fm RADIO

as developed and perfected by

ZENITH

No matter what we tell you . . . regardless of how enthusiastic friends may be over FM reception, you can't possibly appreciate how much better it is until you hear it yourself. We cordially invite you to come in for a demonstration of Zenith FM, at your convenience. Naturally, there is no obligation.

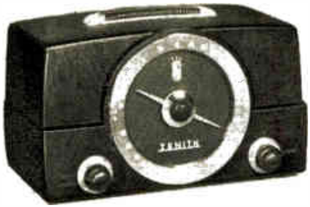
Part No. 202-697-E

A Simple, Non-Technical Explanation of FM, Radio's Greatest Development

ZENITH RADIO CORPORATION
CHICAGO 39, ILLINOIS

The Super-Medallion

FM-AM Table Radio, Model H723



The Super-Symphony

FM/AM Table Radio, Model H725

The Waldorf

FM-AM Radio-Phonograph, Model J880R

To Enjoy FM at Its Finest—

Insist on ZENITH® Super-Sensitive FM

Now you can enjoy the many new and exciting programs being broadcast by powerful FM stations—enjoy them with the matchless static-free reception that only Zenith's new Super-Sensitive FM circuit makes possible! Far more sensitive than ordinary FM radios, Zenith's new FM models eliminate unwanted interference and 'cross-talk'—give you consistently clear reception even in the remote 'fringe' areas where satisfactory reception has previously been impossible with many other sets.

Zenith's New Super-Sensitive FM Gives You All This!

MOST SENSITIVE PERFORMANCE—Superb, drift-free reception . . . with ALL the benefits made possible only by Genuine FM . . . even on weak signals.

LONGER DISTANCE—Because of high sensitivity, Zenith's new FM brings in stations in fringe areas that other, less-sensitive FM sets miss.

BETTER TONE QUALITY—Every note from the lowest to the highest—even delicate overtones—is heard with the true-to-life sound of "in person" performances.

NO INTERFERENCE . . . NO STATIC—No whistles, no over-lap, no cross-talk. Even in worst storms, only rich, glorious tone on background of velvety silence.

NO SPECIAL ANTENNA—With Zenith's patented Power-Line antenna, just plug in and play. No aerial necessary in primary signal areas.

secondary coverage might extend it to a considerable distance. In practice, however, many AM stations are operating within the country on the same or neighboring wave lengths, and this broad secondary coverage causes greater interference and actually limits usefulness of the AM signal to a comparatively small area. FM stations, on the other hand, put out steady, unvarying signals to the limit of their primary service area. They are not interfered with by other distant stations, and they do not fade in and out as do "secondary" signals of AM stations on the wave lengths now in use.

An important FM advantage springs from the differences in studio control. In AM broadcasting, the control engineer has to watch constantly to make sure too great volume does not cause tone distortion or injure the transmitter. The result is that he has to cut peak volume. On very soft tones the engineer is at times forced to increase volume so that they will not be entirely lost. In FM, the signal strength is always constant; changes in volume, like changes in tone, occur by changes within the wave itself. Therefore, the full orchestral range in volume, as well as in pitch and tone quality, is transmitted and received with almost perfect fidelity.

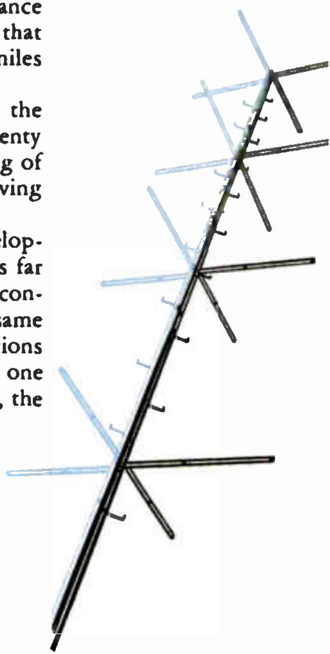
THE ROYALTY OF RADIO AND TELEVISION

One is a quality, as yet not thoroughly understood, inherent in FM. One wave will not interfere with another, even on the same band, unless the two have almost equal strength. The receiver will automatically select the stronger, and reproduce it perfectly, while blanking out the weaker, completely; there is no double rendition of programs from different stations, as frequently happens with AM broadcasts. Engineers have tested this characteristic with an FM receiver mounted on an automobile driven to a point approximately midway between two FM stations transmitting on the same frequency. The balance is so delicate that moving the car just a few feet will completely blank out one station in favor of the other.

Another important point is that FM waves tend to act like light and travel in straight lines. This limits the range of FM broadcasts, ordinarily, to a little more than twice the distance from the transmitter antenna to the horizon, which means that powerful stations on the same band only a few hundred miles apart do not interfere.

Additional insurance against overlapping stems from the fact that each FM channel is 200 kilocycles wide, or twenty times the width of an AM channel . . . and from the ruling of the Federal Communications Commission that stations serving the same area shall not operate on adjacent channels.

Those who are opposed to the full and ultimate develop- of FM frequently foster the idea that the range on AM is far greater than that on FM. Actually, FM stations have considerably greater *solid signal range* than AM stations of the same power—particularly at night. The greater range of AM stations is a theoretical range only. If an AM station were the only one operating at or near its wave length in the entire country, the



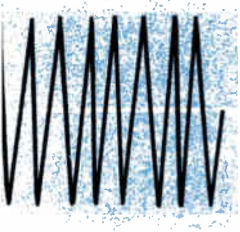


FIGURE 4

One of the basic differences between the two types of broadcasting is the low "signal to noise" ratio of FM as compared to AM. As you can readily understand, there is always some background noise in any radio signal—static, electrical interference, etc. For reasonably good reception of AM signals, the signal itself must be approximately 100 times stronger than the noise. In FM, a signal only two times as strong as the noise is a satisfactory signal, because of the "limiter" effect of the FM circuit. The effect of the limiter is to dampen and silence background noise in FM reception. Since there is no limiter in an AM circuit, the signal must be much stronger than the noise to insure satisfactory reception.

There are more than 2055 AM stations crowded into the standard 535 to 1620 kilocycle broadcast band. Despite clear channels, sunrise to sunset limitations on some stations, power reduction at night on others, directional antennas and other expedients, interference continues to be a nightmare in many parts of the country. The trouble is that even a low power AM station will occasionally reach out for great distances, to cause squealing and "doubletalk" hundreds of miles away.

This is a problem which does not exist for FM; there is virtually no limit to the number of highpower transmitters that can be operated within the frequencies assigned to FM broadcasting. For this there are a number of reasons.

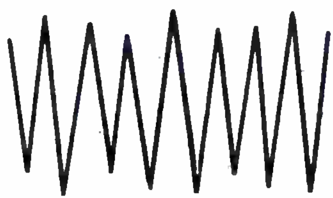
etc., create waves which are of the identical electrical type as the amplitude modulated wave. They tend to decrease or increase the height of the peaks, and since the *height* determines the sound to come from the AM receiver, these "stray" waves come through your radio set along with the program you are attempting to hear, to cause static.

However, these unwanted waves, which affect the *height* of the peaks, have virtually no effect on the distance between them —their *frequency* remains unchanged. This phenomenon was noticed as early as 1923 by Major Edwin H. Armstrong, whose many developments and inventions have made his the greatest living name in radio. He therefore began work on a new system in which the basic carrier wave is modulated, not by changing the height of the peaks, but by changing the frequency, or distance between them (Figure 4). Subsequently, his cooperation with Zenith and other interested manufacturers produced compact and reliable FM receivers that will also provide reception of standard broadcasts.

Static can act on the FM signal just as it does on AM, but it makes no difference to you, listening to your FM receiver. The FM transmitting station modulates the carrier waves by altering the distance between them. Your FM radio converts back into sound only these differences in the *frequency* of the waves, and this is not changed by the stray, or static, waves. The result is reception virtually free from static.

FIGURE 2

FIGURE 3



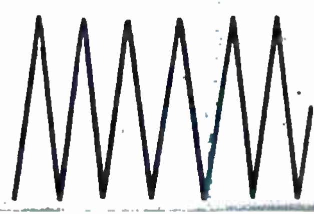
broadcasting, for such waves vary in *frequency* instead of their height or *amplitude*.

Radio, both AM and FM, is transmitted by electromagnetic waves which emanate from the antenna of the transmitter. Such a wave is illustrated by the peaked line in Figure 1. The portion above the straight line represents *plus* voltage, that below the line is *minus* voltage. The distance between the peaks depends on the *frequency* of the wave. This *carrier wave* will operate a radio receiver at the one point on the dial which corresponds with its frequency.

To transmit sound on this wave, we can modulate it by combining it with another wave which varies in accordance with the sounds to be transmitted, as in Figure 2. The result of such a combination is Amplitude Modulation, represented by Figure 3. The differences between the height of the peaks are the differences of *amplitude* of the wave as compared to its average value, indicated by the straight line. The waves remain at the same distance apart, or at the same frequency. The receiver converts these amplitude differences back into sound.

There are serious drawbacks to this method of transmission. Lightning, street cars, electrical motors, dialing the telephone,

FIGURE 1



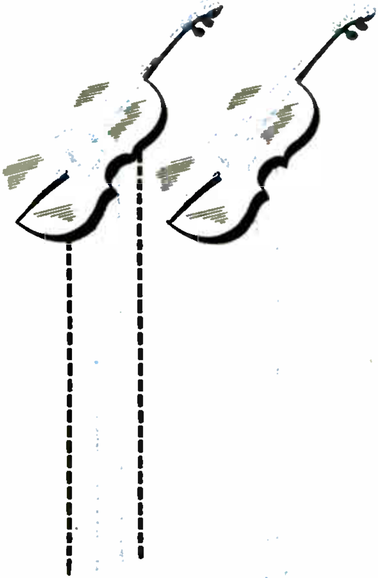
meaning—to them, FM means Finer Music. The faithful reproduction . . . the freedom from noise, distortion, and interference . . . that has been sought in vain since radio broadcasting began, is now possible with this new method of transmission.

You will hear one station, and one only, until you tune in another. There will be no fading . . . no intrusion in the background of a favorite program by some station a thousand miles away . . . no fishing for a station that was there on your dial yesterday but is inaudible today. The stations you want will be where you expect them, every day of the year, ready to bring you perfect radio entertainment.

The difference between AM and FM broadcasting can be visualized something like this: Think of two different lakes, each with a machine in the center creating waves which cover the surface. On one lake the waves are exactly the same distance apart but they differ in height. Some are only tiny ripples; others are great surging white-caps. Regardless of their height, however, the distance from one to the other is exactly the same.

The waves of such a lake are comparable with the radio waves used in AM broadcasting, for these waves transmit different sounds by variations in height or *amplitude* instead of in distance apart or *frequency*.

The machine or "transmitter" in the other lake causes it to be covered with a series of waves all exactly the same height but with varying distances separating them. This second lake is comparable with waves which transmit sounds in FM



The "highway" or broadcasting channel for standard (AM) radio is only 10 kilocycles wide. Within these narrow limits it is impossible to reproduce more than approximately 5,000 vibrations per second without producing "side bands" which would broaden the channel until it overlapped other broadcasting channels. Each FM channel or "highway" over which radio broadcasts are carried is 200 kilocycles wide, so that there is plenty of room for "side bands". In addition, the character of FM is such that frequencies of the entire normal range of music are contained within the wave itself. That is why FM reception can bring you the music of the orchestra itself . . . why soloists seem to be playing right in your home . . . with a *naturalness* of tone that you have never known from standard AM reception.

To the technically minded, FM means Frequency Modulation . . . a new, different, and *better* method of sending and receiving radio signals. To the millions of music lovers who make up the radio audience, this new kind of radio makes possible such tonal realism, fidelity and clarity that FM is rapidly coming to have a warmer, less technical

Any musical note is simply the sound caused by vibrations at some definite rate of frequency. Middle C on a violin or piano is the sound of a string vibrating about 260 times per second. The faster the vibration, the higher the tone—the slower the vibration, the lower the tone. On a standard 88-key piano, the lowest note has a frequency of 25 vibrations per second, while the highest note has a rate of 4,138—and few musical instruments have a greater fundamental range. Since any good radio is capable of reproducing sound vibrations up to 5,000 per second from a standard AM network broadcast, it would seem that little more in tone quality could be expected.

Actually, however, tone quality is determined by an additional series of vibrations, called *overtones*. When a violin vibrates 260 times per second to produce Middle C, it is also vibrating in 2, 3 or more equal segments to produce overtones of 520, 780, 1040, etc. vibrations, and one or more of the other strings are also made to vibrate at varying rates. The result is a fundamental tone, plus a series of overtones which give richness and quality to the musical note.

Different instruments vary in their overtones. The high notes of a violin produce overtones up to 13,500 vibrations per second, while other instruments have tones and overtones ranging in frequency from 20 all the way to 15,000 vibrations per second. Obviously, then, high fidelity broadcasting requires a range much greater than that possessed by standard or AM radio—and FM radio does have this broader tonal range.

fm Reception Is Almost Unbelievably Clear and Distinct . . . And Here's Why

The first time you listen to a musical program over FM, you will be amazed. Until you hear FM, you cannot possibly realize how much of the real beauty of music you have missed with standard radio. In the past, standard or AM radio has been able to bring you only a *reproduction* of music or voice—a good reproduction, of course, but admittedly lacking the rich, full, natural tone quality you would hear if you were sitting in the broadcast studio. Now, with FM, you can hear all the music, in *full color* tone . . . just as it was played.

We might compare the difference between FM and AM reception as being something like two different artists' drawings of a familiar scene. In the first drawing, the artist has given us the basic details but has left out the delicate supplementary details. In the second, the same scene is revealed in all its beauty—the shadings, the shadows, have all been included. Both are drawings of the same scene, both are recognizable—but the second is far more natural. In its reproduction of musical programs, standard or AM (Amplitude Modulation) radio is similar to the first drawing. It reproduces the basic tones, but it does not carry the delicate overtones which are so essential to musical beauty. FM (Frequency Modulation), on the other hand, has all these shadings of tone—like the second drawing, it has the naturalness that is possible only with a complete rendition.

fm Brings You an *Entirely New* Conception Of Radio Enjoyment

FM Brings You Beautiful, Brilliant Tone Fidelity

Now, for the first time, you can enjoy radio music in full natural color. Orchestral, vocal and dramatic programs will pour from the speaker of your FM radio with all the rich, natural tone of personal performances. The delicate musical shadings and nuances, the slightest change in inflection of a speaker—these true-to-life sounds that you have never heard from your standard AM radio will be yours in FM—for FM offers beautiful, brilliant, full fidelity tone.

FM Eliminates Static, Interference, Fading

When you listen to your favorite program as broadcast and reproduced by FM, you hear it crystal-clear, against a background of utter silence. Even if lightning is crackling and causing ear-splitting static in standard radios—even if street-cars, motors, X-ray machines or other interference sources are spoiling the enjoyment of standard radio listeners, your FM radio brings you perfect reception, completely free from annoying interference. With FM, static is a thing of the past.

ONLY WITH fm DO YOU HEAR RADIO AT ITS FINEST