

# How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE, WASHINGTON, D. C.

**No. 28**

**How To Fix a  
Weak Receiver**

**RADIO SERVICING METHODS**



# NRI TRAINING PAYS...

Dear Mr. Smith:

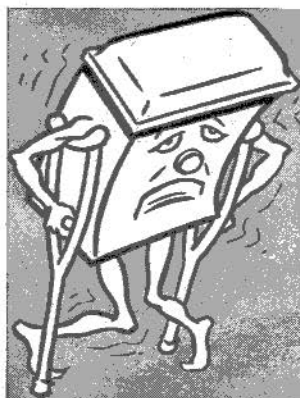
I took your Course in a depression year at a time when I was scarcely making enough to live. I am now engaged in full time service work with steadily increased earnings. I might add that the Course has paid for itself several times this year. Let me say that the NRI Course is the most thorough I have ever seen and that your school is the most friendly I know of.

H.E.H., North Carolina



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## HOW TO FIX A WEAK RECEIVER

**W**EAKE reception is a complaint that may be completely baffling to the "radio mechanic." But the man who has a professional knowledge of radio circuits can often locate the defective section almost at once by observing how the set acts, and can usually run down the defective stage in a matter of minutes.

This Booklet will teach you the quick, professional ways to find out why a set plays weakly. We'll follow our usual plan of study: first, we'll see what can cause the complaint, then we'll see how the defect can be located. The last section of the Booklet is a continuation of your NRI Practical Training Plan; it will show you how you can gain experience in tracking down the causes of weak reception.

### CAUSES OF WEAK RECEPTION

When you confirm the complaint, make sure that the weak reception is real and not just in the customer's imagination. Sometimes a customer will suddenly decide that he wants to pick up a distant station that he has never heard before—one that his set, even when brand new, could not receive. Or, if he has recently moved, perhaps he enjoyed better reception at his last home because of a better antenna-ground installation, or because of a better location. Furthermore, the customer may not realize that because of atmospheric conditions, he may not be able to get stations in the summer that he receives well in winter.

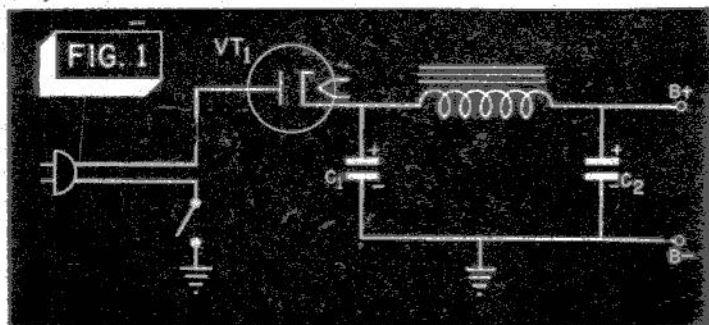
Weak reception exists when stations that have been

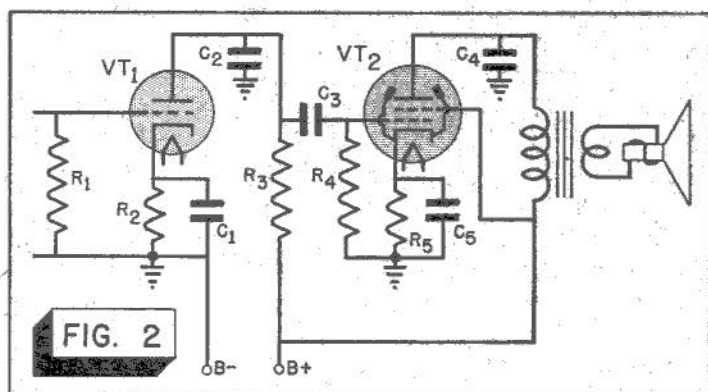
heard normally no longer come in at a satisfactory volume level. The cause may or may not be a defect in the receiver—often the antenna-ground system is to blame. In fact, you should always check the antenna-ground system first when the complaint is weak reception. Look for breaks, short circuits, and accidental grounds—any of these can cause weak reception.

If a receiver defect is the cause of the weak reception, you will always find that the defect has: (1) interfered with the signal path through the receiver, or (2) caused the gain in one or more stages to fall below normal. The first condition is caused by such things as open antenna coils or open coupling condensers. The second condition, low stage gain, occurs if something reduces the tube gain (improper operating voltages or loss of emission), or if the load impedance decreases. A drop in load impedance can be caused by short circuits across the load, reduced Q factor in tuned circuits, or improper alignment.

Before we go on to localizing the defective section and stage, let's see in more detail what part and circuit defects are most likely to cause weak reception.

**Tubes.** Many complaints of weak reception are caused by tubes that have lost their emission. This may have happened suddenly (a break in the filament or an open in the cathode lead could do this), or it may be the result of gradual deterioration of the tubes. In the latter case, more than one tube may be involved. Since defective tubes are such a common cause of this complaint, it is a good idea to check all the tubes with a tube tester early in the test procedure, and to replace any that are





below normal in emission.

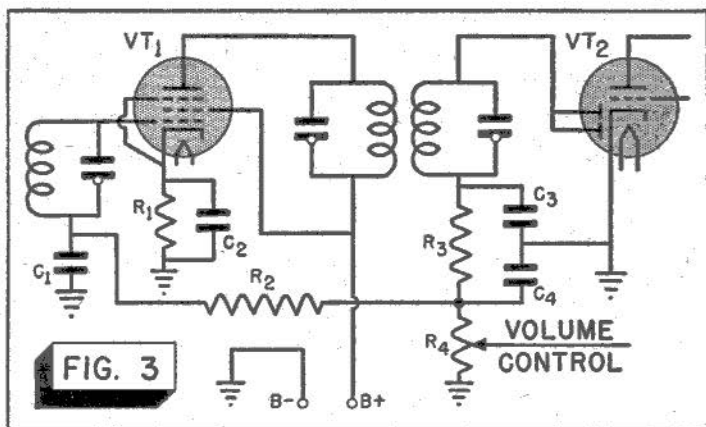
**Improper Voltages.** Lower - than - normal plate or screen grid voltages are sometimes the reason why the stage gain is below normal. Usually a leaky or shorted by-pass condenser is to blame for the voltage drop, although shorted by-pass condensers are more likely to cause a completely dead set than weak reception.

► If the input filter condenser ( $C_1$  in Fig. 1) opens or develops high power factor, the B supply voltage will drop considerably. This is particularly important in a.c.-d.c. receivers; since such sets operate on low voltages anyway, any drop is quite noticeable.

► Excessive grid bias is another possible cause of weak reception, although distortion is a more usual result. Excessive bias may be caused by excessive current through a bias resistor in the power supply circuit, or by an open bias resistor in the cathode circuit.

**Condensers.** An open grid-plate coupling condenser in an R-C coupled amplifier will usually make the set dead. However, a powerful signal from a nearby station may get by the condenser to some extent; you will then get weak reception from this station, and none from others.

► An open cathode by-pass condenser used in only one stage (like condenser  $C_1$  in Fig. 2), may cause weak reception because of degeneration. On the other hand, when a cathode by-pass condenser is common to more than one stage, opening of the condenser may cause regeneration. This may cause oscillation but not neces-



sarily weak reception. Keep this in mind when you are servicing for weak reception.

► An open plate by-pass condenser in the power output stage may cause weak reception indirectly. For example, if condenser  $C_4$  in Fig. 2 opens, the power output stage may oscillate at a frequency too high to be heard. The tube may then draw so much current from the power supply that the B+ voltage is reduced sharply, causing weak reception. (This is an interesting example of a multiple cause for a complaint; the weak reception is caused by a low B supply voltage, which is caused by oscillation in the power output stage, which, in turn, is caused by an open condenser.)

► An open a.v.c. filter condenser, such as  $C_1$  in Fig. 3, can also cause weak reception. Normally, the signal applied to the grid of tube  $VT_1$  reaches ground through condenser  $C_1$ —a relatively low-impedance path. If  $C_1$  opens, however, the signal must reach ground through resistors  $R_2$  and  $R_4$ . These form a high-impedance path, over which much of the signal is dropped; consequently, the signal output of tube  $VT_1$  is seriously reduced.

**Resonant Circuit Defects.** There are two possible defects in a tuned circuit that can cause weak reception—(1) misalignment of the circuit, and (2) a reduction in the circuit Q factor. Loss of Q may be caused by the addition of resistance in the circuit (a high-resistance connection, for example), by absorption of moisture in a coil form, or by shorted turns in a coil winding. Low-

ered Q is one of the important reasons for weak reception in an old receiver; look for this if you have found that the tubes are normal.

**Loudspeakers.** If the field coil is not used as a choke, it can open without interrupting the supply voltages. An open field coil will cause very weak reception mixed with distortion. An open voice coil may also cause weak reception, though it is more apt to make the set dead altogether. A voice coil that cannot move freely will cause weak reception plus a loss of bass notes.

These are the most important causes of weak reception. Now let's see what techniques will locate these defects quickly.

## LOCATING THE DEFECTIVE SECTION

You can generally locate the defective section by using effect-to-cause reasoning while you are confirming the complaint. There are several possible symptoms the receiver can exhibit, each of which can tell you much about what the trouble is. We'll take up each symptom in turn.

**Distant Stations Weak — Locals Normal.** In summer, it is normal to receive only local stations during the day, although there should be some distant-station reception during the night. However, reception of this sort in the *wintertime* is a sure indication of trouble in the r.f.-i.f. section or in the antenna system. In this case, weak signals receive so little r.f. amplification before reaching the second detector, that the audio section cannot bring them up to normal volume. The signals from powerful local stations are heard well enough because they are so strong when they reach the receiver that they do not need much r.f. amplification.

If the set is a superheterodyne, and the amount of first detector noise (a hissing sound) is above normal when you tune in a distant station, either the antenna system is at fault, or there is a break in the primary of the antenna coil (if the set has one). If the set uses a loop antenna, you might try changing its position to see if that helps matters.

**Weak Reception of BOTH Distant and Local Stations.** The fact that you hear both distant stations



and locals indicates that the r.f.-i.f. section is all right; the defect is probably in the second detector, the a.f. section, or the loudspeaker. If the set has a tuning eye, notice if it closes the usual amount when you tune in a station. If it does, the r.f.-i.f. section, the second detector, and the a.v.c. circuit are working properly; the a.f. section or the speaker must be to blame.

***Local Stations Weak—No Distant Stations Heard.***

Reception of this sort does not tell you quite as much about the defective section as do the two kinds previously discussed. It may mean that some r.f. stage is very weak—practically dead—or that some power supply defect has reduced the voltage supply to all tubes below the value at which they can work properly. You will have to make a localizing test before you can be sure which section is defective.

***Receiver Weak at One End of Dial.*** This is a sure indication of trouble in one of the tuning circuits. It is caused by improper alignment.

***All-Wave Set Weak on Certain Bands—Normal on Others.*** This can only be an r.f. preselector defect. Suspect misalignment, a defective band-change switch, or open coils on the weak bands.

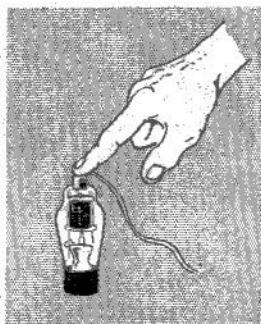
***Weak When Lights Are Turned On or Off.*** This shows that the trouble is in the antenna system rather than in the receiver itself. The signals from some stations may be affected more than others. Usually the cause is a poor ground. If the set uses an indoor antenna, you should recommend the installation of a good outside one.

***Localizing Tests.*** You can almost always localize the trouble to the r.f. section or to the a.f.-power supply sections with the familiar circuit disturbance test made by touching the top cap of the first audio tube with your finger. (If this tube has no top cap, you can make this test by turning the volume control up full, and touching the hot, or ungrounded, terminal of the control with your finger.) If a loud hum or buzz is heard from the speaker, the a.f. section and the power supply are all right; the defect is in the r.f.-i.f. stages. If the hum or buzz is very weak, the a.f. section or the power supply is to blame.



Touching the top cap of the first audio tube (or the hot end of the volume control, if the first audio tube does not have a top cap) will usually let you locate the defective section in a weak set.

If the set is a phono-radio combination, try the phonograph. Normal volume on records indicates an r.f.-i.f. section defect, but low volume means an audio or power supply defect.



Watch the tuning indicator (if one is used). A tuning eye that closes on distant signals indicates a normal r.f.-i.f. section, hence an audio defect. On the other hand, little or no response may mean either an r.f.-i.f. defect or trouble in the power supply.

The foregoing tests, and reasoning from the symptoms, should enable you to localize the defective section. If not, proceed with the following stage localizing tests anyway—there is little point in further attempts to locate the defective section.

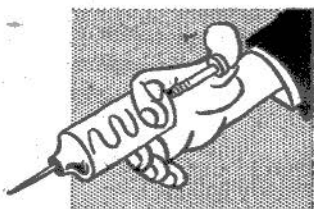
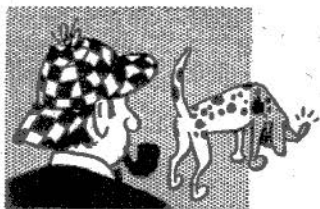
## LOCATING THE DEFECTIVE STAGE IN THE A.F. SECTION

The audio section of most modern radio receivers contains two stages—a first audio stage and either a single-ended or a push-pull output stage. (A phase inverter or some other special tube may also be used.) Since the audio section contains so few stages, there is little need for stage localization tests for weak reception. If the defect is apparently in the audio section, first test the tubes in this section, and then, if the tubes are good, measure the supply voltages in the stages.

Abnormal voltages usually indicate trouble in the power supply or a by-pass condenser breakdown, either of which you can quickly find in the usual manner with a voltmeter and an ohmmeter.

► If the tubes are all right, and the voltages are normal, probably the coupling condenser ( $C_3$  in Fig. 2) is open, or there is something wrong with the loudspeaker.

You can quickly check the coupling condenser by trying another one across it. If the set is instantly restored to normal operation, replace the original condenser.



These are the three methods you can use to locate the defective stage when the set is weak—signal tracing, signal injection, and circuit disturbance. Signal tracing is the only method that can be used in all cases; the other two are useful only once in a while.

**Circuit Disturbance Tests.** Of course, if you wish to find the defective stage first, you can use a circuit disturbance test. The best way is to use a voltmeter, because you can kill two birds with one stone—you can measure supply voltages and create the disturbance at the same time. Let's use Fig. 2 as our example.

To use this method, start by measuring the plate voltage of the output tube. If you find normal voltage here, then in all probability the power supply is all right.

However, if the plate voltage in this stage is abnormally low, the power supply is defective—or the output tube is improperly biased because of a leaky coupling condenser, gas in the tube, or a short-circuited  $C_5$ —or the output tube is oscillating because of an open  $C_4$ . Check the bias from cathode to ground, and check for current through the grid resistor  $R_4$ . If the bias is normal, and there is no current through  $R_4$ , then the trouble must be caused by an open condenser  $C_4$ , or by a power supply defect.

If the plate voltage is normal, touch the voltmeter probes between the screen grid and control grid terminals of this tube. Have the positive voltmeter terminal go to the screen grid. The sudden current surge as you make and break the contacts with the voltmeter will cause a sharp click from the loudspeaker if  $VT_2$  is capable of amplifying, and if the speaker and output transformer are in good condition.

If you get a normal click, measure the plate voltage of tube  $VT_1$ . You should hear a click when you touch the positive voltmeter probe to the plate of  $VT_1$ , and another when you remove it. No click and a low voltage reading, indicates trouble in the plate circuit of  $VT_1$ . No click, but a normal voltage reading, indicates an open coupling condenser  $C_3$ .

If you get a normal click, check the  $VT_1$  stage by touching the voltmeter probes between B+ and the control grid of  $VT_1$ . Weak clicks usually indicate a defective  $VT_1$  or a short-circuited grid circuit.

► An open in either  $C_1$  or  $C_5$  would cause degeneration and a loss of output. Ordinary voltage readings will not show up either of these conditions, so if everything is normal up to now, check these condensers by shunting them with good ones.

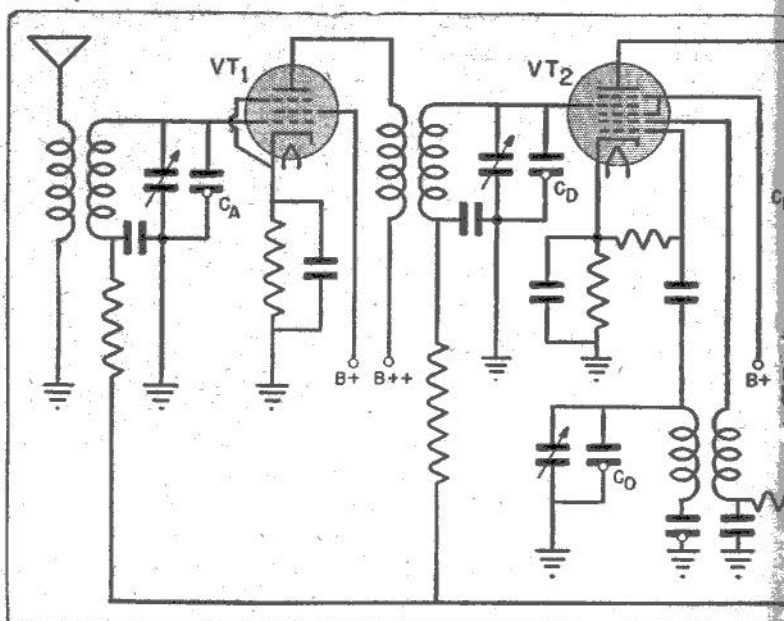
► Signal injection could also be used to locate the defective stage, except that there is practically no source of audio voltage readily available to the average serviceman. However, the circuit disturbance test just described will usually work. Its greatest drawback lies in the fact that you must judge the loudness of the clicks. You will have to have experience with this before you can tell when a click is below normal in loudness.

**Signal Tracing.** A signal tracer is ideal for locating the defective stage in either the a.f. or the r.f.-i.f. sections. Since much the same technique is used in both sections, we shall describe how to use a signal tracer for both a little farther on.

## LOCATING THE DEFECTIVE STAGE IN THE R.F.-I.F. SECTIONS

Locating the defective stage in the r.f.-i.f. section is somewhat more complicated both because there are more stages than in the average a.f. section, and because there may be a defect that affects a number of stages at the same time—for example, improper alignment or change in coil Q.

If you have a clue that makes you suspect improper alignment, such as weak reception only on certain bands or only at one end of a band, then try re-aligning as the next step. However, assuming for the moment that you



do not have a clue like this, let's see how it is possible to locate the defective stage in the r.f.-i.f. section.

Only three of the localization techniques can be used—circuit disturbance, signal injection, and signal tracing. Signal tracing is by far the best method. Neither circuit disturbance nor signal injection is very useful unless some one stage is the source of trouble, and that stage is nearly dead. However, we shall describe all three methods, as usual.

**Circuit Disturbance.** Let's use the typical r.f.-i.f. section shown in Fig. 4 to show how to locate the defective stage. If the tubes in the r.f.-i.f. section have top caps, make the circuit disturbance test by removing and replacing the top caps on the tubes, one at a time, starting with  $VT_2$  and working back to  $VT_1$ . If everything is in good condition, you should hear a fairly loud click or thump when you remove and when you replace each top cap. If you do not hear the click, the stage you are testing is defective.

If the r.f. tubes do not have top cap grid connections, you can disturb the circuits either by pulling out and replacing the tubes or by using a voltmeter. Pulling and

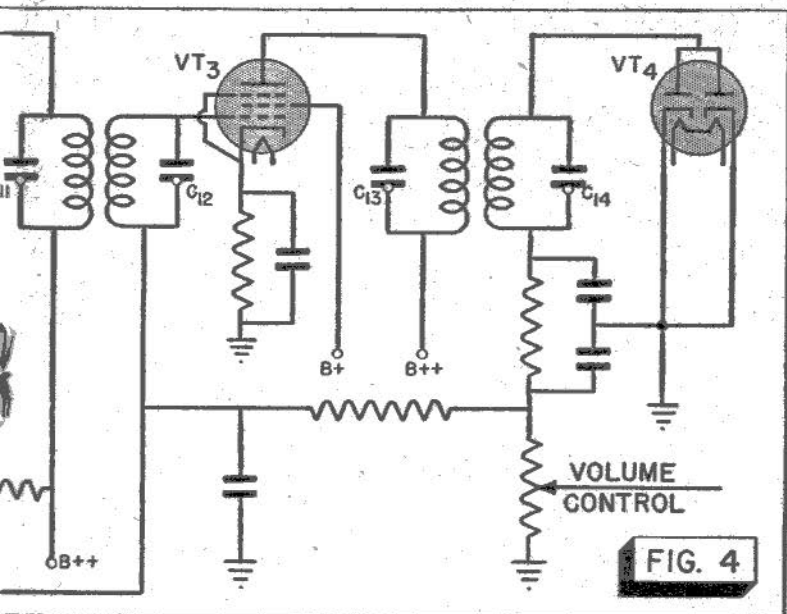


FIG. 4

replacing tubes should have the same results as making and breaking top cap connections. Of course, tubes can be pulled only in sets such as straight a.c. receivers or auto radios, in which tube filaments are connected in parallel to a source that supplies the exact filament voltage. A voltmeter, however, can be used to disturb circuits in any kind of radio.

To make voltmeter tests in the circuit of Fig. 4, first check the voltage between the plate of VT<sub>3</sub> and the chassis (connecting the positive voltmeter probe to the plate terminal of the tube). If you measure normal voltage, but do not get a click of normal intensity in the loudspeaker, the defect must lie between the plate of VT<sub>3</sub> and the volume control. If you do not measure normal voltage, very likely there is a defect in the plate circuit of the tube. Next, measure between the plate of VT<sub>2</sub> and the chassis. A click should be produced. Finally, measure the voltage between the plate of VT<sub>1</sub> and the chassis; again, a click should be produced. No click means that the defect is between the plate of the tube being tested and the plate of the tube next nearest the loudspeaker.

► If you find a defective stage by this means, and the tube tests O.K., probably the difficulty will be lack of plate or screen grid voltage, improper alignment, lowered Q in one of the tuned circuits, or perhaps an open a.v.c. by-pass condenser. Rarely, you may find an open by-pass condenser across the bias resistor in the cathode circuit of an r.f. or i.f. stage.

Of course, if you get clicks from all stages, and none of them appears abnormally weak, then you may have an over-all defect—such as improper alignment, or low Q, in more than one circuit.

**Signal Injection.** Signal injection with a signal generator will give you a rough idea of the gain of each stage, and at the same time let you check the alignment as you go along. Before you can get the most out of this method, you must have had considerable practical experience in alignment. You must be able to judge whether the Q of a tuned circuit is normal by noticing whether the trimmer tunes as sharply as it should. If a trimmer should tune sharply, but instead is rather broad in its tuning (that is, you can turn it quite a bit without affecting the output much), the circuit has lower than normal Q. Only experience will teach you how sharply the trimmers should tune in specific sets—receivers differ in this respect.

As a practical pointer—you will find that circuits using variable-inductance tuning (a fixed condenser and a variable-inductance coil) always seem to tune much more broadly than do the fixed-inductance variable-trimmer types.

► If your signal generator does not already have an isolating condenser in the hot lead, isolate the lead as shown in Fig. 5 by connecting a condenser to its tip. You can then use the lead of the condenser as the probe.

To make tests on the receiver circuit shown in Fig. 4, connect an output meter to the set, turn on the receiver, set the volume control for maximum output, and set the s.g. attenuator for maximum output. Clip the ground lead of the s.g. to the chassis.

Tune the s.g. to the i.f. amplifier frequency, and touch the hot probe to the plate socket terminal of  $VT_3$ . You should hear the modulating tone of the s.g. in the loud-

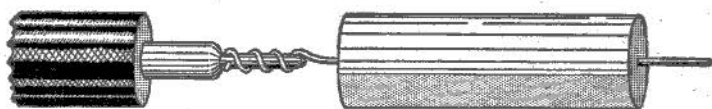


FIG. 5. To put a condenser in series with the hot lead of your s.g., wrap one lead of the condenser around the probe as shown. Use the other lead of the condenser as your probe.

speaker, but the reading on the output meter may be small. If you do not hear the modulating tone, or the level is far below normal, there is a defect in the plate circuit of  $VT_3$  or in the circuits of the second detector  $VT_4$ . (We are assuming that the trouble is in the r.f.-i.f. section.)

If you hear the tone at normal volume, move the hot s.g. probe to the control grid of  $VT_3$ . The tone should be considerably louder, and you should get a reading on the output meter. If the output does not increase satisfactorily, look for trouble in the  $VT_3$  stage. Try adjusting trimmers  $C_{13}$  and  $C_{14}$  to see if the alignment is off or if there is broad tuning, indicating low  $Q$ .

► If the output is satisfactory, peak trimmers  $C_{13}$  and  $C_{14}$  (that is, adjust them for maximum output with the hot s.g. probe touching the control grid terminal of  $VT_3$ ). Next, move the hot s.g. probe to the control grid of  $VT_2$ . (Be sure you get the control grid, not the oscillator grid.) You should get a large increase in output over that obtained at the grid of  $VT_3$ , both in sound and in the meter reading. If you do not, the defect is in the detector-mixer portions of the  $VT_2$  stage. Adjust i.f. trimmers  $C_{11}$  and  $C_{12}$  to see if perhaps alignment or low  $Q$  is responsible.

Next, tune the receiver to the high-frequency end of the dial, choosing some point at which no station is received. Switch the s.g. to its r.f. range, and tune it carefully to the receiver dial setting. Touch the hot probe of the s.g. to the plate of  $VT_1$ . If you don't hear the signal, adjust the oscillator high-frequency trimmer  $C_0$  until you do. Next, adjust trimmer  $C_D$  for maximum output. If  $VT_2$  is acting satisfactorily as a mixer, the output meter reading should be about the same as the one you got when you fed the i.f. signal into the control grid of  $VT_2$ . If you find a loss in output, the defect is between the plate of  $VT_1$  and the control grid of  $VT_2$ .



If this test is satisfactory, move the s.g. hot probe to the antenna post, and adjust trimmer condenser  $C_A$  for maximum output. There should be a marked increase in the output meter reading. If there is none, the defect is in the  $VT_1$  stage.

► Notice that we have done nothing to check the oscillator part of the  $VT_2$  stage. The reason is that the oscillator is never involved in a weak-reception complaint. True, the oscillator signal voltage can decrease below its normal value—but the oscillator usually will cut out, either at all frequencies or at one end of the dial, long before its signal voltage can drop enough to cause weak reception. The complaint would then be a dead set, not just a weak one.

► The signal injection procedure is as good as the circuit disturbance test for localizing a stage that is almost dead, except that it takes somewhat longer. In addition, it is considerably better as a means of localizing over-all difficulties, since it makes it easier for you to judge the increase in output and to notice the effect of the various trimmers as you go along.

## USING A SIGNAL TRACER

Although the signal generator and output meter will enable you to get some idea of the relative gain of the stages in the radio, the signal tracer is far better in that it allows you to measure the gain fairly accurately. For simplicity, instead of determining the exact amount of signal, you get a comparison by determining how much *greater* the signal is at one point than it is at another point. This gives the gain of the section or stage, and tells you at once whether or not things are normal within that portion of the radio.

Of course, you must know what gain to expect in each portion of the radio. Many manufacturers now include gain measurements in the information on their sets. Some do not, however; for their sets, you will have to go by average gain values.

Table 1 gives the manufacturer's gain figures for the set shown in Fig. 6, and Table 2 lists what are considered to be average gain values. As you can see by comparing the two, some of the values in Table 1 are within

**TABLE 1**

<i>Gain between points</i>	<i>Tracer tuned to</i>	<i>Approximate gain</i>
1 and 2	600 kc.	2.5
2 and 3	600 kc.	1 (A) or 7(B)
3 and 4	455 kc.	70
4 and 5	455 kc.	0.7
5 and 6	455 kc.	60(A) or 125 (B)
6 and 7	455 kc.	0.7
7 and 8	400 cycles	30
8 and 9	400 cycles	15
(A) with a.v.c. voltage applied.		
(B) with the a.v.c. voltage shorted out.		

the average, but others are somewhat outside. Therefore, you can't rely on average values absolutely—you will have to supplement them with what you learn from experience with specific receivers. Even when you get a reading that is within the average limits, you will have to be careful. It may be below normal for that particular radio. That is, if you get a reading near the minimum value of Table 2, you won't always know whether this is natural for the receiver, or whether the gain for this particular stage should be near the maximum and is actually far below normal. Be guided in cases like this by the value you get in the rest of the receiver. If the manufacturer has designed one section to have fairly low gain, then another section must make up for this by having a higher gain.

► Now, let's see how to make gain measurements on the set shown in Fig. 6.

As you know, the basic signal tracer is a vacuum tube voltmeter with a tuned input for checking r.f. sections, and an untuned input for a.f. section measurements. The output indicator on the signal tracer may be either a magic eye tube or a meter. A calibrated volume control, also called an attenuator, on the signal tracer is used to adjust the amount of signal fed in.

To use the signal tracer, you must have a signal, either from a local broadcast station or from a signal generator, to feed into the set. The signal generator is

preferable, particularly when you expect to make measurements in the audio section of the receiver, because there a steady audio signal of unvarying amplitude is necessary. Let's suppose you are going to use a signal generator.

► The gain of the r.f. and i.f. stages depends on the a.v.c. voltage. Hence, most manufacturers recommend that the a.v.c. voltage be killed—in this case by shorting a.v.c. condenser  $C_2$ . Grounding the a.v.c. lead this way permits the set to operate with a maximum and fixed sensitivity. Notice that the r.f. stage gain varies from 1 to 7, depending on whether or not the a.v.c. is working. Let's prepare the set by shorting the a.v.c. condenser  $C_2$ .

► Table 1 shows that the signal strength is increased 2.5 times (the gain is 2.5) between the input of the receiver and the grid of the r.f. amplifier. The measurement, as the table also shows, is to be made with a 600 kc. signal input. Therefore, tune the receiver, the signal generator, and the signal tracer to 600 kc. Connect the signal generator to the aerial and ground posts of the receiver. Attach the ground lead of the signal tracer to the receiver chassis, and touch its hot probe to the antenna post. Adjust the calibrated attenuator of the tracer until the indicator eye of the signal tracer just closes. (For convenience, we will assume you are using a tracer that has a magic-eye indicator. If, instead, you are using a tracer that has a meter, adjust the s.g. output to bring the meter to the value recommended by the tracer manufacturer.)

Next, move the signal tracer hot probe to the control grid of  $VT_1$ . Adjust the attenuator until the indicator eye again closes. The ratio between this attenuator reading and the previous one shows the gain or loss in signal strength between the antenna post and the control grid of  $VT_1$ . (Thus, if the first reading was 3, and the second reading is 8, the gain is  $8 \div 3$ , or  $2\frac{2}{3}$ .) If a gain of about 2.5 is found, you know that the input section of the receiver is functioning properly.

Next, move the hot probe of the signal tracer to the plate socket terminal of  $VT_1$ . The ratio between the new attenuator reading and the last one should be about 7 when the a.v.c. is not working.

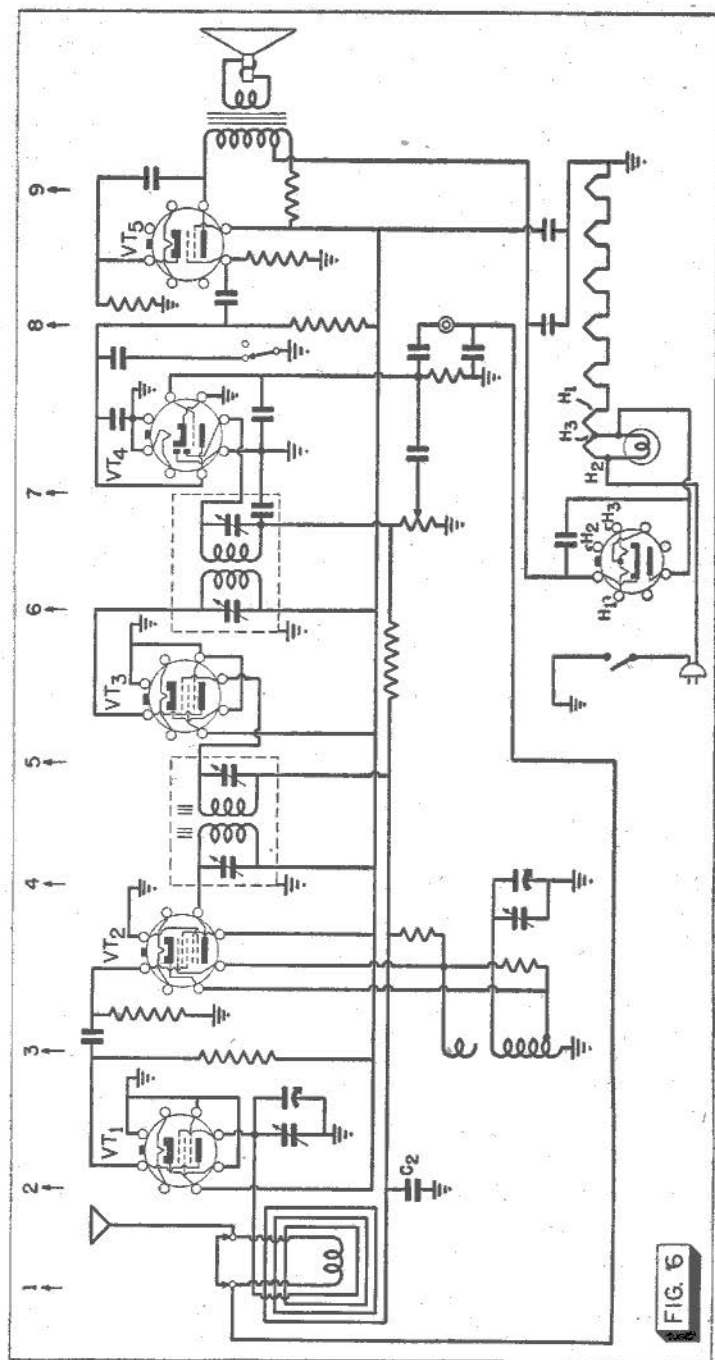


FIG. 6

Next, tune the signal tracer to 455 kc., the frequency of the i.f. amplifier, and touch its hot lead to the plate of  $VT_2$ . Adjust the attenuator until the tuning eye of the signal tracer closes. The attenuator setting ratio should show a gain of about 70.

Next, touch the hot probe to the control grid of  $VT_3$ , and adjust the attenuator gain. The "gain" should be about .7—actually, this represents a loss, which is to be expected in a double-tuned i.f. transformer.

Next, move the hot probe to the plate of  $VT_3$ , and adjust the attenuator. There should be a gain of about 125 when the a.v.c. is not working (about 60 if it is).

In this case, the first reading may be 20 (adjust the s.g. output until the signal tracer eye closes at some convenient attenuator setting), and the second reading may be 2500. The gain is  $2500 \div 20$ , or 125. (The attenuator is calibrated to cover a range of from 1 to 10,000.)

Finally, touch the hot probe to the ungrounded diode plate of  $VT_4$  of the volume control. This should show a "gain" of .7—the loss in the second i.f. transformer. This completes your check of the r.f.-i.f. section of the receiver.

► To check stage gain in the a.f. section, adjust the signal tracer to receive audio signals, and check the level at the volume control. Next, touch the hot probe to the triode plate of  $VT_4$ , and adjust the attenuator; the gain should be about 30. Finally, touch the hot probe to the plate of  $VT_5$ , and adjust the attenuator; this gain should be about 15. This completes your check of the gain of each stage of the receiver.

Naturally, if the gain in any stage is below normal, then that stage is the defective one.

## LOCATING THE DEFECTIVE CIRCUIT AND PART

You will seldom carry out completely any of the isolation procedures we have described. When you locate the defective stage, you will proceed to check the circuits and parts involved, following the same methods you have learned to use to locate other defects most likely to cause weak reception; these were discussed in the first part of this Booklet.

**TABLE 2**  
**AVERAGE GAIN DATA**

SECTION	GAIN	
	MIN	MAX
<b>R.F.</b>		
Antenna to 1st grid	2	10
Antenna to 1st grid, auto sets	10	50
R.F. amplifier, supers, broadcast	10	40
R.F. amplifier, t.r.f., broadcast	40	100
R.F. amplifier, supers, short wave	5	25
<b>MIXER</b>		
Converter grid to 1st i.f. grid (single i.f. stage)	30	60
Converter grid to 1st i.f. grid (2-stage i.f.)	5	30
<b>I.F. AMPLIFIER</b>		
I.F. stage (single stage)	40	180
I.F. stage (2-stage i.f., per stage)	5	30
<b>DETECTOR</b>		
Biased detector, 57, 6J7, 6C6, etc. (depends on % modulation)	5	40
Grid leak detector, square law	5	50
Diode detector (a loss—depends upon % modulation)	.2	.5
<b>AUDIO AMPLIFIER</b>		
Triode (low gain)	5	14
Triode (high gain)	22	50
Pentode	50	150
<b>POWER OUTPUT</b>		
Triode	2	3
Pentode and beam	6	20

One defect that you have not previously had experience in isolating is low  $Q$  in a coil. As we said earlier, this defect is indicated if the associated trimmer condenser tunes very broadly. It is also a definite possibility if you can find no other defect in a stage. When you suspect a coil of having low  $Q$ , it is worth while to go over all soldered connections with a hot soldering iron to remove any high-resistance connections. If this does not correct the difficulty, it is best to replace the coil. If the coil has a lowered  $Q$  because it has absorbed water vapor, it is sometimes possible to drive out the vapor by baking the coils in an oven. Immediately after-

wards, you should coat the coil with coil dope to prevent re-absorption of moisture. If loss of  $Q$  is caused by an internal short in one of the coil windings, no repair can be made; the coil must be replaced.

## NRI PRACTICAL TRAINING PLAN

In servicing a weak receiver, the most important thing is to localize the trouble by its symptoms or through one of the localization techniques. Because of this, you should introduce defects in your receiver that will cause weak reception, note any of the identifying symptoms mentioned at the beginning of this Booklet, and practice the localization techniques that can be made with the test equipment at your disposal. Following is a list of defects, and suggestions as to how they can be introduced in a receiver.

**Open Cathode By-Pass Condenser.** Look at your diagram, and note which r.f. or a.f. amplifier tubes use an individual cathode resistor by-pass condenser. Unsolder one lead of this condenser and tune in a station. Now touch the unsoldered lead back in place and note how the volume increases. With the condenser disconnected, try out localization tests. You will find that considerable patience is required to localize the trouble.

**Open Antenna Coil Primary.** This trouble can be demonstrated if your receiver uses an antenna. It is not necessary to unsolder the primary leads of the antenna coil. Simply remove and ground the antenna lead. Now connect about 5 feet of insulated hook-up wire to the antenna post of the receiver, and lay the wire on the floor. Tune for both weak and local stations. Notice the characteristic hissing when weak stations are tuned in.

**Low  $Q$  in Resonant Circuit.** This defect may be duplicated quite easily. Simply unsolder the lead from the coil to the condenser in a resonant circuit, and insert a 100-ohm resistor in the circuit. If you find that the receiver is dead, use lower values of resistance until strong locals or the full output of your s.g. will cause the loudspeaker to produce weak signals. Now peak the trimmer of this modified tuned circuit. Note how broad the adjustment of the trimmer in the low  $Q$  circuit has become. Compare this broadness to its normal sharpness after you



have removed the resistor from the circuit. Try this in several circuits, both in the preselector and in the i.f. circuits. Before you restore the circuit to normal, tune in both weak and distant signals and try all localization procedures.

**Weak Stage Localization.** Simulate the effect of a low emission tube in each stage, one at a time. (You can do this readily only in an a.c. set.) To lower the emission of a tube, place a resistor in series with its filament. This will reduce the voltage across the filament, thus lowering the cathode emission. A 5- to 10-ohm, 2-watt resistor will be satisfactory. Tune in weak and distant stations, and note the results when the weak stage is located in different sections. Watch the action of the tuning eye if one is used. Practice the localization procedures.

**Misalign the Set.** You have had practice in alignment before, but try throwing the set out of alignment again, to notice particularly the symptoms of weak reception.

**Measuring Stage Gain.** If you have a signal tracer, practice measuring stage gain. Many servicemen check the gain of all sets they service, and prepare tables for themselves for future reference.

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