WARRANTY

B & K warrants that each instrument manufactured by it will be free from defects in material and workmanship under normal usage and service for a period of ninety days after its purchase new from an authorized B & K distributor. Our obligation under this warranty is limited to repairing, or replacing any instrument or component which we are satisfied does not conform with the fore-going warranty and which is returned to our factory or our authorized service contractor, transpor-tation prepaid, and we shall not otherwise be liable for any damages consequential or otherwise. *The foregoing warranty is exclusive and in lieu of all other warranties (including any warranty of merchantability), whether express or implied.* Such warranty shall not apply to any instrument or component (i) repaired or altered by anyone other than B & K or its authorized service contractor (except normal tube replacement) without B & K's prior written approval; (ii) tampered with or altered in any way or subjected to misuse, negligence or accident; (iii) which has the serial number altered, defaced or removed; or (iv) which has been improperly connected, installed or adjusted otherwise than in accordance with B & K's instructions. B & K reserves the right to discontinue any model at any time or change specifications or design without notice and without incurring any obligation. *The warranty shall be void and there shall be no warranty of any instrument or com-ponent if a B & K warranty registration card is not properly completed and postmarked to the B & K factory within five days after the purchase of the instrument new from an authorized B & K distributor."*

B & K MANUFACTURING COMPANY
DIVISION OF DYNASCAN CORPORATION
1801 W. BELLE PLAINE AVE. • CHICAGO, 13

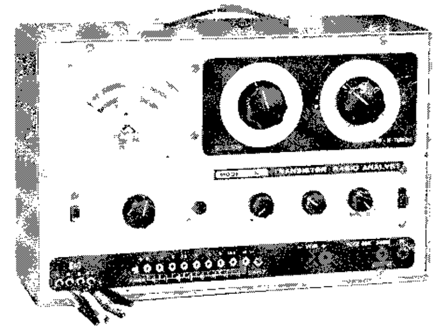
PM 272, 5 61 R R PRESS

©1962

TRANSISTOR RADIO ANALYST

Model 960

INSTRUCTION MANUAL



B & K MANUFACTURING COMPANY
DIVISION OF DYNASCAN CORPORATION
1801 W. BELLE PLAINE AVENUE, CHICAGO 13, ILLINOIS

EVERYTHING 4 LESS

ENJOY YOUR BOOKS

PLEASE VISIT OUR STORE FOR EVEN MORE GREAT STUFF!

WWW.EVERYTHING4LESSSTORE.COM

COPYRIGHT NOTICE

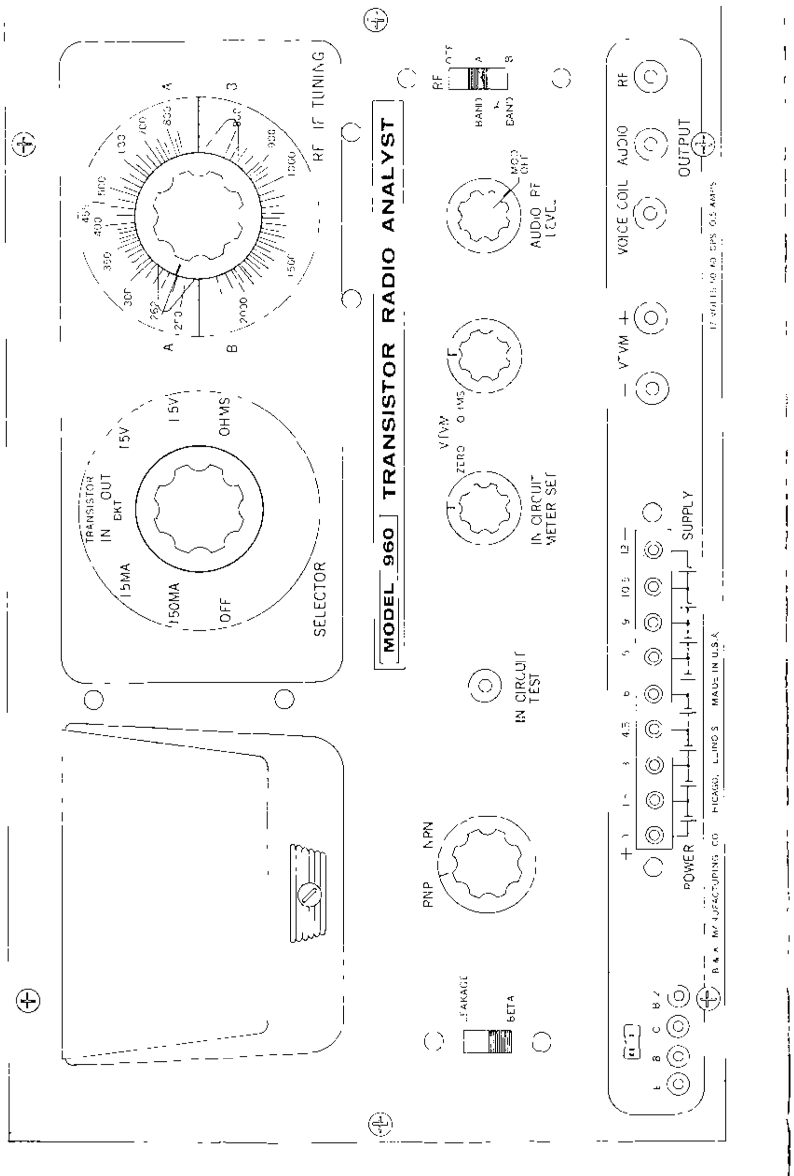
ALL MATERIALS INCLUDING CD/DVD AND PDF FILES ARE COPYRIGHTED WWW.EVERYTHING4LESSSTORE.COM VON WALTHOUR PRODUCTIONS AND MAY NOT BE REPRODUCED, COPIED OR RESOLD UNDER ANY CIRCUMSTANCES. YOU MAY HOWEVER MAKE A COPY FOR YOUR OWN PERSONAL BACKUP. MATERIALS ARE FOR PERSONAL USE ONLY.

IF YOU PURCHASED THIS FROM ANYWHERE BUT FROM US PLEASE NOTIFY US IMMEDIATELY SO THAT WE MAY CHECK IF YOU PURCHASED FROM AN AUTHORIZED RESELLER SO WE CAN LET YOU KNOW IF YOU NEED TO RETURN FOR FULL REFUND FROM AN UNAUTHORIZED SELLER.

THANKS AGAIN AND PLEASE TAKE THE TIME TO VISIT OUR STORE.

ATTENTION! EVERYTHING ON SALE NOW!!

HOT SALE!



INSTRUCTION MANUAL

FOR

MODEL 960

Transistor Radio Analyst

B & K MANUFACTURING COMPANY
DIVISION OF DYNASCAN CORPORATION
1801 West Belle Plaine Avenue
Chicago 13, Illinois

TABLE OF CONTENTS

MODEL 960 TRANSISTOR RADIO ANALYST

What The Model 960 Transistor Radio Analyst Will Do

Some idea of the inherent versatility of the Model 960 can be gained by an examination of its features

The Model 960 provides:

1. A signal generator that tunes from 250kc to 2 2mc in two bands The output level from the generator is variable and may be used for Signal Injection or R.F & I F alignment The generator can be operated with an internal 2kc tone or left unmodulated

2. A 2 000 cycle signal at the front panel for Signal Injection into the Audio section of a radio. The signal level is adjustable by a front panel control

A 2 000 cycle low impedance signal for Signal Injection directly into the voice coil of the radio receiver

3. A built in "In Circuit" transistor tester for in circuit testing of the transistors. This section also may be used as a D C Signal Tracer for rapidly localizing a dead stage. The test is made using the Dyna Trace which is a single probe

4 A metered power supply for powering the radio under test. The current ranges are 0-15ma and 0-150ma. Both are protected against meter damage in the event of a short circuit This unique power supply provides any voltage from zero to 12 volts in 1½ volt steps Even radios employing tapped power supplies may be fully operated from this built in source

5 A two range DC vacuum tube voltmeter. The voltage ranges are 0-1 5 and 0-15 volts. The meter is fully protected against accidental overloading Being a VTVM the internal impedance is high and therefore does not circuit load or cause erroneous readings

6 An ohmmeter in the VTVM section Its resistance range is such that it has a 1K ohm center scale and a 1 megohm full scale reading The voltage across the ohmmeter leads is 1.5 volts thus permitting the safe testing of low voltage electrolytics

7 An accurate "out of circuit" test for transistors Leakage and Beta are individually tested Leakage is read directly on a GOOD-BAD scale The Beta is read directly on a 0-150 BETA scale or on a GOOD-BAD scale. A socket and clip leads are on the front panel for transistor testing There is also a PNP-NPN switch for transistor polarity

CONTROLS AND JACKS

What They Do and How They Work

The Model 960 Transistor Radio Analyst is a complete instrument for use in the servicing of transistor radios. When using this new instrument for the first time the best way to become familiar with the controls and signals is to make a "Dry run" on a known good radio. Carefully observe the effects of the controls and signals. It is the purpose of this section to familiarize the technician with all of the operating controls of the Analyst.

SELECTOR SWITCH . . The main SELECTOR switch, located just to the right of the meter enables the technician to select the desired function of the Analyst.

The first position is OFF and disconnects the AC line power input to the instrument. When the SELECTOR switch is in any other position, the instrument is in operation.

The next two positions are the 150 ma and 15 ma current ranges. In these positions the meter is connected in series with the built in power supply and meters the current drawn by the load. The power supply for operating transistor radios is in operation in all positions except OHMS, TRANSISTOR OUT CKT and OFF. This internal power supply must be used when performing the 'in circuit' tests with the DYNA TRACE and when metering the current in the 150 ma and 15 ma positions of the selector switch.

POWER SUPPLY JACKS . To connect a radio to the power supply insert a red test lead into the POWER SUPPLY jack marked "O". This is the plus terminal of the power supply and connects to the terminal of the radio that would connect to the plus terminal of the battery. Insert the black test lead into the

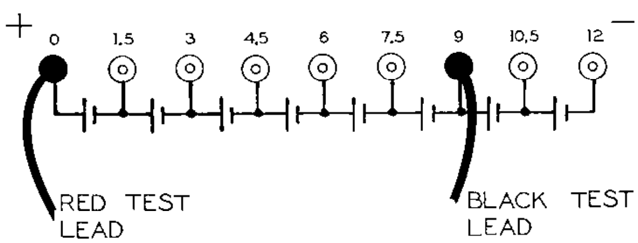


Fig. 1—9V Power Supply Connections.

voltage jack corresponding to the battery voltage of the radio. If the radio uses a 9 volt battery the black lead would plug into the 9 volt jack. The voltages at each jack are marked on the panel directly above the jack.

In Fig. 1 the test leads are shown connected for 9 volt operation. If the radio under test used a 6 volt battery the black test lead would plug into the 6 volt jack. See Fig. 2. Whenever using the Analyst power supply the battery in the radio must be removed.

In all cases the red test lead connects to the positive terminal of the radio and the black test lead connects to the negative terminal of the radio. With the radio connected and operating, the current drawn by the radio will be indicated on the meter when the selector switch is in the 150 ma or 15 ma positions.

The current drain of the radio is a very important reading to make and will often indicate the defect in the radio. Normal currents drawn by the radio will vary from set to set, but the manufacturers' service data will usually supply this information.

A 9 volt radio for example will draw about 4 or 5 ma at minimum volume and 8 or 9 ma at normal volume. Currents much in excess of this would indicate internal defects and would certainly result in reduced battery life.

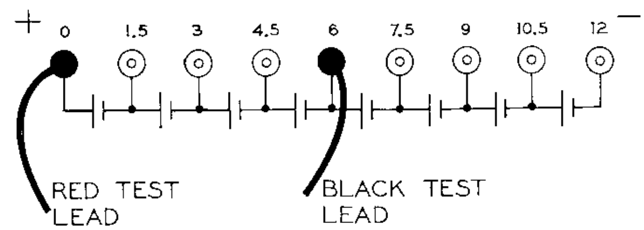


Fig. 2—6V Power Supply Connections

If the radio to be serviced employs a tap (such as will be found in radios operating from 3 and 4.5 volt supplies) a third connection must be made to the power supply. Fig. 3 shows the connection to a radio using a tapped battery voltage.

In this circuit the common or ground is the positive end of the battery and the most negative is 6.0 volts. Notice that there is a tap at 3.0 volts below the 6.0 volt point. To connect such a radio to the Analyst power supply proceed as

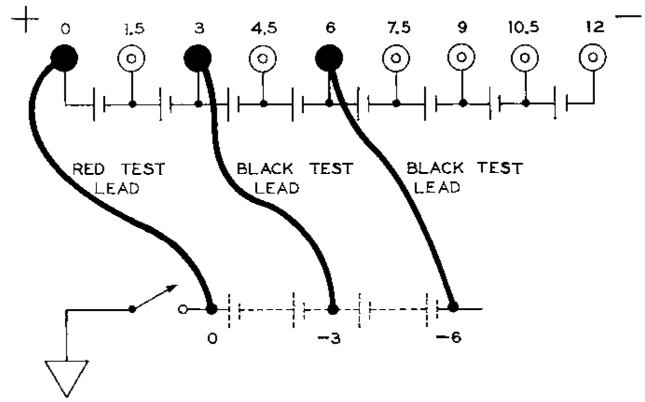


Fig. 3—6V Tapped Power Supply Connections

follows: Insert a red test lead into the jack marked "O". This connects to the positive terminal of the radio which is the point where the plus terminal of the battery would connect. Insert a black test lead into the jack corresponding to the battery voltage which, in the case of Fig. 3, is 6.0 volts. Since schematically the tap is shown as two cells less than 6 volts, it is at 3 volts. Insert a third test lead into the Analyst jack that is marked 3 volts on the power supply of the Analyst. Notice that under each voltage jack there is drawn the symbol for a battery. The 3 volt point is two cells less than the full battery voltage. The panel is marked in this manner to correspond with the way in which batteries are drawn on schematic diagrams.

Note: The Model 960 develops its voltages from the AC power line. If your line voltage is higher or lower than the nominal reading of 117V, the DC output voltage on the Model 960 will vary by the same percentage. Obviously the current drawn by the transistor radio will likewise increase or decrease by a similar percentage. A slightly higher or lower radio current can be attributable, therefore, to this line voltage increase or decrease. This should be kept in mind when measuring the total radio current.

IN CKT — DYNA TRACE

The next position of the SELECTOR switch is the test marked "IN CKT". This is perhaps the most useful test employed in the Analyst. Since only a single probe is needed when this test is used for signal tracing or, in circuit testing of transistors, it is a very rapid method of locating a defective stage or transistor. To use this test the radio must be connected to the Analyst power supply and not to an external battery.

Turn the SELECTOR switch to the IN CKT test position and connect the radio to the power supply. When switching from the 150 ma, thru the 15 ma, to the IN CKT test position you may go beyond full scale on the 15 ma position. This should be of no concern since the meter is fully protected against overload. Insert the Dyna Trace into the IN CIRCUIT TEST signal jack. This jack is

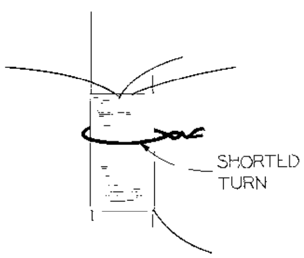


Fig. 4—Antenna Disabling by Shorted Turn.

located just below and to the right of the meter. Whenever using the Dyna Trace test turn the volume control on the radio to minimum. Take a piece of bare copper wire and wrap it around the loopstick of the radio and short the ends together. This is shown in Fig. 4.

The purpose of this shorted turn is to load the antenna circuit thereby keeping the radio from picking up a broadcast station and disturbing the test. In the case of a dead radio this would not be necessary. The control marked IN CIRCUIT

METER SET, located just to the right of the IN CIRCUIT TEST signal jack is adjusted until the pointer on the meter rests inside the green area of the meter scale marked IN CKT SET. See Fig. 5.

Rotate the PNP NPN switch to the proper position for the transistor being tested. Take the DYNA TRACE and touch it to the base of the output transistor. The pointer on the meter will now swing out of the GREEN area and read up the scale. This indicates that the transistor is working and can amplify a signal. It further indicates that the DC circuitry of the stage is working properly. Repeat this test on the remaining transistors in the radio. Each time the DYNA TRACE

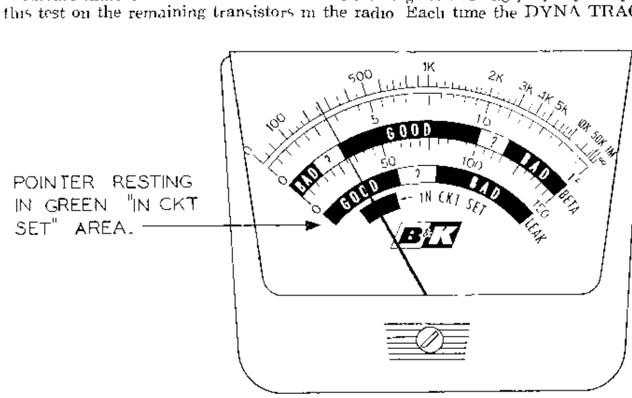


Fig. 5—In Ckt Set.

is touched to the base of a transistor the pointer will swing up scale and out of the GREEN area. Some stages will cause the pointer to go off scale while others may just barely move the pointer out of the GREEN area. As long as the pointer moves up scale this indicates that the stage is operating and that the DC circuitry is O.K. When a stage is reached that does not make the pointer read up the meter scale, a defective stage or transistor has been located. A few simple voltage readings will quickly isolate the defect to the component or to the transistor itself. This will be explained more completely under the section entitled TROUBLE SHOOTING.

OUT CKT TEST — TRANSISTOR TESTING

Following the IN CKT position of the SELECTOR switch is the OUT CKT (out of circuit) test for transistors. This test should be used to confirm whether or not a transistor is defective. The test should be made with the transistor out of the circuit. A test for both Leakage and Beta (H_{FE}) is made and both tests can be read on a GOOD-BAD scale. In addition the true value of Beta can be read on the 0-150 scale. The Leakage test is the Iceo test which is the leakage between collector and emitter. High leakage between base and collector will show up on the Beta test as a high Beta reading and will probably read in the bad area of the meter scale.

The Beta test is a DC test where a fixed amount of current is applied to the base of the transistor and the resultant collector current read on the meter. The meter scale is calibrated directly on the 0-150 range in Beta. The GOOD-BAD scale for Beta is based on certain assumptions concerning transistors found in portable radios.

A transistor whose Beta is less than 20 is generally not considered useful in a radio. Between 20 and 30 is considered questionable. From 30 to 110 is the area into which most transistors will fall and this is considered a good transistor. The area above 110 is marked questionable (?) and then BAD. Transistors that fall into this region will usually have high base to collector leakage and are not considered useful. Since the actual Beta of transistors found in portable radios is rarely known, this GOOD-BAD scale will be extremely helpful in determining the quality of a transistor. As a general rule defective radio transistors usually have high leakage, shorted or open junctions. Low Beta units will not normally result in a dead radio, but might result in low gain. In high Beta transistors it is possible that the reading may go off or to full scale and the leakage not be excessive. In that case check the manufacturers specifications. If leakage is again checked after the Beta test allow the leakage reading to go down as the transistor cools.

To perform the out of circuit test, connect the transistor to the clip leads marked E (emitter), B (base) and C (collector). If the transistor is a tetrode connect B2 to Base #2, otherwise leave the B2 clip disconnected. If the transistor has stiff wire leads simply plug the transistor into the socket. As an aid in identifying the emitter base and collector leads, the more common basings for transistors is shown in Fig 6A. The location of the E, B & C of the test socket of the Analyst is shown in Fig 6B.

BASE DIAGRAMS

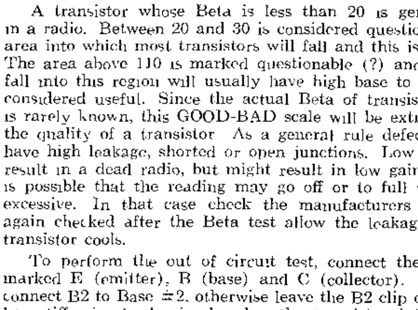


Fig. 6A—Transistor Basing Configurations.

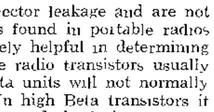


Fig 6B—Transistor Socket Connections.

If the transistor is known to be a PNP or an NPN set the switch located under the meter to the proper position. With the test switch (under the meter) in the LEAKAGE position, the leakage can be read directly on the GOOD-BAD scale (LEAK). If the leakage is within tolerance (GOOD Region) switch to the BETA position. Read the numerical value of Beta directly on the 0-150 scale, or on the GOOD-BAD scale. It is not absolutely necessary that it be known whether the transistor is NPN or PNP. By a process of elimination the transistor can be tested without this information.

Let us test an unknown transistor. Test the transistor with the PNP-NPN switch in the PNP position. If the transistor shows low leakage and reads on the Beta scale the transistor is good and is now known to be a PNP. If the transistor shows no leakage and no Beta, switch to the NPN position. If the transistor tests good in this position, the transistor is now known to be good and of the NPN variety. If the transistor tests BAD in both positions of the PNP-NPN switch the transistor is defective and must be replaced with the same or equivalent type. Certain transistors, those usually found in high frequency circuits of FM sets, etc., may have very high Betas. If you note a high Beta reading check the manufacturers specification.

As an aid in the replacement of transistors a cross reference in the rear of this manual shows American replacements for Foreign types.

VTVM

The next two positions of the Selector switch activate the VTVM. The 0-15 and 0-1.5 volt ranges are read on the 0-15 scale of the meter.

To use the VTVM set the Selector switch to the 15 or 1.5 volt positions. Power is still being supplied to the radio under test from the built in power supply. Insert a red and a black test lead into the red and black jacks respectively marked VTVM. Short the test leads together and adjust the VTVM zero control for zero reading on the left side of the meter. These jacks are located just to the right of the power supply strip. You are now ready to make voltage readings. When connecting the test leads into the circuit be sure to observe proper polarity. If the meter reads negatively simply reverse the test leads.

Unlike vacuum tube circuits, where negative is usually ground and positive goes to the plates of the tubes, transistors can operate either with the positive or negative at ground. It is sometimes convenient to remember that the middle letter of PNP or NPN stands for the potential of the collector. A PNP transistor would have a negative collector potential with respect to emitter while the base would be biased to the same negative direction as the collector. Just the opposite would be true of an NPN type of transistor.

The lowest range of the VTVM is 1.5 volts full scale and each scale division corresponds to .05 volts. It is therefore possible to read small voltages to as low as .025 volts. This feature is extremely useful in measuring base to emitter bias which is usually in the range of 0.1 to 0.3 volts. The meter is protected against damage due to accidental overload. The high input impedance of the VTVM prevents circuit loading which could cause reading errors or a change of operating conditions which might cause damage to a transistor or circuit component. Do not leave VTVM leads connected to the circuit in any other position of the SELECTOR switch.

OHMMETER

The Ohmmeter is connected in the last position of the SELECTOR switch (OHMS). In the OHMS position power to the radio under test is automatically

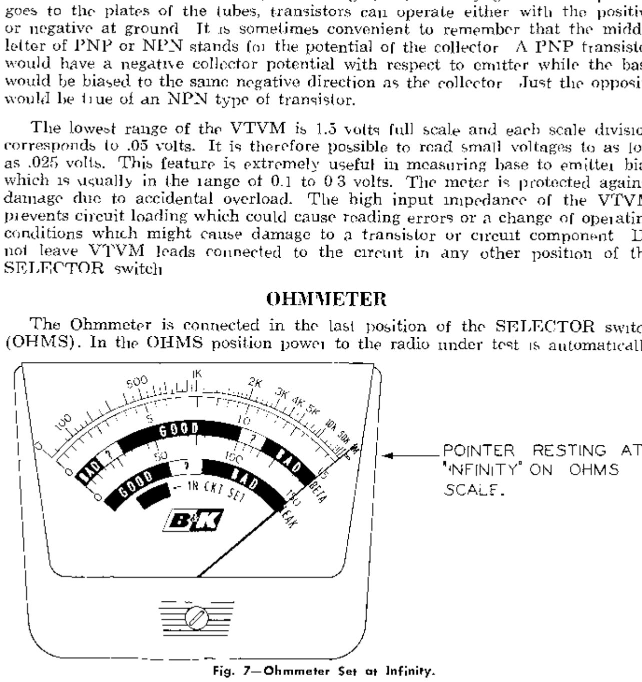


Fig. 7—Ohmmeter Set at Infinity.

disconnected. To operate the Ohmmeter insert two test leads into the red and black jacks marked VTVM. Short the ends of the two test leads together and adjust the front panel control marked VTVM ZERO until the pointer on the meter reads on the left side of the meter scale.

With the test leads open adjust the front panel control marked VTVM OHMS until the pointer comes to rest at the infinity point (∞) at the right hand edge of the meter scale. See Fig 7. You can now read the value of resistance by connecting the test leads across the part to be measured.

Capacitors can also be tested for leakage or shorts by connecting the test leads across the suspected capacitor. Since the voltage at the terminals of the leads is no more than 1.5 volts you can test all capacitors found in transistor radios without danger of damaging them. When testing electrolytics be sure to observe polarity. Reverse polarity across an electrolytic can destroy the capacitor The red jack on the panel is positive with respect to the black jack

The front to back ratio of diodes can also be measured on the Ohmmeter. The resistance in the forward direction should be quite low while in the reverse direction the resistance should be quite high. A front to back ratio of about 100 to 1 is common for a good diode If the resistance of the diode in both directions is equal. that is very high or very low, then the diode is defective and should be replaced.

AUDIO SIGNAL INJECTION

The next function of the Analyst to be covered is the Audio Signal Injection section. The audio injection circuits of the Analyst are in operation in all positions of the Selector switch except OFF. Two outputs are provided· One (marked

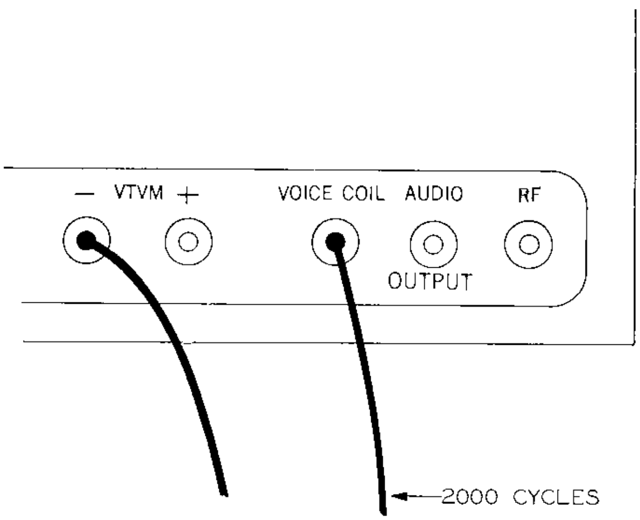


Fig. 8—Voice Coil Injection.

VOICE COIL) is for low impedance circuits such as loudspeaker voice coils Fig 8 shows test leads connected for VOICE COIL SIGNAL INJECTION The (—) minus lead from VTVM jack is necessary only for Voice Coil Signal Injection

The second (marked AUDIO OUTPUT) is used for all other Audio Signal Injection functions. See Fig. 9. The ground return for Audio Output Signal Injection is provided for through the Analyst power supply and the negative lead from VTVM must not be used

The output level at the AUDIO OUTPUT jack is adjustable by means of the control marked AUDIO R.F. LEVEL. When this control is turned fully clockwise to the MOD OFF position, the audio signal is turned off. Since the same audio signal that is used for audio injection is also used for Modulation of the R F-I F, this is a means of turning the Modulation off.

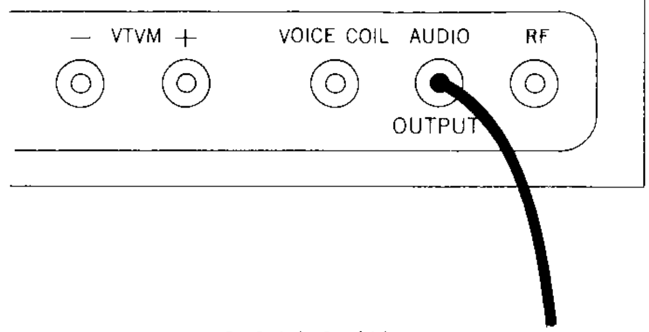


Fig. 9—Audio Signal Injection

In order to become familiar with audio signal injection we will practice signal injection on a known good radio and observe the effect of this signal Signal Injection in transistor devices is similar to that used in vacuum tube circuits. The signal in vacuum tube stages is normally fed into the grid In transistors it is generally fed into the base In the vacuum tube circuit the output is usually from the plate In transistors it is usually from the collector The main difference, of course, is that the vacuum tube is a voltage amplifying device while the transistor is a current amplifying device Fig 10* is a schematic of a typical six transistor radio. Constant reference will be made throughout this instruction book to Fig 10. For this reason it is a large pull out page printed at the rear of the book This will enable the reader to refer to it easily regardless of what page in the instruction book you are reading.

In order to use the Signal Injection of the Analyst only one test lead must be used, except in the case of Voice Coil injection. For Voice Coil injection the common or ground lead is connected to the — (minus) jack of the VTVM The lead with the Red test prod is inserted into the jack marked VOICE COIL. See Fig 8 The test lead plugged into the Analyst as shown in Fig 8 must now be connected to the radio The ground or common lead is connected to the ground point of the radio In the schematic of Fig. 10 this point could be the positive terminal of the battery or the + of the Analyst power supply

With the common lead connected to the radio. Touch the test prod to the hot side of the loudspeaker voice coil This is point 34 on the schematic of Fig 10

*Courtesy of Howard W. Sams & Company

The AUDIO R F LEVEL control should be in any position other than MOD OFF. You should now hear the 2000 cycle audio tone in the loudspeaker. This would indicate that not only is the loudspeaker operating properly, but so are the contacts of the earphone plug. This incidentally is a common source of trouble in transistor portables. If these contacts do not make properly the lead to the loudspeaker voice coil will be open and a dead radio will result. Now connect the the test prod into the jack marked AUDIO OUTPUT. See Fig. 9. No isolation capacitor is needed since it is within the Analyst. This is the signal source used for all other audio signal injection. The ground lead coming from the (—) minus VTVM jack is no longer needed and should be disconnected.

The next stage to be tested by signal injection will be the push-pull output stage. Touch the test prod to the primary of the push pull driver transformer. This is point 26 in the schematic of Fig. 10. Adjust the level control for an audible signal in the loudspeaker. Presence of a signal indicates that the output stage is capable of passing an audio signal and would not be the source of trouble if the receiver were dead. Other troubles may however occur in the output stage. Distortion is one such trouble. Techniques for locating these other troubles will be explained in following sections of this instruction book.

Now shift the test prod to point 24 which is the base of the audio driver transistor. The level of the signal heard in the loudspeaker will increase substantially due to the added gain provided by the driver stage. The signal may be restored to a lower level by reducing the level control of the Analyst. For this and subsequent tests be sure the radio volume control is at maximum gain. Any trouble that might be present in the audio section of the receiver can easily be isolated to the specific stage by means of this signal injection method.

Action of the volume control can be observed by injecting a signal at point 22. Adjustment of the volume control should cause the volume of the signal to change at the loudspeaker.

Another use for signal injection would be to check the effectiveness of the emitter bypass condenser. Inject signal at point 25. If the bypass capacitor C-7 is operating properly, very little signal will be heard in the loudspeaker. If C-7 is open the signal heard in the loudspeaker will be quite loud, as loud as the signal would be when the probe is brought to the base of the same transistor. Typical troubles and the test procedures to be followed will be explained in detail in other sections of this manual.

RF-IF SIGNAL INJECTION

RF IF Signal Injection is accomplished using the calibrated signal generator. The tuning range of the generator is from 250 kc to 2.2 mc. Two ranges are employed namely Bands A and B. Band A tunes from 250 kc to 850 kc. This is the upper scale on the panel. See Fig. 11.

Since Band A covers the IF frequency range the two most common IF frequencies are marked on the dial. These points are 262 kc and 455 kc. Band B tunes from 800 kc to 2200 kc, or 2.2 mc. This range would be used most commonly for signal injection into RF stages. The RF-IF signal generator can be turned OFF, or BAND A or BAND B can be selected by means of the Band Selector switch. This switch is located just above the RF output jack and is shown in Fig. 12.

The upper position of the switch is OFF. In this position the signal generator is turned OFF. The middle position is BAND A and the lower position is BAND B.

The output from this signal generator is taken from the RF output jack. See Fig. 12. No ground connection to the (—) minus VTVM jack is necessary and should not be used. The level control for the signal generator is located above the output jacks. This is the same control that is used to adjust the Audio level

The RF-IF oscillator is AM modulated with a 2000 cycle audio tone. To turn the modulation OFF, rotate the AUDIO-RF level control fully clockwise until the switch clicks at the MOD OFF position. For normal RF and IF signal injection the modulation would be left on. In the event that the local oscillator of the receiver is to be replaced with the signal from the Analyst, the modulation would be turned OFF.

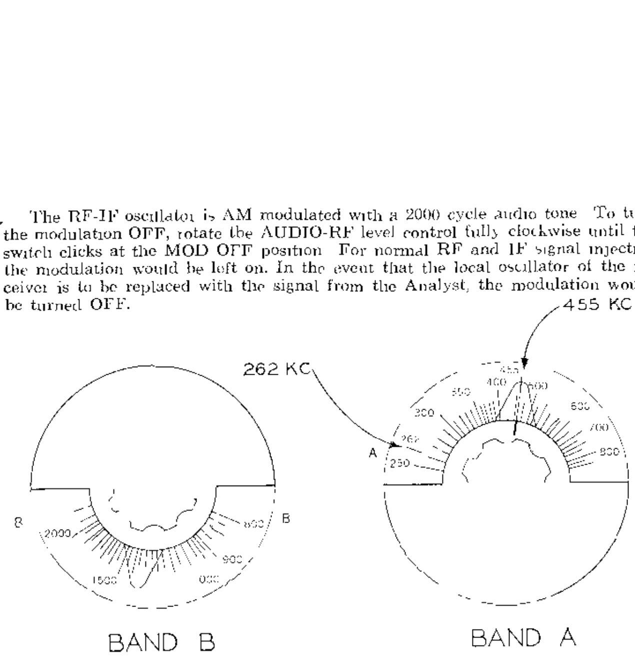


Fig. 11—RF-IF Tuning Dial.

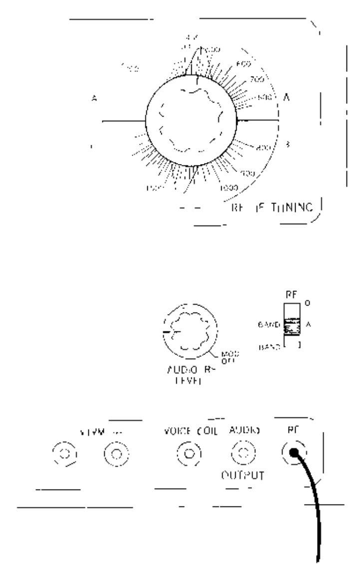


Fig. 12—Signal Generating Section

We are now ready to practice signal injection on a known good radio to become familiar with this technique Fig 12 shows the test lead connected for signal injection. The Band selector switch is shown set to Band A. The pointer on the tuning dial is set so that the hairline on the plastic pointer is on 455 kc since this is the I F frequency of the radio we are testing The test lead with the test prod on one end is connected to the R F output of the Analyst.

Before signal injection the radio must be disabled by wrapping a single shorted turn of wire around the loopstick antenna. This will prevent the radio from picking up any broadcast stations that would produce faulty indications In normal use this would not be necessary since the radio is defective and will not normally pick up a station

We are now ready to begin Signal injection. The BAND switch should be in the BAND A position and the R.F-I F TUNING set to 455 on the A dial. Touch the test prod to point 19 of Fig. 10 This is the input to the diode detector. For injection at this point the level control would normally be set to maximum. Be sure the switch does not click since this will turn the modulation Off. The 2000 cycle test tone will now be heard in the loudspeaker. If the sound fails to appear in the loudspeaker be sure to advance the volume control until the sound is heard. By switching the Range Switch to the 15 ma position you may watch the supply current increase as the signal is injected and becomes stronger This same feature can be used as a tuning indicator in alignment

Since the volume control appears between the source of signal and the loudspeaker, it will control the amount of sound heard in the loudspeaker. We would not normally expect the intensity of the test tone in the loudspeaker to be very loud since there is little amplification being provided for the signal

Move the test prod from point 19 and touch it to point 16. If the signal is again heard in the loudspeaker we have proved that transformer L-5 is operating If the Signal Generator frequency is changed the signal will get weaker as it is detuned away from the proper I F frequency

Reset the generator back to 455 kc Shift the test prod from point 16 to point 15. We are now feeding the signal into the base of the 2nd I.F. amplifier Since the signal is now being amplified by the 2nd I F. amplifier, the level of the signal heard in the loudspeaker will increase substantially Reduce the level control on the Analyst to compensate for this increase in gain Always work with the minimum amount of signal in order to prevent overload of the amplifier stages in the receiver.

We have now demonstrated that from the Base of the 2nd I.F amplifier to the loudspeaker the radio is operating properly. Shift the test prod to point 10 of Fig 10 This is the Base of the 1st I F. amplifier With another stage of gain present the signal should again increase in level at the loudspeaker Again reduce the level control of the Analyst to compensate for this increase in gain Since the signal can be heard when injected into the base of the 1st I F amplifier transistor, we have demonstrated that the I F system and audio system are operating normally.

The next point that we will inject signal into is point 2 This is the base of the converter transistor Although some I F. signal will get through, the signal at this point is in the R.F range and the Signal Generator must be retuned to an R F frequency Let us use 1 0 mc For this frequency the Band selector switch must be set to Band B and the R F-I F TUNING dial set to 1 0 mc (1000 kc). This is illustrated in Fig. 13.

The radio must also be tuned to 1 mc. Touch the test prod to point 2 The signal should now be heard in the loudspeaker at full volume since all of the gain of the radio is now in use

The oscillator section may be tested for oscillation by measuring the base to emitter voltage. This voltage should change slightly as the variable tuning capacitor is rotated through its range

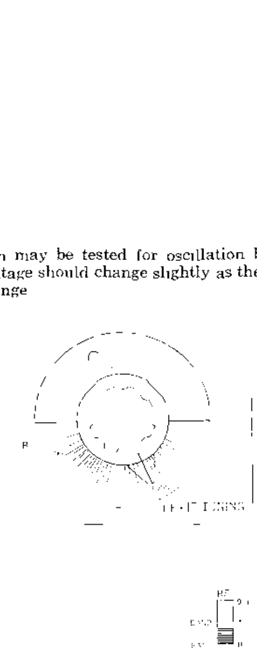


Fig. 13—Setting for 1 mc Operation

IF ALIGNMENT

IF Alignment normally consists of peaking each of the IF transformers for maximum output

If all the stages are operating properly, connect the lead from the RF jack to the base of the converter. (Point 2 of Fig 10) Set the R F-I F TUNING dial for 455 kc (or whatever frequency the manufacturer suggests). The R F Band switch to BAND A The modulation on — set the tuning dial on the radio to 1600 K C.

The VTVM should be set to the 1.5V range Connect the negative lead of the VTVM to the output of the diode detector—point 20 on Fig 10. In this case the + lead will be placed at ground Use as low a signal level as possible Adjust each IF transformer for a maximum reading on the VTVM

RF ALIGNMENT

Remove the shorted turn across the antenna if one was used during the IF alignment The RF section of the receiver may be aligned by feeding the RF signal thru C 8 into the antenna or loosely coupling to the loopstick To loosely couple lay the RF lead close to the loopstick, but do not electrically connect to its wires

Set the generator to BAND B (1500 kc) Rotate the tuning control of the radio until a maximum is seen on the meter close to the same frequency as the generator The signal should be heard thru the loudspeaker. If the maximum is noted at a slightly higher frequency setting on the radio dial move the radio dial to 1500 kc and unscrew the trimmer A4 until a maximum is again seen The trimmer should be adjusted in the opposite direction if the radio had originally tuned to a lower frequency. While at the same frequency adjust the trimmer A5 across the RF part of the variable condenser, for a maximum

If the RF and oscillator coils had slugs in them for low frequency adjustment the procedure would be the same except that the slugs would be adjusted at 600 kc rather than the trimmers. Then go to the 1500 kc adjustment described above and adjust the trimmer. Repeat the low and high methods above until no further adjustment is necessary.

Instead of connecting to the diode output, when making adjustments for maximum, you may switch the SELECTOR switch to one of the current ranges The meter reading will go up as the circuits are tuned This is primarily true of radios with a push-pull output stage The volume control should of course be turned up to a comfortable level.

Note If the radios own batteries are used and the analyst power supply is not used, the negative lead of the VTVM must be connected to the radio ground during signal injection or alignment.

This completes the explanation of the various controls and signals that are incorporated in the Model 960 Transistor Radio Analyst. It would be worth while for the technician to repeat this portion of the Instruction Manual to gain the greatest possible degree of familiarity with the instrument

VOLTAGE READINGS AND THEIR SIGNIFICANCE IN TROUBLE SHOOTING TRANSISTOR RADIOS

The logical sequence of operation is to isolate trouble to a particular stage or section of the radio and then within that stage or section determine the specific fault The isolation of a trouble to a particular stage is normally accomplished by means of Signal Injection

Signal injection begins at the loudspeaker end of the radio and then the signal is injected stage by stage until the point is reached where no signal is passed The defective stage has thus been located It is the technique of determining the trouble in a specific stage that will be explained in this section

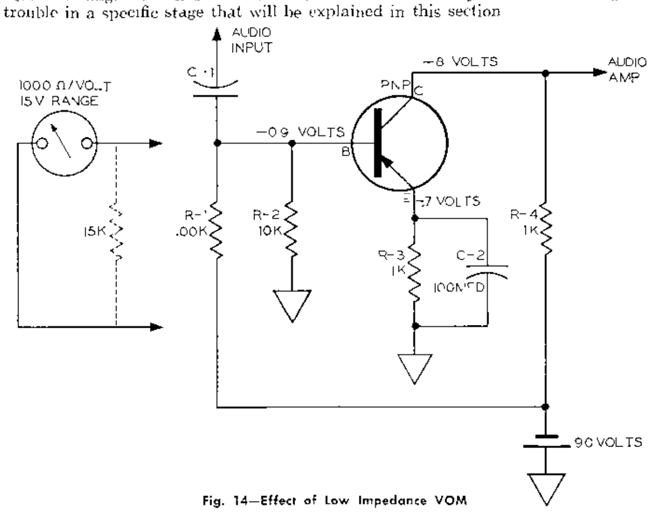


Fig. 14—Effect of Low Impedance VOM

The voltage check method of determining the proper operating condition of a transistor circuit is very easily accomplished One of the requirements of voltage readings is that the measuring instrument present a very high impedance to the circuit This is necessary to prevent the meter resistance from upsetting the operating conditions of the transistor stage For example Fig 14 shows the schematic diagram of a simple audio amplifier employing a PNP transistor

If a 1,000 ohm per volt meter on a 15 volt range were connected across the 10K resistor (R-2) used to bias the base of this transistor, observe what would happen. Since the meter is 1,000 ohms per volt and the full scale reading is 15 volts, the meter resistance is 15 000 ohms If 15 000 ohms were connected in parallel with a 10 000 ohm resistor the net resistance would be 6 000 ohms. This is going to greatly decrease the bias to the base of the transistor and will completely change its operating conditions. It is for this reason that the volt meter employed in the Analyst is a VTVM with a high input impedance Therefore, under no circumstances will the test meter load the circuit and upset the operating conditions of the transistor

Most transistor circuits that are used in portable radios operate, insofar as D.C is concerned, in an almost identical manner. Examination of these circuits will show that they have the same basic parts as the simple schematic shows in Fig. 14. For example, in Fig 14 the resistor R-3 located in the emitter circuit will be found in practically all stages of the transistor radio. The resistor R-2 connected from base to ground in Fig 14 is 10K and is part of the bias stabilizing circuit The 100K resistor R-1 in the base circuit which connects to the negative terminal of the battery is employed to bias the transistor to the proper operating conditions.

Note Since the normal Base Current is very small its D C voltage comes primarily from the voltage divider network. This is the junction of the 100K and 10K resistors

For this reason an incorrect base voltage reading is usually attributable to some component in the base circuit rather than from the components in the emitter or collector circuits

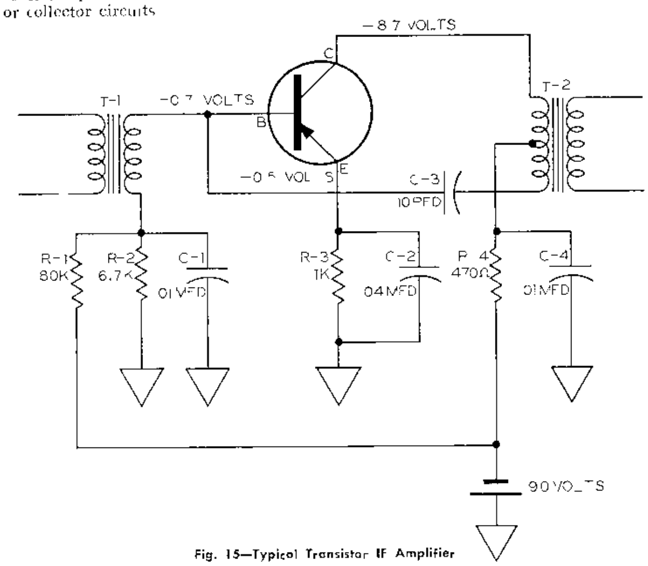


Fig. 15—Typical Transistor IF Amplifier

We will now compare the simple audio amplifier in Fig 14 to a typical I.F. amplifier Notice that from a D C standpoint resistor R 2 of Fig. 15 goes to ground from the base of the transistor just as R 2 does in Fig 14 Also notice that resistor R-1 effectively connects from the base back to battery minus just as R-1 does in Fig. 14 The outstanding difference is that there is a transformer winding in series between the bias network and the base. This is the means whereby the A.C signal, which is to be amplified, is fed to the base of the transistor. Capacitor C-1 in Fig 15 is present to decouple and place at signal ground potential the bottom end of the transformer winding Notice that R-3 and C-2 are present in the emitter circuit to ground in both Fig 14 and 15, and that in both circuits R 3 is by-passed with capacitor C-2 to prevent A C. signal degeneration. The load impedance for the I.F. amplifier in Fig 15 is the primary of transformer T 2 whereas in Fig 14 the load impedance is R 4, a 1 000 ohm resistor. This, of course, is necessary since the operating frequency of the circuit in Fig. 15 is approximately 455 kc and uses a transformer for inter stage coupling

This comparison between a simple AF amplifier and a simple I F. amplifier shows that from a D C point of view these stages are similar in configuration, except that the absolute value of the circuit components are selected to satisfy the requirements of the different transistors.

A SIMPLE METHOD OF MEASURING TRANSISTOR OPERATING VOLTAGES

This method does not require the technician to know whether the transistor is PNP or NPN, and further this method does not require any arithmetic to determine the operating bias of the transistor stage

Connect one test prod of the VTVM to the emitter lead of a transistor in an operating radio Touch the other lead to the collector If the meter reads negatively, reverse the test prods so that the meter reads up scale The voltage that is read in this manner should be slightly less than the battery voltage The actual value of this voltage will be determined by the size of the emitter resistor and how much resistance is present in the collector circuit Lift the test prod from the collector lead and shift it to the base lead The meter must read up scale again and the magnitude of the voltage should be 0 1 to 0 4 volts This is the range of emitter base bias that will be found on most transistors in portable radios Note: A voltage of opposite polarity may be present on operating oscillator stages

Let us see the advantage of this method of measuring voltage in a transistor circuit where the collector is operated at ground potential. This is shown in Fig 16. The collector load in this case is a coil of 4 ohms resistance. The emitter resistance is 100 ohms and the problem is to determine the operating bias between base and emitter in this transistor. Connect the positive lead of the VTVM to ground, touch the negative lead of the VTVM to the emitter we now read —8 4 volts. Now shift the minus test prod to the base of the transistor in Fig 16 and record the voltage This voltage is —8.2 volts By subtraction we see that the base emitter bias is 0 2 volts and that the base is positive with respect to the emitter which is the proper polarity for an NPN transistor. Now let us measure the operating voltage with the method just outlined above. Notice that this will be performed without knowing what polarities are involved.

Touch one of the test prods to the emitter lead and the other test prod to the collector lead. The voltmeter should now read up scale. If it does not, reverse the test prods so that the meter does read up scale The meter should now read approximately 8 4 volts. The difference between 8 4 volts and the battery voltage which is 9 represents the voltage drop across the emitter resistor Since the resistance in the collector circuit is extremely low, there is practically no D.C. voltage drop Now shift the test prod from the collector lead to the base lead and the meter will again read up scale and the voltmeter should read 0 2 volts. The absolute value of the voltage is correct, and since the base is biased in the same direction as the collector this stage has the proper operating potentials and polarities.

This technique will be very useful in the trouble shooting of transistor radios and will be used extensively to determine whether a transistor stage has the proper operating conditions

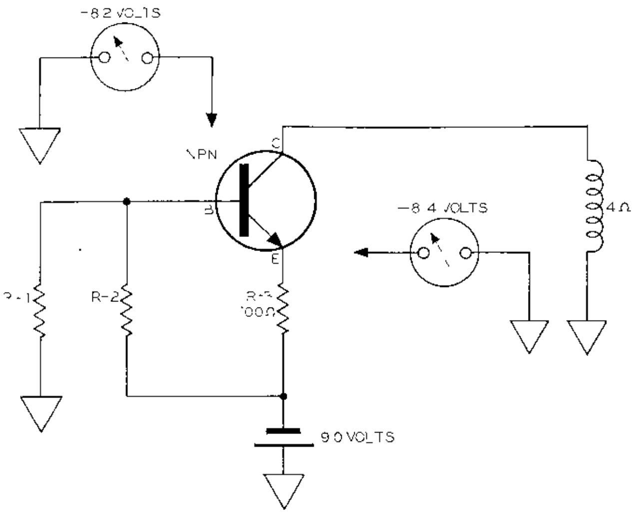


Fig. 16—Voltages to Ground.

Voltage readings can supply much information about a transistor stage. We will examine therefore, a few different circuits that have abnormal voltage readings and see what defects in the circuit could cause these readings to occur. Let us assume the circuit and voltages of Fig. 15 represents the normal condition. Fig 17 shows the same circuit as Fig 15 except that the voltage readings are in error.

Measurement shows that the base to emitter bias is zero and that the collector voltage is at full battery potential Observation of the base circuit shows that the bias for this stage is obtained by means of a voltage divider R-1 and R-2 connected from the battery to ground With the base and the emitter at the same potential there is no forward bias on the transistor and little or no collector current flows. This can be seen from the fact that the collector voltage is the full 9 volts of the battery, i e. no drop across R-4 Since we note also that there is no voltage drop across R-3 we may safely assume no current is flowing in the collector and emitter circuits. A voltage check is now called for at the junction of R-2 and R-1 If there were voltage present at this point then transformer T-1 would be suspected of being open Since no voltage is present at the junction of R-1 and R-2 then capacitor C-1 might be shorted or R 1 might be open. R-2 of course could be shorted but this is unlikely We can conclude that since the base voltage is obtained from a voltage divider directly from the battery that abnormal voltages at the base of the transistor are usually due to a defect in the base circuit of the transistor stage in question. In the above case no emitter current flowed because there was no forward bias between emitter and base With no emitter current there would be no collector current. The transistor is practically speaking cut off

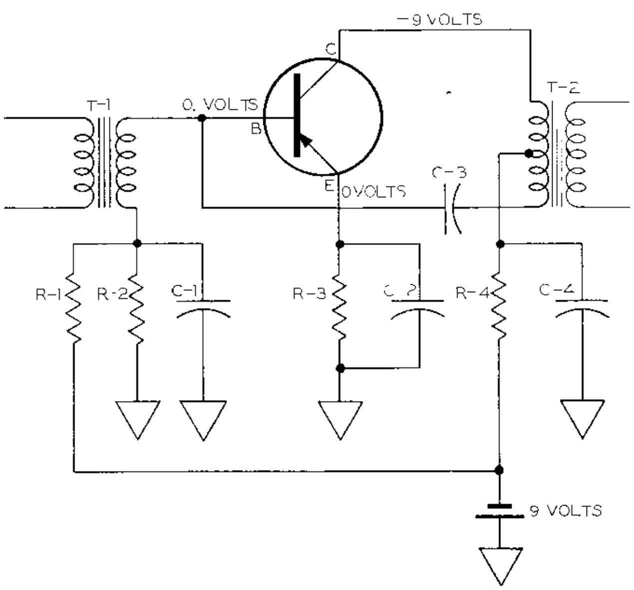


Fig. 17—Defective IF Amplifier (0 Base Voltage).

Fig 18 shows the same stage as previously discussed except that a new set of voltages are shown to represent another type of trouble Notice that the base potential is approximately normal and from the conclusion drawn from the previous section we would not suspect trouble in the base circuit The collector has voltage on it and therefore the D C. path back to the battery supply must be O K Since the collector potential is at the full battery voltage this would indicate that there is no voltage drop in the collector circuit and therefore no current flowing

Since the base to emitter junction is very low resistance the base or emitter will rise to the potential of the other if either one of them is open in their external circuit Since the base has approximately the correct voltage the trouble must be in the emitter circuit An ohmmeter measurement of emitter to ground in this case would show an open circuit (R-3 is open) The fact that the emitter does have a voltage is very misleading unless you remember that the resistance of the base emitter junction is quite low and if either is open they will assume the same voltage

Since the power consumption in these circuits is quite low it is rather unusual that a resistor will actually open Cracked printed circuit boards and poor solder connections will most frequently account for open circuits of this nature The exception to this case would be in power output stages where the power capabilities of the circuit are such that a resistor can actually burn out. This would be most evident by inspection since the resistor in question would be visibly charred The bias voltages on a transistor are so very important that they must be measured accurately and close attention must be paid to small differences. For example in

the case just discussed, the emitter voltage differed from its normal value by 0 2 volts and the collector voltage varied from its normal value by about 0 3 volts. It is these small changes in voltage that supply the clue to determine the defect in a transistor circuit

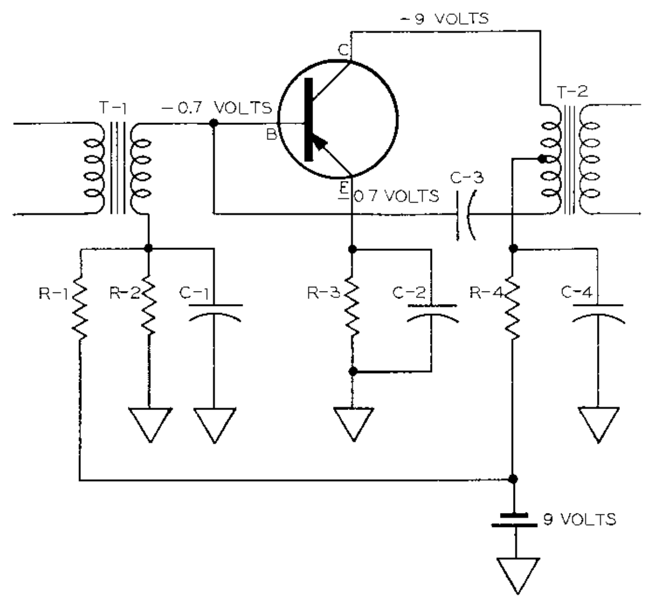


Fig. 18—Defective IF Amplifier (No Forward Bias).

The third class of trouble that can quickly be determined by means of voltage readings at the transistor is the case where the collector potential is far from normal This is shown in Fig. 19. The potential from collector to emitter is zero or very near zero Voltage does exist between base and emitter although they may not be normal. This trouble must be due to an open circuit or a short circuit to ground in the collector This could be an open T-2 or R-4 or a shorted C-4. If C-4 were shorted this would also show up as abnormally high current drawn from the battery.

The methods just outlined show the symptoms that may occur in a transistor circuit and the way in which the voltages will react. There is the case however where the transistor itself is at fault We will now look into some of the ways in which a transistor may become defective and the effect that these defects have on the circuit voltages.

If any element in a transistor should become open circuited this will result in loss of collector current The voltage in the collector circuit will rise to the full battery voltage. This is due to the fact that since no collector current flows there can be no voltage drop across the collector load impedance T-2 or across R-4 in Fig 19

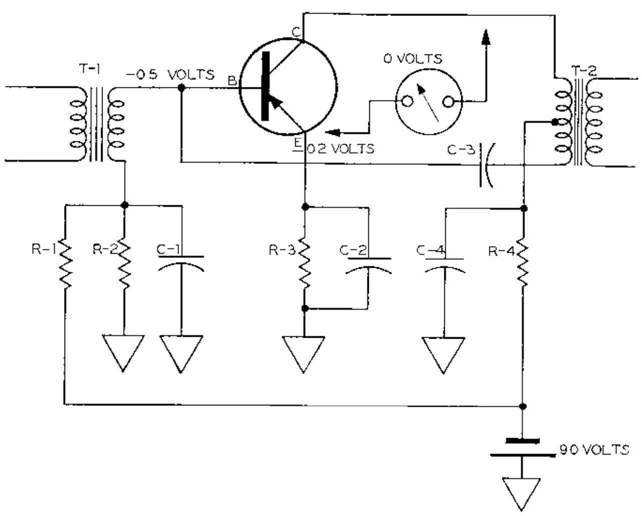


Fig. 19—Defective IF Amplifier (0 Collector Voltage)

If the base of the transistor were to open there would be no forward bias on the transistor and the collector current would cease to flow. If the emitter were to open the collector current would again cease to flow since the collector current must flow through the emitter circuit. It also follows that if the collector circuit were to open no collector current would flow and the emitter voltage would assume the same potential as the base. Since the base voltage is obtained from a voltage divider, the base potential will be normal or even higher since the base voltage divider is not loaded by the transistor when the collector is open.

Perhaps a more common defect that will occur in low power transistors found in portable radios is their tendency to develop high internal leakage. When this occurs it is usually accompanied by an increase in collector current. The base voltage will usually remain at its normal value, but due to the increase in collector current (which also flows through the emitter resistance) the emitter voltage will increase. If the leakage of the transistor is great enough the emitter voltage can increase enough to reverse the bias on the transistor. With reverse bias you would expect the transistor to be cut off and have no collector current, but because of the internal transistor leakage the collector current actually increases. The voltage distribution for this leakage condition is shown in Fig. 20.

Examination of Fig 20 shows that the collector voltage has dropped considerably from its normal voltage. The emitter voltage has risen to 3 volts from its normal 0.5 volts and the base voltage is approximately at its correct value. This

represents a transistor with very high leakage and it is possible that if this condition were allowed to continue the transistor would destroy itself due to excecessive collector dissipation. This would then result in an open or shorted transistor.

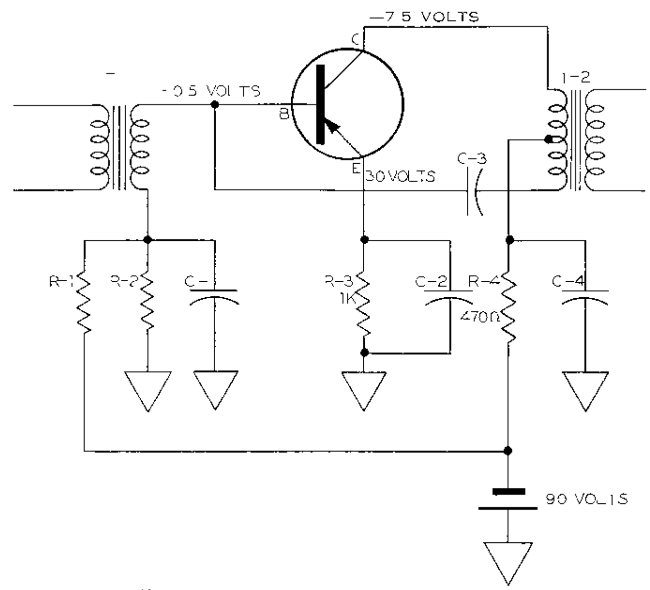


Fig. 20—Defective IF Amplifier (High Emitter Voltage).

A.G.C. OPERATION & TESTING

The purpose of the A.G.C. (Automatic Gain Control) is to maintain the output volume of the receiver at an equal level even though the signal levels received from each station are different.

It should be remembered that a forward Bias is needed between Base and Emitter in order for conduction and transistor action to take place. If this Bias is lowered the gain of the stage will gradually decrease. The aforementioned is, of course, taken within the normal operating limits of the transistor.

A.G.C. simply decreases the bias (less gain) for strong stations. The stronger the station the less bias and the less gain. Weak stations will therefore be operating with the transistors in their maximum gain position. This will tend to make all stations have about the same level of output.

When an I.F. signal is fed through transformer L-5 to the 1N60 diode a pulsating D.C. current will flow. Using the conventional flow of current (+ to —) the diode will conduct as follows:

(a) Thru the secondary of L-5 down and thru resistor R-6 to ground. Since the first side of a resistor that the plus hits (in conventional flow) is positive, it will make the top of resistor R 6 'more positive' than it was before

(b) From ground it will go up through resistor R 7 and thru R-10 and R 9 back to the anode of the diode

This is the D C path of the diode If a measurement were taken it would be noted that the top of resistor R 6 is negative The negative voltage is caused by the battery supply. The reason, in (a) above, the expression 'more positive' was used, was to indicate that the voltage went more positive than it was previously. If it was normally — 7V and it went to — 6V, it would have gone 1 volts more positive

The base of X2 is driven more positive than it was and the bias is therefore decreased lowering the gain of the stage The stronger the I.F. signal, the more the bias will decrease We therefore have A G C action on the 1st I F amplifier

Following the A G C. circuit how do we get A.G.C. action on the 2nd I.F ? As the Base of the 1st I.F. decreased its forward Bias, this decreased the emitter current The voltage drop across R-7 therefore decreases Since the normal voltage at the top of R 7 is negative, and it decreases, it therefore went more positive Noting that the Base of the 2nd I F is connected thru the secondary of L-4 to the emitter of X2 and that the emitter voltage went less negative (more positive) we see that the forward Bias of X3 was likewise decreased The gain therefore was decreased depending on the strength of the input signal

To measure these voltages connect the negative lead of the VTVM to the A G C line point 11 of Fig 10 The positive lead would then go to the emitter of X2 (point 13) Feed an R F signal from the Analyst into the antenna thru C-8 As the radio is tuned thru the frequency of the R.F signal the A.G C voltage will be seen to decrease when the signal generator is tuned in A similar reading may be taken for the 2nd I.F by connecting the negative lead of the VTVM to point 13 and the positive lead to point 17 The forward bias will again decrease as the Signal Generator frequency is tuned in

GENERAL TROUBLE SHOOTING PROCEDURE

Trouble shooting with the Model 960 Analyst is a logical and simple series of steps Following this procedure should quickly isolate the defect Once the stage is isolated, proceed to Step 7 without performing the intermediate steps

1 **TEST THE RADIO POWER SUPPLY.** This is automatically accomplished by using the internal power supply of the Analyst. Once connected the total radio current is measured by switching to the 150 ma or 15 ma positions of the SELECTOR switch. If the current is as expected, proceed to the next step. If it is not, then trouble shoot the power supply section of the radio.

Connections to the Analyst power supply are fully described in the section entitled POWER SUPPLY JACKS Typical power supply difficulties are listed in section entitled POWER SUPPLY TROUBLES

2. **DYNA TRACE** the entire radio for a transistor defect or a transistor circuit trouble This should isolate most troubles

The use of the Dyna Trace is explained in the section entitled IN CKT DYNA TRACE Troubles found with the Dyna Trace are in each section of the trouble shooting examples.

3. **AUDIO SIGNAL INJECT** into the loudspeaker and then into the AF sections AF Signal injection is explained in the section entitled AUDIO SIGNAL INJECTION Typical AF troubles are in section entitled AUDIO TROUBLES

Note. The entire AF section may be checked out to see if it is functioning by Signal Injection into the Base of the 1st AF stage (usually the top of the volume control with the control at maximum) If the AF operates proceed to the next step. If not, start at the loudspeaker and work stage by stage toward the detector

4. **I.F. SIGNAL INJECT** into each stage of the IF section IF Signal injection is explained in the section entitled RF-IF SIGNAL INJECTION Typical IF troubles in section entitled IF TROUBLES

5 **R.F. SIGNAL INJECT** into the mixer stage. If the stage operates proceed to the RF section If not, check to see if the oscillator is operating

Mixer and RF Signal Injection is explained in section entitled RF-IF SIGNAL INJECTION. Typical RF and Oscillator troubles in the section entitled RF MIXER OSCILLATOR TROUBLES.

6 **DETECTOR A.G.C. TEST** may be made by feeding a signal into the antenna and measuring the voltage developed across the A G.C. line. The VTVM should be used for these measurements

A more complete explanation of A G C. voltage measurements is found in the section entitled A G.C. OPERATION & TESTING. Typical troubles in the section entitled A G C TROUBLES.

7 **DC VOLTAGES & RESISTANCES.** If the trouble encountered was not picked up in Steps 1 & 2 of the above, the DC circuits and transistors are probably operating correctly. The Signal Injection method therefore will normally isolate the defective stage.

Once the stage is isolated, check the voltages around the transistor Then proceed to take Ohmmeter checks. Remember to test the electrolytics with the Ohmmeter (Use proper polarity.)

Voltmeter and Ohmmeter operation is explained more fully in the section entitled VTVM and OHMMETER respectively

8 **INTERMITTENTS** are tested as above with emphasis placed on stage isolation. Typical intermittents are shown in the section entitled TROUBLE SHOOTING INTERMITTENTS

POWER SUPPLY TROUBLES

EXAMPLE NO. 1:

The first trouble is a radio brought into the shop as dead The first step in all cases is to connect the radio to the power supply of the Analyst. (Step 1 of the General Trouble Shooting Procedure.) The radio shown in the schematic of Fig 10 will be used for the trouble shooting Since this radio requires 6 volts for operation we connect the power supply test leads into the jacks marked O" and "6" The schematic shows that positive is ground and we connect the positive lead from the power supply to the positive terminal of the battery holder and the negative lead of the power supply to the negative end of he battery holder This is shown in Fig. 21

Turn the selector switch to the 150 ma position and turn the radio on. The Analyst is now supplying power to the radio and the amount of current that is being drawn is shown on the meter The schematic shows that the normal current is 4 ma If the current is greatly in excess of this value, turn off the Analyst and check the power supply connections to make sure that the proper polarity has been observed Improper polarity will put reverse voltage on the electrolytics and cause excessive current This could damage the electrolytics. This value of 4 ma is the current drawn by the radio with the volume turned to minimum or the radio tuned off-station.

The radio that we are servicing shows a power supply current of about 60 ma This would indicate a short circuit in the power lead feeding B— to the radio or an improperly biased transistor that was drawing excessive current

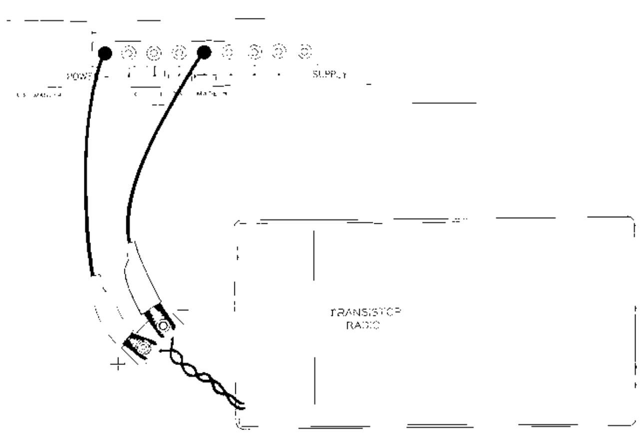


Fig 21—Analyst Connected to Radio.

If a vacuum tube voltmeter reading at point 28 of Fig. 10, shows a reading of about 6 volts, this would be correct However, at the other side of R 13 (a de-coupling resistor) the voltage is zero This indicates that the de-coupled B— supply is shorted The trouble is probably a short in capacitor C-2 This type of trouble where the large electrolytic capacitor on the B— line shorts out is very common in transistor radio portables. It will in all cases show up as an abnormally high power supply current

EXAMPLE NO. 2:

Another typical trouble that might be encountered is a customer complaint of motorboating

When the radio is operated on the customer's battery the set motorboats, but when the radio is connected to the Analyst power supply (Step 1 of General Trouble Shooting Procedure) the motorboating stops This can be due to a defective battery which has high internal resistance or it can be due to an open electrolytic in the radio This electrolytic is usually connected across the battery (see C 1 in Fig 10) The reason the set stopped motorboating is because the Analyst has a large capacitor in its output circuit and took the place of the defective part C-1

The first trouble shooting step is to replace the battery If the motorboating persists jump another capacitor of equal value across C-1. With the additional capacitor across C-1 the motorboating stops This shows that C 1 is open and should be replaced

AUDIO TROUBLES

EXAMPLE NO 1:

The complaint in this case is a dead set Step 1 of the General Trouble Shooting Procedure shows a slightly lower than normal battery current. Step 2 shows that the Audio Driver stage X4 is inoperative. Proceeding to Step 7 shows that the Base voltage is correct. The emitter voltage is slightly lower than normal The Collector voltage, however, is 0.

There are two normal possibilities that would reduce the collector voltage to 0 The first would be a short in the collector circuit to ground The other would be an open in the D C. supply to the collector A short in the collector circuit would have resulted in high battery current so we may therefore eliminate this as a possibility An open in the D.C supply to the collector satisfies the 0 voltage at the collector and also accounts for the lower than normal battery current Measurements with the Ohmmeter show that the primary of T-1 is defective.

EXAMPLE NO. 2:

The symptom is a dead set. Step 1 shows normal current from the supply. Step 2 also responds correctly.

In Step 3 the signal is heard properly through point 24 on Fig. 10 At point 22, however, no signal is heard First, we would make certain that the volume control is at maximum since this could cause the same effect. Since each stage is in operation as shown by the Dyna-Trace tests, the problem is probably in the signal circuit This would make us suspect capacitor C-6 An ohmmeter check shows it to be open.

EXAMPLE NO. 3:

The next problem is one of excessive distortion Step 1 indicates higher than normal battery current In Step 3 the signal becomes distorted when moved from point 29 to point 24 It was clear on point 29, but distorted on 24.

Going to Step 7, the emitter voltage of X-2 is excessively high This coupled with the higher than normal current of Step 1 would cause the transistor to be suspected of leakage An OUT CKT test of the transistor confirms our suspicion.

IF TROUBLES

EXAMPLE NO. 1:

The trouble in this example is a dead set Step 1 of the General Trouble Shooting Procedure shows up a slightly less than normal battery current

In Step 2 the Dyna-Trace shows X2 to be inoperative because the meter did not go above the green portion of the scale

Skipping to Step 7 indicates no collector voltage (point 12) Measuring point 6 we find about —5 4 volts the B— to L4 An Ohmmeter check shows that the copper foil going to the collector from the primary of L 4 is open Soldering the break repairs the trouble

Another defect that could cause this same set of conditions would be L 4 internally open The Ohmmeter would also show this up

EXAMPLE NO. 2:

The Trouble in this example is that the set squeals when a station is tuned in.

Steps 1, 2 & 3 indicate proper operation Step 4 produces the squeal when a 455 kc signal is injected at the Base of X2 (point 10), but not at the Base of X3 (point 15)

Signal Injecting at the Collector of X2 (point 12) also produces the squeal The trouble is between the Collector of X2 and the Base of X3

Since the stage is probably oscillating we would replace C-13 (the neutralization capacitor) which would eliminate the trouble.

A fine point here—the reason we did beat with the oscillation when we connected to point 15 is because our signal lead loaded the Base of X3 to the point where it would not oscillate. By going to the other side of the transformer the loading was reduced and the stage oscillated with our injected signal

EXAMPLE NO. 3:

In the next case the problem is very low output. Steps 1 2 & 3 indicate proper operation Signal injecting at point 16 we find ample output Going to point 15 the gain does not increase particularly. The signal injected at point 17 has as much gain as at 15 This immediately points to C-14 as being open. Replacement eliminates the trouble

We would not normally have Signal Injected into the emitter circuit, but this was called for since we did not have gain in the stage We know that an open bypass in this emitter would cause de-generation.

R.F. MIXER — OSCILLATOR TROUBLES

EXAMPLE NO. 1:

Step 1 is OK. Step 2 indicates that X1 is not operating. Step 7 shows all voltages about normal except the emitter is 0V with respect to ground

An ohmmeter test shows the 1500 ohm resistor is correct. The X1 transistor is suspected. Remove the transistor and make the OUT CKT test to confirm that the transistor is defective Replacement will correct the trouble.

EXAMPLE NO. 2:

In the next case the set is dead Steps 1 thru 4 are OK The I F signal can be inserted up thru point 9 R F, however, does not come thru on point 2 Note: When testing the R.F or oscillator do not use a shorted turn around the antenna coil. When the R F -I F. TUNING of the Analyst dial is rotated to a point 455 kc above the frequency to which the radio is tuned, a station is heard. But so is a loud 2000 cycle signal Rotating to the MOD OFF position of the AUDIO R F LEVEL switch eliminates the 2000 cycle note.

Obviously the Analyst is taking the place of the radio local oscillator Step 7 indicates an open oscillator coil Replacing of said coil makes the set operative. Other causes of this could be, open C-9, or a shorted tuning capacitor in the oscillator section

A. G. C. TROUBLES

EXAMPLE NO. 1:

The symptom in this example is that the set is dead. Step 1 of the General Trouble Shooting Procedure shows an approximately normal current. The Dyna-Trace shows that the 1st I F amplifier is inoperative Going directly to Step 7 voltage tests show zero bias (between Base & Emitter) and zero volts to ground

on both the Base & Emitter of X2 An ohmmeter test to ground shows a short from point 11 to ground The electrolytic C-3 is shorted (No forward Bias on X2 therefore no gain and lower battery current)

EXAMPLE NO. 2:

The next receiver carries the complaint that the set is dead Step 1 of the trouble shooting procedure indicates high battery current Step 2 shows that X2 and X3 are inoperative Going directly to Step 7 shows a much larger than normal negative voltage on the bases of X2 and X3 An ohmmeter test shows that R 6 is open; probably an open in the copper foil The base voltage on X2 went up Therefore the emitter voltage on X2 went up due to increased collector current The base of X3 connects D C wise to the emitter of X2 Therefore this base voltage increased. This caused the increase in battery current

TROUBLE SHOOTING INTERMITTENTS

The Transistor Radio Analyst makes it possible for service technicians to easily and conveniently trouble shoot intermittents in transistor portable radios. A brief understanding of the nature of intermittents that can occur in a portable radio will make it that much easier to find these troubles

Most of the intermittents that will be found will be due to mechanical problems Small cracks in a printed circuit board, rosin solder connections of components to the printed circuit board are frequently encountered. Erratic operation of the radio under conditions of high temperature such as might be found in direct sun light or in the trunk of an automobile is another cause which usually can be traced to a defective transistor that has higher than normal leakage This leakage is increased under conditions of high temperature

The principle of trouble shooting intermittents with the signal injection technique can be extremely effective if properly applied. Where an intermittent does occur in the radio and the technician has no knowledge of either the section or stage that is causing this trouble, the particular section or stage can be isolated. This is accomplished by injecting a signal into the receiver, starting at the loudspeaker and working forward toward the antenna. As a signal is injected into each stage or section, the technician examines solder connections in that stage for rosin or open connections on the printed circuit board. He will then flex the board slightly to see if any cracks in the board could cause this difficulty

The temperature of the transistor may be elevated by bringing a small soldering iron close to the transistor Note: Do not overly heat the transistor since this could cause a permanent breakdown When the defective stage is finally reached, careful investigation of each of the above items in the stage will locate the defective component

We will now trouble shoot some typical intermittent troubles that might occur in a transistor radio

EXAMPLE NO. 1:

A radio comes in for service whose schematic is shown in Fig. 10. Step 1 of our General Trouble Shooting Procedure indicates that the radio draws 4.25 ma of current and the schematic shows that 4 ma is the approximate load for this radio Therefore, no abnormal current is being drawn by the radio. The customer complaint is that the radio will stop playing and will begin playing again all by itself

We will attempt to isolate this defect one section at a time First the complete audio system, then the I F 's and then the converter circuit. Connect the test leads into the Analyst for audio signal injection. Touch the audio lead to the base of the audio drive transistor, point 24 on the schematic in Fig 10. If the audio system is operating properly, the audio tone will be heard in the loudspeaker of the radio We now flex the board to see if there are any small cracks which cause the audio tone to be interrupted A tool such as a soldering aid, may be used to pick on the solder connections associated with the AF circuit If the audio continues to play un-interruptedly, we may be reasonably sure that there are no mechanical defects in the audio system Whenever injecting audio into the driver transistor, the receiver volume control must never be set at minimum since this will ground out the injected audio signal. Capacitor C-6 in Fig. 10 would be connected to ground and act as a short circuit for the injected signal

We will now inject a signal into the I F amplifier system by shifting our signal injection probe to the RF output jack of the Analyst Tune the generator to 455 kc Touch the test prod to the base of the 1st I F amplifier (point 10). If the tone appears in the loudspeaker we then proceed with the flexing and examination of the board observing if there is any mechanical damage, loose components, etc At this point we find that when we flex the board the test tone in the loudspeaker becomes interrupted Apparently our source of intermittent trouble is somewhere in the I F amplifier We must now determine whether it is in the 1st or 2nd I F amplifier stage

We now shift our signal injection probe to point 15 which is the base of the 2nd I F amplifier. Flexing of the board again causes the tone to be interrupted Therefore, our trouble must lie between the base of the 2nd I F amplifier and the detector. Careful examination of the printed circuit board shows up a crack in the copper foil leading to the center tap of transformer T-5 This is the collector load of the 2nd I.F amplifier This could have been caused by the radio being jarred or dropped The trouble can be corrected by carefully cleaning the copper foil and flowing solder across the above joint, or by soldering a short piece of bare wire across the copper foil A small soldering iron should be used to avoid over heating the copper which could cause the foil to peel

By logically following a pattern of stage by stage signal injection, the trouble can be isolated to one particular stage Since the total number of components involved in any one stage is rather small, this narrows down the possible components that could be producing the trouble

EXAMPLE NO. 2:

Here is an example of an intermittent defect and the method of trouble shooting Again the customers complaint is that the radio will cut out all by itself and then seemingly correct itself and begin playing again

Step 1 is to connect the radio to the power supply of the Analyst and meter the current being drawn by the radio The current is approximately 4 ma which agrees with the value as shown on the schematic in Fig 10

We now begin our signal injection at the base of the audio driver transistor which is point 24 on the schematic. In this way we will either eliminate, or pin point the trouble to the audio system With the injection at the base of the audio driver the test tone should be clearly heard in the loudspeaker The volume control of the receiver must be advanced above minimum to prevent shorting out the injected signal Now flex the printed circuit board and examine the components in the audio system for breakage or poor solder connections while listening for an intermittent We find that by tapping the radio the audio in the loudspeaker goes on and off The indication is that the trouble is somewhere in the audio system Proceeding on a step by step basis we may now localize the trouble. Connect the signal injection test prod into the VOICE COIL output jack and touch this prod to the voice coil of the loudspeaker. Tap the radio gently to see if the intermittent occurs No intermittent is noticed at this point Realizing that a common source of trouble in transistor radios is a poor contact on the earphone jack, we check the jack carefully. Examination of the earphone jack shows that it is working properly and is not the cause of the intermittent

We now advance our test prod to the base of one of the audio output transistors (point 29 or 32 on the schematic) The source of signal from the Analyst is now the AUDIO OUTPUT rather than the VOICE COIL jack The test tone should be clearly heard in the loudspeaker and if tapping the radio does not introduce an intermittent the trouble does not lie in the audio output stage. We know from the first test that the trouble occurred when a signal was injected into the base of the audio driver transistor. We will now connect our test prod to the collector of the audio driver transistor which is point 26 on the schematic. Tapping the radio again introduces the intermittent so the trouble must lie in the collector circuit of the audio driver transistor Examination of the parts associated with this circuit show no sign of physical damage and all solder joints appear solid and making good contact

We must now resort to voltage readings to determine the defect. With our VTVM we now measure the collector potential of the audio driver transistor X4. The voltage at this point correctly reads 5 volts However, when the radio is jarred or tapped the voltage falls to zero indicating some sort of intermittently open circuit element in the collector of the transistor Shifting our test prod to the bottom, or + side of transformer T-1, produces a voltage of better than 5 volts It does not appear erratic or intermittent when the radio is jarred It would now seem that the transformer primary must be intermittent This would cause both loss of audio signal and the intermittent collector voltage at the driver transistor Removal of the transformer from the circuit or an ohmmeter check across the primary shows that it has an intermittent connection within the transformer. Replacement of the transformer would cure this trouble

FM ALIGNMENT & TROUBLE SHOOTING

FM alignment consists of peaking the IF stages and then aligning the discriminator for a '0' reading between a maximum and a maximum —.

In all cases consult the manufacturers specifications before aligning The manufacturer will explain which point should be used for peaking and which for discriminator alignment.

Set the RF-IF Tuning Dial to 2.14 mc. The 5th harmonic of 2 14 mc is 10.7 mc 10.7 mc is the most often used FM-IF frequency. Use the MOD. OFF position Connect the RF lead to the input of the converter Connect your VTVM between ground and the take off peaking point recommended by the manufacturer. Align each IF for maximum.

Switch the VTVM lead to the output of the discriminator Align the discriminator for a 0 reading between a maximum — and + excursion

The RF stages can be aligned in the same manner by using actual FM stations and tuning for a maximum at the take off peaking point

FM SIGNAL TRACING

Use the General Trouble Shooting Procedure Steps 1 thru 4 In Step 4 connect the VTVM to the peaking point and leave the MOD ON. Most FM sets will pass some AM Signal inject stage by stage as described in Step 4. The signal when injected may be heard in the loudspeaker or observed as a voltage on the VTVM at the peaking point. Once the trouble has been located go directly to Step 7

If the trouble does not show up in the previous step, then go to Step 7 for the RF and Oscillator sections of the FM receiver This follows since we have already tested all the sections except the RF & Mixer stages

POWER TRANSISTORS

The Analyst may be used to qualitatively test power transistors Power transistors as you probably know are usually good or bad, shorted or open The test therefore is for these characteristics Connect to the elements as you would for a regular transistor.

A good power transistor usually shows considerable leakage in the leakage position If you are testing a PNP use the PNP position of the switch Momentarily switch to the NPN position—the leakage should go down considerably.

Switch to the Beta position. In the PNP position the meter should read somewhat up scale Switch to the NPN position and the reading should go down considerably. If not the transistor is probably defective In most cases this should show up defective power transistors

For NPN power transistors use the same procedure except that you would test for leakage in the NPN position and then momentarily switch to the PNP to see the leakage decrease on the scale Then test for Beta in the NPN position; the reading will decrease on the scale when momentarily switched to the PNP position.

From the above test we have established that the transistor does have Beta and we have also shown that there is not a short or an open Going back to our original premise that power transistors are usually open or shorted we have a satisfactory test for the great majority of this type of transistor. A shorted transistor will read high leakage in both positions One without Beta would not read or would not decrease in the reverse test

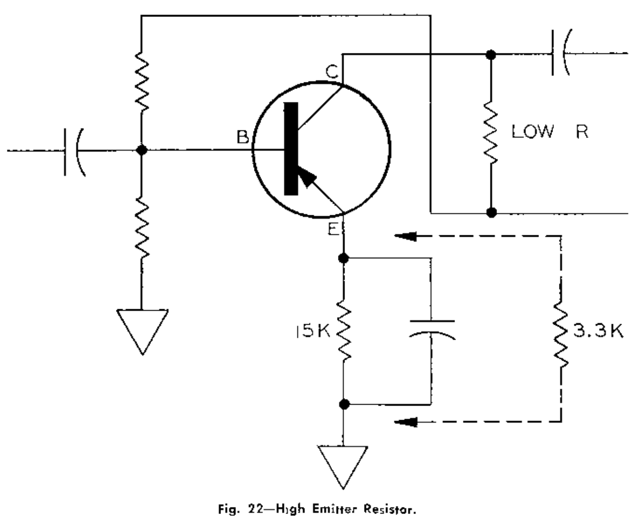


Fig. 22—High Emitter Resistor.

SERVICING AUTOMOBILE RADIOS

Automobile radios, as you undoubtedly know, require very high battery currents; sometimes in the neighborhood of amperes. The Model 960 due to the increased weight and cost involved was not designed to power these radios The auto radio however may be serviced effectively and the transistors tested with the Analyst.

The only difference in the servicing technique is that the IN CKT test will not be used Since an external power supply, such as battery or battery eliminator, supplies the power to the radio, monitoring of the radio DC current is also omitted.

Steps 3 thru 7 of the General Trouble Shooting Procedure will therefore comprise the method of quickly isolating the defective component.

SPECIAL CONDITIONS

Most transistor circuits employ low resistances, in the order of hundreds of ohms, in the DC portion of the emitter and collector circuits. In special cases, however, one might find emitter or collector resistances in the order of thousands of ohms See Fig 22

In this special case the Dyna Trace test to the base of the transistor will cause the meter to move very slightly upward, not into the white area Another check may be used here to verify the action of the transistor Remove the Dyna Trace probe, parallel the high resistance (usually emitter to ground) with a 3300 ohm resistor The meter should deflect upward into the white area

If the high resistance is in the collector circuit, parallel it with the 3300 ohm resistor. See Fig. 23. The Dyna Trace connected to the base should make the meter deflect upward

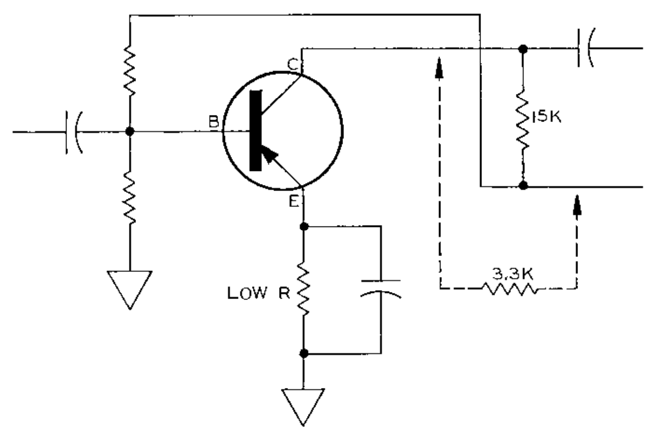


Fig 23—High Collector Resistor.

In general, when encountering high resistances in the base and emitter DC circuits, a slight upward deflection when using the Dyna Trace in the normal manner, is an indication of a properly operating circuit

In circuits having 0 or very little base resistance to ground (20 ohms or less) the Dyna Trace may not cause sufficient or any motion of the needle.

Summarizing—the Dyna Trace will operate in practically all cases. The only two major exceptions to consider would be the case of abnormally high emitter or collector resistors (10,000 ohms or greater) or when very low base to ground resistors are used. The aforementioned, of course, refers to the DC circuit resistances.

Testing Batteries

The simplest manner of testing a battery for a transistor portable is to measure the battery voltage without load (disconnected) and then under load (radio turned on and operating). If the battery voltage falls down by 20% the battery should be rejected, i.e. if the battery originally read 9V without load, it should not go below 7.2 V under full load. Full load would be with the radio playing at normal volume.

HIGH VOLTAGE RADIOS

Although most transistor radios use voltages well within the internal power supply voltages of the Analyst, it is conceivable that you may run across a set that uses higher than 12 volts.

In this case you may use the Analyst exactly as described herein except that an additional battery should be connected in series with the most negative lead. The plus (—) side of the additional battery should be connected to the negative of the Analyst.

MAINTENANCE OF 960 TRANSISTOR RADIO ANALYST

Your instrument will require little service. If however a trouble occurs use the following adjustment procedure.

The VTVM is factory calibrated, but if the instrument gets out of calibration, or if V-1 is replaced, a slight adjustment may be necessary. This is accomplished as follows.

Carefully remove instrument from case. Connect to A.C. power line. Set to the 1.5V position. Allow instrument to warm up for 15 minutes. Insert Test leads into the — and — jacks of the VTVM and short them together. Adjust the VTVM zero adjust for zero reading on the meter. Apply 1.5V across the VTVM terminals and adjust R-23 (located on printed circuit board) for full scale reading. Now the meter is calibrated.

If the audio or RF oscillators do not function, check V-2 first by replacing it with another 12AU7.

RF Alignment

If R.F. alignment is needed a radio receiver may be used as follows.

1. Turn AUDIO-RF-LEVEL knob until it clicks the modulation OFF (MAX clockwise rotation).

2. Place a lead from the R.F. output jack of the Analyst close to the antenna terminal of the receiver.

3. Switch the R.F. Band switch to BAND B.

4. Tune the receiver to a station around 860 kc.

5. Starting at 800 kc rotate the RF-IF tuning control until the signal from the Analyst zero beats with the station. If the reading on BAND B is not the same frequency as the station, set the RF IF tuning knob to the frequency of the station. If the RF IF tuning knob originally read higher than the station frequency (when zero beat was heard) the iron core of coil L-2 should be rotated out of the coil slightly until another zero beat is heard. (L-2 is the coil mounted on the printed circuit board farthest from the panel.) If the tuning knob originally read lower than the station frequency, the iron core should be rotated clockwise into the coil. Use a non-metallic hex head alignment wrench.

6. Tune the receiver to a station around 1500 kc. Set the RF IF TUNING knob to the same frequency as the station. Adjust the small trimmer capacitor on the variable for a zero beat. The trimmer is accessible at the side of the variable between the two coils.

7. Repeat steps 6 & 7 until no further adjustment is needed.

When Band A alignment is necessary proceed as follows.

1. Repeat Steps 1, 2, 3 & 4 of R.F. alignment except that the RF BAND switch is switched to BAND A and a station tuned beween 700 kc & 800 kc.

2. Adjust the RF IF TUNING knob to the same frequency as the station.

3. Adjust the front trimmer on the variable condenser closest to the panel for a zero beat.

4. Without changing the tuning of the radio receiver, rotate the RF-IF TUNING knob to ½ the frequency of the station. Adjust the powdered iron core on coil L-1 until a zero beat is heard on the receiver.

5. Repeat Steps 2 & 3 of IF alignment until no further adjustment is needed.

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the maintenance section of the instruction manual for adjustments that may be applicable.
2. Check common electronic parts such as tubes and batteries. Always check instruction manual for applicable adjustments after such replacement.
3. Defective parts removed from units which are within the warranty period should be sent to the factory prepaid with model and serial number of instrument from which removed and date of instrument purchase. These parts will be exchanged at no charge.
4. If the above mentioned procedures do not correct the difficulty, pack the instrument securely (preferably double packed). A detailed list of troubles encountered must be enclosed as well as your name and address. Forward prepaid (express preferred) to the nearest B&K authorized service agency.

Contact your local B&K Distributor for the name and location of your nearest service agency, or write to

Service Department

B & K MANUFACTURING COMPANY

DIVISION OF DYNASCAN CORPORATION

1801 W. Belle Plaine

Chicago 13, Ill.

See General Trouble Shooting Procedure Schematic back of this page

Be sure to see pages 36 and 37

AMERICAN SUBSTITUTES FOR FOREIGN TRANSISTORS

To Replace	SIMILAR TYPE
2S12	2N410 2N411
2S13	2N139 2N409
2S14	2N109 2N405 2N-06
2S15	2N408
2S15A	2N109
2S22	2N407
2S24	2N406 2N408
2S25	2N139
2S30	2N411 2N412
2S31	2N409 2N410 2N412
2S32	2N406
2S33	2N405, 2N408
2S44	2N406, 2N407 2N108
2S45	2N409, 2N410
2S49	2N410
2S52	2N140, 2N411 2N412
2S53	2N409, 2N410
2S54	2N407 2N408, 2N410
2S56	2N109 2N407, 2N408
2S60	2N412
2S92	2N411
2S93	2N140
2S93A	2N412
2S101	2N726
2S178	2N140
2S179	2N217
2SA12	2SA13
2SA13	2SA12
2SA15	2SA16
2SA16	2SA15
2SA17	2SA18
2SA18	2SA17
2SA30	2SA35
2SA35	2SA30
2SA37	2SA38 2SA39
2SA38	2SA37, 2SA39
2SA39	2SA37 2SA38
2SA41	2SA42
2SA43	2SA111 2SA112
2SA49	2N137 2N414 2N415, 2N415A 2N416 2SA51 2SA52 2SA53
2SA50	2N269 2N311 2N404 2N518 2N583
2SA51	2N617 2SA49 2SA52 2SA53
2SA52	2N114 2N136 2N140 2N219 2N411 2N412 2N481 2N485 2N486 2SA49 2SA51 2SA53
2SA53	2N111 2N135 2N218 2N410 2N482 2N614 2SA49 2SA51 2SA52
2SA57	2N384 2SA58 2SA175
2SA58	2N370 2SA57 2SA175
2SA59	2N370 2N624
2SA60	2N346 2N371 2N393 2SA92 SB103 2N346

To Replace	SIMILAR TYPE
2SA69	2SA70
2SA70	2SA69
2SA71	2SA70
2SA72	2SA73 2SA93
2SA73	2SA72 2SA93
2SA76	2SA77
2SA77	2SA76
2SA80	2SA82
2SA81	2SA84
2SA82	2SA80
2SA84	2SA81
2SA88	2SA89
2SA89	2SA88
2SA92	2N252, 2N267 2N345 2N371 2N374, 2N544, 2SA60
2SA93	2N129 2N240 2N247 2N248 2N274, 2N308 2N309 2N310 2N344, 2N372 2N373 2N417 2SA72 2SA73
2SA101	2SA102 2SA103, 2SA104
2SA102	2SA101 2SA103 2SA104
2SA103	2SA101 2SA102 2SA104
2SA104	2SA101 2SA102 2SA103
2SA105	2SA106 2SA107
2SA106	2SA105 2SA107
2SA107	2SA105 2SA106
2SA108	2SA109, 2SA110
2SA109	2SA108 2SA110
2SA110	2SA108 2SA109
2SA111	2SA43 2SA112
2SA112	2SA43, 2SA111
2SA113	2SA114
2SA114	2SA113
2SA116	2SA117 2SA118
2SA117	2SA116 2SA118
2SA118	2SA116 2SA117
2SA121	2SA122 2SA123 2SA124
2SA122	2SA121 2SA123 2SA124
2SA123	2SA121 2SA122 2SA124
2SA124	2SA121 2SA122 2SA123
2SA128	2SA129
2SA129	2SA128
2SA130	2SA131 2SA132
2SA131	2SA130 2SA132
2SA132	2SA130 2SA131
2SA134	2SA135
2SA135	2SA134
2SA151	2N139 2N218 2N409, 2N410
2SA175	2N299 2N384 2SA57 2SA58
2SA176	2N128 2N300
2SB21	2N420
2SB25	2N157, 2N268A, 2N353, 2N458 2N538 2N637A 2N638B 2N639A, 2N639B
2SB26	2N155, 2N234 2N250, 2N268 2N307 2N400 2N555 2N637

To Replace	SIMILAR TYPE
2SB27	2SB28 2SB29, 2SB30, 2SB31
2SB28	2SB27, 2SB29, 2SB30, 2SB31
2SB29	2SB27 2SB28, 2SB30, 2SB31
2SB30	2SB27, 2SB28, 2SB29 2SB31
2SB31	2SB27, 2SB28, 2SB29, 2SB30
2SB46	2SB47
2SB47	2N48 2N89, 2N90, 2N131, 2N133, 2N175, 2N207A, 2N220, 2SB46
2SB48	2SB49, 2SB50
2SB49	2SB48 2SB50
2SB50	2SB48, 2SB49
2SB54	2N43, 2N86 2N104, 2N138, 2N199, 2N207 2N280, 2N363, 2N405
2SB56	2N187 2N195 2N198, 2N242, 2N407 2N568 2N571
2SB65	2N1265/5, 2N1392, 2N1394
2SB68	2N398, 2G398, 2SB121
2SB76	2SB154
2SB85	2SB86, 2SB87
2SB89	2N270
2SB121	2N398 2G398, 2SB68
2SB126	2SB127
2SB127	2SB126
2SB128	2SB129
2SB129	2SB128
2SB131	2SB132
2SB132	2SB131
2SB140	2SB141
2SB141	2SB140
2SB142	2SB143, 2SB144, 2SB145, 2SB146
2SB143	2SB142, 2SB144, 2SB145, 2SB146
2SB143P	2SB144P
2SB144	2SB142 2SB143, 2SB145, 2SB146
2SB144P	2SB143P
2SB145	2SB142, 2SB143, 2SB144, 2SB146
2SB146	2SB142, 2SB143, 2SB144, 2SB145
2SB150	2N398
2SB154	2SB76
2SB157	2SB158, 2SB160
2SB158	2SB157, 2SB160
2SB160	2SB157, 2SB158
2SB172	2SB176
2SB176	2SB172
2SB180	2SB181
2SB181	2SB180
2SB189	2N180, 2N223, 2N319, 2N402 2N524, 2N609, 2N612, 2N613
2SB200	2SB202
2SB202	2SB200
2SC41	2SC42
2SC42	2SC41
2SC73	2SC173

To Replace	SIMILAR TYPE
2SC75	2SC76, 2SC77 2SC175, 2SC176, 2SC177
2SC76	2SC75, 2SC77, 2SC175, 2SC176, 2SC177
2SC77	2SC75, 2SC76, 2SC175, 2SC176, 2SC177
2SC78	2SC178
2SC173	2SC73
2SC175	2SC75, 2SC76, 2SC77, 2SC176, 2SC177
2SC177	2SC75, 2SC76, 2SC77, 2SC175, 2SC176
2SC178	2SC78
2SC191	2SC194
2SC192	2SC195
2SC194	2SC191
2SC195	2SC192
2SD61	2SD62 2SD63
2SD62	2SD61, 2SD63
2SD63	2SD61, 2SD62
2SD75	2SD77
2SD77	2SD75
2T64	2N1251
2T65	2N214
2T66	2N214
2T73	2N168A, 2N212 2N1058
2T76	2N169A, 2N233A
2T84	2N1101
2T85	2N214, 2N649, 2N1251
2T86	2N649, 2N1101
2T89	2N214 2N649
2T201	2N371, 2N373
2T203	2N370, 2N372
2T204	2N248
2T513	2N194
2T520	2N233A
2T524	2N216
HJ15	2N104, 2N109, 2N362, 2N405
HJ17	2N109, 2N408
HJ17D	2N109, 2N323, 2N407, 2N632
HJ22	2N139, 2N410
HJ22D	2N139 2N409, 2N410, 2N482 2N483
HJ23	2N140, 2N412
HJ23D	2N140, 2N411, 2N485
HJ54	2N139
HJ60	2N139
HJ71	2N139 2N140
HJ72	2N140
HJ74	2N140
HS-15	2N109
HS 17D	2N109
HS-22D	2N139
HS-23D	2N140

EVERYTHING 4 LESS

 ENJOY YOUR BOOKS 

PLEASE VISIT OUR STORE FOR EVEN MORE GREAT STUFF!

WWW.EVERYTHING4LESSSTORE.COM

COPYRIGHT NOTICE

ALL MATERIALS INCLUDING CD/DVD AND PDF FILES ARE COPYRIGHTED WWW.EVERYTHING4LESSSTORE.COM VON WALTHOUR PRODUCTIONS AND MAY NOT BE REPRODUCED, COPIED OR RESOLD UNDER ANY CIRCUMSTANCES. YOU MAY HOWEVER MAKE A COPY FOR YOUR OWN PERSONAL BACKUP. MATERIALS ARE FOR PERSONAL USE ONLY.

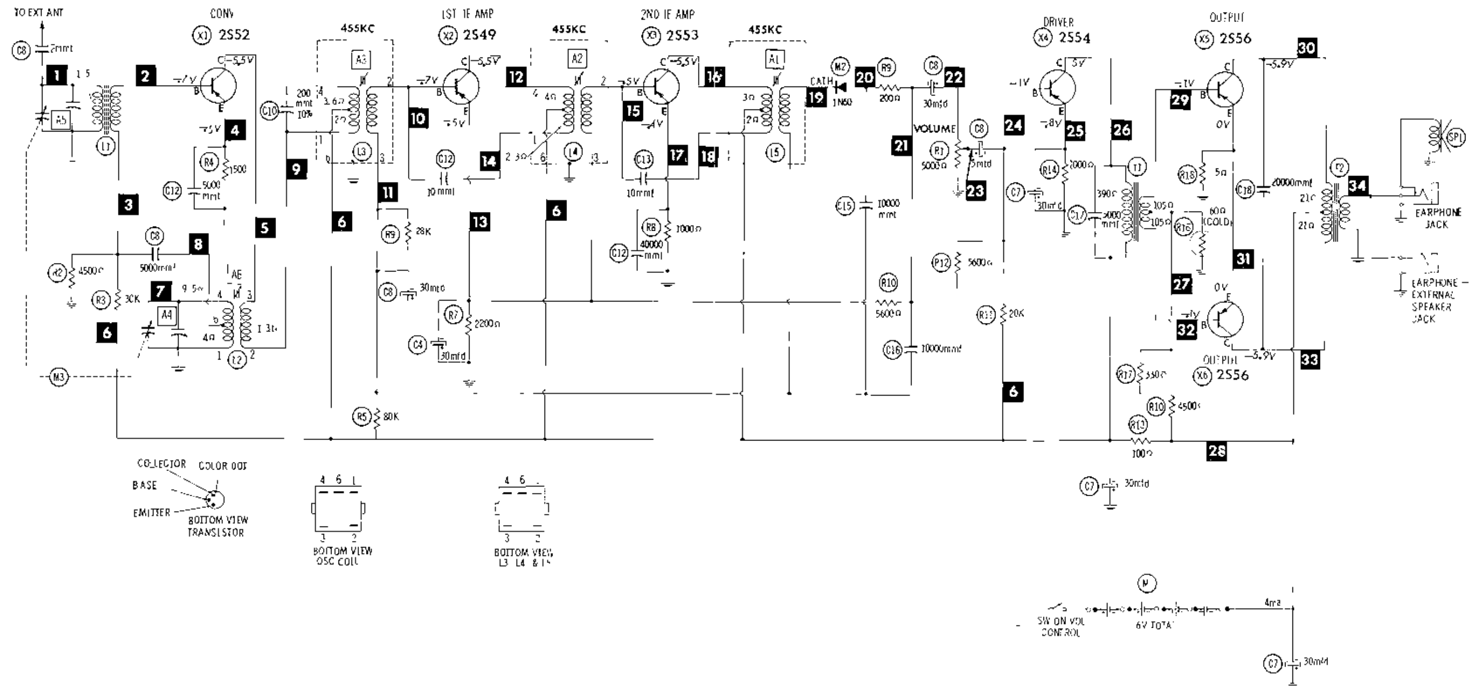
IF YOU PURCHASED THIS FROM ANYWHERE BUT FROM US PLEASE NOTIFY US IMMEDIATELY SO THAT WE MAY CHECK IF YOU PURCHASED FROM AN AUTHORIZED RESELLER SO WE CAN LET YOU KNOW IF YOU NEED TO RETURN FOR FULL REFUND FROM AN UNAUTHORIZED SELLER.

THANKS AGAIN AND PLEASE TAKE THE TIME TO VISIT OUR STORE.

ATTENTION! EVERYTHING ON SALE NOW!!

HOT SALE!

THIS PAGE COPYRIGHT VON WALTHOUR PRODUCTIONS
WWW.EVERYTHING4LESSSTORE.COM



NUMBERS ASSIGNED TO COILS, SWITCHES, PLUGS, SOCKETS, AND TRANSFORMERS ARE TO FACILITATE CIRCUIT TRACING OR COMPONENT REPLACEMENT AND MAY NOT NECESSARILY BE FOUND ON THE UNIT

DC COIL RESISTANCE VALUES UNDER ONE OHM NOT SHOWN ON SCHEMATIC DIAGRAM

A PHOTOFACT STANDARD NOTATION SCHEMATIC with CIRCUITRACE

© Howard W. Sams & Co., Inc. 1960

RESISTANCE MEASUREMENTS NOT GIVEN BECAUSE OF THE WIDE VARIATION IN INTERNAL TRANSISTOR RESISTANCE.

1. DC voltage measurements taken with vacuum tube voltmeter.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative.
4. Nominal tolerance on component values makes possible a variation of ±15% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.

Fig. 10—Typical transistor radio.

GENERAL TROUBLE SHOOTING PROCEDURE*

1. TEST RADIO POWER SUPPLY
2. DYNA TRACE
3. AUDIO SIGNAL INJECT
4. IF SIGNAL INJECT
5. RF SIGNAL INJECT
6. DETECTOR AGC TEST
7. DC VOLTAGES & RESISTANCES
8. INTERMITTENTS

*See text for more detailed procedure.