How to Make Extra Money
FIXING RADIOS

NATIONAL RADIO INSTITUTE, WASHINGTON, D.C.

No. 34

How To Service
F.M. Receivers

RADIO SERVICING METHODS

NRI TRAINING PAYS...

Dear Mr. Smith:

It was a lucky day for me when I sent for the Course in Radio. The only thing I regret is that I did not start sooner. I have built up a good size radio business in my city and it is growing every day. Thanks again for getting me started in Radio and I hope others will take your Course and profit like I did.

F. H., Wisconsin

NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.

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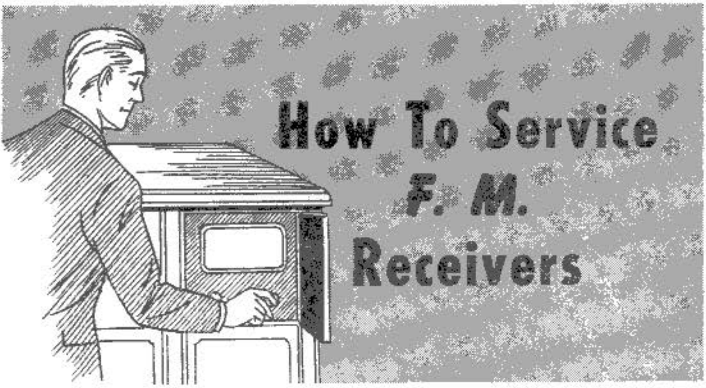


FREQUENCY modulation (f.m.) has two important advantages over amplitude modulation (a.m.)—the possibility of high fidelity, and freedom from noise. Of course, true high fidelity can be achieved only if the receiver is designed for it—an inexpensive table model set cannot give it, no matter how good the transmission is. However, freedom from noise is a real advantage, particularly in large cities where man-made interference is severe.

Because f.m. requires such wide frequency bands, it has been forced to use ultra-high-frequency broadcasting channels. Waves of these frequencies have ranges of only 30 to 50 miles from the transmitter, because they are not reflected by the ionospheric layers. For this reason, f.m. transmitters are being installed only near large centers of population—small towns and rural areas still have to depend on a.m. broadcast services.

If you operate a service business in an area that has (or soon is to have) f.m. stations, you will be expected to repair f.m. as well as a.m. receivers. Let's turn now to the f.m. receiver and learn just what differences there are in the service procedure.

As Fig. *1* shows, the f.m. receiver is basically like the standard a.m. superheterodyne, with the exception of the limiter and discriminator stages. Obviously, since the stages and parts are similar, the f.m. receiver will have the same types of troubles as the a.m. sets. In fact, the a.f. amplifier and the power supply of an f.m. set are serviced in exactly the same manner as are those of an a.m. set. You will have to modify your service procedures only when you service the r.f.-i.f. section of an f.m. receiver. We will show you how to do so in the first part of this Booklet, then show you how to align and install f.m. sets.

THE I.F. SECTION

You will find two types of f.m. receivers: one type that receives only f.m. signals, and another that is a combination a.m.-f.m. set. Since you've already studied f.m. receivers in your Course, we won't discuss the operation of the stages. However, let's take a quick look at a typical combination a.m.-f.m. receiver to learn of the switching used.

A combination usually consists of a standard a.m. receiver to which one or two f.m. bands have been added. This means that the proper i.f. section must be switched in, along with the limiter and the discriminator, when the f.m. bands are to be used. A rather elaborate switching arrangement (a part of the wave-band switch) is necessary.

Of course, it is possible to use entirely separate i.f. amplifiers, and merely switch from one to the other. However, more standard practice is to use the same tubes, with dual transformers, and a switching arrangement like that shown in Fig. *2*.

Switch SW_1 directs the output of the first detector tube into the proper i.f. transformer T_1 or T_2. This signal is amplified by the tube VT_2. From VT_2 the signal path depends on the i.f. signal frequency. A 456-kilocycle a.m. signal passes easily through the primary of the 10-mc. transformer, which offers practically no impedance at these frequencies. Therefore, at 456 kc., the plate load of VT_2 is the low-frequency transformer T_4 and its condenser. On the other hand, transformer T_3 and its trimmer form the plate load when the 10-megacycle f.m. signal is present, because the condenser across transformer T_4 acts as a by-pass around that transformer at this frequency.

For the same reasons, the signal path again divides at the output of VT_3. A 456-kilocycle a.m. signal passes through T_6 to the a.m. detector tube VT_6. The output of this tube is fed (through a switch) to the audio amplifier. On the other hand, a 10-mc. signal passes through T_5 to tube VT_4, which is the limiter. From the limiter, the signal goes into discriminator VT_5. The audio output of the discriminator is then fed to the audio amplifier.

The switch SW_2 opens the cathode circuit of the limiter tube VT_4 so that the limiter stage cannot function when the wave-band switch is set for a.m. reception. Some receivers open the screen supply lead instead.

GENERAL HINTS

One general rule we can state — *don't attempt the slightest design change when you service an f.m. set.* These sets are high-precision devices compared to ordinary a.m. sets. Parts have 5% or 10% tolerances, instead of the 20% (or worse) that are common in a.m. sets. The placement and lengths of wires are often critical. Therefore, disturb circuits as little as possible when you are mak-

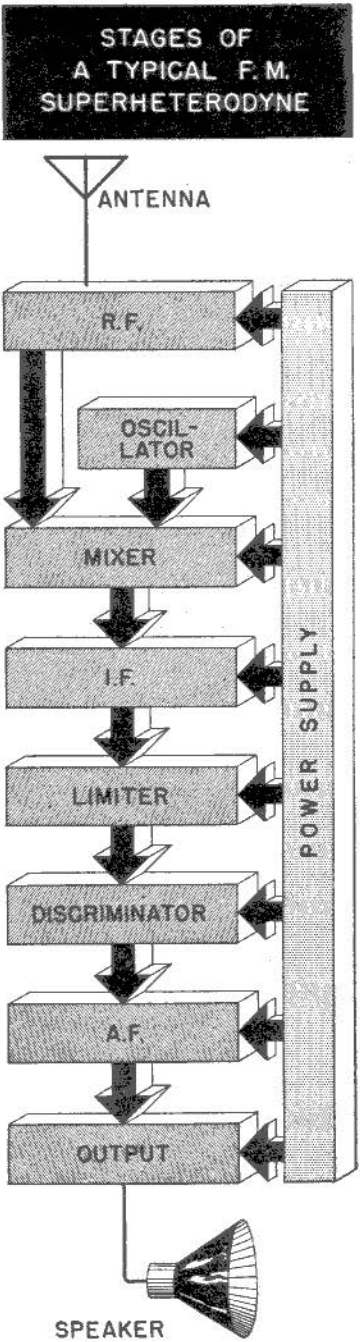


FIG. 1. This diagram shows the stages used in a typical f.m. superheterodyne. Although only one is shown here, there are usually at least two i.f. stages. Some sets do not have an r.f. stage.

ing repairs, and use exact duplicate replacement parts. If you must use a condenser or a resistor that is not an exact duplicate, be sure that both the value and the tolerance match those of the original.

► How you service the r.f.-i.f. portion of the f.m. receiver will depend greatly upon whether the set is a combination, and if so, upon whether the trouble occurs on a.m. reception as well as on f.m.

When you find that the trouble exists on *both* the a.m. and f.m. bands of a combination receiver, switch to an a.m. band, and service the set just as you would any other a.m. receiver, using the standard methods of localization with which you are already familiar. When you have cleared up the trouble on a.m. reception, it should have disappeared from the f.m. portion of the receiver also.

Trouble on F.M. Bands Only. If the set is an a.m.-f.m. combination, and the a.m. section plays satisfactorily, but the f.m. section has suddenly gone bad, then the trouble must be in the wave-band switching arrangement, or in some part that is used only for f.m. reception. Referring to Fig. *2* again, it is obvious that trouble in VT_4 or VT_5 will kill or otherwise interfere with the normal passage of an f.m. signal, but will have no effect on the a.m. signal. Similarly, trouble in transformer T_1 will affect f.m. reception without affecting a.m. reception. A short circuit across one of the windings of the f.m. transformers T_3 or T_5 can also prevent f.m. reception without noticeably affecting a.m. This rarely happens, however.

Of course, you must not overlook the fact that the preselector-mixer-oscillator portion of the receiver may also be at fault. It is standard practice to change the input circuits of the receiver rather completely on the f.m. band, because of the great frequency difference between the present 88-108 megacycle f.m. band and the normal a.m. frequencies. The signal often goes through an entirely different series of r.f. and converter tubes.

► The same test procedures are followed on both the straight f.m. set and the f.m. band of a combination, except, of course, that the latter has switches that must be considered as possible trouble sources. Therefore, *in*

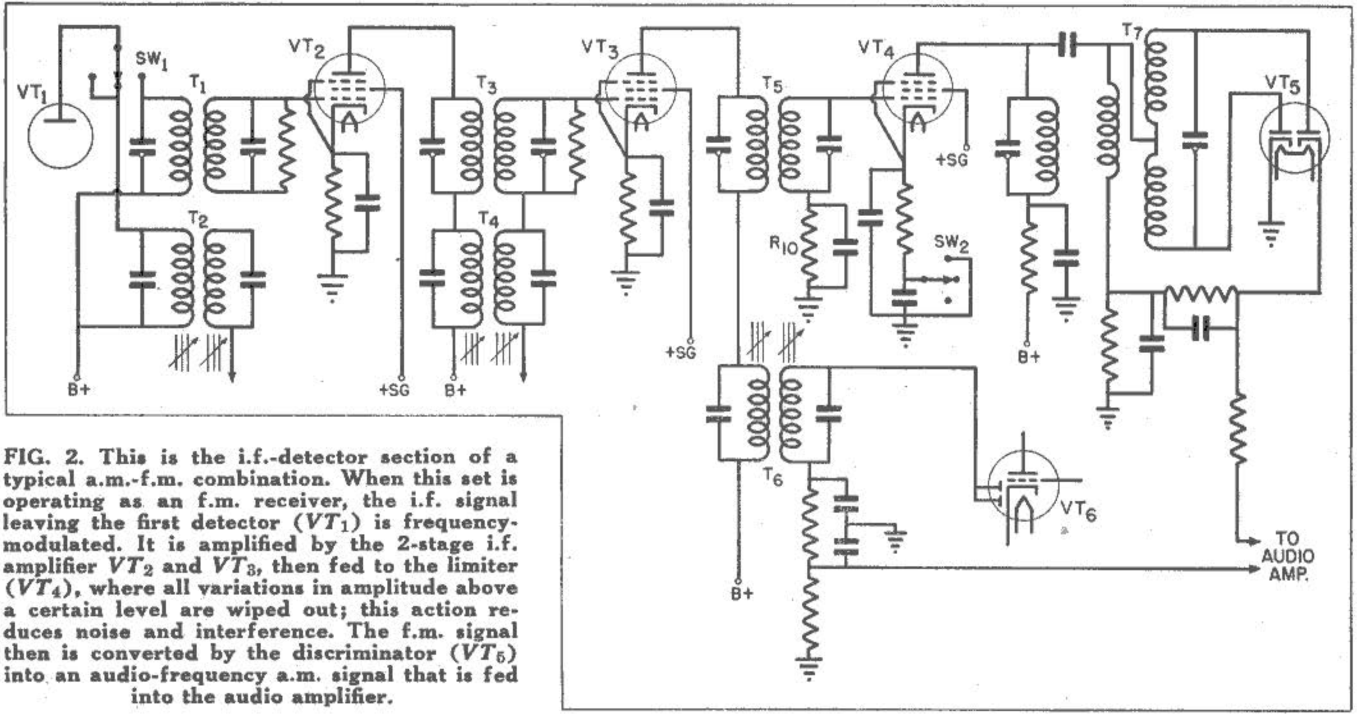


FIG. 2. This is the i.f.-detector section of a typical a.m.-f.m. combination. When this set is operating as an f.m. receiver, the i.f. signal leaving the first detector (VT_1) is frequency-modulated. It is amplified by the 2-stage i.f. amplifier VT_2 and VT_3, then fed to the limiter (VT_4), where all variations in amplitude above a certain level are wiped out; this action reduces noise and interference. The f.m. signal then is converted by the discriminator (VT_5) into an audio-frequency a.m. signal that is fed into the audio amplifier.

the following sections we will assume that you are working on a straight f.m. receiver, or have a set in which only the f.m. bands are defective.

HOW TO LOCALIZE DEFECTS

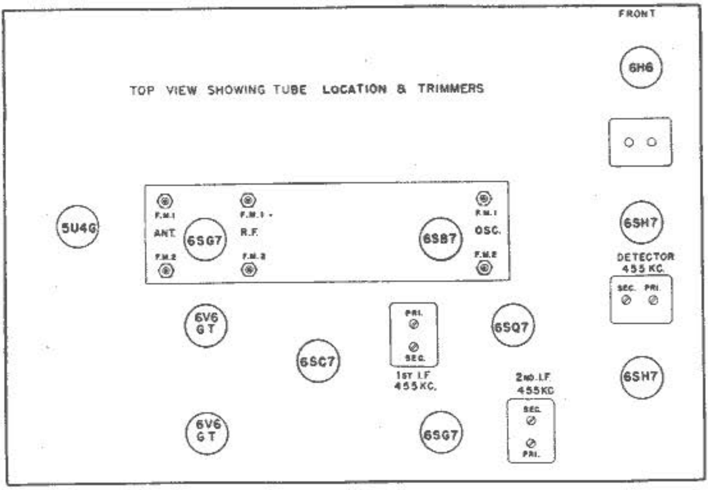
The first steps in servicing an f.m. receiver are the familiar ones of confirming the complaint and looking for surface defects. Then, once you decide the trouble is within the radio, proceed in the usual manner to localize the trouble to the defective section, stage, circuit, and part. You can use the same effect-to-cause reasoning you have learned to use for a.m. receivers, because, for example, any defect that can cause a dead a.m. set can also cause a dead f.m. set. In the following discussion of the various possible complaints, we will point out the methods of localization you can use.

Dead Set. If an f.m. receiver is dead, follow the usual procedure of making a circuit disturbance at the grid input of the first audio stage to determine whether the trouble is in the audio section or in the power supply. Touch the top cap of the first audio tube, or touch the slider arm terminal on the volume control if this tube has no top cap. In either case, you will hear a loud buzzing sound from the speaker if the a.f. section is working. If the a.f. section is not working, proceed to localize the trouble in the a.f. section and the power supply section just as you would in an a.m. set.

► If you get a normal buzz, you know that the trouble is in the r.f.-i.f. section of the radio. You can use circuit disturbance tests, stage-by-stage signal injection, or signal tracing to localize the dead stage.

At first thought, it may seem odd to make circuit disturbance tests on the r.f.-i.f. section of an f.m. receiver, since the limiter is supposed to wipe out noise. However, as you perform a circuit disturbance test on stages ahead of the limiter, there will be a change in the signal amplitude at the limiter. The limiter will wipe out all voltage changes above its saturation level, but the change from zero up to the saturation level will cause a click to travel through the receiver. The click may not be as strong as it is in a.m. sets, but it will be there.

Therefore, you can make the usual circuit disturb-



This is the layout of the top of the chassis of the Stromberg-Carlson No. 1121 a.m.-f.m. combination. Notice that there are separate antenna, oscillator, and preselector trimmers for each of the two f.m. bands. The i.f. trimmers on this side of the chassis are for the a.m. bands only; the i.f. trimmers for the f.m. bands are under the chassis.

ance tests—pull out and replace tubes, use a voltmeter, or remove and replace tube top-cap clips. Start the disturbance at the limiter and work back toward the input of the receiver. As you disturb each stage, you should hear a thud or click if everything between the stage being disturbed and the input of the a.f. section is in good condition.

If you get no click when you disturb the limiter, you won't know whether the limiter stage or the discriminator is at fault. However, a few voltage readings or circuit continuity tests will point to the defective stage.

► You can also use the signal injection method, using a standard amplitude-modulated signal generator. First, feed the signal into the discriminator, then work back through the limiter and the i.f. stages to the first detector.

You will find that the discriminator input transformer tunes very broadly when you feed the signal generator signal in at the plate of the limiter. A signal anywhere within 1 or 2 megacycles of the proper i.f. value will pass through. As you move back toward the first detector and include more resonant circuits, the tuning sharpens somewhat; however, the set is supposed to pass signals up to 100 kilocycles on either side of the i.f. resting frequency, and most sets will tune even more broadly than this.

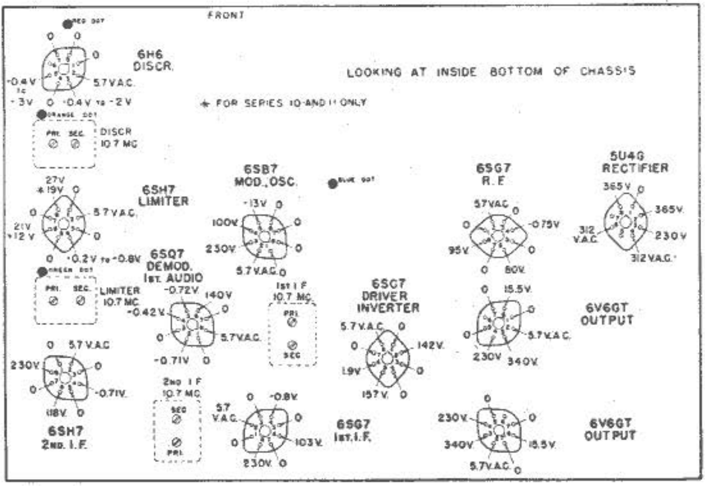
Furthermore, when the discriminator stage is properly aligned, it will tend to produce *minimum output at the resonant frequency*. Therefore, you will get a stronger signal by tuning to one side or the other of the i.f. resting frequency. Thus, if the i.f. frequency is 10.7 megacycles, you may find that a signal of 10.675 or 10.725 megacycles will give greater output from the set loudspeaker than does one of exactly 10.7 mc.

Remember that the limiter stage will tend to hold signals to a fixed top level. Don't expect a great increase in signal strength as you move along through several i.f. amplifier stages. However, as long as the signal comes through, you haven't encountered the dead stage.

Tracing through the first detector or an r.f. stage may be somewhat more troublesome unless your signal generator has a fundamental, or a strong harmonic, that is within the f.m. tuning band of the set. This was not so much trouble on the older f.m. band from 42 to 50 megacycles, but the new band from 88 to 108 megacycles is harder to reach.

► A signal tracer can also be used, provided it will tune to the proper frequencies. A few types will reach at least the 10 or 11 megacycle i.f. value; these can be used for signal tracing through the i.f. portion of an f.m. set. Fortunately, most of the stages in the r.f.-i.f. section are in the i.f. amplifier, so the chances are that the trouble will be somewhere in this portion of the radio.

To use a signal tracer, you must have a signal. Its source can be either an f.m. station or an amplitude-modulated signal generator. If you use the generator, follow the signal through the i.f. amplifier the same as you would in an a.m. receiver. If you use the signal from an f.m. station, detune the signal tracer slightly. This detuning will make the tuned circuit ahead of the signal tracer detector work on the slope of its characteristic rather than at its peak, and thus give frequency discrimination. Naturally, the output won't be of high fidel-



This is the bottom layout of the chassis shown on page 7. Notice that the alignment adjustments for the f.m. discriminator, limiter, and i.f. stages are located on this side.

ity, but you don't care about fidelity when you are looking for a dead stage.

Weak Reception. The same methods used to service a dead receiver are used to localize a weak stage.

If you are using a signal tracer, work from the input of the receiver back toward the limiter. Tune the tracer exactly to the resting frequency of the i.f., and use the signal level indicator of your tracer as a means of indicating the gain per stage. In this way, you'll be able to tell when a signal does not increase properly as you add stages of amplification. Don't worry about the distorted signal sound.

You will find that the output of the limiter stage (or stages) will be *less* than that of the preceding i.f. stages. How much less depends on the degree of limiting. You cannot know just what to expect here unless the manufacturer gives gain data on his set. (Of course, if all other stages are normal, then the limiter should be suspected.)

If you plan to use signal injection (a signal generator), you cannot use the output of the set as a gain indicator, because the limiter cuts off the amplitude changes. However, the limiter *grid* current will vary with the strength of the signal, so you can use a 0-100 microammeter as an output meter by placing it in series with the limiter grid resistor. The stronger the signal fed to the input of the limiter, the greater the amount of grid current flow.

► If you have no such microammeter, you can use a high-resistance d.c. voltmeter by connecting it across the grid resistor of the limiter. The stronger the signal, the higher is the voltage across this resistor.

With either the voltmeter or the microammeter connected as a signal strength indicator, move your signal generator back from the limiter through the i.f. amplifier toward the first detector. As you add stages, the output indicator should show that the signal increases greatly.

► When we speak of weak reception, we mean reception in which something has caused the signal strength to drop below the level formerly received. This could be caused by a defect in either the receiver or the antenna installation. On the other hand, if the receiver has never been properly installed, the receiver owner may describe the trouble as weak reception when he has never had good reception for that particular station. We'll go into the installation of a proper antenna later in this Booklet.

Hum. This is normally only an audio complaint, since any hum modulation introduced in the r.f. section of an f.m. receiver should be removed by a properly operating limiter. Very severe hum modulation may get through, however, if the incoming signal is too weak to saturate the limiter. (The low signal level may mean that something has happened to cause weak reception, that the receiver has not been properly installed, or that it is at the very limits of the field of that particular transmitter.)

Noise. Noise *between* stations is severe on f.m. receivers—it may even be worse than that found on a.m. tuning ranges. The receiver noise level should be judged only when a strong f.m. signal is tuned in. If the noise level then is high, it usually means there is an audio or power supply defect. Any noise originating in an r.f. or i.f. stage should be wiped out through the action of the limiter, so defects in these stages will usually not be noticed until a permanent breakdown, and a dead or highly distorted receiver, results.

Noise may be heard, however, if the signal strength at the input of the limiter is insufficient to drive this stage to saturation. This may be noise picked up by the set, or it may indicate trouble in the r.f.-i.f. section.

Incidentally, excessive noise or modulation hum may also be an indication of faulty limiter operation. Trouble in this stage can be caused by changes in resistor values or by leaky or shorted by-pass condensers.

Distortion. Distortion normally means trouble in the a.f. amplifier, which may be localized with the usual a.m. methods. However, it is also possible for improper alignment—particularly of the discriminator—to cause distortion in f.m. receivers.

► When a receiver sounds all right at first, then exhibits distortion that clears up if the tuning control is retuned slightly, oscillator frequency drift is probably the cause. This is quite a problem at the high frequencies on which f.m. signals are broadcast. The circuits already use extremely tiny amounts of capacity and inductance. Therefore, the slight changes in value of coils and condensers caused by heat expansion may detune the circuits considerably.

Most modern f.m. sets have built-in compensation for temperature effects. One common solution is to use parts with opposite temperature coefficients. For example, if the tuning condenser increases in capacity when heated, another condenser will be added in parallel with it that decreases in capacity when heated. The two will counteract each other.

If you ever replace a temperature-compensated condenser, remember that the replacement must have both the same capacity and the same temperature coefficient as the original.

ALIGNMENT OF F.M. RECEIVERS

A standard amplitude-modulated signal generator can be used to align an f.m. receiver if the s.g. can produce at least the necessary i.f. frequency. Fundamental frequencies or strong harmonics from an s.g., or the signal from a local f.m. station, can be used to align the r.f. section.

Now, let's run through the complete alignment procedure for an f.m. set, starting with a few general rules and precautions:

► If they are available, always read the manufacturer's instructions carefully to find out about trimmer locations, the order of adjusting trimmers, the decoupling resistors and blocking condensers to use with the signal generator, etc.

Some of these instructions call for aligning first the input of the discriminator, then the i.f. amplifier; others reverse the order. If you have the exact equipment specified by the manufacturer, it is probably best to follow his procedure.

Some manufacturers suggest you align the discriminator first, and then move the signal generator from grid to grid as you pass through the i.f. amplifier back toward the input. To do so, you must move the signal generator cable, and there is always a chance you will detune the generator. This stage-by-stage method of alignment is necessary only when the set has been tampered with to such an extent that you cannot get a signal to pass through it at all. For ordinary alignment, and for touch-up alignment, the procedure we recommend below is better.

► Before aligning an f.m. receiver, turn on your signal generator and allow it to warm up until it becomes stable in its output. A half hour is not too long for many types of signal generators. Then, once you have it adjusted, to produce the correct frequency, *leave the tuning dial strictly alone.* If you try to retune the signal generator, the chances are that you will not return to exactly the same frequency as before. When aligning the i.f. and discriminator stages, it isn't as important that you tune to exactly 10.7 megacycles as it is to use the *same frequency for all* the i.f. and discriminator adjustments. If you align the i.f. amplifier to one resting frequency and then align the discriminator to a somewhat different one, you cannot expect proper discrimination or proper fidelity.

Output Indicator. Because of the action of the limiter, you cannot tell from the output of the set when the i.f. stages have been properly aligned. Therefore, you must use an output meter in the limiter stage when aligning the i.f. stages.

Generally, set manufacturers recommend that the grid current be measured by placing a microammeter with a 0-100 microampere range in series with the limiter grid resistor, as shown in Fig. *3*. Note the polarity of the meter connections. Often the set will have a terminal strip arranged for conveniently inserting a microammeter in this manner. With such, unsolder the jumper wire that normally closes the circuit, and connect the meter in its place.

You can also use a high-sensitivity voltmeter when provisions for its use are made. The voltmeter capacity would upset the alignment if it were connected across the grid resistor R_1 in a circuit like Fig. *4*. However, here you can connect the voltmeter in parallel with R_2; now R_1 acts as a decoupler, preventing the voltmeter from affecting the alignment. When the grid resistor is connected as is R_{10} in Fig. *2*, then the voltmeter can be connected right across it.

Aligning the I.F. First, connect your signal generator to the control-grid terminal of the first detector tube. If the signal generator does not have a built-in blocking condenser, use a .01- to .05-mfd. condenser in series with the hot lead.

If the set is a combination, turn to an f.m. band so the proper i.f. coils will be switched into the circuit.

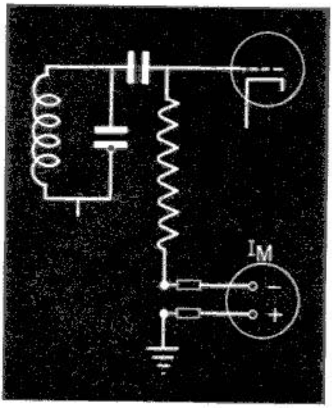


FIG. 3. This is the proper way to connect a microammeter to use it as an output meter in the grid circuit of the limiter stage. Notice that the positive terminal of the meter is connected to ground; this is necessary because grid current flows in this circuit. If your microammeter has several ranges, use the one that is most convenient for reading a 50-microampere current, since that is approximately the current that should flow through the circuit during the alignment procedure to make sure the discriminator input transformer is properly loaded.

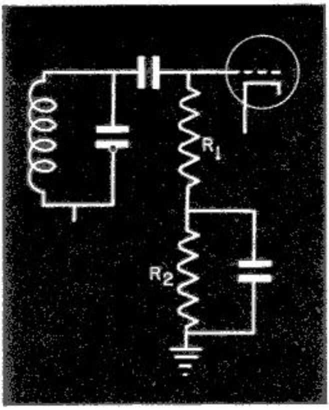


FIG. 4. You can use a high-sensitivity voltmeter (10,000 ohms per volt or more) as an output indicator in the grid circuit of the limiter stage, but only if the manufacturer has included some provision for preventing the capacity of the voltmeter from affecting the alignment. In the circuit shown here, the by-pass condenser makes it possible to connect your voltmeter across R_2. Similarly, you can connect your voltmeter across R_{10} in Fig. 2, because it is by-passed. If there is no provision for using a voltmeter, use a microammeter as your indicator.

Connect your output indicator to the grid circuit of the limiter. Then, allow both the set and the signal generator to warm up thoroughly before attempting the alignment adjustments.

Tune the signal generator to the correct i.f. resting frequency for the receiver. With most modern f.m. receivers, this is between 10 and 11 megacycles. It is standard practice to use the unmodulated output of the s.g. (You don't need a sound output, since the output of the radio is meaningless because of the limiter action. Therefore, if the set is noisy, you can turn the volume control down during this alignment procedure.)

Adjust the signal generator output to give a limiter grid current of approximately 50 microamperes; this loads the discriminator input transformer properly. (When a voltmeter is used, the limiter grid current can be calculated by dividing the voltage by the value of the resistance across which the meter is connected—R_2 in Fig. 4.) Then, adjust the primary and secondary trimmers (or coil cores) of the i.f. transformers between the first detector and the limiter grid circuit. Make each adjustment for maximum output. If any adjustment throws the meter off-scale, reduce the output from your signal generator somewhat. This will keep the input to the limiter somewhere between 50 and 100 microamperes throughout the alignment procedure.

Discriminator Alignment. After you have aligned the i.f. amplifier to give maximum limiter input, you are ready to align the discriminator. Leave the signal generator turned on and connected just as before. *This is important.* If you turn your signal generator off and on, it may shift in frequency.

You can leave the output indicator connected to the limiter grid circuit if you have another meter to use as a discriminator indicator. However, if you are going to use the same meter, it is all right to turn the receiver off to make the change in the output indicator connection. (When you disconnect a microammeter, be sure to resolder the jumper wire so that the limiter grid circuit will be complete.)

To align the discriminator input, first connect a high-resistance d.c. voltmeter across one-half the discriminator output network, as in Fig. *5*. Then, adjust the primary trimmer (C_1) on the discriminator transformer for a maximum reading on this d.c. voltmeter. Next, connect the d.c. voltmeter across the entire output network (Fig. *6*) and adjust the secondary trimmer (C_2) for a *zero reading*, or as near zero as possible.

The output d.c. voltage from the discriminator can reverse in polarity if you carry the secondary adjustment past the proper point. To make sure this has not happened, interchange the test probes so as to reverse the meter polarity. The meter should not now read up-scale. If it does, readjust the secondary trimmer for zero output.

► This completes the i.f.-discriminator alignment. Some instructions tell you to check the discriminator alignment by swinging the signal generator frequency about 50 to 75 kc. above and below the resting frequency, to be certain that the output goes to the same value in each direction. However, this test is meaningless unless your s.g. can be set very accurately, because unless the frequency change is exactly the same on each side of the resting frequency, the output reading won't be the same. Eventually, as f.m. becomes more popular, highly precise signal generators will undoubtedly become available for aligning f.m. sets. Until then, the procedure we have given will be accurate enough.

Aligning the R.F.-Oscillator Section. After the i.f. and discriminator have been aligned, disconnect the s.g. from the first detector and connect it to the input

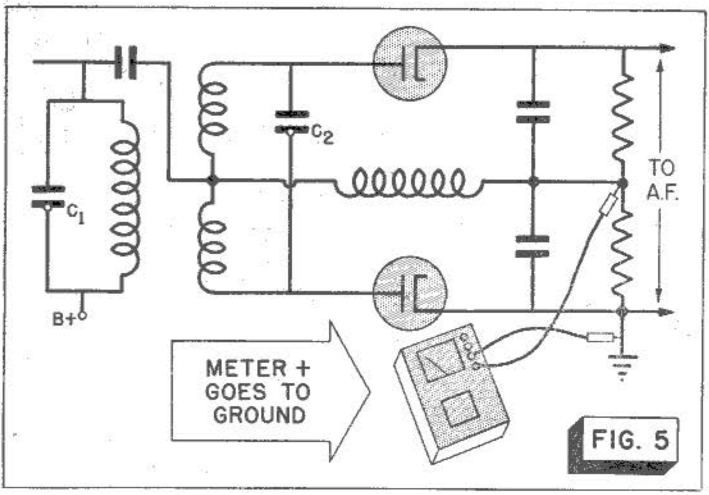


FIG. 5

of the receiver. Follow the manufacturer's instructions carefully, because, for maximum results, the proper decoupling resistors should be used between the s.g. and the antenna terminals of the set.

Next, reconnect the output indicator in the grid circuit of the limiter stage. Tune the s.g. to the frequency required. For the 88-108 megacycle band, 100 megacycles is commonly used. If your s.g. won't produce this as a fundamental, tune it to 50 megacycles and use the second harmonic. If your s.g. will not produce a sufficiently strong harmonic, use a signal from a local f.m. station instead.

Next, adjust the r.f., first detector, and oscillator trimmers for a maximum reading at the input of the limiter. This completes the alignment procedure. As you can see, an f.m. set is aligned much as is a standard a.m. receiver. The chief difference is in the discriminator alignment, where you align one trimmer for minimum instead of maximum output.

F.M. ANTENNAS

A good antenna and ground must be used with an f.m. set. The antenna should deliver sufficient signal to saturate the limiter. Preferably, a noise-reducing variety should be used, because there is plenty of man-made interference at f.m. frequencies.

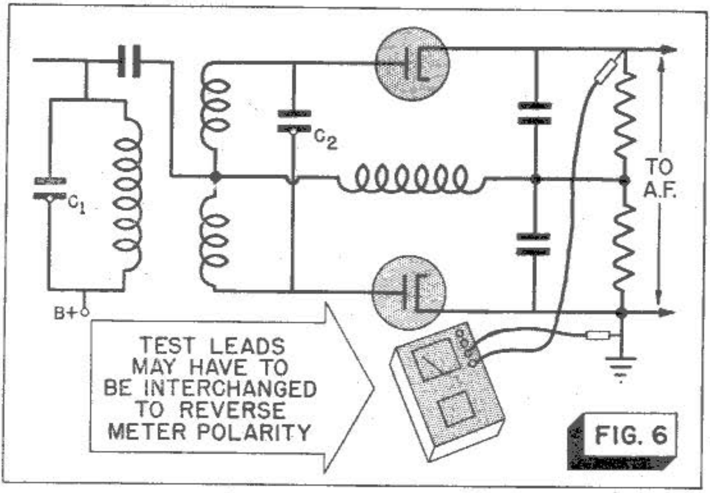


FIG. 6

It is impossible to give hard and fast rules that will work in every installation. Always try the receiver first on an ordinary antenna and see how it works. If the reception is entirely satisfactory, fine—no more need be done. However, if there is excessive noise, or if the signal is weak or is interfered with by signals from another station, then a better antenna installation must be considered.

Most receiver manufacturers recommend specific types of antennas for use with their receivers. The input of the receiver is designed to match the impedance of the transmission line of the recommended antenna, and best results will be obtained through its use. Other types can be used if the proper impedance-matching transformers are used. Most of the antennas available are of the standard half-wavelength dipole style, and are sold with a matching transmission line.

It is standard practice for the f.m. transmitter to radiate a signal having horizontal polarization, so the antenna is mounted in a horizontal plane. It should be mounted securely, as high above grounded objects as is possible.

The half-wave dipole receives best from its side, as shown in Fig. 7. Therefore, the antenna must be rotated so that it is broadside to the radiation from the desired station.

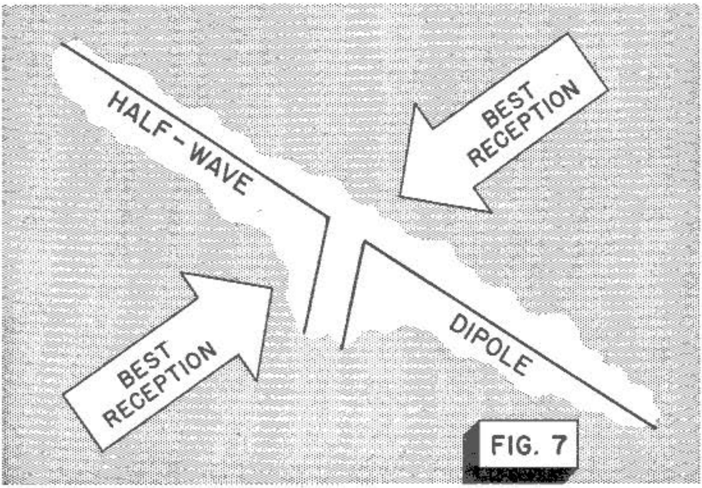


FIG. 7

If the signal pickup is still too low, as may be the case when the receiver is located at some distance from the transmitter, you may have to use an antenna that has a reflector, like the one shown in Fig. *8*, or even one that has both a reflector and a director (Fig. *9*). These are sold by radio supply houses.

Some of the antennas now available are tunable; their lengths may be changed by means of telescoping end sections. In such cases, it is practical to adjust the antenna to receive maximum signals from a particular sta-

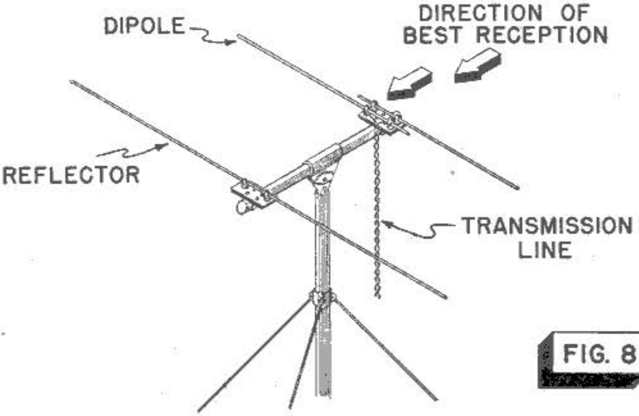


FIG. 8

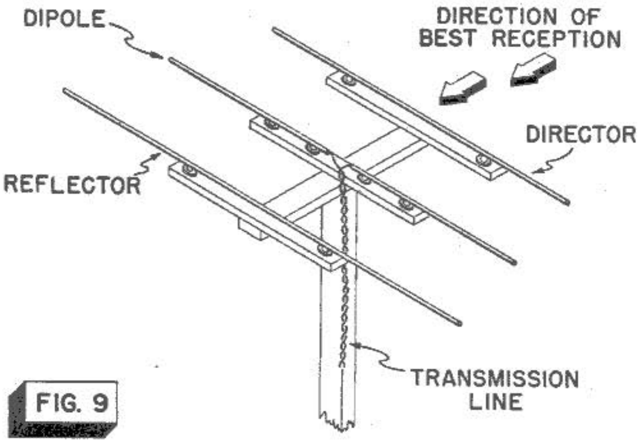


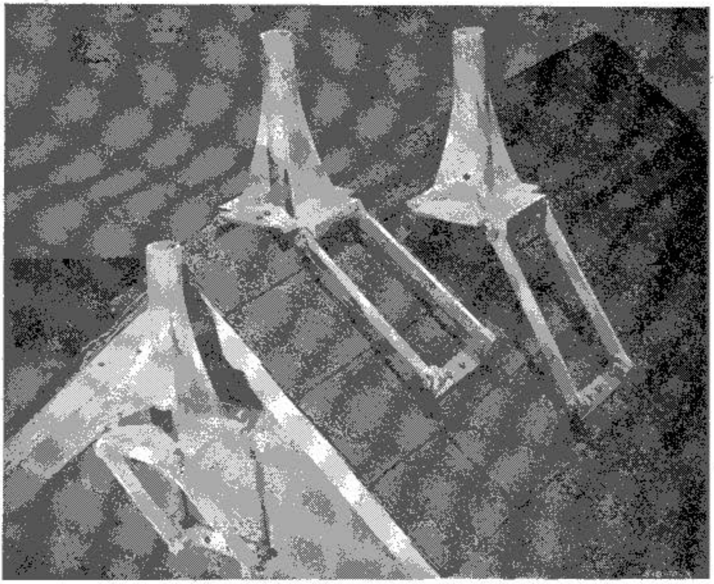
FIG. 9

tion that would otherwise come in weakly.

► If the antenna you use has a different transmission line characteristic impedance from that recommended by the set manufacturer, it is desirable to use a matching transformer at the receiver. If the line has a higher impedance than that for which the set is designed, use a step-down transformer, if it has a lower impedance, use a step-up transformer. Most of the standard antennas come with such matching units, and of course the problem can be avoided altogether by obtaining an antenna system designed for the particular receiver.

► The antenna is often easier to mount than is a standard broadcast antenna, since it is mounted on a single pole or support and is rather small. The length of a half-wave doublet at the f.m. frequencies is only about 4½ to 5½ feet!

To make the installation, first get the antenna in place without anchoring it. Then rotate the system to find the point of maximum reception. This is a job for two men —one at the antenna and the other at the receiver. The man at the antenna should rotate the antenna in steps while the man at the receiver watches a tuning indicator and listens to the receiver output. When the point of



Courtesy Shur-Antenna-Mount, Inc.

Anchoring the base of an antenna mast is often a problem. Shown above is a commercial device that is excellent for the purpose. As the picture shows, this mount can be secured to the gable peak of a house or to the ridge or side of a roof.

maximum reception is reached, anchor the antenna in place.

Not much trouble occurs with the antenna itself—it is practically foolproof. However, the transmission line will eventually require servicing and, probably, replacement. All types of transmission lines are used—twisted pair, coaxial cable, and parallel wire. The coaxial line, if properly sealed against weather at the antenna end, should give very little trouble. However, it is the most expensive of the transmission lines, and cost may be a factor in some installations.

The twisted pair of wires is enclosed in a weatherproof loom, but after a certain number of years of being acted on by the elements and by city fumes, this coating may be penetrated and the line may short. When this happens, a replacement is necessary.