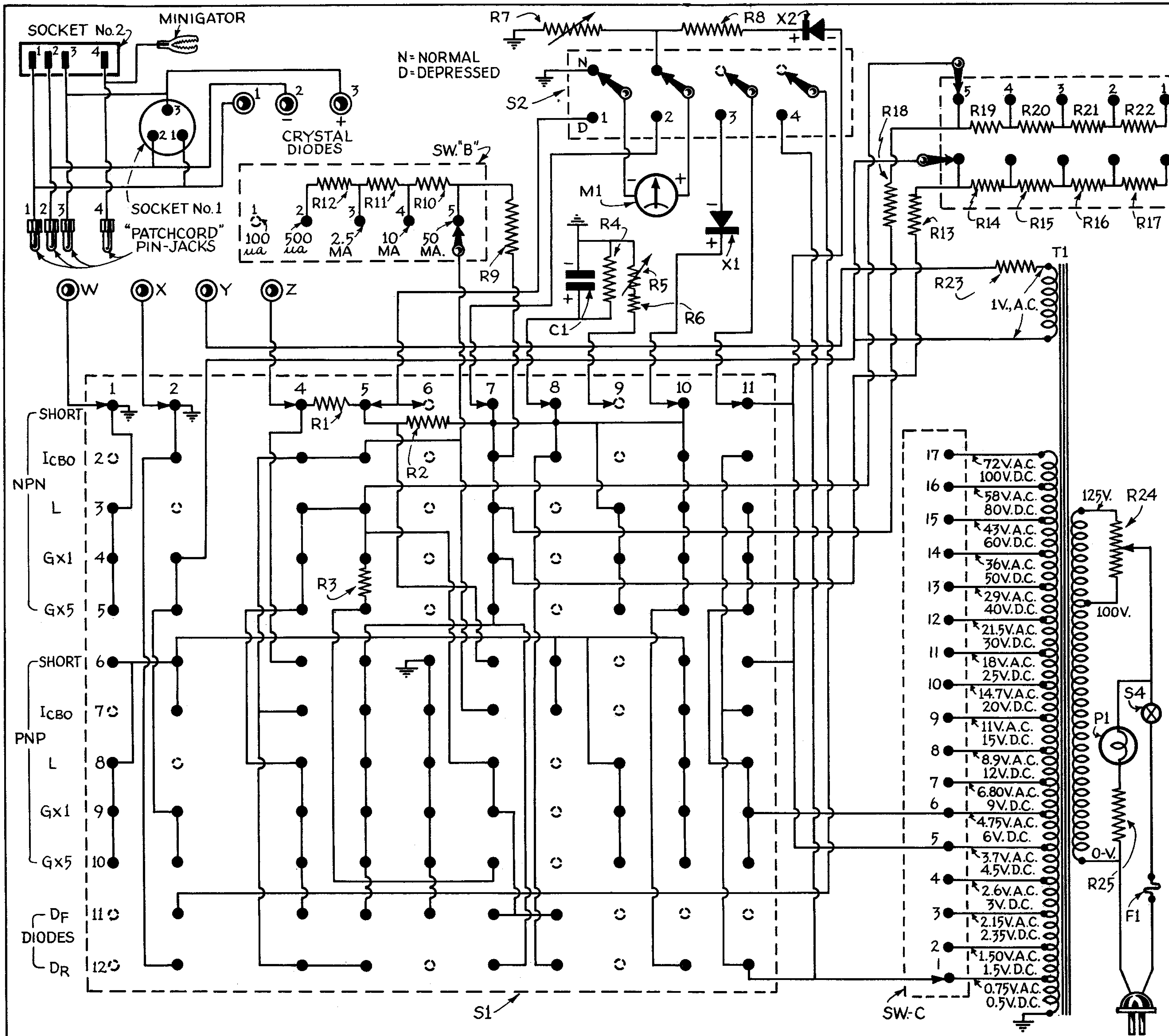
DWG. NO. 1092



PART No.	SPECIFICATION
P1	NE 51 PILOT LAMP
R25	220K Ω
R24	300 Ω LINE ADJ. CONT.
R23	470 Ω
R22	24.6 Ω
R21	4.83 Ω
R20	2.41 Ω
R19	0.480 Ω
R18	0.320 Ω
R17	24700 Ω
R16	5K Ω
R15	2250 Ω
R14	475 Ω
R13	250 Ω
R12	333.3 Ω
R11	50.5 Ω
R10	12.95 Ω
R9	3.21 Ω
R8	470 Ω ±10% BW 1/2
R7	0-60 Ω (MH)
R6	22 Ω
R5	0-200 Ω
R4	33K Ω
R3	6400 Ω
R2	27.1 Ω
R1	640 Ω
C1	100 MFD.
S6	BASE CURRENT & METER SEN. SW. "A"
S5	ICBO & DR SENSITIVITY SW. "B"
S4	OFF-ON POWER SW.
S3	VOLTAGE SEL SW. "C"
S2	READ METER SW.
S1	FUNCTION SELECTOR SW.
X2	CRYSTAL DIODE-1N48 OR EQUAL
X1	POWER RECTIFIER-1N1083 OR EQUAL
T1	POWER TRANSFORMER
M1	100 μa 160 MV.
F1	1/2 AMP. FUSE

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

MODEL 960
TITLE: TRANSISTOR AND DIODE TESTER

DRAWN BY: Wm. Kadlecek Jr.
CHECKED BY: M K DATE: 1-27-58

PRECISION
TEST EQUIPMENT
Standard of Accuracy

RADIO · TELEVISION · ELECTRICAL · INDUSTRIAL · LABORATORY

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Precision Apparatus Company, Inc., of Glendale, L. I., N. Y.

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