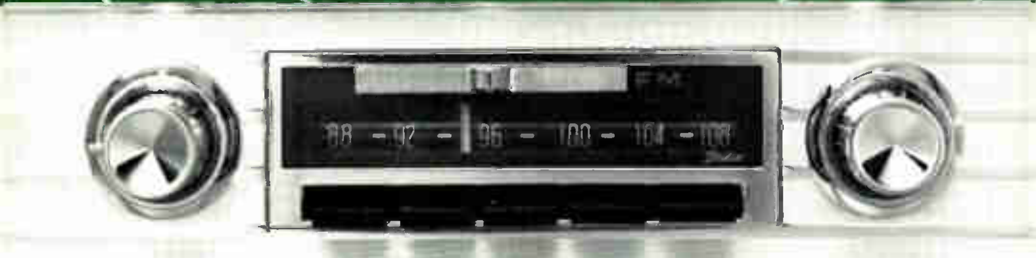
SOMETHING NEW TO LISTEN TO

THE FACTS ABOUT RADIO IN YOUR CAR



THE LONG, uphill road that finally led to the smart-looking, precision-engineered Delco automobile radio you see in today's General Motors cars had its beginning—in a sense—in ancient Miletus, Greece, about the year 600 B.C.

There and then, a man named Thales suggested that the mysterious yellowish and translucent substance found along the beaches be called "elektron." We call it amber.

Elektron was magical to the Greeks. They could rub it briskly on their clothes, then move it back and forth over their arms. The tiny hairs on their arms would magically stand up and "follow" the piece of elektron. (You can do the same thing with a hard-rubber comb!)

The ancient Greeks never did learn why elektron acted this way. Frankly, we don't know exactly why it does, either. But we have theories. And these theories have helped us achieve some remarkable accomplishments.

Among them is present-day AM and FM radio.

A big step in "elektron-ic" history was made long after 600 B.C. In 1865, the English scientist, Professor Clerk Maxwell, published a paper on mathematics and suggested the existence of invisible electromagnetic waves, or radio waves.

Then, in 1887, German scientist Heinrich Hertz proved those waves exist! Hertz went on to establish the theory on which all modern radio broadcasting is based.

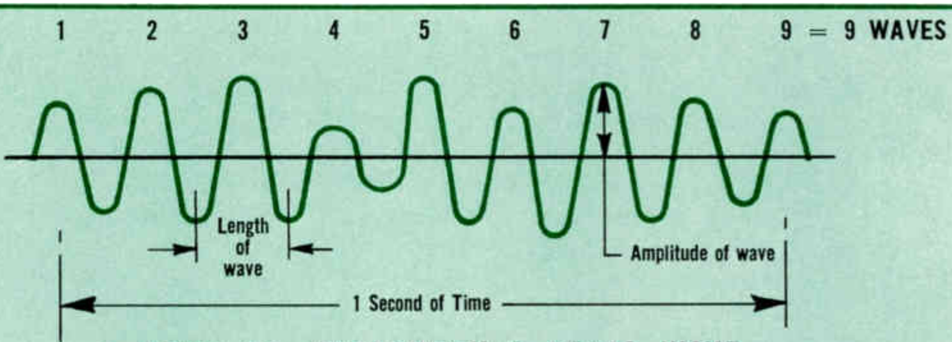
Next came the man almost everybody knows about, Guglielmo Marconi. He's often called "the father of radio." He applied for a British patent on wireless (radio) transmission in 1896, after sending and receiving radio signals over a distance of 1¾ miles. Marconi's first transatlantic broadcast, from Cornwall to Newfoundland in 1901, was a genuine triumph.

Radio communication like Marconi's is possible only because radio waves do exist. They're part of a large family of waves that scientists call the "electromagnetic spectrum." And all the waves in this large family travel at a speed of around 186,000 miles per second, the speed of light waves.

Now, before we can understand the particular problems that had to be solved in order to produce the fine precision instrument that is today's Delco AM-FM auto radio, we first have to understand a little about radio transmission and reception.

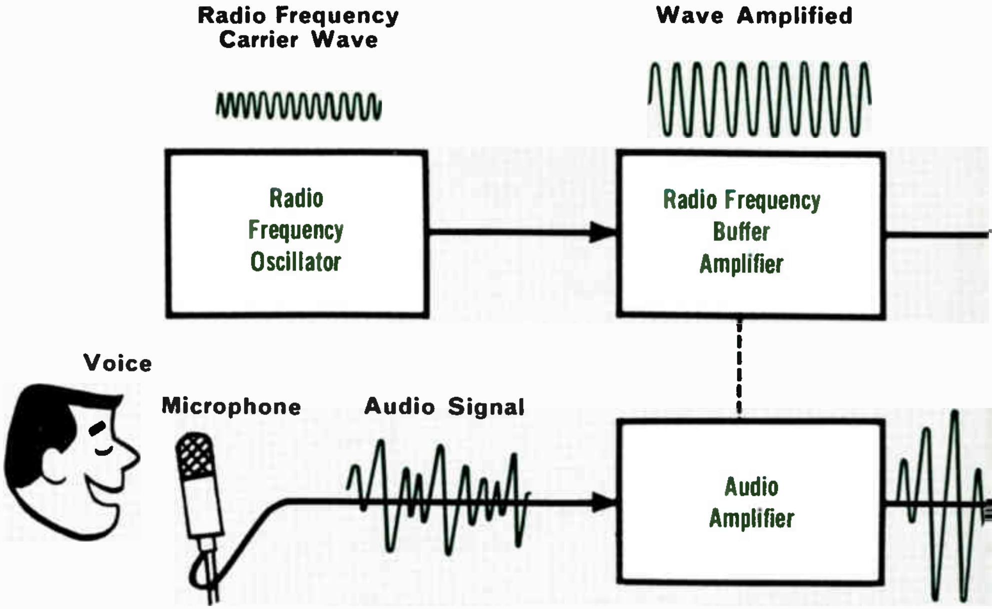
To help us understand, let's start with a definition of a radio wave. Probably the simplest definition is "a wave of electric energy that is radiated into space by an antenna."

These radio waves must be generated, or "manufactured," by a radio transmitter and then "pushed up" an antenna and



3 WAYS TO "MEASURE" A RADIO WAVE

1. **Length: Distance between one place on a wave and the same place on the next succeeding wave**
2. **Amplitude: The "size" or "bigness" of a wave**
3. **Frequency: The number of waves per second**



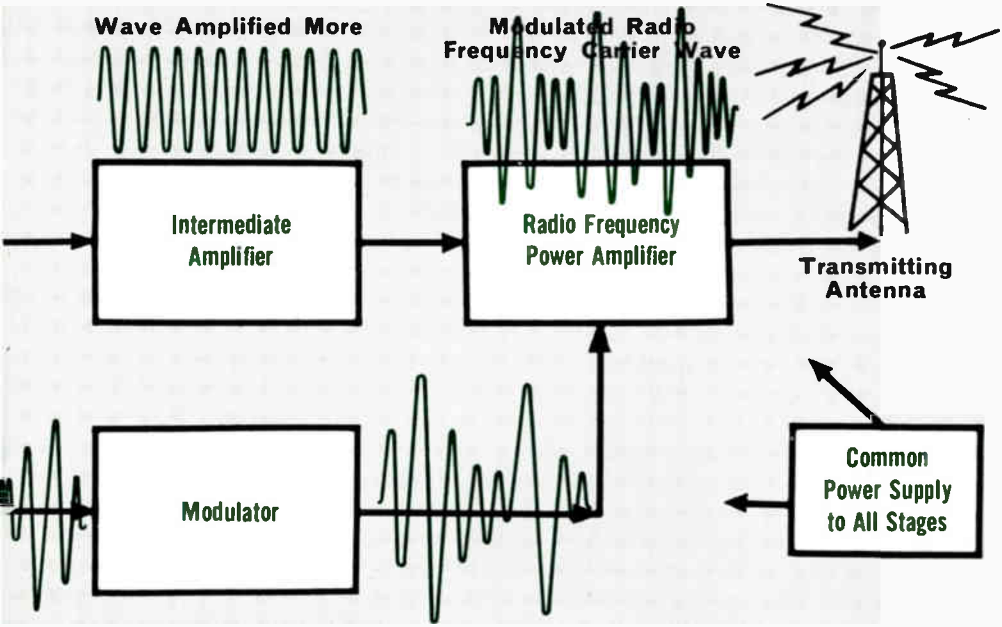
BLOCK DIAGRAM SHOWING HOW AN AMPLITUDE-

radiated out into space. The more power you use to "push out" the radio wave, the stronger the waves will be, and the farther out they'll tend to travel.

Radio waves can be "measured" in several ways. One measurement is length. The length of a wave is measured from one place on a specific wave to the identical spot on the next succeeding wave. You sometimes hear or read about "short-wave radio." Short-wave radio means that the radio waves are shorter in actual length than the much longer waves broadcast by our well-known commercial radio stations.

Another way to measure radio waves is by their amplitude or "size." Most commercial radio stations today broadcast waves that are modulated or "regulated" in their amplitude. That's why these are called "AM stations." They use AM, Amplitude Modulation, to "carry" the voices and music they broadcast.

Still another way to measure radio waves is by their frequency. This is a measure of how often, or frequently, the waves are being transmitted. Transmitters in the United States are assigned specific wave frequencies by the Federal



–MODULATED (AM) STATION BROADCASTS SOUND

Communications Commission (FCC). We'll discuss those FCC assignments and the problems they raise, a little later.

In relatively recent years there has been a rapid growth in commercial radio stations that—instead of broadcasting AM waves—modulate or "regulate" their radio wave *frequency* (instead of amplitude). These are called Frequency Modulation, or FM, stations.

There are many definite advantages to FM radio, and its popularity is growing by leaps and bounds. That's why Delco has pioneered in bringing you "something new to listen to" in your automobile.

While the radio transmitter, whether AM or FM, does the job of "encoding" or "translating" sound signals into inaudible radio waves and pushing them out into space, the radio receiver has the job of picking up the waves and "decoding" them back into sound that you can hear. The radio receiver thus almost exactly reverses the process of the radio transmitter.

Stationary radio receivers in homes, stores and offices have a much easier job to do than roving, mobile radio receivers in cars. In the first place, the stationary radio can take advantage of a large antenna strung outside, up in the attic, or built into the set itself. And, its wall-plug power source is more than ample to furnish a large, steady supply of power to all components.

The home set can also, if need be, use a ground leading to the earth through wire or waterpipe. In addition, the home receiver can be built as large as necessary, within reason, to accommodate larger components set farther apart. The auto radio, on the other hand, must be built tight and compact. Extra bulk and weight in a car radio is not only undesirable, but unacceptable to automotive manufacturers and the car-buying public.

Beyond that, however, the auto radio must operate at its best under the worst conditions—conditions that constantly work against it.

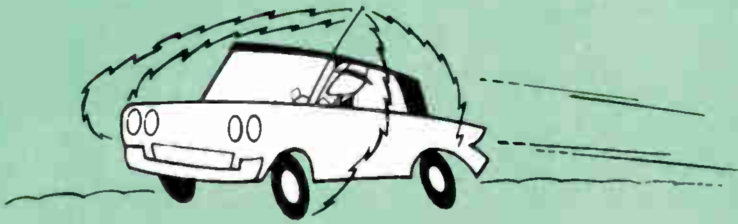
The conditions that must be overcome for satisfactory and dependable auto radio reception can be listed in two major categories—those inside the car, and those outside the car.

In the first category is signal reception. Because the sturdy steel body of the car acts as a "blotter" to soak up radio waves before they reach the interior of the car, your auto radio needs an outside antenna. In fact, the car body acts just like a bridge or underpass. You have probably noticed how your present car radio fades or cuts out, on occasions, as you drive under a viaduct or over a bridge. That's because those structures act like a radio wave "shield" and absorb the waves before they can reach your car antenna. Therefore, the car radio needs an outside antenna. This, in itself, is a partly limiting factor, because not many persons care to have a giant-sized antenna affixed to their automobile.

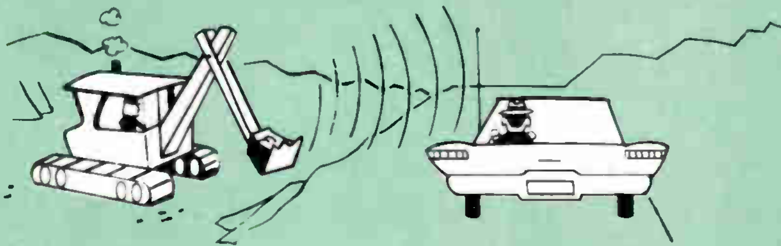
Another "inside" obstacle to high-quality reception is the car's own electrical system. Breaker points, spark plugs, generator, voltage regulator—all can produce static and radio noises such as hissing, sputtering, crackling and clicking. And as you drive along, even your car's tires and fan belt can generate static. To help overcome unwelcome "radio noises," various radio-noise-suppression devices are installed in your automobile, along with the radio.

Yet another "inside" obstacle to pleasurable radio listen-

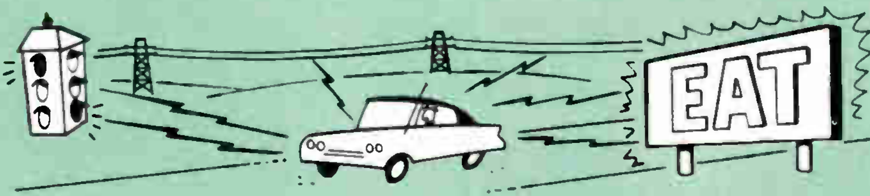
MANY CONDITIONS WORK AGAINST GOOD RADIO RECEPTION IN YOUR CAR



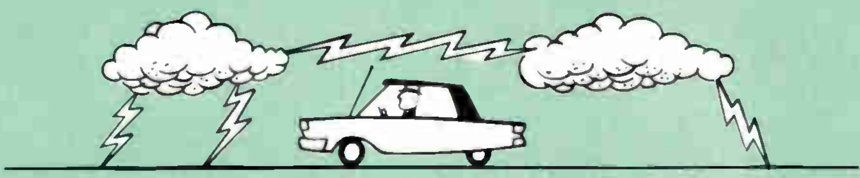
Static is always being generated by the car's own electrical system, tires and fan belt.



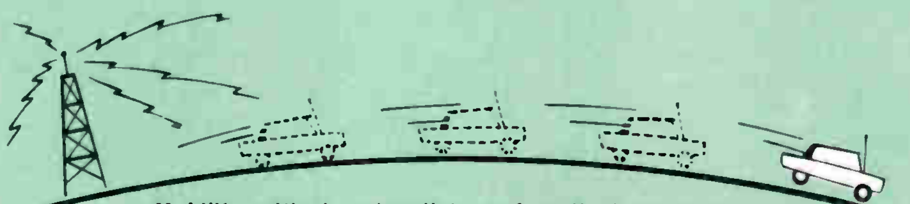
When car windows are open, outside noises can interfere.



Traffic signals, power lines, electric signs—all cause more static.



The atmosphere can disrupt good reception.



Mobility, with changing distance from the transmitter, is another serious handicap to high-quality reception.

ing is extraneous sound—the rumble of traffic, the rush of wind when windows are open, the hum of tires. All these can be overcome by having a correctly designed radio speaker, properly mounted and fed ample power to provide clear, distinct sound that can be heard without strain.

Listed among external conditions that good automobile reception has to overcome are traffic signals, neon signs, other vehicles nearby, large transformers, underground and overhead power lines, and atmospheric conditions. All these, too, can tend to "gang up" and produce static, distortion and poor-quality reception as you drive through town and countryside.

Those who expressly design a radio for a particular automobile will take into consideration all these conditions. Thorough engineering and testing will indicate the proper kind of shielding necessary to build into the set.

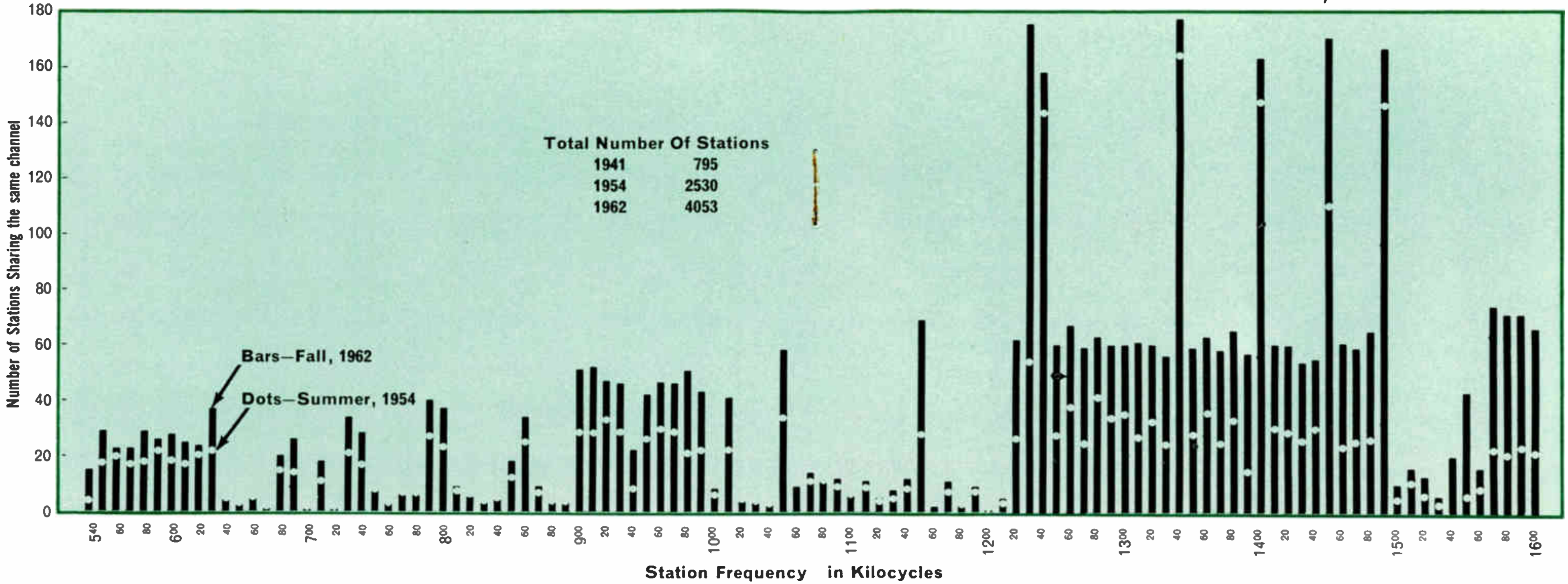
Other problems that affect auto radios far more seriously than stationary home sets are extremes of temperature and other weather conditions. Your car may sit outdoors in a parking lot through a cold winter day, then spend the night outdoors or in an unheated garage. It may sit in blazing sunshine all day, and hardly cool down through a hot summer night. Yet, it must be ready to function dependably at any time, or any place—in midwinter Alaska, or in midsummer Death Valley. It must perform in glazing February ice storms, or in the deluges of a July cloudburst.

That's not all. The greatest handicap under which an auto radio must perform is mobility!

The home radio can sit comfortably in one place. Or at least in one geographically fixed location, even though moved upstairs and down, or from one room to another. The auto radio, however, may be anywhere from one to 50 miles away from the transmitter within an hour's time. And as the auto radio moves away from the station, the signals grow weaker or other signals near the same frequency begin to move in and crowd your selected station's signals.

Of all the specialized and unique problems the auto radio engineers had to lick, this was the toughest of them all! To solve it required ever-increasing refinements in every direction —circuitry, power, tuning accuracy, selectivity, sensitivity, volume control, shielding, precision construction and many

U.S. AND CANADIAN STATION ALLOCATIONS IN THE AM BROADCAST BAND as of December, 1962



broadcasting—AM and FM—it is wise to consider the advantages and disadvantages of each.

In Amplitude Modulation radio, there are certain natural advantages. The longer waves with frequencies from 550 to 1600 kilocycles are better reflected by the ionosphere and—because they can "bounce" around the earth—have a longer range. At night, for atmospheric reasons, AM signals can carry much farther than during the day. This very fact, however, gives rise to a disadvantage. At night, various AM broadcast stations grouped on or near each other in frequency will often intermingle their signals. Because of this, the FCC requires some stations to go off the air, or reduce their power, at twilight. Offsetting this "correction," there is a growing multiplicity of AM stations as new broadcasting licenses are granted and as many stations are allowed to increase their broadcasting power. All of this culminates in the present overwhelming amount of "cross-channel mixing" on the AM band, especially at night. The number of AM stations in the United States and Canada has grown from 795 in January, 1941; to 2,530 in 1954; to 4,053 in 1962—without any increase in the number of available channels.

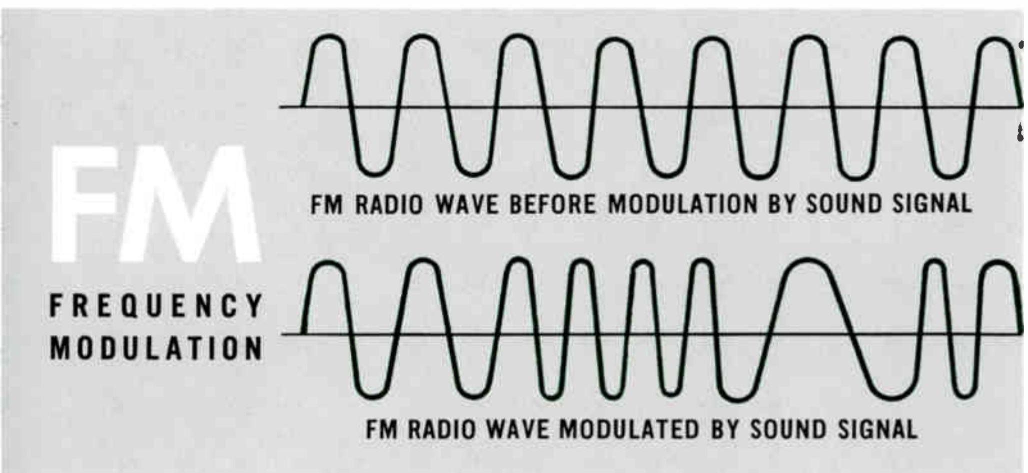
This large number of stations and their closeness of spacing on the broadcast dial make the separation of adjacent weak and strong signals an almost impossible job for any receiver. To help separate these signals in tuning, Delco Radio pioneered the development of an electronic circuit tuner in 1946. This type of tuner has been incorporated in General Motors automobile radios through the years. Simply press the *Wonder Bar* and a mechanism scans the dial and "seeks out" the next station that's desired. The sensitivity of this station-finder can be adjusted so that only strong-signal stations are selected—or, it can be adjusted to select weaker-signal stations—or, it can be adjusted a third way to select the signals of any listenable and tunable stations. The accuracy of tuning by *Wonder Bar* is far greater than manual tuning would normally achieve.

But, with the finest of auto radios, the AM cross-channel mixing is still present. In field tests of auto radios in areas around the Delco Radio Division facilities in Kokomo, Indiana, it was found that "from 10 to 20 good, clear stations" were consistently received during the daytime. Between dusk and dawn, though, the number of "good, clean signals" dwindled to four or five. Careful listening showed that the stations with background interference were getting that interference from one or more other radio stations on the same frequency. Some stations that provided strong, clear signals in the daytime hours and had to reduce their power at dusk (by law), thereby lost their clean signal. Therefore, instead of listeners having one good, strong signal on a given frequency, as in the daytime, there was a mixture of several signals with no one of them listenable at night.

The report on this test also brought forth typical comments that can be applied almost anywhere in the United States, to various individual stations:

"Usually received at night, but affected by background interference from two Cuban stations on evening this test was made."

"Nine other stations on same channel interfere at night."



more. And Delco Radio has been in the forefront, pioneering many of the great developments to achieve ever higher standards.

To spotlight the enormous problems that had to be solved to produce a high-performing auto radio, here's a "box score" of the differences between today's auto radio and a stationary

DIFFERENCES BETWEEN HOME AND AUTO RADIO SETS

	HOME SET	AUTO RADIO
Antenna	Usually much larger for better signal pickup	Necessarily limited in size and location
Power Supply	120-volt AC	12-volt to 14.5-volt DC
Ground	To earth, if desired	To frame of car
Set Size	As large as necessary, within reason	Compact as possible, creating added shielding problems and need for "miniaturization"
Speaker	As large as necessary, with ample power as required, within set's design limits	As small and compact as possible without, however, sacrificing fidelity and power output
Operating Conditions	Totally sheltered; within temperature ranges of family abode	Subject to temperature ranges of −35°F to +120°F; and to relative humidity ranges of 5% to 100%
Static Environment	Subject to surrounding atmospheric conditions; to local-area appliances and transformers. Can be moved within home, however, for optimum reception location	Subject to surrounding atmospheric conditions; to all varying electrical noises met on modern streets and highways. Static field constantly changing. Environment constantly changing
Mobility	Not expected to perform at varying distances from broadcast stations	Expected to perform with minimum change in reception quality, regardless of distance or rate of change of distance from station

home receiver. It shows where and why the auto radio is a far more complicated, more intricate and, yes, more expensive unit—even though it comes in a smaller "package"!

In any discussion of the two major types of commercial

"Subject to nighttime interference from one Puerto Rican and two Cuban stations on same channel."

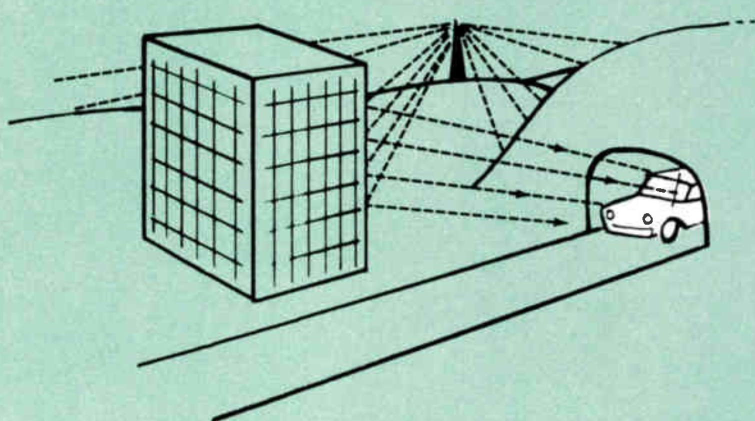
"Reduces power at night. There are 175 stations assigned to this channel."

Comments such as these make it crystal clear that the AM broadcast band is "busting out of its britches!"

The Frequency Modulation broadcast band assigned by the Federal Communications Commission is from 88 to 108 megacycles. Each station is assigned a specific frequency in this band and, when the station is broadcasting its assigned signal frequency, but not modulating it with sound signals, the station is precisely on its frequency. Then, when a sound (audio) signal is applied to the radio wave, the frequency shifts slightly from one side to the other of this frequency because the sound signal is modulating the wave's frequency, instead of its amplitude.

As you can tell by the use of the word "megacycles" in referring to the FM band, the frequencies are much higher than the kilocycle frequencies assigned to the AM band. Therefore, FM waves are much shorter. And because they are shorter, FM waves are not reflected back to the earth by the ionosphere, but go straight out into space. For that reason, as with the short waves used to transmit television, the FM waves depend on direct "line-of-sight" transmission for good reception. In other words, the receiver antenna must be able

In metropolitan areas, auto FM radio reception is possible in tunnels or around corners because the short FM waves can "bounce" off buildings and structures.

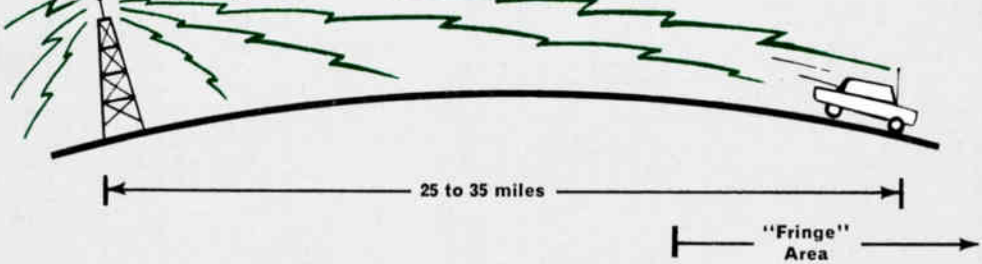


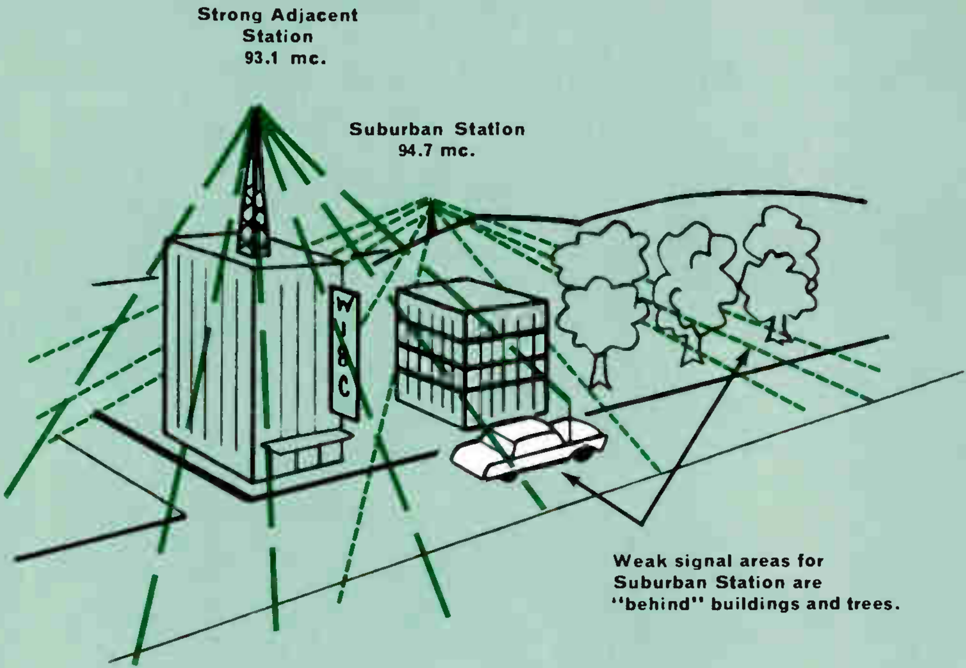
to "see" the transmitter antenna and *vice versa*, for the best reception. This is especially true on the outer fringes of reception areas. A building or a hill between the transmitter and your FM auto radio can blank out the FM wave. On the other hand, in metropolitan areas where the signal is strong, the FM waves can also bounce off buildings and structures to reach your car antenna, even though the transmitter antenna may be "out of direct sight" of it. This makes FM reception sometimes possible even inside tunnels or "around corners" in metropolitan areas.

The normal FM receiving range for superior-design auto radios such as the Delco AM-FM receiver, is about 25-35 miles. And yet, a powerful station transmitting over flat, unobstructed terrain can better that range. Contrarily, "educational" FM stations of low power may reach out only a few miles, or even just a few blocks from the transmitter.

Another seeming anomaly is the fact that FM reception can be very good at distances beyond 25 miles—in the fringe area—while the car is standing still. However, FM popularity is increasing rapidly, and, in the heavily populated areas, there are no FM void areas.

Because FM radio depends mostly on direct, or "line-of-sight," waves, the normal range for good reception is 25 to 35 miles from the transmitter.





"Capture" effect occurs when the weaker, farther-away FM signal is blocked off and "cut out" by a nearer, stronger FM signal which is close to the same frequency on your FM radio dial.

But, should the car be moving, the auto radio may intermittently lose the station in this fringe area, because of intervening hills and buildings. This intermittent "loss" of signal in the fringe reception area is known as "flutter." And driving slowly in the fringe area will cause a low rate of flutter, while driving faster will increase the rate of flutter.

Still another situation that can occur in FM reception while you're driving is the "capture" effect. It happens this way: As you are driving through town, you may have your FM tuned to a weak-signal station whose transmitter is located some distance away. You travel nearer to another FM transmitter which is broadcasting a strong signal on or near the frequency of the weak-signal station you're listening to. Under these conditions, your FM receiver may shift from the weak-signal station to the stronger signal coming in from nearer by. This will especially tend to happen when you drive past a building that intervenes between you and the weak-signal station. As you know, AM radio doesn't do this. Instead, AM brings you a "mixing" of signals so that you suddenly find yourself trying to listen to two stations at once. An FM radio won't mix the signals—it will choose the stronger of the two, "capture" it, and exclude the weaker signal.

One of the greatest advantages of FM radio is the fact that it's almost completely free of ordinary static. Most static sources—such as lightning, overhead and underground power lines, neon signs, transformers and traffic-light signals—will modulate the *amplitude* of radio waves. Therefore, they can affect AM radio. But, they don't normally interfere with FM radio reception.

By learning these facts about how FM auto radio reception differs from AM reception, you can better appreciate the advantages of FM in your own car. Today, FM radio heightens driving pleasure with some of the finest, high-quality entertainment available through the science of "elektron-ics."

FEATURES OF THE DELCO AM-FM AUTO RADIO
available in all GM cars

ANTENNA	Conventional auto type, with built-in trimmer for optimum AM reception. (Trimmer not needed for FM, but antenna should be extended to 30 inches for best FM reception.)
PUSHBUTTONS	Five. Each button can be set for an AM or FM station. A button set for FM cannot be used for a separate AM station unless both happen to fall on same spot on dial.
AM-FM SELECTOR SWITCH	Located above radio dial. Circuit switching limited to three circuits for maximum reliability. Lighted letters, "AM" or "FM" indicate which band is in use.
MANUAL TUNING	A single tuning knob controls station selection, is used for both AM and FM tuning.
TONE CONTROL	Located behind volume control. Controls tone on either AM or FM.
VOLUME CONTROL	Automatically brings in more bass at low volume settings because the human ear does not respond well to bass tones at low volume levels.
SPEAKER	New, 10-ohm speaker for more power output on both AM and FM.
AM RECEPTION	The finest AM circuitry in the field, developed by Delco through many years of pioneering research and engineering.
AUTOMATIC GAIN CONTROL	A doubler type unique in auto radios. Responds quickly, accurately, to changes in AM signal strength to keep volume at more constant level. Proves its superiority in maintaining listenable stations even when driving over bridges.
FM RANGE	Delco AM-FM radio incorporates four stages of Intermediate Frequency (IF) Amplification to maximize listenable reception even in far-out fringe-area range.
FM FLUTTER CONTROL	Delco radio keeps FM flutter to absolute minimum with high gain and doubler type FM Automatic Gain Control (AGC) Circuit. (The AM portion has its own independent automatic gain, or volume, control.)
AUTOMATIC FREQUENCY CONTROL	Instead of strong AFC system with its disadvantages, Delco uses an FM tuner operating from a zener diode controlled power supply. System maintains same voltage on FM tuner under all driving conditions. Delco AFC circuit is designed to provide superior "holding" on frequency without disadvantages of broad tuning and "capture" effect.
MOTOR NOISE SUPPRESSION	While the Delco AM-FM radio is not subject to motor noise from car in which installed, it can pick up noise from other vehicles, especially in fringe reception areas. Delco's four Intermediate Frequency stages and Ratio Detector circuit hold this noise to minimum.

HIGHLIGHTS AND SIGNIFICANT EVENTS
in Delco Automobile Radio History

1929—General Motors Radio Corporation, Dayton, Ohio, begins to produce auto radios for General Motors cars. Radios are made with available home radio parts and powered by four 45-volt "B" batteries, a 9-volt "C" battery and the car battery.

1935—First instrument-panel radio for cars, designed in radio laboratory established by United Motors Service in General Motors Research Building, Detroit.

1936—Delco Radio manufacturing organization established in Kokomo, Indiana.

1938—Old-fashioned "string-and-pulley" dialing system is replaced by straight-line mechanical linkage with lever-type pointer action. A first from Delco Radio.

1939—Delco leads in developing multi-buttoned mechanical tuner. Also initiates development toward a complete, self-contained radio that includes tuner, speaker and power supply all in the same case.

Delco applies irreversible worm principle to manual drive and clutch system —which is still used as best means of locking radio tuner onto station.

1940—Delco develops first elliptically shaped auto radio speaker. Shape provides superior tone quality in a smaller vertical area dictated by the shrinking size of auto instrument panels.

1947—Delco designs and introduces the push-pull, lock-up mechanical tuning buttons.

Delco introduces first practical, successful Signal-Seeking radio. Tuner automatically and electronically seeks a station signal and locks onto station it selects.

1950—Delco produces greatly improved seeking and stopping tuner mechanism, permitting driver to select any program in his driving area, by touching and releasing the *Wonder Bar*—and without taking his eyes off road. A foot-switch feature is made available for using the foot instead of the *hand.*

1952—Delco invents "Favorite Station" version of its signal-seeker. Permits driver to have both signal-seeking and individual selection of his five favorite stations. Accomplished by addition of electronically controlled pushbuttons to signal-seeker.

Delco produces its 10-millionth radio, is producing at rate of three million units annually.

Delco puts first rear seat radio in production. Permits rear seat passenger to select stations and control radio operation.

Delco uses printed circuit in auto radio production, as part of "Favorite Station" circuitry.

1956—Delco produces first auto radio using Delco-developed hi-power transistors capable of replacing power output tubes and providing greater efficiency and performance. Transistors replace both vibrator power pack and power output tubes, eliminating troublesome vibrator buzz. Power transistors further make possible use of 12-volt-plate-voltage tubes operating from 12-volt car battery, for both tube amplifiers and power transistors.

1957—Delco produces a special, completely transistorized auto radio, for the Cadillac Brougham.

1958—Delco introduces a combination auto radio removable from the car for use as a portable.

1961—Delco is first in production of all-transistor auto radios.

1963—Delco is first in producing AM-FM combination auto radios, which are available for entire General Motors car line.

Delco Radio Division

"You've never heard it so good!"

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