Chapter 7
Tuners and Receivers

THE RADIO broadcast signal, as was pointed out in Chapter 3, is a complex combination of radio and audio waves. The complete unit which receives and tunes such signals, and retrieves and recreates the sound portion, is known as a *receiver.*

The ordinary home radio for broadcast reception comprises five basic elements. The first is the antenna, which collects the radio signals. The antenna is usually not tuned, which means that it feeds into the receiver all of those signals which strike it. At the front end of the receiver is the radio-frequency section, which selects the desired signal out of the many thousands striking the antenna, and builds it up to usable strength.

The third unit in the receiver is the detector, which picks the sound off the radio carrier, discards the radio-frequency portion, and sends the remainder along in the form of an electrical audio signal. Following the detector we have the final two units, the audio amplifier and loudspeaker.

Now a hi-fi audio system usually begins with a separate high quality audio amplifier and speaker, so there is no need for the radio system to include these elements. If we have a radio receiver without the audio components, the remaining part is called a *tuner.*

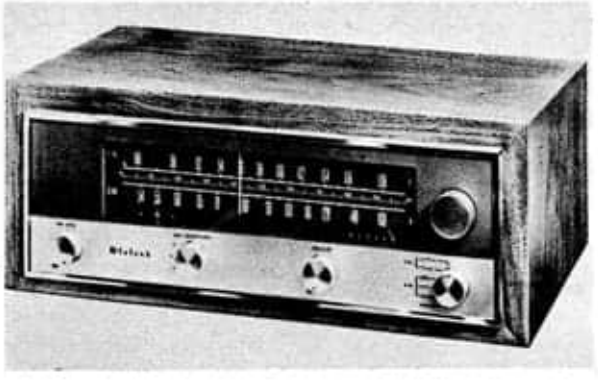
There are two schools of thought on hi-fi radio systems today, one involving the use of a tuner, and the other a complete receiver. Tuners are probably the more popular of the two, but the receiver has much to recommend it.

The so-called hi-fi receiver is really a complete set of hi-fi electronics, including not only a tuner and amplifier, but also a preamplifier, compensator, and all necessary controls. Since best hi-fi practice requires that the speaker and its enclosure always be isolated from the electronics, the reproducer system is not included as a part of the receiver.

But the differences between a hi-fi receiver (or tuner) and an ordinary home model radio are more than functional. To understand both the similarities and differences, let's begin with the tuner antenna. All of the signal voltages induced in it from impinging radio waves are fed into the radio-frequency amplifier or preselec-

AM-FM stereo tuner-preamplifier by Bogen sells for $159.95. Frequency response: 20-20,000 ± 1 db. Noise and hum for FM is —58 db, for AM —48 db.

McIntosh MR-55 AM-FM tuner has FM hum of —75 db, AM —50 db; Multiplex output, phono input. 300 and 72 ohm antenna. 20-20,000 cps ± 3 db.



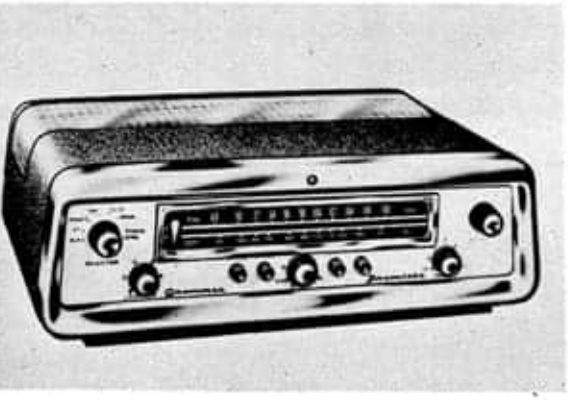
Allied Radio

tor. This amplifier tunes and amplifies the desired signal, rejecting all others. Thus it must be both *sensitive* and *selec ive.*

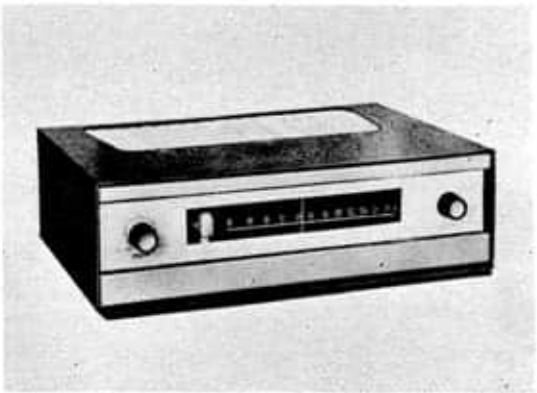
It's a fairly simple design problem to achieve both sensitivity and selectivity in a tuner—provided fidelity is not a serious consideration. But to get all three requires considerably more skill, more and better components, and consequently more expense. Thus in the ordinary home instrument, quality begins to fall off right here, before the signal gets to the audio stage.

The elements following the r-f amplifier are typical of the superheterodyne receiver which is the type used almost exclusively today. The first detector receives not only the r-f signal just discussed, but also a signal from a local oscillator within the set. This locally generated signal is also a radio frequency, usually higher than that of the carrier arriving from the preselector.

When those two signals combine in the first detector, the output is a new and lower carrier frequency, which still carries the

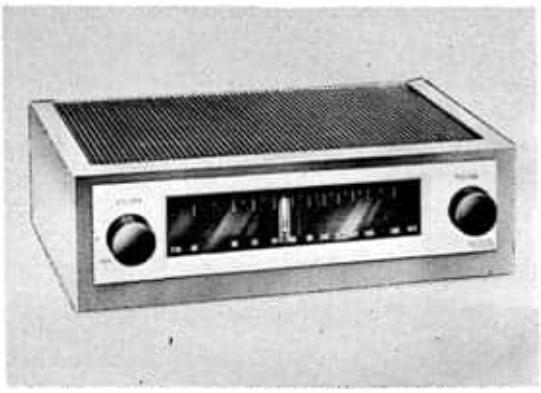


Stereo AM-FM tuner by Grommes has FM response of 20-20,000 cps ± 0.5 db, AM 20-7,500 ± 3 db. It features push-button controls, tuning meter.



FM-only tuner by Grommes has center-of-channel tuning eye, 1 mv for 20 db sensitivity, 88-108 Mc tuning range. Frequency response: 20-20,000.

AM-FM stereo tuner, Carillon, by Bell comes with AFC switch, 88-108 Mc FM band; sensitivity is 1 mv for 20 db quieting. Price with cabinet is $189.95.



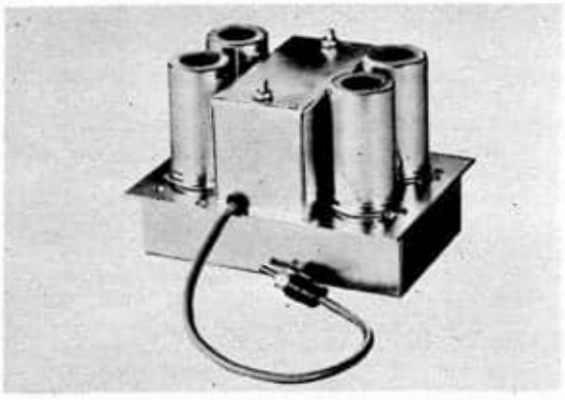
Eico FM tuner is available in kit form or assembled. Response is 20-20,000 ± 1 db. It has Multiplex adaptor output, cathode follower tube.

same modulation which arrived at the input. When the preselector is tuned to the incoming signal, the local oscillator is simultaneously varied in frequency, usually by the setting of the same tuning knob on the front panel of the set.

The local oscillator is varied in such a way that there is a constant difference between the frequency of the local oscillator and that of the incoming signal. The result is that the two "beat" together and emerge as a modulated carrier of fixed frequency known as the *intermediate frequency* and abbreviated *i-f*. In most AM broadcast tuners the i-f is about 455 kilocycles, and in FM sets it is usually 10.7 megacycles.

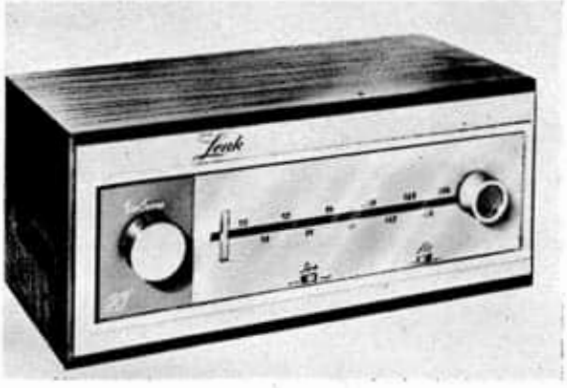
The advantage of this arrangement is that the i-f amplifiers can be fixed rather than variable, specifically designed to operate only at the intermediate frequency. This not only simplifies the design, but also enables greater selectivity. When the i-f amplifier is over-selective, however, it cuts off some of the audio modulation and hence severely limits the fidelity. The components used in i-f circuits of hi-fi tuners are therefore quite different (and more expensive) than ordinary types.

The detector in AM sets may be either a grid, plate or diode type, depending upon the tube and circuitry used. The first two are much more sensitive, and are therefore often found in low-priced sets. They also exhibit considerable distortion, how-



Fisher Radio Corp. makes this plug-in Multiplex adaptor, priced at $49.50. The unit is designed with single phono plug for FM tuner insertion.

Fisher FM-100 tuner has main channel and Multiplex channel switch, four wide-band IF stages with limiters, bridge-connected mixer and oscillator.



A British import is the Leak "Through Line II" FM tuner. Sensitivity is 1.5 mv for 20 db quieting. It has Multiplex output, 9 tubes; price: $129.90.

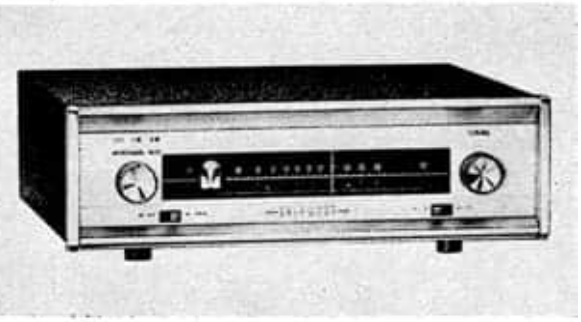
Precise makes the "Perfecta" AM-FM tuner with variable AFC. It has inputs for TV and phono, cathode-follower output, AM-FM output meter.

ever, and the *diode* type detector is the one to be preferred for AM hi-fi tuners.

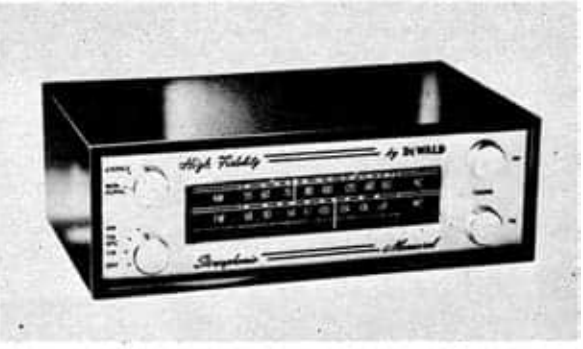
There are two basic types of FM detectors, one known as a phase discriminator, or Armstrong circuit; the other is called a ratio detector. Both of these circuits are actually discriminators and operate on similar principles. The ratio detector was originally devised to avoid the necessity for limiting amplifiers, and also to get around the Armstrong patents. It was not too successful in either attempt.

Limiting is a process occuring in one or more i-f amplifiers immediately preceding the discriminator, in which any AM noise is rejected. Without it the full signal-to-noise capabilities of FM cannot be realized. But since many *ersatz* FM sets were built without limiters, using ratio detectors which are inadequate to do a good limiting job, the ratio detector rather than bad design was held to blame. The fact is, there is nothing wrong with ratio detection which proper limiter design won't cure, but since the circuit now has such a bad name, it is seldom to be found in hi-fi FM tuners.

Radio tuners for hi-fi are available in FM-only, AM-only, AM-FM and AM-plus-FM types. The first two are self-explanatory, but the latter two are not as similar as they might seem. The difference is that the either-or type can receive only one type of signal at a time, since many of



Sherwood FM-AM model has AFC switch; FM response: 20-20,000 cps ± .5 db, AM: 20-7,000 cps ± 6 db. FM hum and noise: —60 db, AM: —55 db.



De Wald stereo tuner has 3 mv sensitivity for 20 db quieting. Output jacks include AM, AM-FM, FM stereo, AM tape and FM tape, Multiplex adaptor.

the tubes and circuits in the set are shared by both the AM and FM functions. The AM-plus-FM or stereo type, on the other hand, is really two complete tuners in one, and if desired it can feed two separate programs to two different hi-fi systems simultaneously. Since such tuners can also handle AM-FM stereocasts, this type unit is often described as a stereo tuner.

The antenna for an AM tuner is no serious problem. Local signals are so strong that almost any sort of antenna will suffice, and the broadcast spectrum is now so crowded that long distance (DX) reception is hardly worth the trouble. Tuners usually have some sort of small antenna built in, often a ferrite loopstick. If this isn't sufficient, a section of ordinary wire, ten feet long or so, will usually do the job.

An external antenna is normally required for FM, but an indoor type is plenty adequate for all except fringe reception. The usual TV "rabbit ears," for example, make an excellent indoor FM antenna.

There are many good FM outdoor antennas commercially available. They look very much like TV antennas, which is not surprising, since the FM band is right in the middle of the TV allocations, between channels 6 and 7. Many, but not all, outdoor TV antennas will work well on FM. Those which do not are purposely designed to have poor response in the FM band, so as to avoid interference from FM in the adjacent TV channels.

An excellent do-it-yourself FM antenna can be constructed by yourself. The only

H. H. Scott AM-FM tuner sells for $139.95, has 3 mv for 20 db quieting sensitivity, FM Multiplex output, logging scale and electron-eye tuning.

Pilot stereo FM-AM tuner and dual preamp costs $289.50, has AM and FM meter, 2 mv sensitivity for AM, 1 mv for 20 db FM, dual cathode output.

materials are some ordinary antenna wire, ribbon-type transmission line, and three strain insulators. This antenna can be strung from garage to house, between trees, or with supporting posts or towers. To get a fairly good impedance match between the antenna *V* and the transmission line, the ribbon insulation should be split for a length of two feet, so the wires can fan out to a four-inch spacing where they join the antenna.

Ribbon-type transmission line of 300 ohms impedance, commonly used in television installations, is also widely used for FM, although there are some exceptions. In noisy areas it may be necessary to use shielded 300-ohm line. Some antennas have a characteristic impedance which is closer to 72 ohms, in which case 72-ohm line should be used. This is available in both ribbon and coaxial types. Many of the better tuners have antenna input terminals for both 72 and 300 ohms to accommodate these varying conditions.

Tuning indicators are useful with AM tuners and essential in FM operation. They can be either of the electron-ray "magic eye" variety, or an electric meter. In AM sets they usually indicate the condition of maximum signal, while in FM sets they normally indicate the correct tuning to the center of the channel. Although the tuning eye is more difficult to read, it is every bit as accurate, and not as expensive, as the meter.

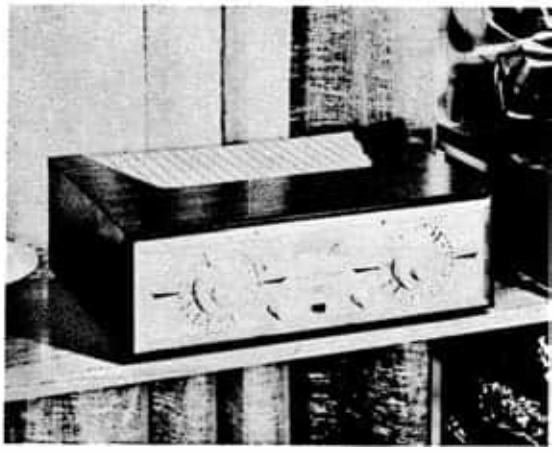
Sensitivity specifications for tuners are best given in terms of the amount of input signal required to produce a certain signal-to-noise ratio. Although this method is quite generally used for FM, it is unfortunately not often used for AM in the United States, although that method of testing is rather widespread in England.

In this country the usual AM sensitivity specification gives the number of signal microvolts (mv or μv) necessary to be fed into a standard antenna to obtain the rated output of the tuner or receiver. This is too nebulous a figure to enable valid comparisons between tuners of different manufacture, although it may be useful in evaluating those in a given line. With these reservations, it can generally be said that the fewer the microvolts required, the more sensitive is the receiver.

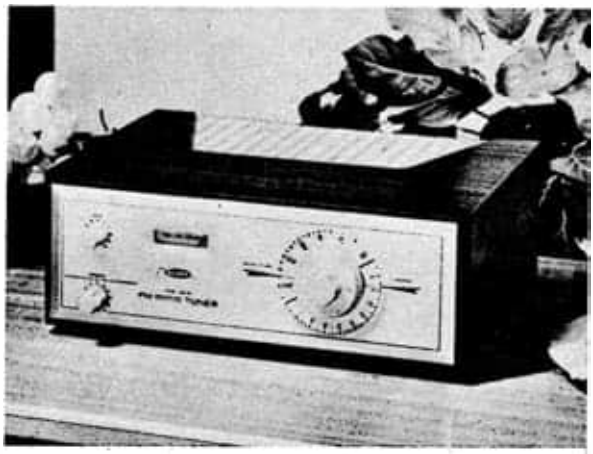
There are several types of sensitivity measurements which can be made on FM tuners, but the one usually mentioned in manufacturers' literature is the quieting-signal sensitivity. This in effect tells the minimum amount of radio signal required to produce a certain signal-to-noise ratio in the output. Although good engineering practice calls for this quantity to be expressed in terms of 30 db (decibels) of quieting, some manufacturers, with apparent malice aforethought, have adopted their own standard.

These people have arbitrarily decided that, since a sensitivity figure based on only 20 db of quieting looks a lot prettier, they will use that instead. This certainly makes for confusion in the mind of the consumer, which no doubt was the whole

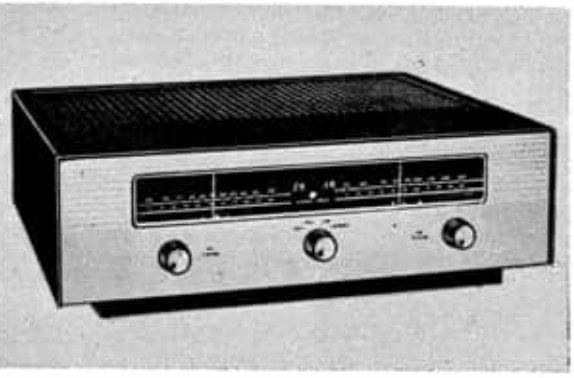
Scott AM-FM stereo tuner, 330-C, has 2 mv for 20 db quieting FM sensitivity. Multiplex output, AM-FM tuning meter, includes two tape outputs.



FM-only tuner by H. H. Scott features automatic gain control, interstation noise suppressor, a signal strength and tuning meter. Multiplex jack.



The "Duet" stereo tuner by Harman-Kardon sells for $114.95, has FM sensitivity of 3.5 mv for 20 db quieting, 30-15,000 cps response, ± 0.75 db.



Harman-Kardon "Madrigal" ST350 stereophonic AM-FM tuner has push-button controls for Multiplex, AM noise filter, FM-AFC, FM, AM and stereo.

idea of this flummery. But you still can't add oranges and apples, and you can't compare sensitivity statistics having two different bases.

Just remember this: it's a lot harder to get 30 db of quieting than it is 20 db. Obviously then, a tuner which requires 2 mv for 20 db of quieting is less sensitive than one which will deliver 30 db of quieting for the same 2 mv input signal. To summarize, then:

1. If the microvolts are the same, the set with more decibels of quieting is the more sensitive.

2. If the decibels are the same, the set requiring less microvolts of signal is the more sensitive.

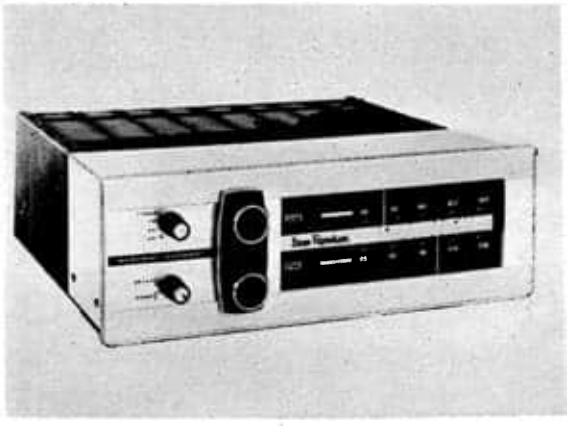
A feature of most of the better tuners, both AM and FM, is automatic volume control (AVC). This is a circuit which automatically varies the gain of the tuner to compensate for changes in received signal level. This is not so important when the set is tuned to local stations, except when for some reason the station changes power. But AVC has its greatest usefulness when tuned to more remote signals, which have a tendency to fade.

Another refinement is quiet AVC, which automatically kills the noise ordinarily heard when tuning between stations. Such circuits are also sometimes referred to as muting, squelch or interstation noise suppression. Since noise can be a real annoyance when attempting to find a weak signal from a distant station, it is most important that the tuner be provided with a switch for defeating this circuit when desired.

Since broadcast transmissions are held to their assigned channels within very close tolerances, the tuner, too, should have

Heathkit FM tuner comes in kit form, has 2.5 mv sensitivity, AFC, flywheel dial tuning and Multiplex adaptor output. Price of kit, below, $34.95.

Sargent-Rayment AM-FM stereo tuner is priced at $184.50, has Multiplex adaptor switch, a 10 Kc whistle filter, gold-plated frame grid cascode.



some means of keeping itself locked in on frequency. But there is a tendency for tuners to drift, and this is especially noticeable at the high frequencies employed for FM. The means used to compensate for this is automatic frequency control (AFC). This circuit usually controls the local oscillator, to correct its frequency so that the required i-f is always produced. An AFC circuit is indispensable for FM, and it is very useful for AM as well.

Another factor sometimes mentioned in tuner specifications is the FCC radiation specifications. Since every superheterodyne circuit has a local radio-frequency oscillator, it is in effect a miniature radio station itself. The Federal Communications Commission has laid down specifications concerning the amount of external radiation permissible from these circuits, so as to minimize interference with other receivers. All tuners, both AM and FM, must meet or exceed these specifications.

Sometimes the term "capture ratio" is found in sales literature. This refers to the ability of an FM tuner to accept the stronger of two signals on the same channel, while rejecting the weaker. It apparently evolved as a sales point from the tendency of an FM set to flip-flop back and forth between two signals of approximately equal strength, as they vary slightly with atmospheric conditions. There are no accepted standards for this particular figure, so the laudatory adjectives found in promotion material are next to meaningless.

The Stereo Story

The simplest means of broadcasting two-channel transmissions for stereo is to use two separate stations. Since a broadcaster may be licensed to operate an AM, an FM and a TV station in the same city, he could use any two of these for two-channel stereo. Thus we have the possibility of AM-FM, AM-TV or FM-TV stereocasts. All of these combinations have been used for stereo, but only the AM-FM type is today used with any regularity. To receive such stereocasts you need an AM-plus-FM tuner, as we have already discussed.

The newest method of stereocasting uses only one FM station in a system known as *Multiplex*. In this arrangement a conventional modulator superimposes an audio signal on the FM carrier in the usual way. But in addition a supersonic frequency is imposed on the FM carrier, and then audio is also imposed on this supersonic subcarrier as well. (See drawing on page 34.)

Ordinarily an FM tuner will detect only the audio on the main carrier. But with the aid of a Multiplex adapter the tuner can detect and separate the second audio signal as well. Very few tuners are as yet featuring multiplex circuits built in, but they are readily available as an accessory. As stereo increases in popularity, this method of stereocasting is destined for great future importance. •

Pilot 580 Stereophonic AM-FM tuner has center-of-channel AM and FM indicators. Multiplex outlet, on-off switch, logging scale, 88-108 Mc FM.

Model 680 Stereophonic FM-AM tuner by Pilot is equipped with two tuning meters, separate on-off switches for AM and FM, Multiplex outlet.