Instructions for Operating

The NRI Professional Signal Tracer

Model 33

The Model 34 Signal Tracer is new and improved. A supplemental sheet of instructions is enclosed in this booklet. Be sure to read it.

National Radio Institute
16th and U Sts., NW.
Washington 9, D. C.

TRYING OUT YOUR MODEL 33 SIGNAL TRACER

Once you unpack a new instrument and look it over, there is always a strong desire to try it out immediately without reading the instruction book. With most test equipment there is a real danger of damage to the instrument if this perfectly natural impulse is followed. Not so with the Model 33 NRI Professional Signal Tracer! It's practically foolproof. (*ONE PRECAUTION:* The Model 33 can be operated only from a 110-120 volt, 50-60 cycle a.c. line.) Plug in the line cord, turn the FINE R.F. ATTENUATOR control in a maximum clockwise direction to 1, and wait for the magic eye to become green. Set the COARSE R.F. ATTENUATOR on 1 and the A.F. ATTENUATOR on .5. Throw the RF-AF switch to RF and connect the end of the R.F. probe to an antenna. Set the BAND SELECTOR switch to "B" and tune in any nearby local stations operating in the broadcast band. Experiment with the three attenuator controls (the FINE R.F. ATTENUATOR, the COARSE R.F. ATTENUATOR, and the A.F. ATTENUATOR). You will find that greatest sensitivity is obtained at the "low number" settings of these three controls. Don't be alarmed if overloading or blocking occurs on powerful local stations. The Model 33 is supposed to be sensitive— just turn the attenuators to higher numbers to reduce sensitivity. Naturally, a real tryout will come after you have read the instructions and you should proceed to do so without too much delay.

IMPORTANT

Read Carefully

We have good news for you! The Signal Tracer which you have received is a new and improved model. Several important modifications have been made which, we feel, greatly improve the utility of the instrument. We have used two type 6BA6 miniature tubes as R.F. amplifiers in place of the type 6SK7's used originally in this instrument. These new tubes give the Signal Tracer much greater gain, especially at higher frequencies. Uniformity of gain on the four R.F. bands has been greatly improved.

The operating procedure for your new instrument has not been changed. It therefore has not been necessary to print an entirely new instruction manual. A new diagram and parts list are included in this supplement.

The figures in the right-hand column of the CONVERTER GAIN CORRECTION FACTOR chart, on page 7, should be changed as follows:

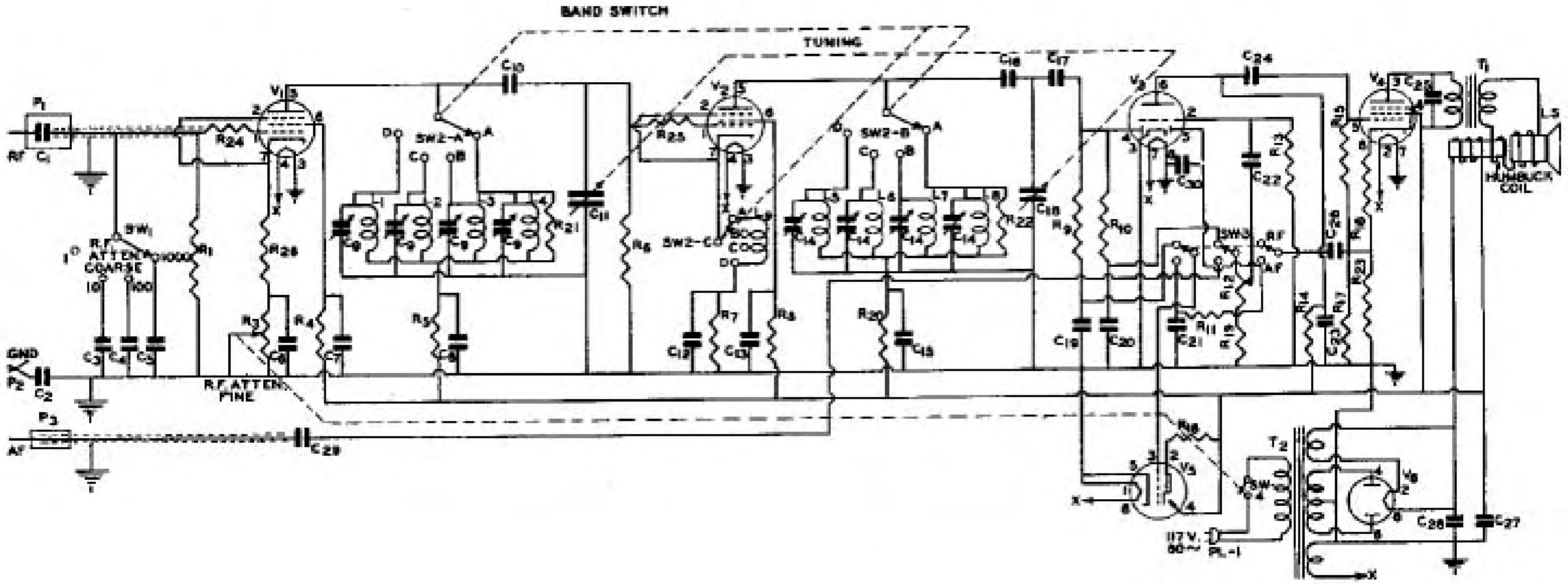
CONVERTER GAIN CORRECTION FACTOR

Input Frequency	I.F.	Multiply By
1000 kc.	175 kc.	1
1000 kc.	256 kc.	2
1000 kc.	370 kc.	2
1000 kc.	456 kc. or 455 kc.	2
1000 kc.	470 kc.	2

If you have any questions in regard to your instrument, feel free to write to us.

L.L. Menne, Director
Supply Division
National Radio Institute

OPERATING HINT: In signal tracing, it may be desirable to operate the Signal Tracer in such a way that no signal is heard from the Tracer until the R.F. Probe is placed on a test point in the set. To do this, first tune the Tracer to the desired signal. Then adjust the Fine R.F. Attenuator (and Coarse R.F. Attenuator if necessary) to the point where the signal level is not quite audible. Applying the R.F. Probe to a test point where a signal is present will increase the output from the Tracer and an audible signal will be heard. This procedure is recommended for aural tracing.



Item	Description
C1	2.2 mmf cond. 10% in rf probe
C2	0.25 mfd cond. paper 400V 20%
C3	.0004 mfd cond. mica 5%
C4	.004 mfd cond. mica 5%
C5	.04 mfd cond. paper 5%
C6	0.01 mfd cond. paper 400V 20%
C7	0.01 mfd cond. paper 400V 20%
C8	0.02 mfd cond. paper 400V 20%
C9	3-30 mmf mica trimmer cond.
C14	3-30 mmf mica trimmer cond.
C10	0.01 mfd cond. paper 400V 20%
C11	2 section variable cond.
C18	2 section variable cond.
C12	.05 mfd cond. paper 200V 20%
C13	0.01 mfd cond. paper 400V 20%
C15	0.01 mfd cond. paper 400V 20%
C16	0.01 mfd cond. paper 400V 20%
C17	250 mmf cond. mica 500V 20%
C19	0.05 mfd cond. paper 200V 20%
C20	250 mmf cond. mica 500V 20%
C21	.05 mfd 200V paper cond.
C22	.005 mfd 400V paper cond.

Item	Description
C23	250 mmf cond. mica 500V 20%
C24	0.01 mfd cond. paper 400V 20%
C25	0.005 mfd cond. paper 500V 20%
C26	0.01 mfd cond. paper 400V 20%
C27	10 mfd } dual electrolytic
C28	30 mfd } cond. 450 WV D.C.
C29	0.01 mfd cond. paper 400V 20%
C30	250 mmf cond. mica 500V 20%
T1	Audio output trans.
T2	Power trans.
R1	0.47 meg res. carbon ½W 20%
R3	3000 ohm pot. carbon with on-off sw.
R4	47,000 ohm res. carbon ½W 20%
R5	2000 ohm res. carbon ½W 20%
R6	0.47 meg res. carbon ½W 20%
R7	100 ohm res. carbon ½W 20%
R8	47,000 ohm res. carbon ½W 20%
R9	3.0 meg res. carbon ½W 20%
R10	0.47 meg res. carbon ½W 20%
R11	3.0 meg res. carbon ½W 20%

Item	Description
R12	0.5 meg pot. carbon audio taper
R13	10.0 meg res. carbon ½W 20%
R14	0.22 meg res. carbon ½W 20%
R15	0.22 meg res. carbon ½W 20%
R16	470 ohm res. carbon 1W 20%
R17	1.0 meg res. carbon ½W 20%
R18	1.0 meg res. carbon ½W 20%
R19	2400 ohm res. carbon ½W 10%
R20	2000 ohm res. carbon ½W 20%
R21	0.22 meg res. carbon ½W 20%
R22	0.22 meg res. carbon ½W 20%
R23	1500 ohm res. carbon 1W 20%
R24	100 ohm res. carbon ½W 20%
R25	100 ohm res. carbon ½W 20%
R26	47 ohm res. carbon ½W 20%
V1	6BA6 tube
V2	6BA6 tube
V3	6SQ7 tube
V4	6K6G tube
V5	6E5 tube
V6	5Y3G tube

Item	Description
SW1	Switch single circuit 4 pos.
SW2	Switch 3 wafer 3 circuit 4 pos.
SW3	Switch slide 3 circuit 2 pos.
SW4	Switch SPST (part of R3)
L1	Inductor band D
L2	Inductor band C
L3	Inductor band B
L4	Inductor band A
L5	Inductor band D
L6	Inductor band C
L7	Inductor band B
L8	Inductor band A
L9	Tapped rf choke coil
LS	Loud speaker
PL1	Line cord and plug
P1	RF assembled probe
P2	Ground clip
P3	AF assembled probe

HOW TO USE THE NRI PROFESSIONAL SIGNAL TRACER

All of the fast, certain, professional methods used by NRI trained service experts are built on the idea of localizing the trouble to the r.f. section or to the a.f. section of a receiver and then to a single stage in the defective section. There are many ways of localizing trouble, all described in the NRI Lessons, but the best all-around method is, without doubt, Signal Tracing. This method, although the most scientific, is also especially valuable for the beginner, for it not only aids him in doing professional work, but also assists him in understanding radio theory.

What is Meant by Signal Tracing

Signal Tracing means to sample or examine the signal at any point in its passage from the antenna through the various stages in a receiver to the loudspeaker. When you pass from a point of normal signal to the point at which your Signal Tracer verifies or confirms the complaint, you have just passed into or through the defective stage.

The Signal Tracer enables you to examine both the quantity (amount) and the quality of the signal. If the set is dead, you can determine where the signal stops. Or, if the complaint is weak reception, you can find which stage is causing a loss rather than a gain in signal strength. Should distortion, noise, hum or oscillation be the symptom, the Signal Tracer will quickly narrow your search to the defective stage and in many cases to the defective part itself.

The Signal Tracer's tuning eye and the calibrated attenuator controls will be used to show the relative amount of signal present and the relative gain, if any, contributed by each stage. The Signal Tracer's loudspeaker, which enables you to listen to the actual signal as it is traced through the set, is an "ear" check on the signal quality at each sampling point.

Description of the Model 33 Signal Tracer

For the convenience of those interested, a wiring diagram of the Model 33 is shown in Fig. 1. To use your Signal Tracer it is *not* necessary to refer to this schematic. However, as you can see, this instrument is actually a special kind of all-wave, tuned radio frequency (t.r.f.) receiver, complete with audio amplifier and loudspeaker. Any one of the following four frequency bands may be selected by the BAND SELECTOR switch.

Band A	170-490 kc.
Band B	490-1470 kc.
Band C	1470 kc.-3.9 mc.
Band D	3.8-11.3 mc.

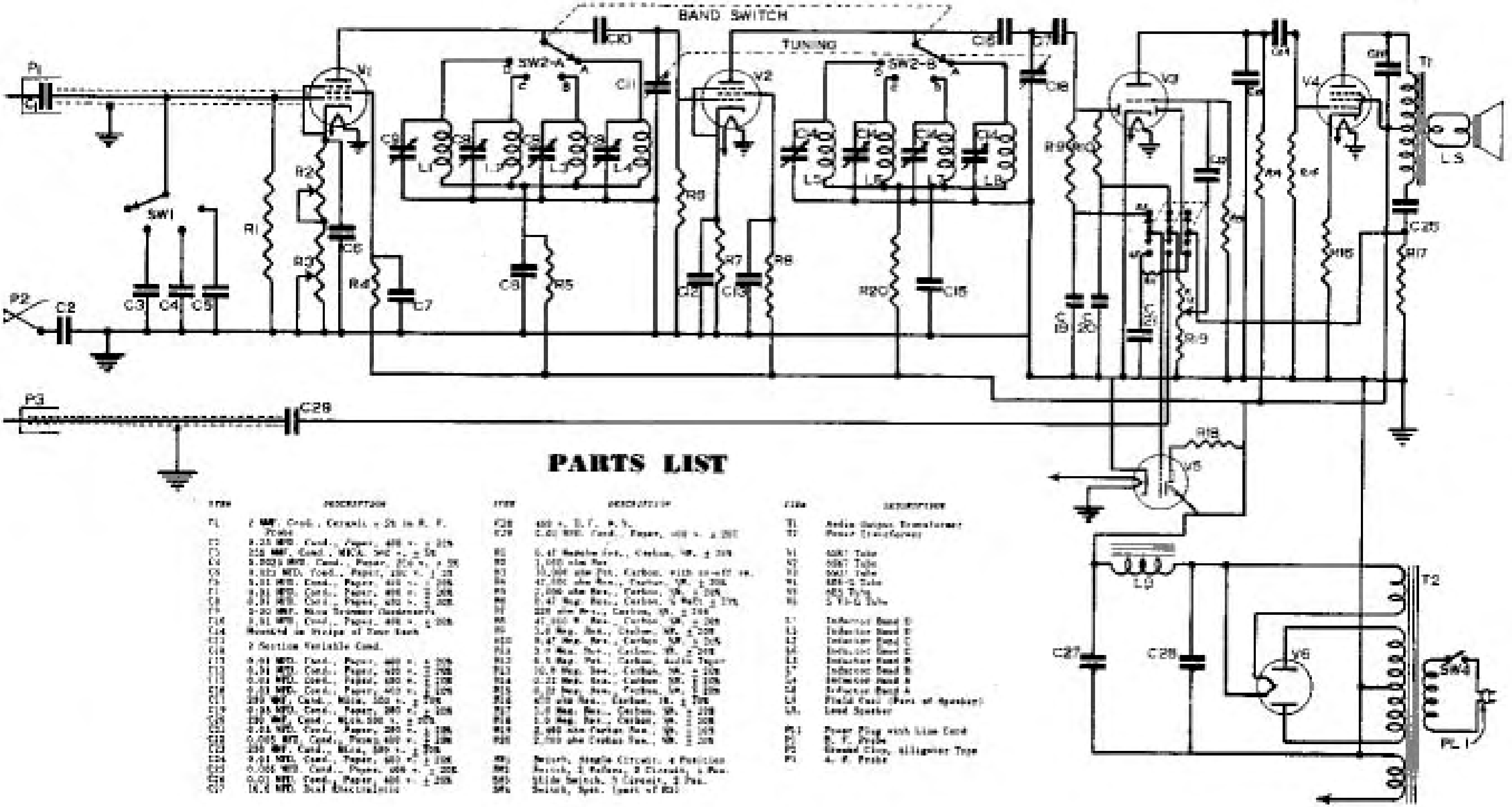
What is normally an antenna lead is actually the R.F. probe, and any r.f. signals within the frequency range of the instrument may be fed into it through this probe. When the R.F. probe is connected to a resonant circuit, very little detuning will occur because of the 2 micro-microfarad series condenser built into the probe handle. The COARSE R.F. ATTENUATOR (SW-1) is a capacity type voltage divider which controls the amount of signal fed to the first r.f. amplifier tube. The FINE R.F. ATTENUATOR (R_3) controls the bias, and hence the gain, of the first r.f. tube. The use of these controls in making gain measurements will be described later.

When the R.F. probe is used, the tuning eye indicates the relative strength of the signal reaching the 6SQ7 diode detector plate (pin No. 4). After demodulation, the audio signal passes on through the a.f. amplifier section to the loudspeaker. When the RF-AF switch is in the A.F. position, it disconnects the r.f. amplifier and makes it possible to use the audio section of the Signal Tracer independently. In this case a.f. signals are fed through the A.F. probe and blocking condenser C_{29} to the calibrated volume control (A.F. ATTENUATOR), and are amplified and reproduced by the loudspeaker. The method of using the calibrated markings on the A.F. ATTENUATOR to measure a.f. gain is discussed later. Part of the amplified signal is fed back from output transformer T_1 and rectified by the other diode plate of the 6SQ7 (pin No. 5). This rectified voltage is used to close the tuning eye to indicate the relative strength of the a.f. signal being examined.

While the over-all sensitivity of the Model 33 is exceptionally high for an instrument of this type, there is no attempt made to keep the sensitivity constant with variations in frequency. To do so would add considerable cost to the instrument. However, as gain measurements are generally made at a single frequency, this proves to be no drawback.

Servicing With the NRI Professional Signal Tracer - Testing Routine

The NRI Signal Tracer is a powerful tool for the solution of service problems. But, for best results, a systematic method of use should be adopted. As taught in the NRI Course, there is a



PARTS LIST

ITEM	DESCRIPTION
C1	2 MMF. Cond., Ceramic ± 2% in R. F. Probe
C2	0.25 MFD. Cond., Paper, 400 v. ± 20%
C3	250 MMF. Cond., MICA, 500 v. ± 5%
C4	0.0025 MFD. Cond., Paper, 200 v. ± 2%
C5	0.025 MFD. Cond., Paper, 200 v. ± 2%
C6	0.01 MFD. Cond., Paper, 400 v. ± 20%
C7	0.01 MFD. Cond., Paper, 400 v. ± 20%
C8	0.01 MFD. Cond., Paper, 400 v. ± 20%
C9	3-30 MMF. Mica Trimmer Condensers
C10	0.01 MFD. Cond., Paper, 400 v. ± 20%
C14	Mounted on Strips of Four Each
C11	2 Section Variable Cond.
C18	
C12	0.01 MFD. Cond., Paper, 400 v. ± 20%
C13	0.01 MFD. Cond., Paper, 400 v. ± 20%
C15	0.01 MFD. Cond., Paper, 400 v. ± 20%
C16	0.01 MFD. Cond., Paper, 400 v. ± 20%
C17	250 MMF. Cond., Mica, 500 v. ± 20%
C19	0.05 MFD. Cond., Paper, 200 v. ± 20%
C20	250 MMF. Cond., Mica 500 v. ± 20%
C21	0.01 MFD. Cond., Paper, 200 v. ± 20%
C22	0.005 MFD. Cond., Paper, 400 v. ± 20%
C23	250 MMF. Cond., Mica, 500 v. ± 20%
C24	0.01 MFD. Cond., Paper, 400 v. ± 20%
C25	0.005 MFD. Cond., Paper, 400 v. ± 20%
C26	0.01 MFD. Cond., Paper, 400 v. ± 20%
C27	16.0 MFD. Dual Electrolytic
C28	450 v. D.C. W.V.
C29	0.01 MFD. Cond., Paper, 400 v. ± 20%
R1	0.47 Megohm Res., Carbon, ½W. ± 20%
R2	1,000 ohm Res.
R3	10,000 ohm Pot., Carbon, with on-off sw.
R4	47,000 ohm Res., Carbon, ½W. ± 20%
R5	2,000 ohm Res., Carbon, ½W. ± 20%
R6	0.47 Meg. Res., Carbon, ½ Watt ± 20%
R7	220 ohm Res., Carbon, ½W. ± 20%
R8	47,000 ohm Res., Carbon, ½W. ± 20%
R9	1.0 Meg. Res., Carbon, ½W. ± 20%
R10	0.47 Meg. Res., Carbon, ½W. ± 20%
R11	2.2 Meg. Res., Carbon, ½W. ± 20%
R12	0.5 Meg. Pot., Carbon, Audio Taper
R13	10.0 Meg. Res., Carbon, ½W. ± 20%
R14	0.22 Meg. Res., Carbon, ½W. ± 20%
R15	0.22 Meg. Res., Carbon, 1W. ± 20%
R16	470 ohm Res., Carbon, 1W. ± 20%
R17	1.0 Meg. Res., Carbon, ½W. ± 20%
R18	1.5 Meg. Res., Carbon, ½W. ± 20%
R19	2,000 ohm Carbon Res., ½W. ± 20%
R20	2,200 ohm Carbon Res., ½W. ± 20%
SW1	Switch, Single Circuit, 4 Position
SW2	Switch, 2 Wafers, 2 Circuit, 4 Pos.
SW3	Slide Switch, 1 Circuit, 2 Pos.
SW4	Switch, Spst. (part of R3)
T1	Audio Output Transformer
T2	Power Transformer
V1	6SK7 Tube
V2	6SK7 Tube
V3	6SQ7 Tube
V4	6K6-G Tube
V5	6E5 Tube
V6	5Y3-G Tube
L1	Inductor Band D
L5	Inductor Band D
L2	Inductor Band C
L6	Inductor Band C
L3	Inductor Band B
L7	Inductor Band B
L4	Inductor Band A
L8	Inductor Band A
L9	Field Coil (Part of Speaker)
LS	Loud Speaker
PL1	Power Plug with Line Cord
P1	R. F. Probe
P2	Ground Clip, Alligator Type
P3	A. F. Probe

FIGURE 1
SCHEMATIC OF THE MODEL 33 NRI PROFESSIONAL SIGNAL TRACER

definite method of approach to a service job. These steps are repeated here in Fig. 2. Success in step 3 can make possible the omission of up to five of the next steps, and success in step 4 may permit omission of the next four steps. The Signal Tracer does not invalidate these steps. It is used as a localization tool in steps 5 and 6, and also often in steps 7 and 8. Experience alone will show how much the servicing procedure is speeded up with the Signal Tracer. It suffices to say that no Radio serviceman who has learned to use the Model 33, or any other good *tuned* Signal Tracer, would ever be without this basic instrument. Careful study, and review, of these instructions will be necessary if you are to get the maximum good from your Signal Tracer. Do not expect complete mastery of *the use of* your instrument in one evening, or one week. Patience and study on your part NOW, will soon reward you with a surprisingly more efficient radio servicing technique.

Now let us see how to trace signals through a receiver, using the Model 33 Signal Tracer. The schematic diagram shown in Fig. 3 will be used for purposes of illustration, and the various signal tracing steps follow:

1. Plug the receiver and the Model 33 into an a.c. power line and allow both to warm up.
2. Clip the "ground" lead of Model 33 to the receiver chassis.
3. Set all three attenuators to their lowest calibration numbers. (FINE to 1, COARSE to 1, and A.F. ATTENUATOR to .5)
4. Throw the RF-AF switch to RF.
5. Tune in a powerful station between 500 kc. and 1450 kc. on the receiver.
6. Set the Model 33 BAND SELECTOR switch to Band "B," as this band covers the frequency of the station tuned in on step 5.
7. Touch the R.F. probe to the primary of the antenna transformer (Junction of C_3 and L_1).
8. Tune the Model 33 until you hear the same program as is being reproduced by the receiver's loudspeaker. (Make any attenuator adjustments necessary to prevent overloading.)
9. Move the R.F. probe to the signal grid of the mixer tube (top cap of the type 6A8 tube). If necessary, re-tune the RECEIVER for maximum signal tracer tuning eye closure. If the tuning eye overlaps, increase the setting of the FINE or COARSE R.F. ATTENUATOR as necessary, so that the tuning eye just closes.
10. Remove the R.F. probe from the 6A8 top cap and re-tune the receiver if you changed its dial setting in step 9.

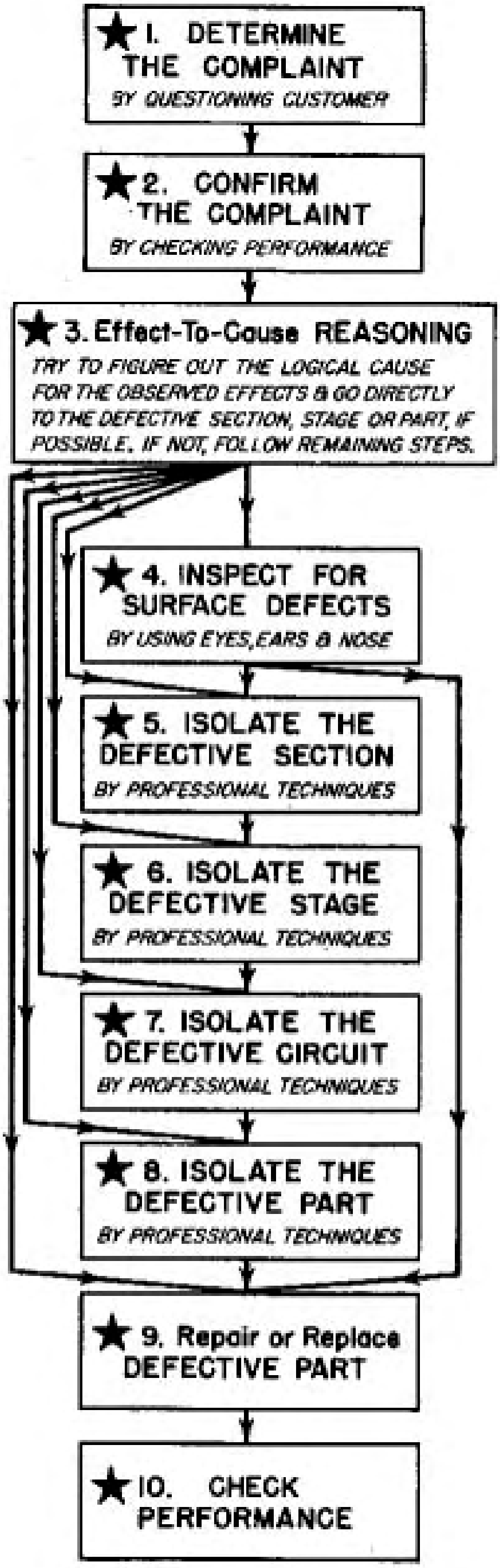


FIGURE 2
COMPLETE PROFESSIONAL SERVICING PROCEDURE FOR RADIO RECEIVERS

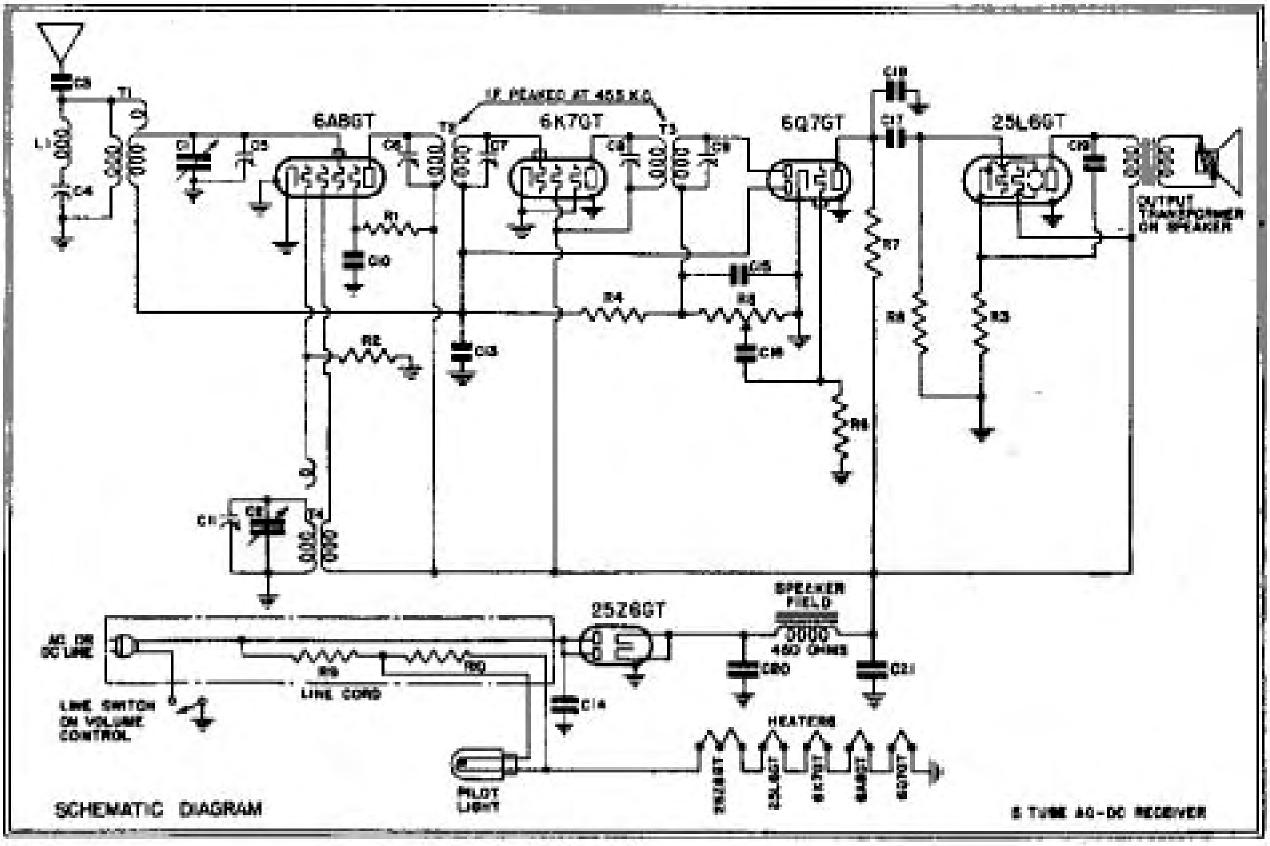


FIGURE 3
EMERSON MODEL CH RECEIVER

11. Turn the Signal Tracer BAND SELECTOR switch to Band "A," which covers the i.f. frequency of this receiver. Tune the Model 33 to 455 kc. (half way between 450 and the next scale mark to its left).

12. Touch the R.F. probe to the plate socket terminal of the 6A8 mixer tube. The i.f. signal of the receiver should now be audible in the speaker of the Model 33. If not, tune the Model 33 on both sides of 455 kc., as the receiver's i.f. may be slightly misaligned. If necessary, adjust the R.F. ATTENUATORS until the eye just closes and turn the A.F. ATTENUATOR so the program is audible in the Model 33 loudspeaker.

13. Move the R.F. probe to the signal grid of the first i.f. amplifier tube (top cap of the 6K7). The eye will open up, showing a decrease in amplitude of the receiver's i.f. signal. This is correct, as there is normally a loss in a double-tuned i.f. transformer.

14. Shift the R.F. probe to the plate socket terminal of the 6K7 i.f. amplifier tube. The tuning eye should overlap due to the gain in the i.f. amplifier tube. It should be necessary to turn the COARSE R.F. ATTENUATOR control from 1 to 10, 100 or even 1000, before you can adjust the closure of the tuning eye with the FINE R.F. ATTENUATOR. (The i.f. tube's gain should also be apparent by increased audible output from the Model 33's loudspeaker.)

15. Touch the R.F. probe to the diode detector plate of the 6Q7 tube. Some decrease in signal strength will be noted.

16. Next shift the R.F. probe to the ungrounded side of volume control R_5. To hear the i.f. signals, you must set the R.F. ATTENUATORS for maximum sensitivity, as only a small amount of i.f. signal should exist at this point. This completes the Signal Tracing in the r.f. and i.f. sections of the receiver.

17. Slide the RF-AF switch to the AF position, and now touch the A.F. probe to the "hot" (ungrounded) side of the volume control R_5, and listen to the audio signal at this point. The A.F. ATTENUATOR may be used to decrease the output of the Model 33.

18. Move the A.F. probe to the plate of the 1st a.f. amplifier tube (plate socket terminal of the 6Q7). A large increase in volume should result. This

may be decreased to a reasonable level by turning the A.F. ATTENUATOR to a higher number, or by turning down the volume of the receiver.

19. Next, touch the A.F. probe to the control grid of the 25L6 output tube. The signal level, i.e., sound from the Model 33 loudspeaker, should be about the same as in previous step, No. 18.

20. Move the A.F. probe to the plate socket terminal of the 25L6 output tube. An increase in signal level should be noted.

21. Disconnect the Model 33's "ground" lead clip from the receiver chassis and connect it to one of the receiver loudspeaker voice coil leads. Touch the A.F. probe to the other voice coil lead. A large drop in signal level compared to that obtained in step 20 is to be expected due to the step-down action of the output transformer.

With the completion of step 21 we have traced the signal through each stage of the receiver, from the antenna to the loudspeaker voice coil. These are the same points at which you will make tests on an improperly operating set.

To get experience, it will be worthwhile for you to go through this procedure on one or more receivers which are in good operating condition. This will enable you to get the feel of your instrument. Whenever possible, obtain a schematic diagram of the receiver you are testing. Now, let us see how tests would be made on an improperly operating receiver.

SERVICING A DEAD RECEIVER

The Model 33 is ideal for following the signal from the input of the set to determine where it is interrupted. As an example, we will use the circuit shown in Fig. 4.

The input signal may be either that of a local broadcast station or the modulated output of a signal generator. Turn on the receiver and tune it to the point where this signal would be received if the set were working. Connect the ground clip of the Signal Tracer to the set chassis. Set the R.F.-A.F. switch to R.F. position and the BAND SELECTOR switch to the proper band.

As you become expert in the use of a Signal Tracer, you will probably eliminate as much testing as possible by making rather large jumps in following the signal--jumping from grid to grid, or even from section to section. At the beginning, however, it is best to sample the signal at each grid and plate circuit.

In this example (Fig. 4), start with the R.F. probe on the control grid of the 12SA7 converter tube. With the BAND SELECTOR switch on "B," tune the Signal Tracer to the frequency of the incoming signal, and re-tune the set, if necessary, to give maximum indication on the

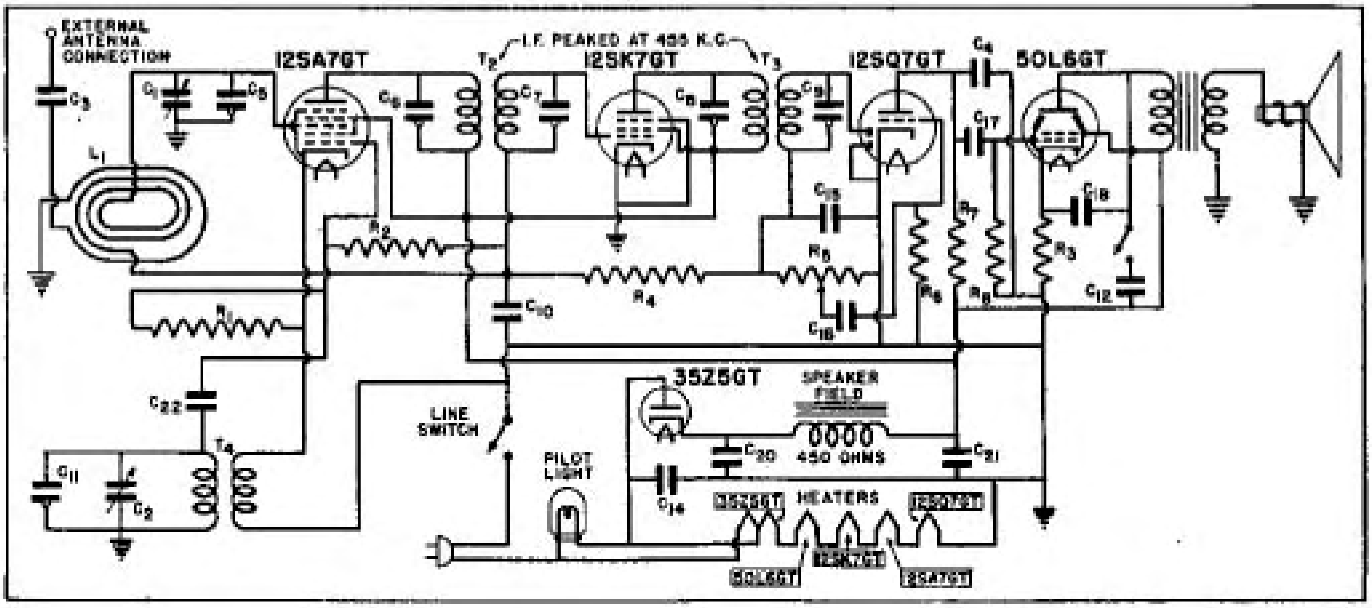


FIGURE 4

Signal Tracer tuning eye. If the signal is picked up at the grid of the 12SA7 tube, the input circuits of the receiver are in good condition.

Next, move the R.F. probe to the plate of the 12SA7 tube. Set BAND SELECTOR switch on "A," and tune the Signal Tracer to the receiver's i.f. frequency of 455 kc. No signal here may mean that there is no B supply voltage, that at least one section of the 12SA7 tube is not working, that C_6 is short-circuited, that the primary of i.f. transformer T_2 is short-circuited, that the local oscillator is not working or is misaligned. (Tune the Signal Tracer on both sides of 455 kc. to be sure that no i.f. signal is present.)

You can check the oscillator with the Signal Tracer by placing the R.F. probe on the first grid of the 12SA7 tube or the stator of the oscillator tuning condenser. Tune the Signal Tracer over the band covering a frequency 455 kc. higher than the receiver dial setting and see if you can pick up the oscillator signal as indicated by closing of the tuning eye. (Since this signal is unmodulated, you won't hear anything in the loudspeaker when you pick up the signal.) If you cannot pick up the oscillator signal, then there is trouble in the oscillator circuit. If you do pick it up, notice the frequency at which you find it on the Signal Tracer dial. This frequency should be equal to the incoming signal frequency plus the i.f. frequency of the set. If it is far different from this, then the trouble may be that the oscillator circuit is out of alignment.

Assuming that you hear a signal at the i.f. frequency at the plate of the 12SA7 tube, move the R.F. probe to the grid of the 12SK7 i.f. amplifier tube. Lack of a signal here indicates trouble in transformer T_2, or in its trimmers C_6 and C_7.

If you find the signal at the grid of the 12SK7 i.f. amplifier tube, move to its plate. The Signal Tracer must still be tuned to the i.f. frequency. Lack of a signal here indicates a defective 12SK7 tube, improper operating voltages, or trouble in the primary of T_3 or condenser C_8.

Next, move to the plate of the diode detector section of the 12SQ7 tube, leaving the Signal Tracer tuned to the i.f. frequency. No signal here probably indicates an open in the secondary of T_3, or a short in C_9. If you find the signal, throw the R.F.-A.F. switch to A.F., change to the A.F. probe of the Signal Tracer, and apply it to the grid of the 12SQ7 1st a.f. amplifier tube. No signal here probably means an open in C_{16} or a short in C_{15}. There is also the possibility that the volume control is defective.

If you find the signal at the grid of the 12SQ7 tube, move to its plate. Lack of signal here indicates a short in C_4, an open in R_7, or a defective 12SQ7 tube.

If a signal is present at the plate of the 12SQ7, move the A.F. probe to the grid of the 50L6 power amplifier tube. If you find no signal here, but get a signal at the plate of the 12SQ7, then coupling condenser C_{17} could be open.

Finally, if you find a signal at the 50L6 grid, move the A.F. probe to the plate of the 50L6 tube. No signal here means a defective 50L6 tube, an open primary of the output transformer, a short-circuited condenser C_{18}, or an open in R_3.

As you can see, the Signal Tracer is used by moving successively from grid to plate circuit throughout the receiver until you find the point at which you hear no signal. At that point, you can stop and resort to your ohmmeter and voltmeter to find the defect. The Signal Tracer has the advantage of finding not only the defective stage, but, in most cases, the defective circuit as well.

As mentioned earlier, it is a waste of time to check and follow the signal through the entire receiver just to find that the trouble is in the output stage. For this reason, most servicemen first make some circuit disturbance test to assure themselves that the audio amplifier is working and that the power supply is normal, before using the Signal Tracer. For example, if the a.f. system and power supply are o.k., you will hear a loud buzz when you touch your finger to the ungrounded terminal of the volume control. You will probably find the Signal Tracer is of greatest use in locating troubles in the i.f.-r.f. section of the receiver.

SERVICING WEAK RECEIVERS

When it comes to localizing trouble in a weak receiver, there is nothing that equals the Signal Tracer. With it you can actually measure the gain per stage.

For simplicity, instead of determining the exact amount of signal in volts, you get a comparison by determining how much greater the signal is at one point than it is at another point. This comparison, or ratio, 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, it must be known what gain to expect in each portion of the radio. Many manufacturers now include stage-by-stage gain measurements in the information on their sets. Some do not, and, for their sets, you will have to rely on average gain values. As a matter of fact, average gain values are generally more reliable, because set manufacturers may take their measurements with a particular make of instrument and an instrument of another make may not give duplicate results. This is particularly true where a change in frequency is involved, as it is when measuring conversion gain from the input of the mixer of a superheterodyne to its output. The reason for inaccuracy at this point is that the sensitivity of most Signal Tracers is not constant over a given band or between bands. However, we have worked out a very simple system of obtaining conversion gain with the Model 33 as you will learn now.

USING THE R.F. ATTENUATORS FOR GAIN MEASUREMENTS - CONVERTER GAIN CORRECTION FACTOR

In making r.f. stage gain measurements, it is only necessary to determine how many times stronger or weaker the signal is between the input of a stage and its output. With the Model 33, you do not measure the signal level in volts, but in the ATTENUATOR value required to close the tuning eye for the particular frequency in question. Suppose that, to close the eye at the grid of a tube, the FINE R.F. ATTENUATOR is set half way between 3 and 4. This is read 3.5. Also, you find that the COARSE R.F. ATTENUATOR is set to 10. Multiply the COARSE and FINE settings together. Thus 3.5 x 10 equals 35, which is the relative signal strength at the grid of the tube. Now, move the R.F. probe to the plate of the tube. The signal will be much stronger here and you may find it necessary to set the COARSE R.F. ATTENUATOR to 100 and the FINE at 7. Again, multiplying the COARSE and FINE settings, we obtain 100 x 7 or 700 as the relative signal strength at the plate of the tube. *The relative plate signal strength divided by the relative grid signal strength is the gain of the stage.* Thus 700 ÷ 35 = 20, and the gain of this stage is 20. If the relative signal strength at the plate were 70 rather than 700, the stage gain would be 70 ÷ 35, or 2. But suppose the relative signal strength at the plate were 7. At once you would know that there was less signal at the plate than at the grid, and that a *loss* rather than a gain had occurred. The actual "gain" would still be found by dividing the plate reading by the grid reading. In this case 7 ÷ 35 equals .2, and we say that the gain is .2 times.

Since conversion gain measurements on a superheterodyne mixer stage are taken at two frequencies, division of the output reading by the input reading will not always give the true gain. However, if the gain value you obtain is multiplied by the right correction factor, the results will be quite accurate. The correction factor will vary with the difference between the signal frequency at the mixer grid, and the i.f. frequency at the mixer plate, as this factor depends on the difference in Signal Tracer sensitivity at the two frequencies involved. The table below gives the correction factors for the i.f. frequencies found in standard a.m. receivers. Note that in each case the input frequency must be 1000 kc. which may be obtained from a station or signal generator. As a matter of fact, any station between 900 kc. and 1100 kc. may be used and the results will still be acceptable.

CONVERTER GAIN CORRECTION FACTOR

Input Frequency	*I.F.*	*Multiply by*
1000 kc.	175 kc.	.5
1000 kc.	256 kc.	1
1000 kc.	370 kc.	2
1000 kc.	456 kc. or 455 kc.	2.5
1000 kc.	470 kc.	2.5

Table 1 gives the manufacturer's gain figures for the set shown in Fig. 5, 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 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 gain values 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.

TABLE 1

Gain between points	*Tracer tuned to*	*Approximate gain*
1 and 2	1000 kc.	2.5
2 and 3	1000 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.

TABLE 2
AVERAGE GAIN DATA

SECTION	GAIN MIN	GAIN MAX
R.F.		
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
MIXER		
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
I.F. AMPLIFIER		
I.F. stage (single stage)	40	160
I.F. stage (2-stage i.f., per stage)	5	30
DETECTOR		
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
AUDIO AMPLIFIER		
Triode (low gain)	5	14
Triode (high gain)	22	50
Pentode	50	150
POWER OUTPUT		
Triode	2	3
Pentode and beam	6	20

Examples of Gain Measurements.

Now, let's see how to make gain measurements on the set shown in Fig. 5. 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 gain 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 in modern receivers depends on the a.v.c. voltage. Hence, most manufacturers recommend that the a.v.c. voltage be killed while making gain measurements--in the case of Fig. 5 by shorting a.v.c. filter condenser C_2. Shorting the a.v.c. in this way permits the set to operate with a maximum and fixed sensitivity. Notice in Table 1 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 for gain measurements by shorting a.v.c. filter condenser C_2.

Table 1 shows that the signal strength is increased 2.5 times (the gain is 2.5) between the input and the r.f. amplifier grid of the receiver in Fig. 5. This measurement, as the table also shows, is to be made with a 1000 kc. signal input. Therefore, tune the receiver, the signal generator, and the Signal Tracer to 1000 kc. Remove the antenna-ground shorting bar and connect the signal generator to the antenna and ground posts of the receiver. Attach the ground lead of the Signal Tracer to the receiver chassis. Set the slide switch to R.F., the BAND SELECTOR switch to B, and touch the R.F. probe to the antenna post. Adjust the two calibrated R.F. ATTENUATORS of the Signal Tracer until the indicator eye just closes. If necessary, increase the output of the Signal Generator.

Multiply together the FINE and COARSE R.F. ATTENUATOR settings. The result represents the relative signal strength at this point needed to close the indicator eye.

Next, move the R.F. probe to the control grid of VT_1. Adjust the R.F. ATTENUATORS until the indicator eye just closes and again multiply the COARSE and FINE settings together to get the relative signal strength at this point. The ratio between this attenuator value and the previous one shows the gain or loss in signal strength between the antenna and the control grid of VT_1. (Thus, if the first value were 3, and the second were 8, the gain is 8 ÷ 3, or approximately 2.7.) If a gain of about 2.5 is found, you know that the input section of this receiver is functioning properly.

Next, move the R.F. probe of the Signal Tracer to the plate socket terminal of VT_1. Adjust R.F. ATTENUATORS until the indicator eye closes. The ratio between this new ATTENUATOR value and that at the grid of VT_1 should be about 7 to 1 when the a.v.c. is not working.

The signal strength at the plate of VT_1 and at the grid of VT_2 is approxi-

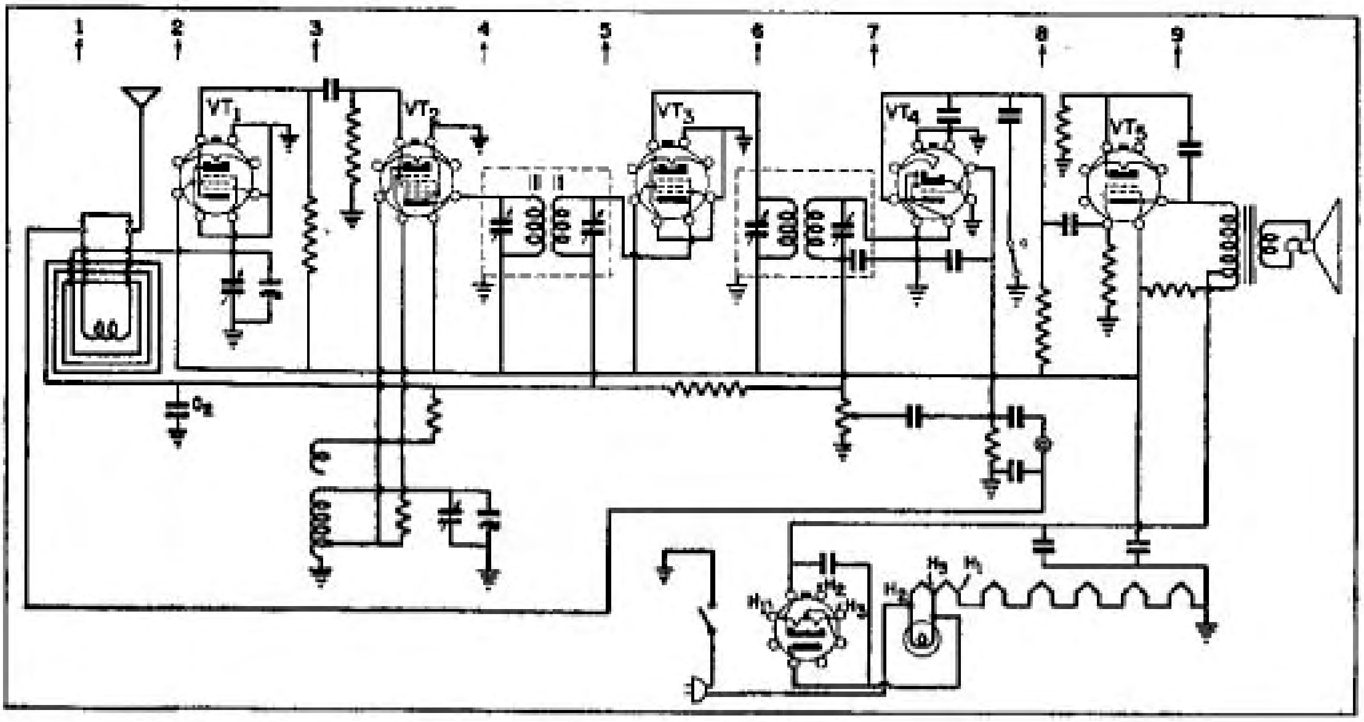


FIGURE 5

mately equal, so no measurement need be taken at the grid of VT$_2$.

Next, reset the BAND SELECTOR switch to "A" and tune the Signal Tracer to 455 kc., the frequency of the i.f. amplifier. Touch the R.F. probe to the plate of VT$_2$. Adjust the R.F. ATTENUATORS until the indicator eye of the Signal Tracer closes. The attenuator setting ratio between grid and plate of VT$_2$ should be about 28 to 1. Multiplying by the "conversion gain" correction factor of 2.5, for an I.F. of 455 kc., will give the true conversion gain as 28 x 2.5 or 70.

Next, touch the R.F. probe to the control grid of VT$_3$, and adjust the R.F. ATTENUATORS for closing of indicator eye. The "gain" of this i.f. transformer should be about .7 (actually, this represents a loss, which is to be expected in a doubletuned i.f. transformer).

Next, move the R.F. probe to the plate of VT$_3$, and adjust the R.F. ATTENUATORS for closing of indicator eye. The gain of VT$_3$ should be about 125 when the a.v.c. is not working (about 60 if it is). In this stage, the ATTENUATOR setting at the grid may be 20, and the ATTENUATOR setting at the plate may be 2500. The gain is therefore 2500 ÷ 20, or 125. (Notice that the R.F. ATTENUATORS are calibrated to cover a range of from 1 to 10,000.)

Finally, touch the R.F. probe to the ungrounded diode plate of VT$_4$. This should show a "gain" of .7--the loss occurring in the second i.f. transformer. This completes the gain measurements in the r.f.-i.f. section of this receiver.

A.F. Gain Measurements

A.F. gain measurements are taken in much the same way as R.F. gain measurements. However, the A.F. probe is used and there is only one A.F. ATTENUATOR control. To calculate stage gain, the A.F. ATTENUATOR reading at the input is divided by the A.F. ATTENUATOR reading at the output of the stage. (In both readings, the A.F. ATTENUATOR being set for a position which just closes the indicator eye.)

A.F. gain measurements cannot be made when the receiver is tuned to a broadcast station, because the station modulation varies from instant to instant. An audio signal of constant strength is required. A modulated r.f. signal generator, connected to the antenna of the set, is quite satisfactory. You can also use an audio signal generator connected across the receiver volume control.

To check stage gain in the a.f. section of the receiver in Fig. 5, adjust the Signal Tracer to receive audio signals by sliding the RF-AF switch to AF. The Model 33 "ground" lead is clipped on the receiver's chassis as done previously. Touch the A.F. probe to the grid of tube VT$_4$. Set the A.F. ATTENUATOR control at

1. Adjust the receiver volume control so the indicator eye just closes. Next move the A.F. probe to the plate of VT_4 and re-adjust the A.F. ATTENUATOR for indicator eye closure. This new A.F. ATTENUATOR setting is actually the stage gain. (No division is necessary, since the A.F. ATTENUATOR setting at the grid of VT_4 was 1. Dividing the setting at plate of VT_4 by 1 always gives a stage gain equal to the A.F. ATTENUATOR setting at the plate of VT_4.)

Before going further, reduce the receiver volume by means of its volume control so the indicator eye again just closes at an A.F. ATTENUATOR setting of 1, with the A.F. probe still on VT_4 plate. Now move the A.F. probe to the plate of VT_5 and re-adjust the A.F. ATTENUATOR for eye closure. This new ATTENUATOR setting is the gain contributed by the power output stage. This completes your check of the gain of each stage of the receiver. Naturally, if the gain of any stage is below normal, then that stage is the defective one.

SERVICING RECEIVERS THAT DISTORT

The receiver in which distortion is to be localized should be tuned to a station so its loudspeaker will reproduce that distortion. With the receiver volume set at a low level, connect the Model 33 "ground" lead to the receiver chassis. Set the slide switch to A.F., and touch the A.F. probe to the ungrounded side of the receiver voice coil. (If one side of the voice coil is not grounded, the Model 33 "ground" lead should be clipped directly to one side of the voice coil and the A.F. probe to the other side.) Turn up the Signal Tracer gain, so that the audio output from the Signal Tracer exceeds the output from the receiver. Listen for the distortion. If it is absent in the output from the Signal Tracer, you know at once that the receiver loudspeaker is at fault and appropriate steps as outlined in the NRI Course should be taken to correct the speaker trouble.

If the distortion is present across the speaker voice coil, it is still possible that the loudspeaker is defective. You should proceed to mute the speaker by disconnecting one lead of its voice coil. Substitute a dummy load of a 10 ohm, 5 to 10 watt resistor in place of the speaker voice coil. Using the Signal Tracer, check the audio voltage appearing across the dummy load resistor for distortion. If normal reception is now obtained, the loudspeaker is definitely at fault. (Note: In making this check, the Signal Tracer "ground" lead should go to the grounded side of the speaker voice coil if one side of the voice coil is grounded. Otherwise, connect the A.F. probe to either side of the dummy load and the "ground" lead to the other.)

Should the distortion continue, however, re-connect the Model 33 "ground" lead to the receiver chassis and touch the A.F. probe to the ungrounded side of the diode load resistor, where the detected audio signals are first developed. If the distortion is not present at the diode load, proceed to trace the audio signal toward the loudspeaker, using the audio section of the Signal Tracer, just as was previously described. The first point at which the distortion is present indicates that you have just passed through the defective stage. You should then concentrate on that stage, checking the operating voltages with a d.c. voltmeter and being on the lookout for defective parts.

Perhaps the most common cause for distortion is a leaky coupling condenser or a gassy tube. (Many servicemen who regularly use a Signal Tracer will first, in the case of distortion, check for leaky coupling condensers and gassy tubes with a d.c. voltmeter, before resorting to the signal tracing procedure. The d.c. voltmeter test for coupling condenser leakage and gas in a tube is described in the regular NRI Lessons.)

If distortion is present across the diode load resistor, set the slide switch to R.F. and prepare the Signal Tracer to pick up the i.f. signals, by changing the BAND SELECTOR switch to Band "A."

Touch the R.F. probe to the plate of the diode detector, and tune in the i.f. signals on the Signal Tracer. If there is no distortion at the input of the detector (between the diode plates and chassis), but the a.f. output of the detector is distorted, a new 2nd detector tube should be tried. Also, the resistance of the diode load resistor should be checked with an ohmmeter. Too high a diode load resistance can cause distortion.

If the distortion is present across the input to the diode detector, touch the R.F. probe to the input of the i.f. amplifier tube driving the 2nd detector. If distortion does not exist here, but is present at the plate of this tube, try a new tube. Also, use a high resistance d.c. voltmeter to check the a.v.c. voltage applied to this i.f. tube. Lack of a.v.c. voltage can cause this tube to deliver a distorted signal to the 2nd detector. Check the a.v.c. circuit for continuity and the a.v.c. filter condensers for leakage or for a short. Also be on the lookout for oscillation in the r.f. or i.f. sections of the receiver. Instructions for using the Model 33 to localize oscillation are given later.

SERVICING RECEIVERS FOR EXCESSIVE HUM

In most sets, excessive hum is caused by defective electrolytic condensers or cathode-to-heater leakage in tubes. It is advisable to check these parts first before trying to localize the point at which hum enters the receiver circuit. The tubes may be checked for leakage in a reliable tube tester, and any method you desire may be used to check the condensers. You can shunt them with good condensers, or check them with an R-C Tester such as the Model 111 NRI Professional R-C Tester.

The Signal Tracer can be used to check for excessive hum voltage across the filter condensers. To do this, the Model 33 is prepared for A.F. listening tests by throwing the slide switch to A.F. The "ground" lead is clipped to the negative lead of the condenser under test. (Do not unsolder the condenser leads.) The A.F. probe is then touched to the positive condenser lead. The A.F. ATTENUATOR is set so the amount of hum can be readily heard. The hum should be very loud across the input filter condenser. However, hum should be at a low level across the output filter condenser.

After you have made this test on a few receivers in first-class condition, you will know how to interpret the results of this test.

When the tubes and filter condensers are not at fault, trace the hum to its point of entry into the receiver and then concentrate on that circuit.

If hum modulation is the complaint, tune the receiver to a powerful local station, or use an unmodulated signal from a signal generator. Trace the signal from the antenna towards the second detector, until you find the stage in which the hum modulation first starts. The regular r.f. signal tracing procedure previously explained, should be employed.

SERVICING RECEIVERS THAT SQUEAL OR MOTORBOAT

Make the necessary preliminary inspection for surface defects, being on the lookout for shielding out of place, poor grounding of shields, dirty wiping contacts on the tuning condenser rotor shaft, etc. Disconnect the receiver antenna, or be sure the receiver is not tuned to a station. Next, with the Model 33 tuned to the correct frequency, check for r.f. voltage across the various plate, screen and cathode by-pass condensers in the r.f. and i.f. circuits. No appreciable r.f. voltage should appear across a good by-pass condenser. Should you find an r.f. or i.f. voltage exists across some by-pass condenser, that one is probably open and another condenser should be tried.

In all probability, replacing a faulty by-pass condenser will clear up the trouble. If not, check right through the receiver from the antenna to the second detector. Use the R.F. probe, and tune the Signal Tracer to the correct frequency, just as described for measuring gain in weak receivers. Oscillation in an i.f. stage will usually be indicated by closure of the tuning eye with no signal being fed to the receiver. Since the oscillating stage will not be modulated, no sound will be heard in the Model 33 loudspeaker.

Oscillation in the r.f. stage will usually be indicated by closure of the Model 33's tuning eye with no signal being fed to the receiver. As in the case of i.f. oscillation, no sound will be reproduced by the Model 33 loudspeaker. The frequency of the oscillation will depend on the dial setting of the receiver.

HOW TO SERVICE A NOISY RECEIVER

Certain clues will lead directly to the noise source. (We are assuming that you have definitely concluded that the noise is originating within the receiver.) A change in noise level when actually moving the waveband switch, a push-button switch, the volume control, the tone control, or the tuning condenser, indicates that this device is at fault. Even if you do not have any of these clues, the noise can be localized to one section rather simply.

In the modern superheterodyne receiver, the volume control is either the diode load resistor, or is in the input circuit of the first a.f. amplifier tube. Therefore, the volume control separates the r.f.-i.f. section from the audio section of the receiver. If you turn the volume control to the minimum volume position and the noise disappears, the source of the noise is in the r.f.-i.f. section of the receiver. If the noise remains with the volume control set at minimum, the source of the noise is in the audio amplifier section, or in the power pack of the receiver. (This is not quite always true. Severe changes in current, such as may be caused by a plate circuit defect in an r.f. or i.f.

tube, may affect the power supply to the audio amplifier enough to introduce noise - even when the volume control is turned to zero volume. However, in such cases, turning down the volume control will decrease the noise intensity greatly.)

Noise signals pass through the receiver stages in the same way as other signals do. Their source can be readily located with the Model 33 Signal Tracer.

To trace noise signals with the Signal Tracer, tune the receiver and Signal Tracer to some quiet point on the dial (not to a station). Trace from the first stage of the defective section (r.f.-i.f. section or a.f. section) toward the set's loudspeaker. When you first hear the noise coming from the Signal Tracer speaker, you have located the defective stage.

Remember that noises originating in one stage may feed back into a number of previous stages through a power supply circuit common to these stages. This can occur only when the noise signal is unusually strong, or in sets in which there is insufficient by-passing of the supply leads. Therefore, in rare cases, it is possible to pick up a noise signal in the plate circuit of one tube when the noise is actually originating in a later stage. Short the output of the first stage in which noise is traced, using a 1 mfd. condenser. If the noise disappears in the receiver's output, this stage is more than likely introducing the noise. If the noise is still present in the receiver's output, suspect a following stage.

HOW TO SERVICE AN INTERMITTENT RECEIVER

The Model 33 Signal Tracer is ideal for localizing intermittent defects, but you should not use the Signal Tracer until you have tried the "Brute Force" method. This consists of wiggling individual parts and pulling on leads to parts while the receiver is operating. If, by doing this, you can make the intermittent action occur, you have found the defective part or connection. In the vast majority of intermittent receivers, you can quickly find the cause of the trouble with this "Brute Force" method. When this method fails, use your Signal Tracer to localize the trouble to a section and then to a stage.

There is one important fact you should consider before you start to use your Signal Tracer (or any other piece of test equipment) to locate an intermittent defect. You must leave the equipment connected until the set "acts up." Therefore, your test equipment is tied up to this intermittent receiver. You cannot use it to service other sets while you are waiting for the defective set to "act up." For this reason, be sure to learn how often the intermittent defect occurs before you even accept the job. If the intermittent trouble is relatively infrequent, it may be best to advise the receiver owner to keep his set for a while, as the trouble will probably soon start to occur more often. Point out to him that, at this time, the repair will cost him more than it is worth, because of the time you will have to spend looking for the defect. However, if the intermittent trouble occurs several times an hour, then it is becoming frequent enough to consider tying up equipment to locate the defect.

Of course, in between "cut-outs," you need pay little attention to the set. Service other receivers, or attend to other shop duties, as long as you can stay within hearing distance of the intermittent set. When you hear the set act up, a glance at the Signal Tracer indicator eye will show how much progress you are making in locating the trouble.

To attach your Signal Tracer probes to the receiver, you will need a pair of alligator clips which can be slipped on the ends of the R.F. and A.F. probes. These clips are *not* furnished by NRI. Most servicemen have such clips. You can purchase a pair from your local parts distributor or from any mail order house. If possible, obtain a pair of the insulated alligator clips with phone tip jacks attached. These will slip over the tips of the R.F. and A.F. probes. Some semi-permanent connections of this sort are necessary when dealing with intermittent receivers, because touching a probe to a circuit while the receiver is intermittent may disturb the circuit enough to restore operation, thus defeating the purpose of the test.

The R.F. and A.F. probes of the Signal Tracer cannot actually be used at the same time. However, both may be connected to the receiver at one time. By throwing the RF-AF switch from one position to the other, you can sample the signal in two different sections of the receiver without disturbing the receiver by connecting or disconnecting test probes. It is suggested that the R.F. probe be clipped to the plate of the mixer tube and the Signal Tracer adjusted to pick up the i.f. signal here. With the slide switch in the R.F. position, adjust the FINE and COARSE R.F. ATTENUATOR controls so the indicator eye is just closed. The A.F. probe should be connected to the plate of the first a.f. tube. With the slide switch in the

A.F. position, adjust the A.F. ATTENUATOR to give normal loudspeaker reproduction. (The amount of eye closure at this point is of little importance since the closure will vary with the carrier modulation.) When the intermittent occurs, check the signal at the R.F. position and then at the A.F. position of the slide switch. If it has faded at the R.F. position, the trouble is between the mixer plate and the antenna. On the other hand, if the signal is *a little stronger* at the R.F. position and *weak* at the A.F. position, the trouble is between the mixer plate and the second detector. (The increase in signal level at the mixer plate is due to the drop in a.v.c. voltage which permits the R.F. gain to increase.) If the r.f. signal level is constant, but the a.f. signal level is weak, the trouble is between the second detector and the plate of the first a.f. tube.

Once you have determined whether the trouble is in the r.f. or a.f. section of the receiver, only the R.F. or A.F. Signal Tracer probe will be used. You should trace the signal in the defective section towards the output of the receiver. Leave the probe connected at each test point until the signal fades or "cuts out" in the set loudspeaker. Check the finding at the Signal Tracer. When you pass from a point of normal operation to a point at which the signal is intermittent, the last point checked is in the defective stage.

SIGNAL TRACING IN AN F.M. RECEIVER

The "D" band in the Model 33 Signal Tracer will cover the i.f. frequencies of f.m. receivers, and permits tracing of the f.m. signal from the mixer plate to the plate of the limiter stage. The same tests already described for a.m. receivers may be made. The f.m. receiver can be tuned either to an f.m. station or to a signal from a signal generator. The indicator eye of the Signal Tracer is used to indicate the presence or absence of the signal. Although loss of signal may be easily detected, and stage gain measurements can be made, you cannot listen to the quality of the Frequency Modulated i.f. signal with the Signal Tracer, because the a.m. detector in the Signal Tracer will give somewhat distorted audio reproduction. If an amplitude modulated signal generator is used as the signal source, only the audio modulating tone will be heard. It is difficult to tell anything about signal quality by listening to a single audio frequency.

Signal Tracing in the audio section of an f.m. receiver is no different from tracing in the audio section of an ordinary a.m. set.

You can quickly check to see if an f.m. oscillator is working by measuring for d.c. voltage across the oscillator grid resistor. A voltage of 5 to 15 volts indicates a normal oscillator. Lack of voltage or only a low voltage across the grid resistor shows failure of the oscillator.

HOW TO ALIGN RECEIVERS WITH THE SIGNAL TRACER

If a signal generator is available, it should be used for alignment purposes. However, the Model 33 Signal Tracer may be satisfactorily used to align a receiver. The Signal Tracer is employed to align the i.f. amplifier and also the broadcast preselector and oscillator sections. On all-wave receivers, the oscillator frequency may be checked if it falls within the range of band "D" of the Model 33. However, once the receiver i.f. is properly adjusted, stations may be used for oscillator and preselector adjustment. To align the broadcast band of a receiver, proceed in the following manner:

1. Clip the R.F. probe to the plate of the mixer tube.

2. Set the receiver dial to the frequency of a broadcast station in the neighborhood of 1400 kc. and tune the Signal Tracer exactly to the same frequency as the station. (Do not tune the Signal Tracer to the i.f. frequency of the receiver.)

3. Block the oscillator of the receiver by shorting its tuning condenser.

4. Adjust the receiver r.f. trimmer or trimmers for maximum closure of the Signal Tracer indicator eye. (If the indicator eye overlaps, adjust the R.F. ATTENUATORS for some indicator eye shadow.)

5. Tune the Model 33 to the i.f. specified by the receiver manufacturer, remove the short across the oscillator condenser and adjust the oscillator trimmer for maximum closure of the Signal Tracer indicator eye.

6. (If the oscillator is not equipped with a low frequency padder condenser, omit steps 7 and 8. Go immediately to step 9.)

Assuming the receiver has a low frequency oscillator padder condenser, adjust it as follows: Tune the Signal Tracer to a station near 600 kc. with the R.F. probe connected to the receiver antenna. Next clip the R.F. probe on the mixer plate, block the receiver oscillator, and manually tune the receiver to this station, for maximum closure of the Signal Tracer eye.

7. Tune the Signal Tracer to the receiver's correct i.f. frequency, as in step 5, unblock the oscillator and adjust the oscillator low frequency padder condenser for maximum Signal Tracer indicator eye closure.

8. Tune the receiver to the station near 1400 kc. and repeat the oscillator trimmer adjustment in step 5. Now repeat steps 6 and 7.

9. Move the R.F. probe to the plate of the first i.f. amplifier tube, and adjust the first i.f. transformer trimmers for maximum Signal Tracer indicator eye closure.

10. Move the R.F. probe to the ungrounded side of the diode load resistor, adjust the R.F. ATTENUATORS for maximum Signal Tracer sensitivity. A small signal should be present. Adjust the second i.f. transformer trimmers for maximum Signal Tracer indicator eye closure. This completes the i.f. alignment.

11. The short-wave preselector and oscillator trimmers can now be adjusted when tuned to known stations, so that maximum gain and proper dial settings are obtained.

SPECIAL INFORMATION

1. The noise heard when the FINE R.F. ATTENUATOR is turned past 1 does not indicate that this control is noisy. This is natural and is due to the construction of the control.

2. If the Model 33 breaks into oscillation at any frequency, reduce its sensitivity by turning the R.F. ATTENUATOR control counter-clockwise.

3. On very strong signals, do not allow the indicator eye to overlap, because blocking will then occur if the A.F. ATTENUATOR is turned too far clockwise. Simply re-adjust the R.F. ATTENUATORS for proper eye closure--no damage will result.

4. The Model 33 "ground" lead should always connect to B-. This is generally the receiver chassis. Where B- is not the chassis (an examination of the receiver diagram will show if this is true), the Model 33 "ground" lead should connect to B-. If you wish, an insulated wire may be temporarily soldered to B- and the Model 33 "ground" lead clipped to the bare end of this wire. This will make it possible to turn the chassis over while signal tracing.

GETTING MAXIMUM SELECTIVITY. Since the Model 33 is a test instrument and not a receiver, selectivity is not judged by listening to the speaker output when tuning. On very strong strong signals, the R.F. ATTENUATOR should be kept in as far a counter-clockwise position as possible. Use the tuning eye indicator tube as a means of selecting or separating one signal from another.