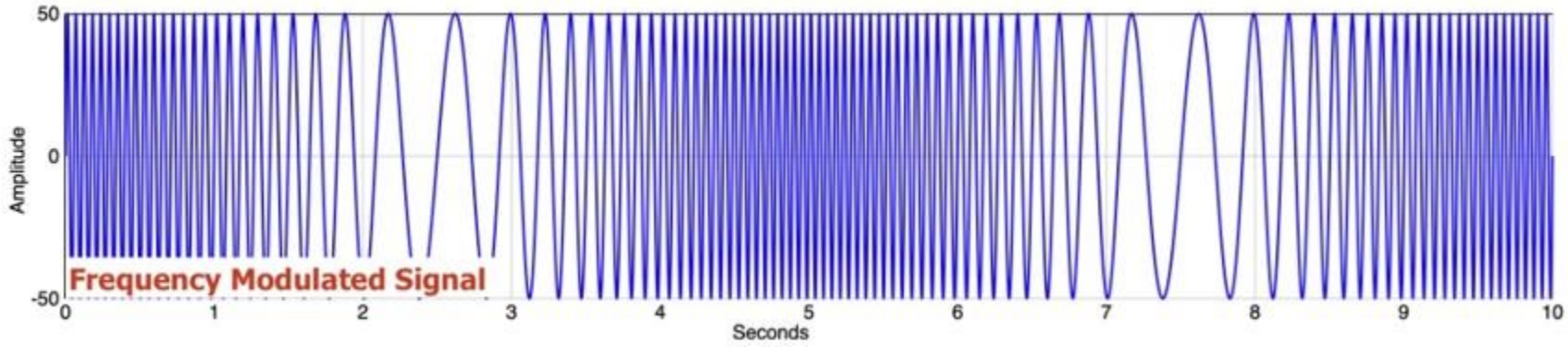
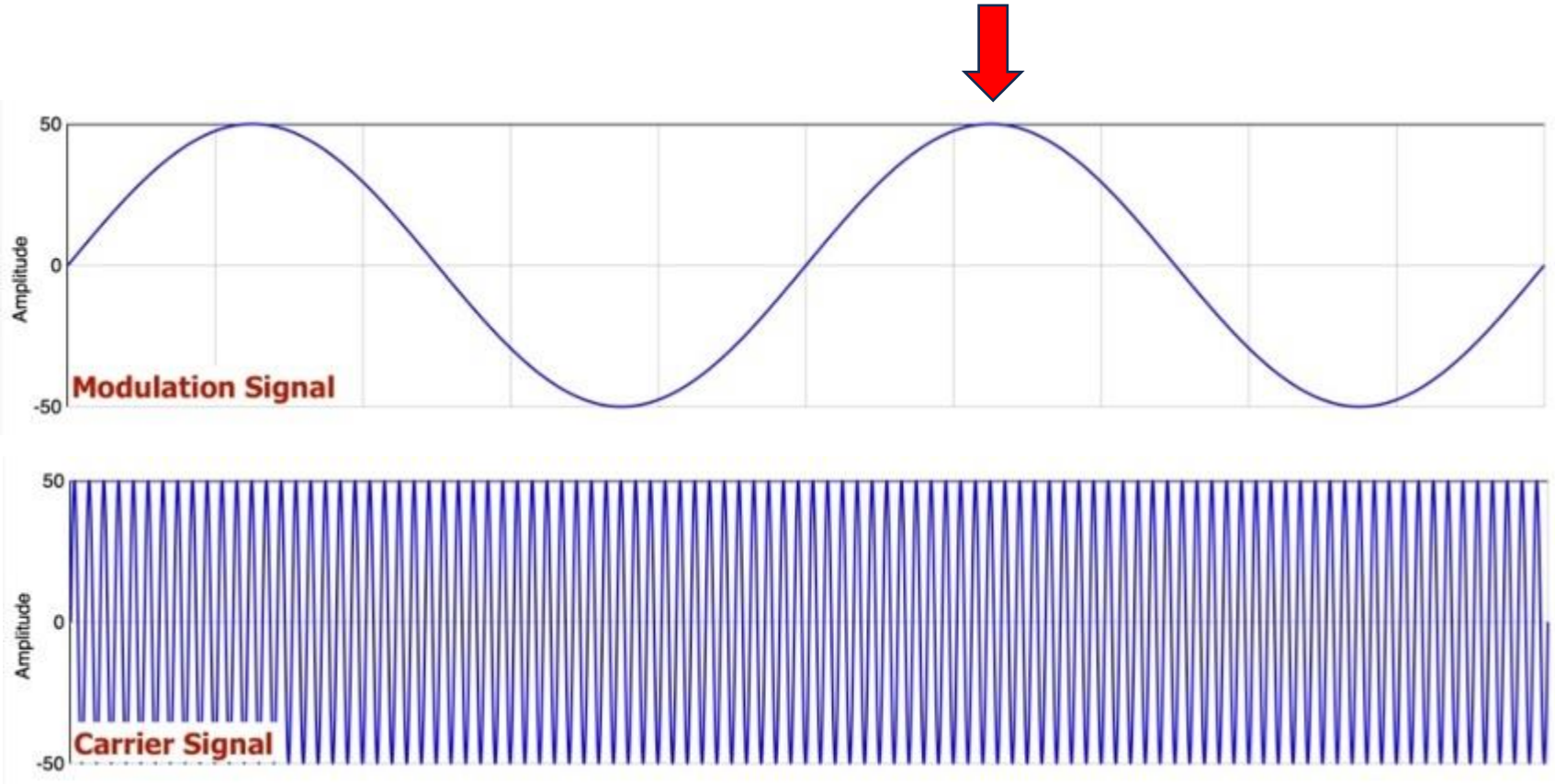
The History of Frequency Modulation



FM almost died so many times over the decades; it is amazing that it survived to be the powerhouse it is today.

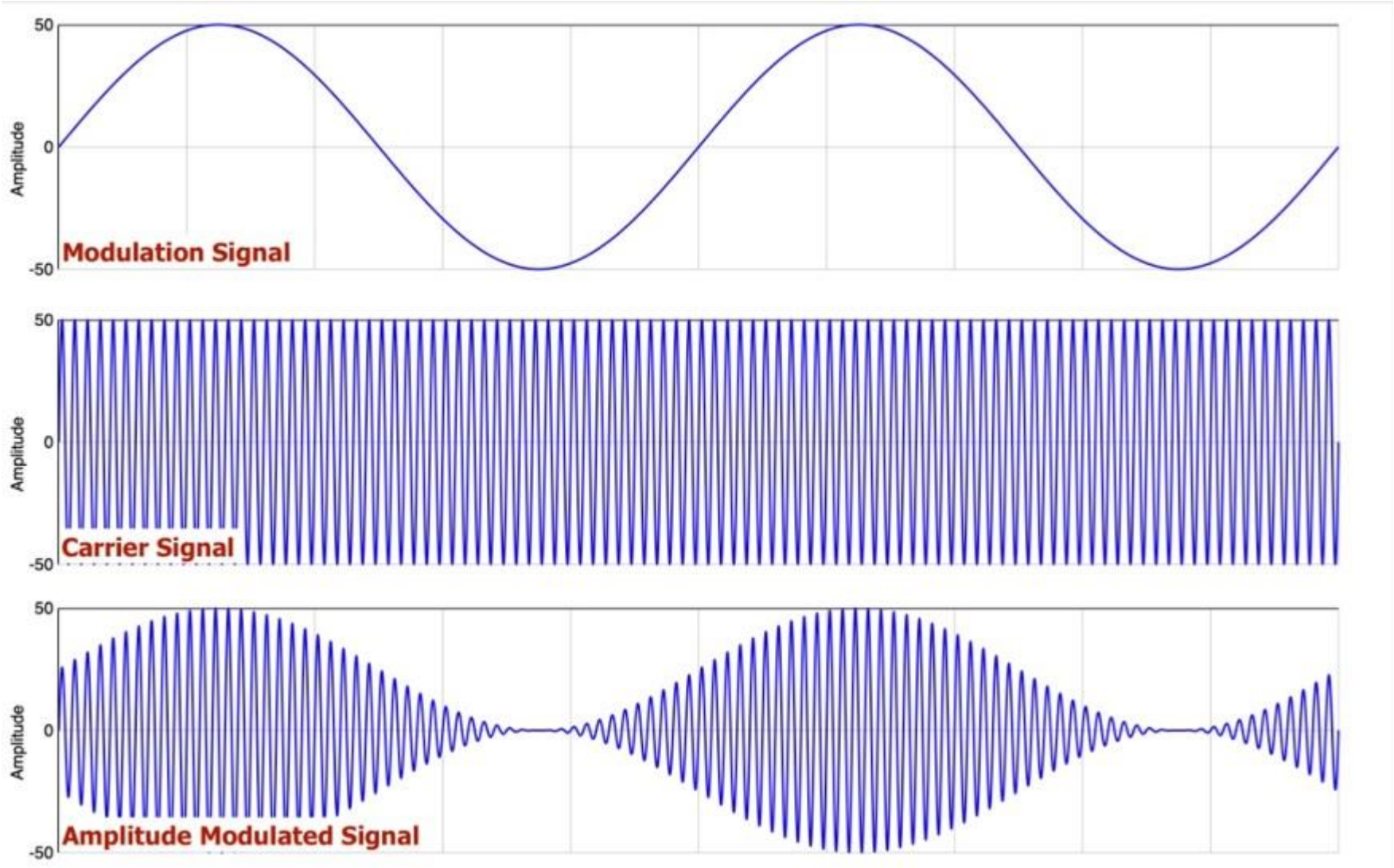
First, some Modulation Basics

Plain old audio



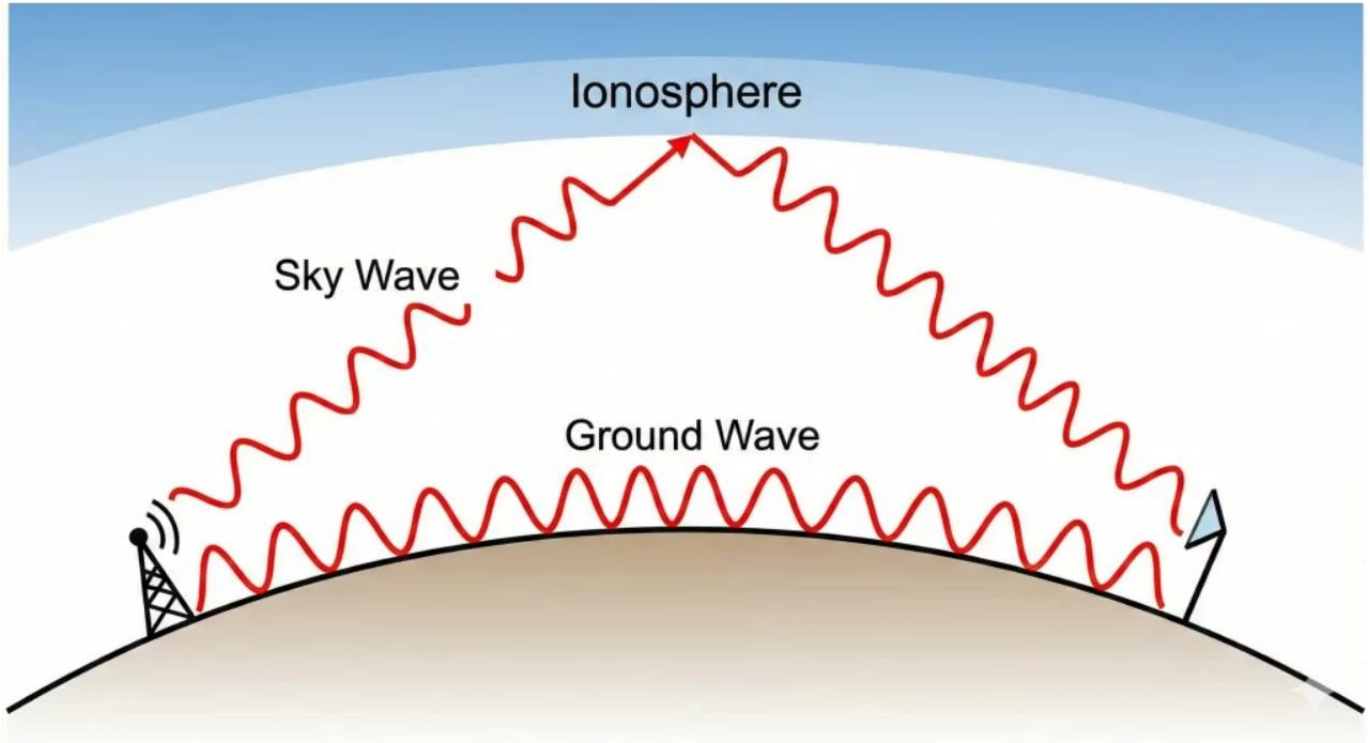
Radio Frequency “RF”

Amplitude Modulation



AM has a ground wave and a sky wave

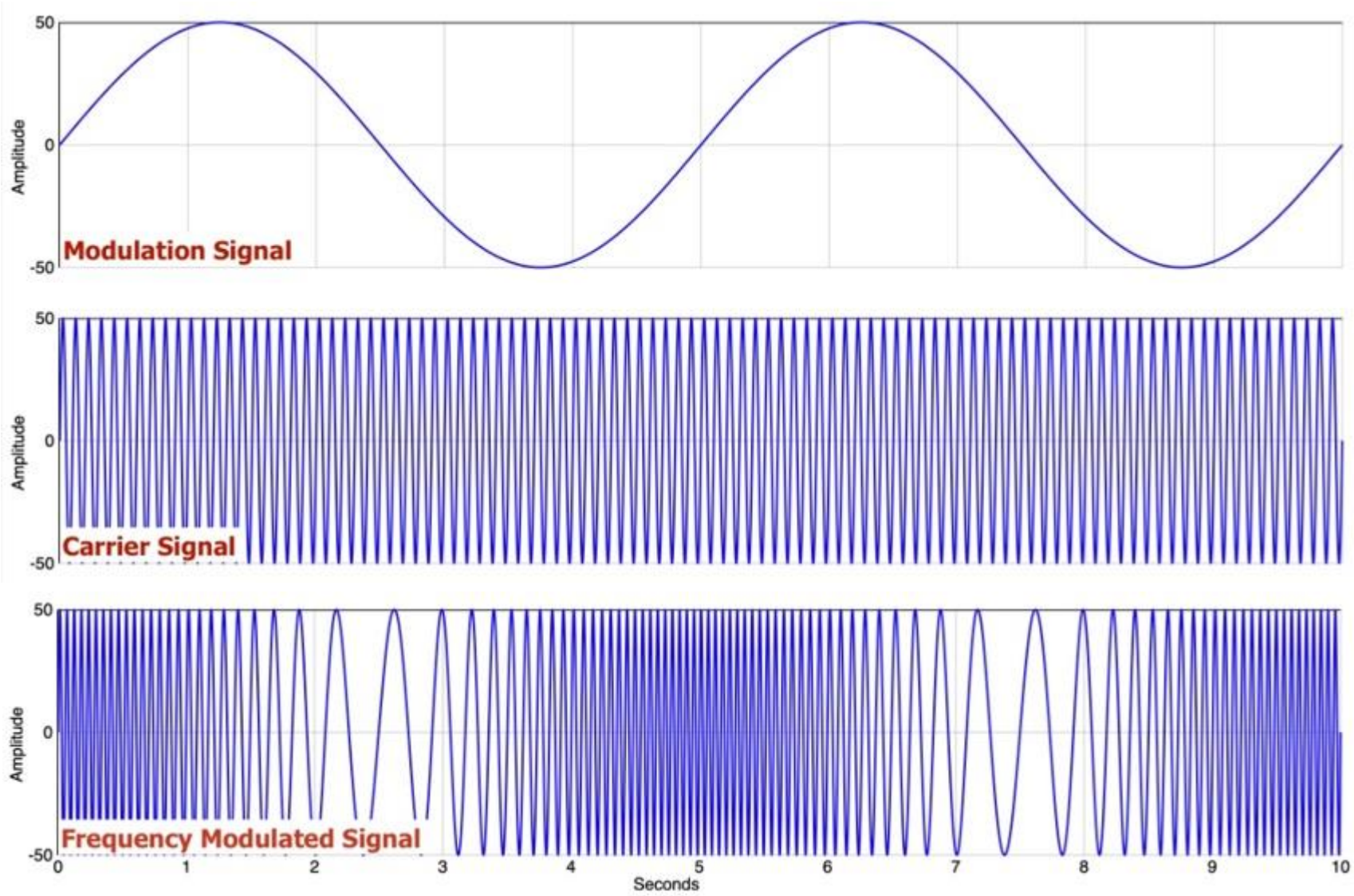
- The ground wave travels on the ground, so ground conductivity is extremely important.
- AM travels long distances due to the sky wave (aka “skip”).



- Skywave interference at night
- AM is subject to a lot of noise like lightning, motors, and machinery
- AM has limited audio fidelity
- Many times an AM station has directional antennas or limits on the hours they broadcast to minimize interference with other AM stations
- The entire tower is the antenna



Frequency Modulation

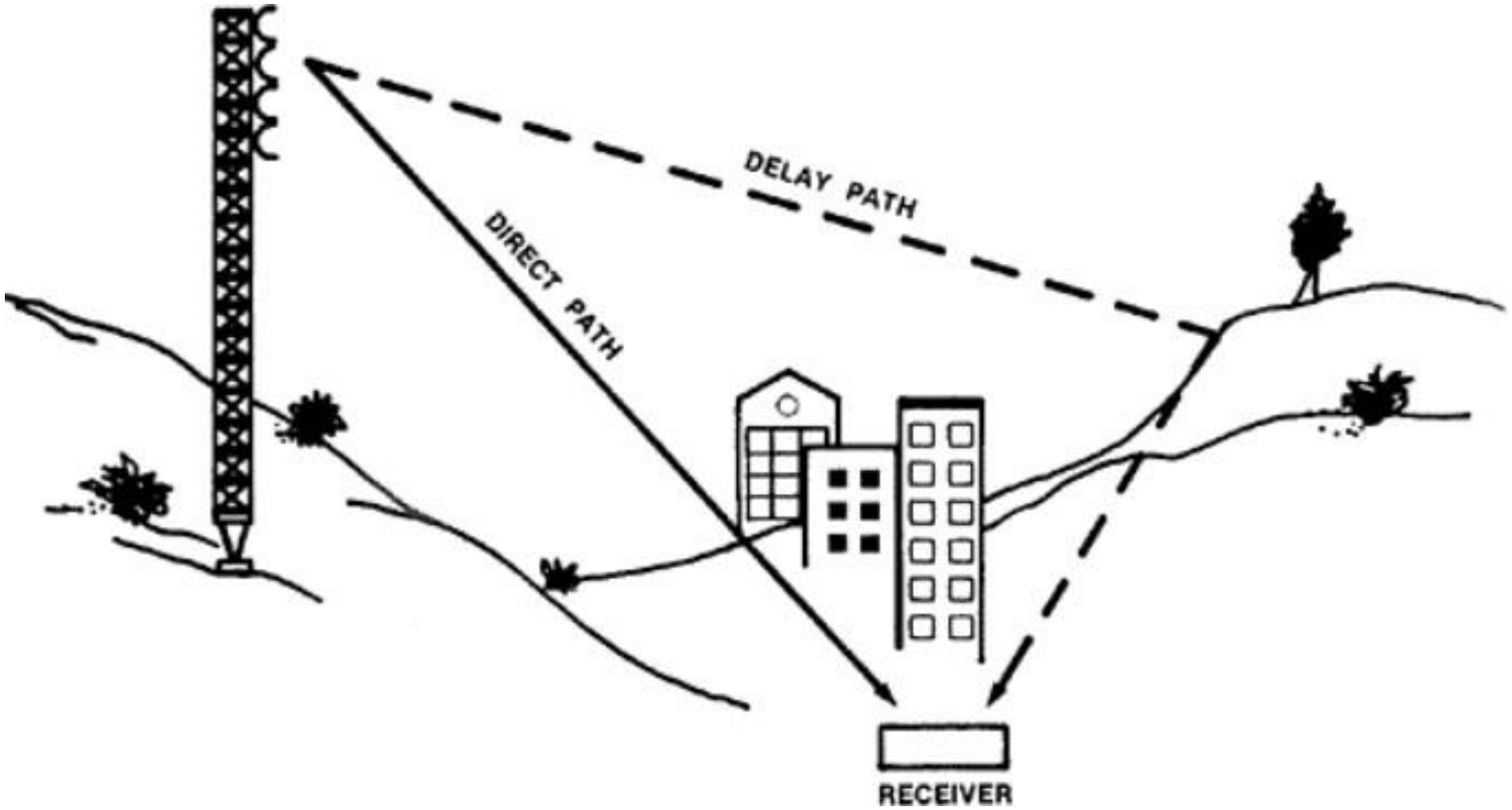


FM transmits a signal that travels the line of sight

- Usually located on a hill top or tall building
- Is not subject to static and noise
- A wider bandwidth than AM
- A greater frequency response than AM
- Not subject to interference of a station on the same frequency (capture effect)
- FM can carry ancillary services in addition to its main channel
- An FM antenna is side mounted on a tower or pylon


FM Antenna

A problem with FM is multipath



FM History

The primary cast of characters:

- Inventor Major Edwin Howard Armstrong
- RCA President David Sarnoff (the General)

FM came about during the search to solve a problem.
That problem was static noise on the AM broadcast band.

Amplitude Modulated noise interfering with AM radio

Back then it was lightning, switches and motors. Today it is also switching power supplies, LED lights, and computers.

The noise is Amplitude Modulated, as is the radio signal. The AM receiver can't distinguish noise from program material.

Most people were aware of the problem, but were having difficulty solving it.

Some engineers thought you could somehow add FM to AM to get rid of the noise. In 1922 an AT&T engineer who tried narrow band FM declared it a waste of time.

By 1930 most researchers decided FM was just a lab curiosity. And many engineers assumed the static noise was simply unavoidable.

David Sarnoff of RCA and NBC just wanted a “black box” to attach to an AM radio receiver to get rid of the noise.

But it was proving to be much more complicated.



Enter Major Edwin Howard Armstrong

Armstrong invented:

- Regenerative circuits
- Superregenerative circuits
- Superheterodyne circuits

His work on Superregenerative circuits led him to research on AM noise.

Prior FM experiments were with narrow band FM and failed.

Armstrong decided to try wide band FM.



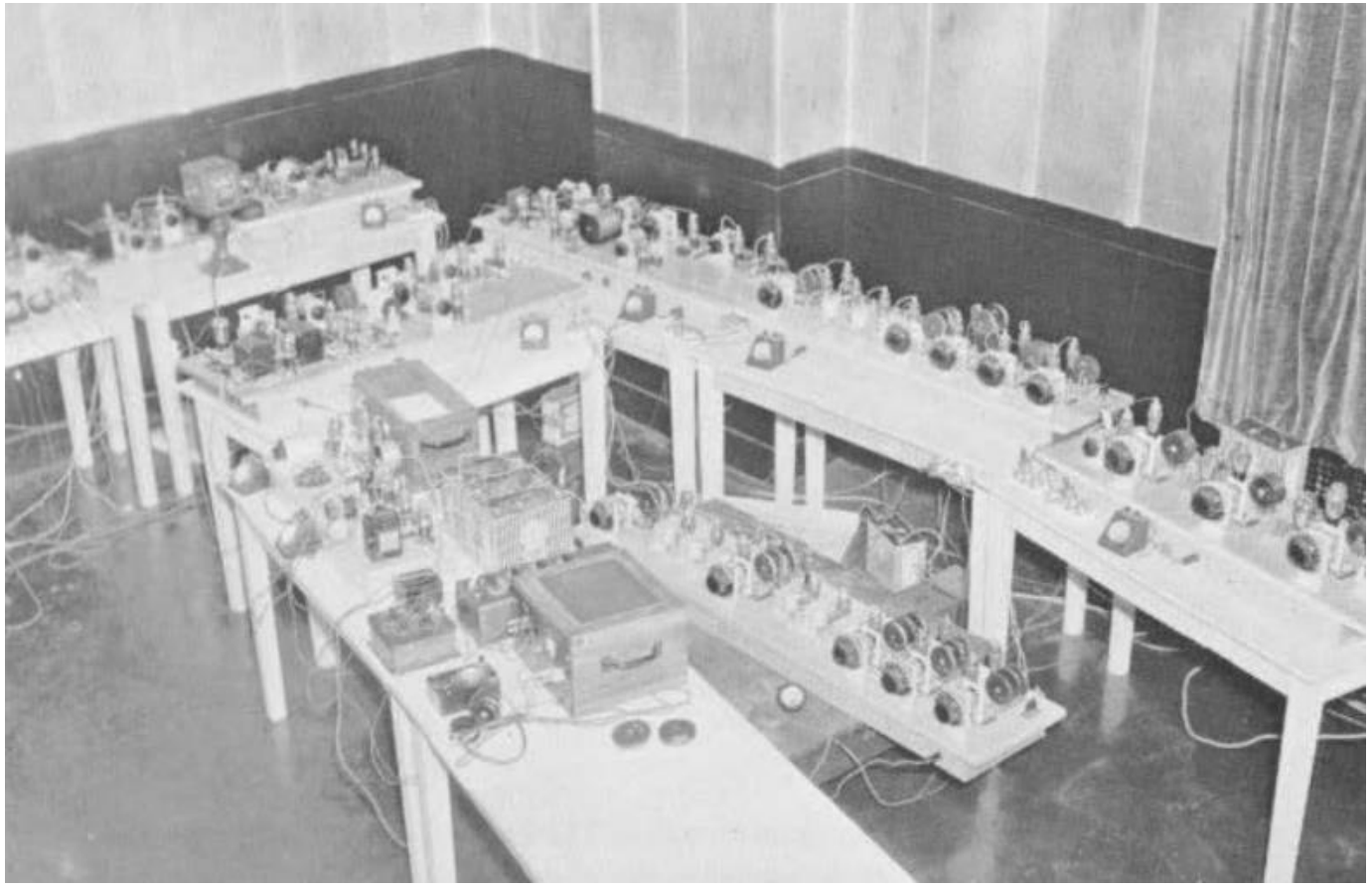
He didn't invent the "Black Box" David Sarnoff wanted.
Instead, he invented a whole new way of doing radio.

Armstrong experimented at the Columbia University lab. He worked full time for 6 years to perfect his wideband system (200 khz wide). He conducted an estimated 100,00 experiments between 1928 and 1933.

He applied for his first FM patent in July 1930 and the last of the four basic patents by January 1933. All were granted on Dec 26, 1933.

Now it was time to get other people interested by doing demonstrations.

In 1933 he gave a demonstration to David Sarnoff of RCA.

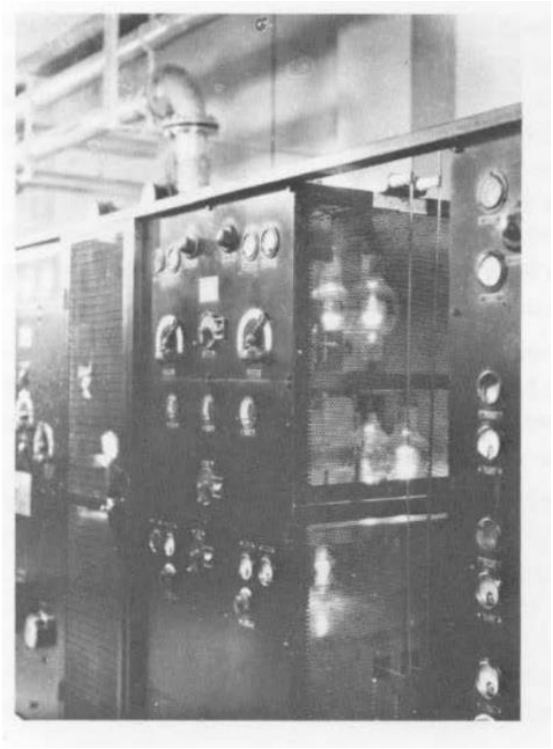


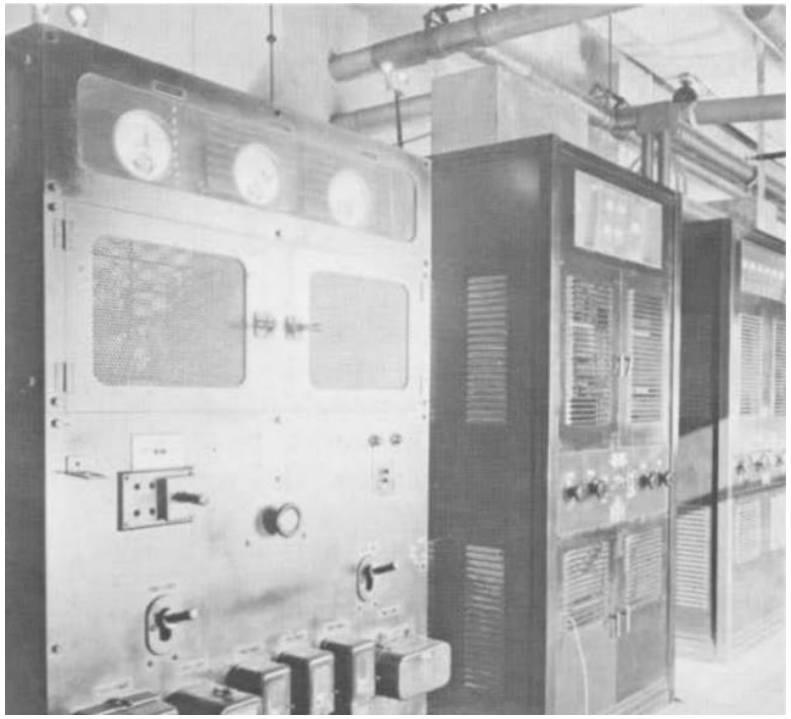
Two rooms full of breadboard circuits and over 100 vacuum tubes were needed to transmit and receive the first wideband FM transmission.

David Sarnoff wasn't impressed.

But his RCA engineers were very impressed.

Sarnoff invited Armstrong to use the RCA lab on the 85th floor of The Empire State Building.





Beginning June 2, 1934 Armstrong broadcast test signals as W2XDG, the world's first FM transmitter.

Sarnoff and his engineer's interest was short lived.

Armstrong hoped Sarnoff would purchase the patent rights. But Sarnoff seemed to feel that this new radio "system" could replace AM stations and jeopardize his existing investments in AM.

Sarnoff also felt FM would cause huge expenditures, just when he was preparing for the latest and greatest invention, Television.

By October 1935, Sarnoff demanded the FM equipment be dismantled and removed so RCA had the space for TV testing.

Armstrong wanted the testing to continue so he sold his RCA stock to finance and build an experimental FM station in Alpine, NJ.

Construction of the 400 foot tower and associated buildings were completed in 1937.

The tower had 3 cross arms so multiple antennas could be placed on the tower and not interfere with each other.

On April 10, 1938 experimental station W2XMN went on the air with program tests at low power (600w).

By July 1939 the station was broadcasting full power of 35kw, though no one could hear it.






armstrong.txt ●
1[+]
1 Armstrong Tower
2
3 The Armstrong Tower, also known as Alpine Tower, is a distinctive 129.5 meter tall lattice tower featuring three large cross-arms, located atop the Alpine, New Jersey palisades overlooking the Hudson River a few kilometers north of New York City at 40°57'39.0" N and 73°55'21.0" W.
4
5 It is owned by Alpine Tower Company and managed by CSC Management, LLC, both owned by Charles E. Sackermann, Jr. The tower is the permanent transmitter site for locally based experimental station WA2XMN and Fairleigh Dickinson University's educational FM station WFDU, in additional to numerous directional radio services. It is clearly visible from across the Hudson River and is used as a Visual flight rules waypoint by aircraft flying within the New York City Special flight rules area.
6
7 The tower was originally constructed by prolific radio endineer Edwin Howard Armstrong in 1938 for the development of FM radio. Among his other accomplishments, Armstong invented the srgenerative receiver and the superheterodyne radio architecture.
INSERT armstrong.txt [+] text Bot 7:276
6 0 vi* user@debian 2024-01-28 21:08:13

Armstrong was not the only one to believe in the future of FM radio.

Several other people did and formed FM relay “networks” to distribute radio programming on an experimental basis.

- The Yankee Network
- The Don Lee Network
- The Continental Network
- The Rural Radio Network
- The American Network
- The Colonial Network

A total of seven experimental stations were on the air in 1939, increasing to eleven in 1940

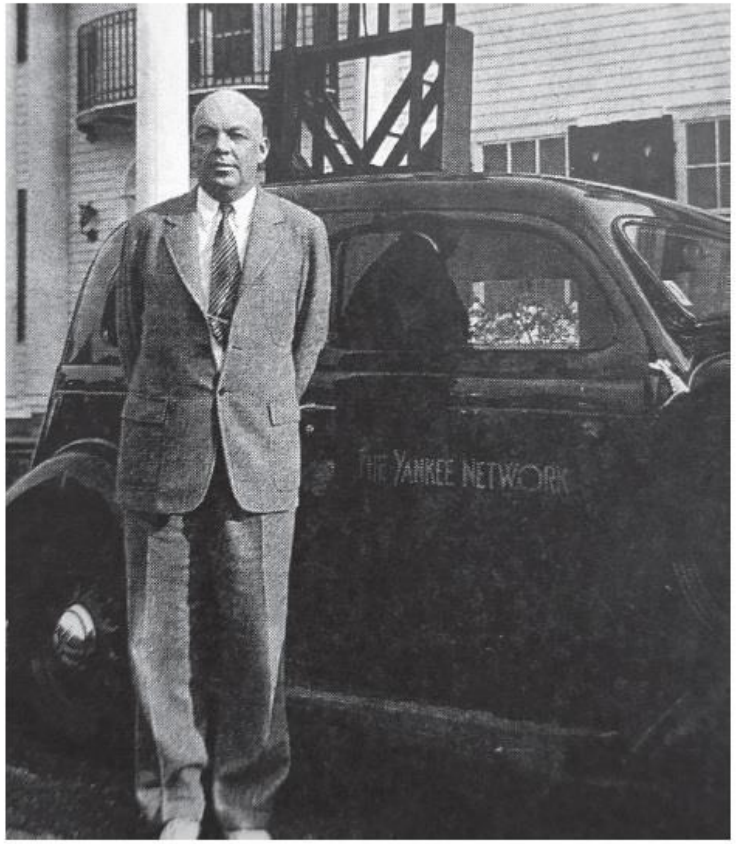


Fig. 5. Armstrong, shown here, traveled with The Yankee Network and others to demonstrate the benefits of FM. (Armstrong Family Archive)

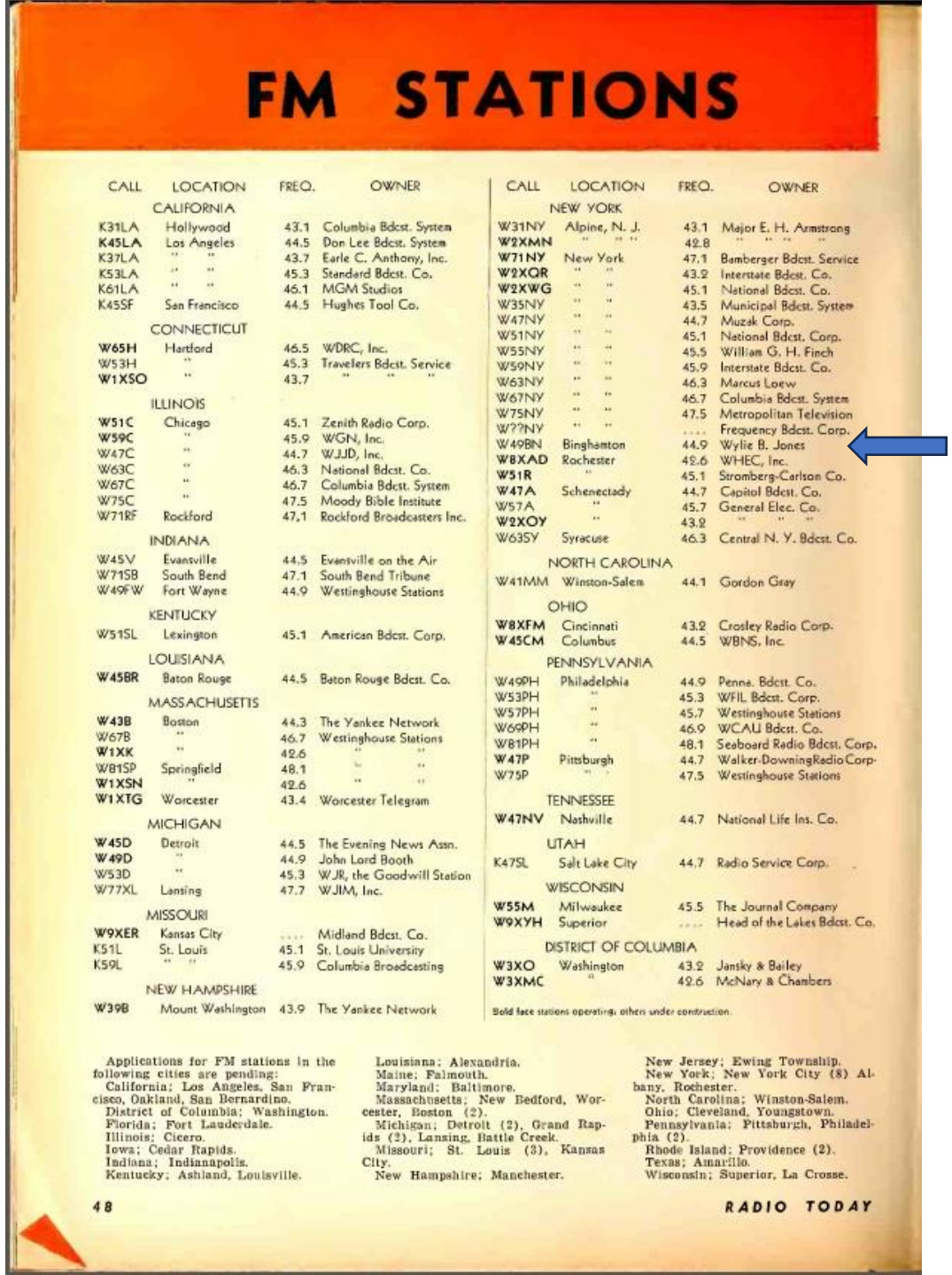


W1XOJ'S DEMONSTRATION CAR TAKES F-M QUALITY TO RADIO LISTENERS OF NEW ENGLAND

Fig. 6. The Yankee Network runs a FM demonstration tour around New England. Shown is their transmitter trailer pulled by an attention-getting car. (Poppele Collection FM Scrapbooks, AWA Museum)

December 1940 the FCC announced that the FM stations would be identified by a series of letters and numbers to denote the frequency and the city where it operated.

So W49BN operated at 49 Mhz and was licensed to Binghamton, NY.



FM STATIONS

CALL	LOCATION	FREQ.	OWNER
	CALIFORNIA		
K31LA	Hollywood	43.1	Columbia Bdcst. System
K45LA	Los Angeles	44.5	Don Lee Bdcst. System
K37LA	" "	43.7	Earle C. Anthony, Inc.
K53LA	" "	45.3	Standard Bdcst. Co.
K61LA	" "	46.1	MGM Studios
K45SF	San Francisco	44.5	Hughes Tool Co.
	CONNECTICUT		
W65H	Hartford	46.5	WDRC, Inc.
W53H	"	45.3	Travelers Bdcst. Service
W1XSO	"	43.7	" " "
	ILLINOIS		
W51C	Chicago	45.1	Zenith Radio Corp.
W59C	"	45.9	WGN, Inc.
W47C	"	44.7	WJJD, Inc.
W63C	"	46.3	National Bdcst. Co.
W67C	"	46.7	Columbia Bdcst. System
W75C	"	47.5	Moody Bible Institute
W71RF	Rockford	47.1	Rockford Broadcasters Inc.
	INDIANA		
W45V	Evansville	44.5	Evansville on the Air
W71SB	South Bend	47.1	South Bend Tribune
W49FW	Fort Wayne	44.9	Westinghouse Stations
	KENTUCKY		
W51SL	Lexington	45.1	American Bdcst. Corp.
	LOUISIANA		
W45BR	Baton Rouge	44.5	Baton Rouge Bdcst. Co.
	MASSACHUSETTS		
W43B	Boston	44.3	The Yankee Network
W67B	"	46.7	Westinghouse Stations
W1XK	"	42.6	" "
W81SP	Springfield	48.1	" "
W1XSN	"	42.6	" "
W1XTG	Worcester	43.4	Worcester Telegram
	MICHIGAN		
W45D	Detroit	44.5	The Evening News Assn.
W49D	"	44.9	John Lord Booth
W53D	"	45.3	WJR, the Goodwill Station
W77XL	Lansing	47.7	WJIM, Inc.
	MISSOURI		
W9XER	Kansas City	....	Midland Bdcst. Co.
K51L	St. Louis	45.1	St. Louis University
K59L	" "	45.9	Columbia Broadcasting
	NEW HAMPSHIRE		
W39B	Mount Washington	43.9	The Yankee Network

CALL	LOCATION	FREQ.	OWNER
	NEW YORK		
W31NY	Alpine, N. J.	43.1	Major E. H. Armstrong
W2XMN	" " "	42.8	" " " "
W71NY	New York	47.1	Bamberger Bdcst. Service
W2XQR	" "	43.2	Interstate Bdcst. Co.
W2XWG	" "	45.1	National Bdcst. Co.
W35NY	" "	43.5	Municipal Bdcst. System
W47NY	" "	44.7	Muzak Corp.
W51NY	" "	45.1	National Bdcst. Corp.
W55NY	" "	45.5	William G. H. Finch
W59NY	" "	45.9	Interstate Bdcst. Co.
W63NY	" "	46.3	Marcus Loew
W67NY	" "	46.7	Columbia Bdcst. System
W75NY	" "	47.5	Metropolitan Television
W??NY	" "	....	Frequency Bdcst. Corp.
W49BN	Binghamton	44.9	Wylie B. Jones
W8XAD	Rochester	42.6	WHEC, Inc.
W51R	"	45.1	Stromberg-Carlson Co.
W47A	Schenectady	44.7	Capitol Bdcst. Co.
W57A	"	45.7	General Elec. Co.
W2XOY	"	43.2	" " "
W63SY	Syracuse	46.3	Central N. Y. Bdcst. Co.
	NORTH CAROLINA		
W41MM	Winston-Salem	44.1	Gordon Gray
	OHIO		
W8XFM	Cincinnati	43.2	Crosley Radio Corp.
W45CM	Columbus	44.5	WBNS, Inc.
	PENNSYLVANIA		
W49PH	Philadelphia	44.9	Penna. Bdcst. Co.
W53PH	"	45.3	WFIL Bdcst. Corp.
W57PH	"	45.7	Westinghouse Stations
W69PH	"	46.9	WCAU Bdcst. Co.
W81PH	"	48.1	Seaboard Radio Bdcst. Corp.
W47P	Pittsburgh	44.7	Walker-Downing Radio Corp.
W75P	"	47.5	Westinghouse Stations
	TENNESSEE		
W47NV	Nashville	44.7	National Life Ins. Co.
	UTAH		
K47SL	Salt Lake City	44.7	Radio Service Corp.
	WISCONSIN		
W55M	Milwaukee	45.5	The Journal Company
W9XYH	Superior	....	Head of the Lakes Bdcst. Co.
	DISTRICT OF COLUMBIA		
W3XO	Washington	43.2	Jansky & Bailey
W3XMC	"	42.6	McNary & Chambers

Bold face stations operating, others under construction.

Applications for FM stations in the following cities are pending:

California; Los Angeles, San Francisco, Oakland, San Bernardino.
District of Columbia; Washington.
Florida; Fort Lauderdale.
Illinois; Cicero.
Iowa; Cedar Rapids.
Indiana; Indianapolis.
Kentucky; Ashland, Louisville.
Louisiana; Alexandria.
Maine; Falmouth.
Maryland; Baltimore.
Massachusetts; New Bedford, Worcester, Boston (2).
Michigan; Detroit (2), Grand Rapids (2), Lansing, Battle Creek.
Missouri; St. Louis (3), Kansas City.
New Hampshire; Manchester.
New Jersey; Ewing Township.
New York; New York City (8) Albany, Rochester.
North Carolina; Winston-Salem.
Ohio; Cleveland, Youngstown.
Pennsylvania; Pittsburgh, Philadelphia (2).
Rhode Island; Providence (2).
Texas; Amarillo.
Wisconsin; Superior, La Crosse.

May 20, 1940 FCC issued its landmark “Report on Frequency Modulation” decision approving commercial operation of FM stations starting in 1941. All existing experimental stations would need to apply for a commercial license.

Commercial FM broadcasting got off to a confusing start on January 1, 1941 with the public generally unaware.

PRE-WAR
STATIONS EQUIPPED WITH
REL FM TRANSMITTERS

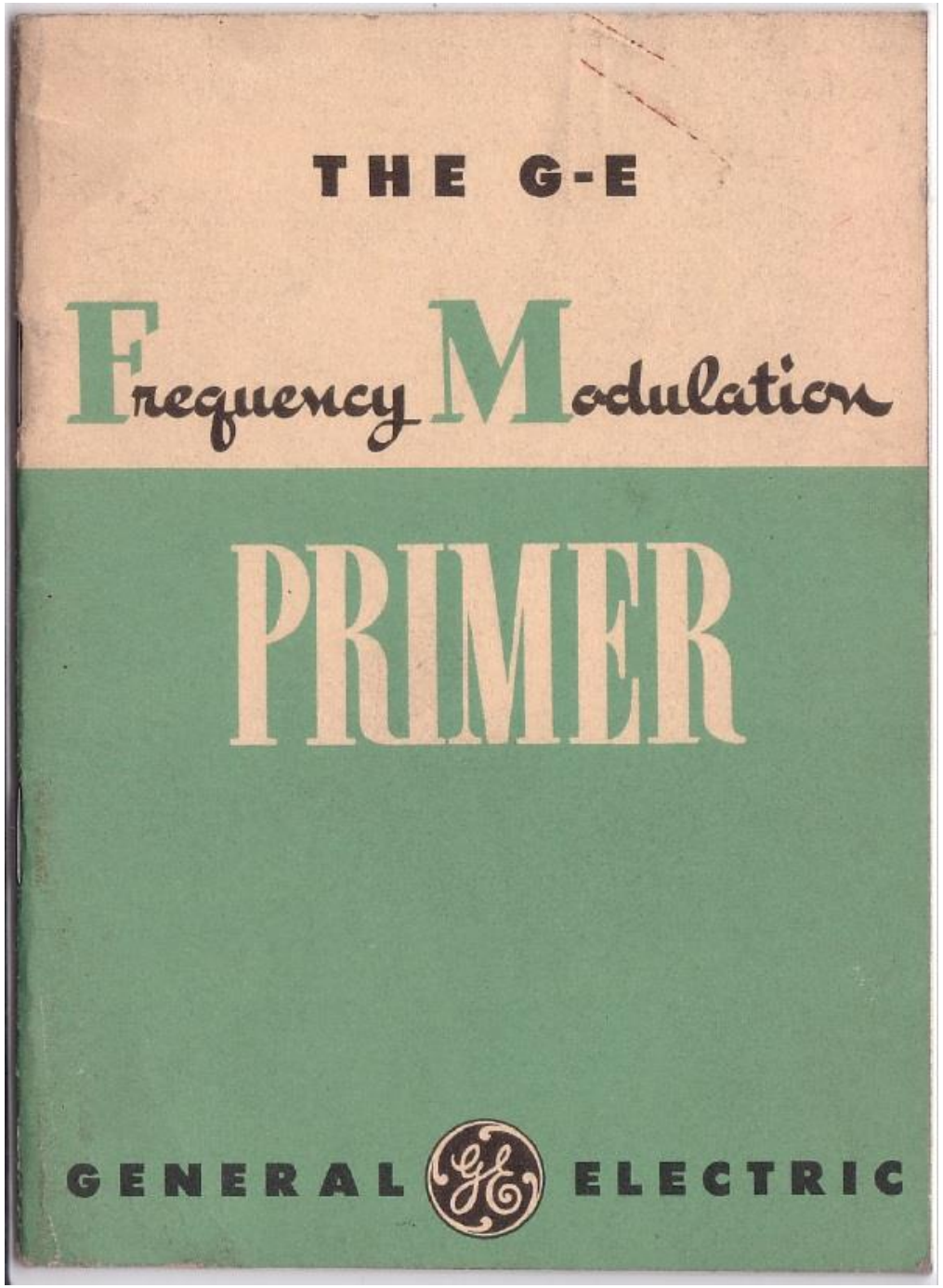
40 - 50 MC.

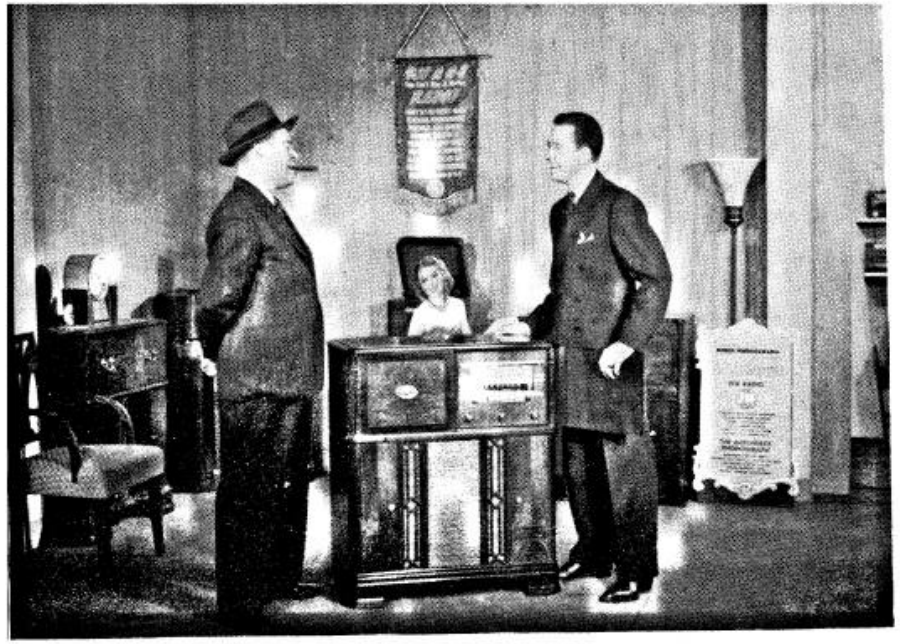
STATION	OWNER	POWER	LOCATION
W2XMN	Major E.H. Armstrong	50 KW	Alpine, New Jersey
WENA	The Detroit News	50 KW	Detroit, Michigan
WGTR	Yankee Network	50 KW	Paxton, Mass.
WMFM	The Journal Company	50 KW	Milwaukee, Wisconsin
WMTW	Yankee Network	10 KW	Mt. Washington, New Hampshire.
WFIL-FM	WFIL Broadcasting Company	10 KW	Philadelphia, Pa.
WELD	Radiohio Inc.	10 KW	Columbus, Ohio.
WHFM	Stromberg Carlson Company	3 KW	Rochester, New York
WHEF	WHEC, Inc.	3 KW	Rochester, New York
WNBF-FM	Wylie B. Jones Advertising Agency	3 KW	Binghamton, New York
WNYE	Board of Education City of New York	1 KW	Brooklyn, New York
WQXQ	New York Times	1 KW	New York, New York



View shows WMTW atop Mt. Washington, New Hampshire

Still, there was a need to educate the public, so receiver manufacturers distributed promotional booklets explaining what FM is and how it works.



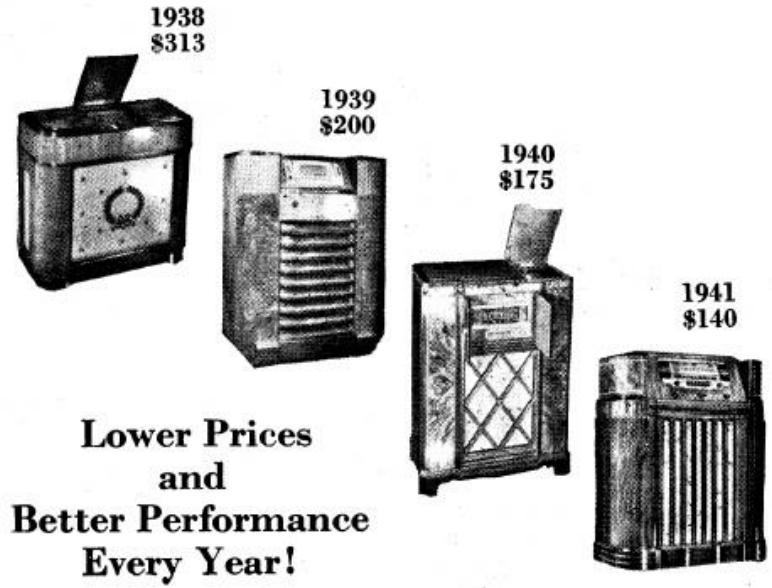


WHY BUY AN FM RADIO NOW?

If you live within listening range of an FM station, by all means *insist* that your new radio receive FM. A moderately-priced G-E radio with FM will bring you musical enjoyment which the most expensive radio without FM cannot bring you.

Even if you don't have FM broadcasting in your area now, you won't have to wait to begin enjoying your General Electric FM set. A radio or radio-phonograph designed and built to General Electric FM standards gives you unsurpassed reception not only of FM but of *all* programs!

New FM stations are going on the air regularly. Even if there isn't one in your area now, it's practically certain there will be before the time comes to retire the radio you buy today. So consider General Electric FM as protection for your radio investment.



Lower Prices and Better Performance Every Year!

WHY BUY A G-E FM RADIO?

General Electric was selected by Major Armstrong, the inventor, to build the first group of FM receivers which he used in perfecting FM.

General Electric has produced a line of FM receivers every year since 1938. And every year performance has been improved and prices have been lowered.

General Electric builds not only FM receivers but complete FM transmitter equipment for commercial broadcasting and for police and military communications systems.

General Electric operates a complete "proving ground" FM station. Its doors are open to everyone interested in FM radio broadcasting.

General Electric is the only manufacturer building receivers with such a complete background of FM experience.

FM

FOR

FINER MUSIC



"STATICLESS"

Stromberg-Carlson

RADIOS

Frequency Modulation

ARMSTRONG SYSTEM

a NEW KIND *of* BROADCASTING

. . . . for FM *radios*

January 1, 1941, is an important date in the history of radio—for that is the day set by the FCC for the first commercial broadcasting by FM stations with sponsored programs on regular schedules, competing with the regular broadcasting stations.

Many of the FM broadcasting stations now experimenting on the air plan to increase their power, and many more stations are under construction. Programs of the originating stations of the NBC, Columbia and Mutual Networks now are being regularly sent out on FM as well as on the regular broadcasting stations. In addition, FM broadcasters will originate many fine musical programs, may even create an additional network or two.

Why was FM *invented*

Originally intended just to overcome static, FM has been perfected to meet almost every limitation and shortcoming of the broadcasting art, for listeners located within the primary service area of broadcasting stations—the useful service range of FM broadcasting stations

?

You will want an FM *radio because you* DON'T *want . . .*

- **the crashes of static marring and making unintelligible your favorite programs;**
- **the buzz and crackle of your neighbor's vacuum cleaner, electric razor or oil burner raising havoc with reception in your home;**
- **two or more stations crowding in and blurring the one to which you wish to listen;**
- **music that is deficient in tone quality—that lacks the bass and treble that you know should be there;**
- **fine orchestral selections that lack color because the sudden crescendos are suppressed, not reproduced in proper proportion.**

The first thing that will strike you, when you hear your first FM program, is undoubtedly the amazing fidelity or naturalness of the speech and music. The full brilliance of the soprano tones, of all percussion sounds, of speech itself, is there to be enjoyed, yet with the bass and middle tones in perfect balance.

Stromberg-Carlson is Ready NOW with a Complete Line of Seasoned FM Radios and Radio-Phonographs

Stromberg-Carlson—Radio's leading quality line—is also the leader in FM.

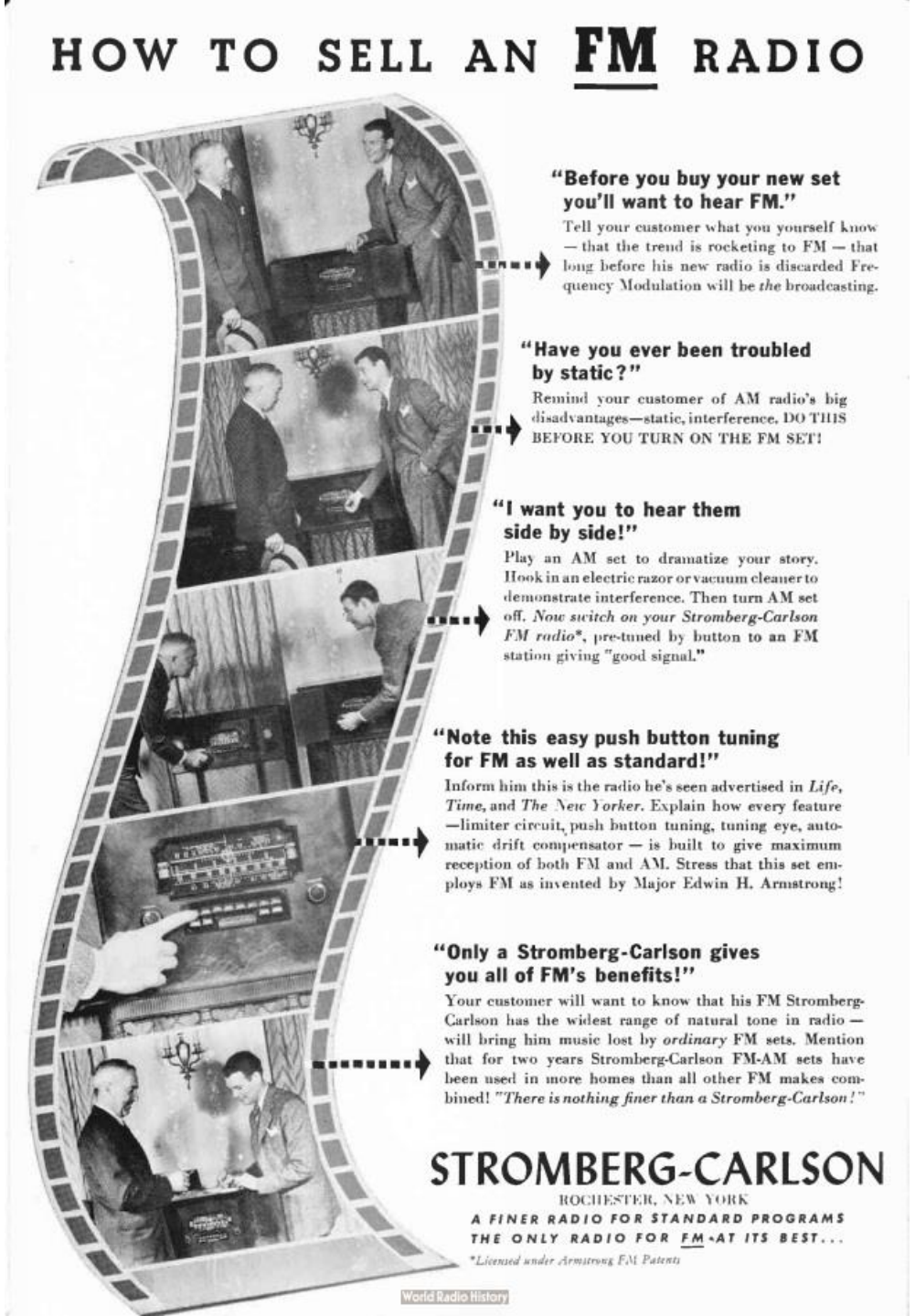
There are more Stromberg-Carlson FM receivers of more types in more homes than there are of any other make.

Stromberg-Carlson's complete line of FM radios and radio-phonograph combinations is a SEASONED line backed by more than a year of field experience.

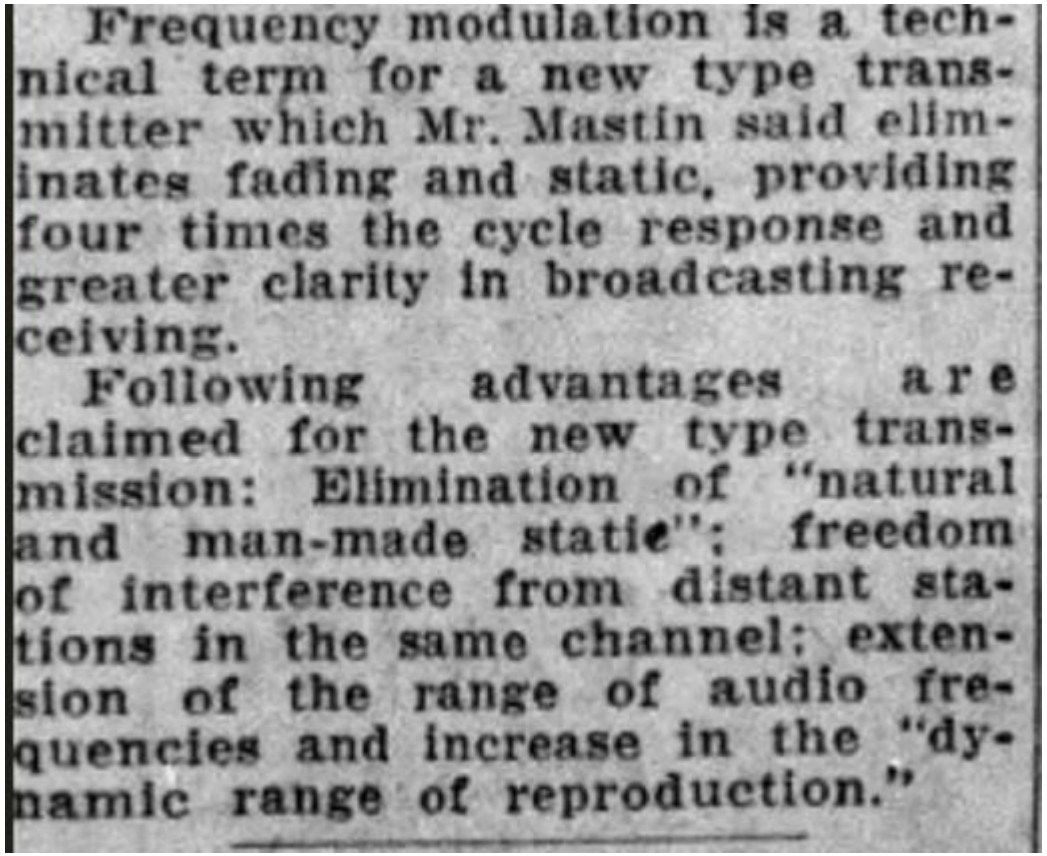
The very fact that Stromberg-Carlson FM receivers have been repeatedly selected to demonstrate Frequency Modulation reception before critical and authoritative groups is indisputable evidence of Stromberg-Carlson's leadership in this new field.

That Stromberg-Carlson should occupy such a position is only natural. No other radio manufacturer has had such long and varied experience in the making of instruments for the transmission and reception of sound. And no one can match Stromberg-Carlson's months of successful manufacture of FM receivers.

Receiver manufacturers had to teach their distributors how to sell FM receivers.



Educating the public was very important.
Some stations wrote articles in the newspaper.



Frequency modulation is a technical term for a new type transmitter which Mr. Mastin said eliminates fading and static, providing four times the cycle response and greater clarity in broadcasting receiving.

Following advantages are claimed for the new type transmission: Elimination of "natural and man-made static"; freedom of interference from distant stations in the same channel; extension of the range of audio frequencies and increase in the "dynamic range of reproduction."

Even though it was commercial and no longer experimental, FM was not making money.

Selling advertising was very difficult when you have almost no listeners.

The first FM advertiser on W2XOR, New York, was the Longine Wittenhauer watch company who signed up to provide a year's worth of time signals in 1941.

Acceptance of FM was very slow.

Then came World War II

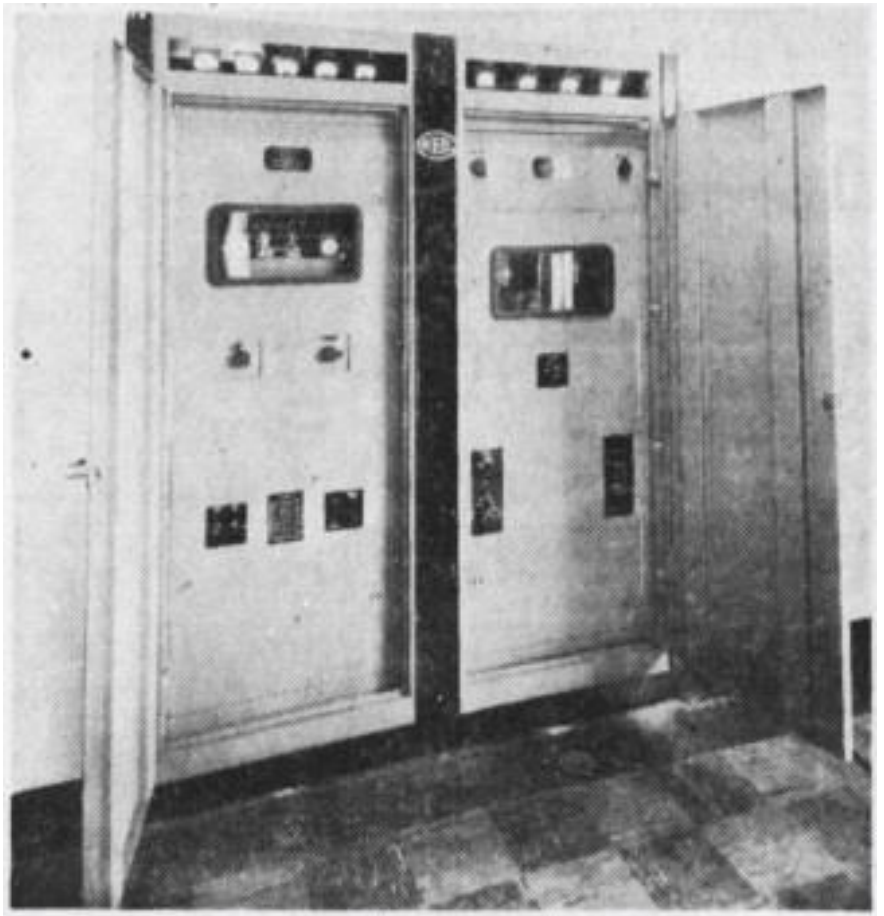
The war nearly killed off FM radio.

- There was a freeze on new radio Construction Permits
- Manufacturing was halted or diverted to military production
- Consumer radio production largely stopped
- Materials were restricted

  Copper, aluminum, steel, vacuum tubes
- FM engineers moved into:
  - Radar
  - Military communications
  - Electronic warfare

Some stations were lucky. WNBF-FM had their Construction Permit before the freeze, and had already taken delivery of their transmitter and other materials, so they could begin building the station despite the freeze.

Others were not so lucky and, not knowing how long the war was going to last, cancelled their Construction Permits.



STATION W49-BN TRANSMITTER—This is the "FM" station transmitter, in the same room as the regular transmitter of WNBF. The "FM" station will be placed in operation in the near future.

By early 1942, a survey showed that of the FM stations who attempted to sell advertising, few sold much advertising, if any.

November 1, 1943 the FCC said the stations could use 4 letter calls just like the AM stations.

In 1943, with the end of World War 2 in sight, Major Armstrong was asked to predict the future for FM. His response was reported in *Broadcasting* magazine. He believed FM would “pick up right where it left off”.

Unfortunately, that’s not what happened.

After World War II, just when you think it couldn't get any worse for FM radio,

IT GOT WORSE.

June 27, 1945 the FCC, by unanimous decision, reallocated FM from 42-50 Mhz up to 88-108 Mhz.

This would not be a matter of just changing the dial settings. All of the broadcast transmitters and the half million receivers in listener's homes would be instantly unusable.

Many early adopters felt betrayed.

In 1945, people expected a radio receiver to last 10–20 years. "You know that expensive radio you bought a year or two ago, it will no longer receive the new FM stations. You will have to buy a new radio."

So why move the FM band?

According to the FCC: Sunspots
and atmospheric disturbances

Kenneth Norton, working for the FCC, produced a report stating that the nine-year cycle of sunspot activity was about to enter a more active period. He concluded that this would cause interference in the current FM band.

It was proposed that FM be moved from the 42−50 MHz band to the 88−108 MHz.

Armstrong and the FM proponents called for another opinion, from the National Bureau of Standards. They testified that the sunspot interference concern was unwarranted, that there was no need to move FM. It didn't matter.

The FCC decided to collect more data on this issue from the military. This was done behind closed doors in secret testimony in March 1945. Afterwards, offering no additional information, the FCC announced that the FM band would still be switched to 88−108 MHz in June 1945.

Years later, the truth would come out during congressional testimony. The testimony agreed that the sunspot prediction was wrong and the FCC report was changed to say the sunspots were the reason for the FM band to be changed.

Later, at an FCC hearing, Armstrong had the opportunity to question Kenneth Norton on his errant sunspot interference prediction. He told Norton directly, "You were wrong." Norton replied: "Oh certainly, I think that can happen frequently to people who can make predictions on the basis of partial information. It happens every day."

Unofficially, most people thought that David Sarnoff of RCA was behind the move.

No matter the reason, the results were devastating to FM.

No new FM stations would be allowed on the old band but existing stations could continue to use the band for a year to serve the approximately 400,000 owners of the existing receivers, until the stations moved to the new band.

Because of the new frequencies most stations needed:

- A new exciter
- A new FM transmitter
- A new frequency monitor
- New RF filters
- A new antenna

Many stations had only recently purchased equipment just before the war.

Now they had to buy it all over again.

PRICE LIST OF
REL FM BROADCAST EQUIPMENT

TRANSMITTERS

MODEL NO.		PRICES F.O.B. FACTORY L.I.C.
549()-DL	250 watt. Bulletin 5005	4,700.00
518()-DL	1 kw., Bulletin 5006	8,200.00
519()-DL	3 kw., Bulletin 5007	11,800.00
520()-DL	10 kw., Bulletin 5012	21,500.00
521()-DL	50 kw., Bulletin 5011	72,000.00

1. Price includes necessary crystals for any single frequency in the range of 88/108 megacycles, one set of operating and one set of spare tubes.
2. 250 watt and 1 kw transmitters have primary power requirements of 208/230 volts, 60 cycles, 1 phase; 3, 10 and 50 kw. transmitters require, 208/230 volts, 60 cycles 3 phase.
3. If desired, orders for 3, 10, and 50 kw transmitters will be accepted at prices indicated, to be furnished in successive stages as equipment becomes available. 250 watt transmitter is driver for 3 kw, 1 kw transmitter is driver unit for 10 kw, 10 kw is driver unit for 50 kw.
4. All transmitters guaranteed to meet or better FCC requirements for FM broadcast service and applicable RMA standards. All transmitters are covered by REL guarantee against defects in manufacture, materials or workmanship for a period of one year after delivery.
5. Engineering check up of each installation will be made by REL after purchaser has installed, connected and set up the REL equipment ready for operation.

CONSOLES

603	Studio speech input desk console unit, including four pre-amplifiers, two program amplifiers, one monitor amplifier, six	1,250.00

1946		2026
$ 4,700	=	$ 83,934
$ 8,200	=	$ 146,439
$ 11,800	=	$ 210,729
$ 21,500	=	$ 383,956
$ 72,000	=	$ 1,285,804

WNBF could afford two sets of FM broadcast equipment.

Unfortunately, many broadcasters could not afford two complete FM transmission systems. Many simply turned in their licenses or Construction Permits.

WNBF Uses 3 Transmitters, 2 for FM Broadcasts Here

Three separate transmitters now are broadcasting WNBF signals, Cecil D. Mastin, general manager of the station, announced today as the Federal Communications Commission granted permission to operate a second frequency modulation transmitter.

In addition to the standard broadcasts transmission that has been in progress for many years, WNBF has been broadcasting on a static-free frequency of 44.9 megacycles for three years and eight months.

Now, the station also is broadcasting on another static-free frequency of 96.3 megacycles.

These last two frequencies cannot be received by the standard radio receiver. Broadcasts carried on those frequencies can be picked up only on receivers equipped with frequency modulation converters.

The overwhelming number of radio receivers in the Triple Cities region consists of standard sets, receptive only to standard transmission of broadcasts on 1290 kilocycles, which is the position on the standard band for WNBF reception.

Until such a time as the standard receivers are replaced throughout the Triple Cities region with frequency modulation receivers, the station will continue to broadcast in triplicate—two transmitters for frequency modulation and one transmitter for standard broadcast.

The value of frequency modulation broadcasting is that reception of programs is free of static and free of interference such as that caused by some vacuum cleaners.

In time, frequency modulation broadcasts and reception will be standard, but as yet, statistics show that only one out of every seven persons ever heard a frequency modulation broadcast.



GUEST — Tallulah Bankhead will add glamour to Fred Allen's Show Sunday at 8:30 p. m. (E. D. T.) over NBC.

Many broadcasters remarked that they spent the late 1940s selling the concept of FM itself all over again.

Manufacturers had enthusiastically promoted FM only a few years earlier emphasizing that it represented the future of radio. Now they had to tell customers that the "future" had moved.

The receiver dilemma.

Should they still build radios on the old band in hopes that the decision would be reversed? Should they build their products to the new band before the actual transition?

Against the recommendation of the FCC, who wanted to “protect” the public from two FM band radios, Zenith built their own transition product, an AM-FM receiver with 2 FM bands, 42−50 MHz and 88−108 MHz.

The FCC went as far as to make threats that if manufacturers kept producing FM receivers on the old band, they would shut down all FM broadcasting.



Zenith 7H820



Zenith

model 8-H-034

Other receiver manufacturers introduced receivers capable of tuning both the old 42–50 MHz band and the new 88–108 MHz band including:

- RCA
- General Electric
- Stromberg-Carlson

These "dual-band FM" sets were intended as a transition measure.

Many radios sold in 1946–1948 had two FM scales.

Radio dealers also tried to soften the blow.

Some offered:

- trade-in allowances,
- discounts on new FM receivers,
- factory conversion programs for premium models.

At midnight on January 8, 1949, all remaining low-band FM transmissions had to cease.

How Many Stations Never Came Back after World War II?

- Around 46 commercial FM stations were operating by the end of WWII.
- Roughly five years later, in the early 1950s, after the band change, about half of the original commercial FM stations had disappeared.
- Of the first 15 commercial FM construction permits issued in 1940 only 7 ultimately survived the difficult late-1940s/early-1950s period in continuous lineage.

Why Did So Many Stations Fail?

The band change arrived at the worst possible time.

Imagine a station owner in 1945:

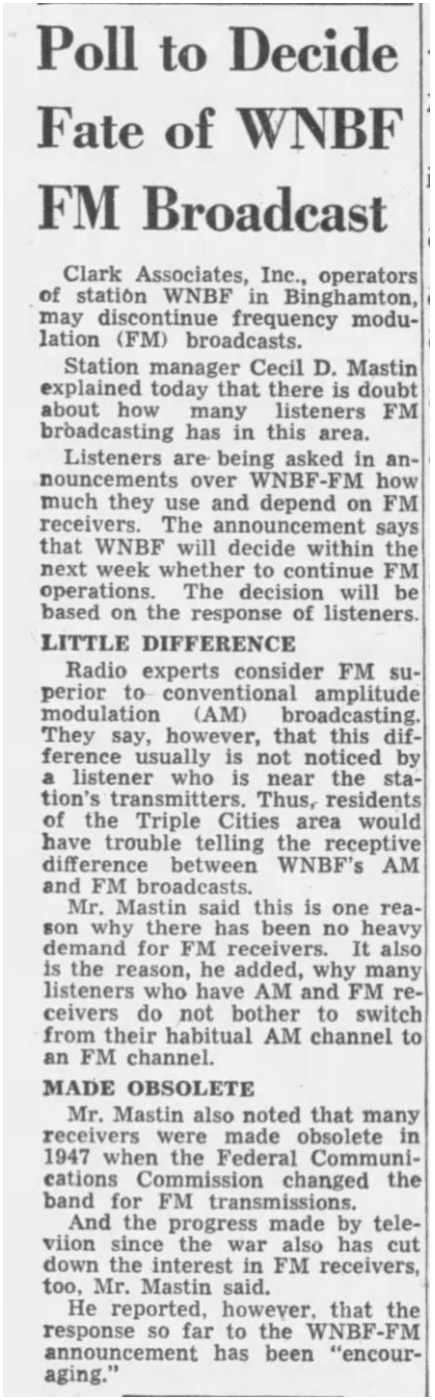
- invested in FM before the war,
- waited through four years of wartime restrictions,
- expected receiver production to resume, and then was told:

"You now need another transmitter, another antenna, and your listeners' radios no longer work.“

And there is still no money to be made with advertising.

Many simply decided not to continue.

Some stations did surveys of listeners to gauge FM popularity in early 1950s.



Poll to Decide Fate of WNBF FM Broadcast

Clark Associates, Inc., operators of station WNBF in Binghamton, may discontinue frequency modulation (FM) broadcasts.

Station manager Cecil D. Mastin explained today that there is doubt about how many listeners FM broadcasting has in this area.

Listeners are being asked in announcements over WNBF-FM how much they use and depend on FM receivers. The announcement says that WNBF will decide within the next week whether to continue FM operations. The decision will be based on the response of listeners.

LITTLE DIFFERENCE

Radio experts consider FM superior to conventional amplitude modulation (AM) broadcasting. They say, however, that this difference usually is not noticed by a listener who is near the station's transmitters. Thus, residents of the Triple Cities area would have trouble telling the receptive difference between WNBF's AM and FM broadcasts.

Mr. Mastin said this is one reason why there has been no heavy demand for FM receivers. It also is the reason, he added, why many listeners who have AM and FM receivers do not bother to switch from their habitual AM channel to an FM channel.

MADE OBSOLETE

Mr. Mastin also noted that many receivers were made obsolete in 1947 when the Federal Communications Commission changed the band for FM transmissions.

And the progress made by television since the war also has cut down the interest in FM receivers, too, Mr. Mastin said.

He reported, however, that the response so far to the WNBF-FM announcement has been "encouraging."

FM’s early life was blighted by its bad luck in having been commercially born at the same time as its more glamorous sister - Television.

While FM was struggling, Television was thriving.

Programming for FM

In FM's early years, many FM stations simply duplicated their AM programming (simulcasting).

After the FM band moved, the FCC recognized that requiring separate programming would likely kill what remained of FM, so broadcasters continued to simulcast freely.

There might be occasional exceptions:

- a hi-fi music hour
- an evening classical program
- educational programming

FM audiences were tiny, separate programming was expensive, so broadcasters used FM mainly to extend service or improve sound quality.

FM continued to struggle.

Year	AM licenses granted	FM licenses granted
1949	200	57
1950	194	35
1951	116	15
1952	60	24
1953	187	29
1954	148	27
1955	161	27
1956	197	31

Finally, the FCC came to the rescue, sort of.

March 1955 FCC adopted multiplexing rules that allowed other services on the FM signal.

SCA: Subsidiary Communications Authorization

SCA was essentially a hidden subcarrier service riding underneath FM broadcasts.

Typical SCA subcarriers were at 67 kHz and 92 kHz

It was used for:

- Background music in stores
- Stock ticker data
- Reading services for the blind

Ordinary radios ignored them because audio filters rolled off anything above ~15 kHz

Special decoders extracted them.

Many FM stations survived financially because SCA subscriptions generated reliable income.

In the 1950s the Korean war manufacturing limitations kicked in.

Firms who had made FM radios stopped making them.

Some FMs started to embrace their small audiences of loyal listeners and higher income level. They sold “class” rather than “mass”. The audience was touted as big spenders for the upscale brands.

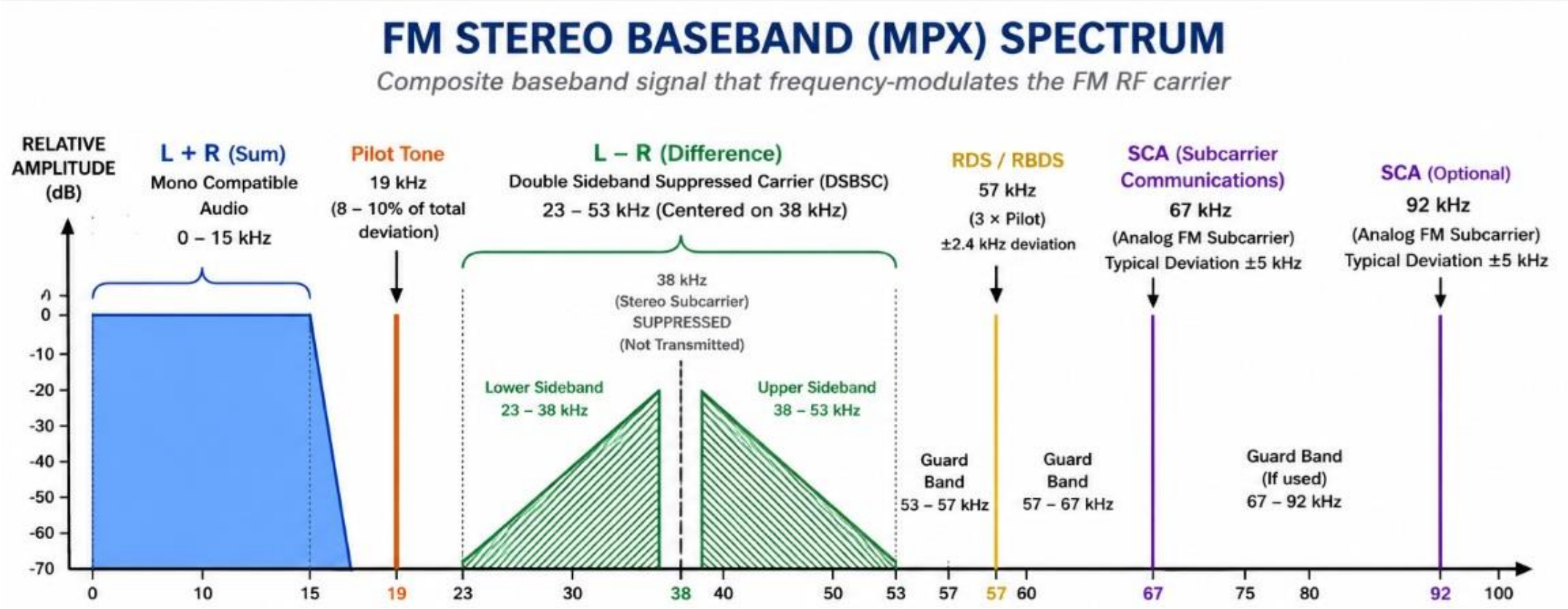
By 1958, TVs dramatic growth had leveled off.

For the first time in 5 years FM set sales exceeded 280,000 units (compared to the millions of AM and TV receivers).

Vinyl stereo recordings in 1958 piqued interest in Hi Fidelity, jazz, and classical music.

In March 1959, the FCC opened its Docket to explore FM stereophonic transmission.
The Requirements: occupy same bandwidth, existing radios would work in mono, stations could continue to use SCAs.

By 1960 the choices were narrowed to seven. On April 19, 1961 the FCC approved a hybrid of the GE and Zenith systems.



Now we have a “chicken or the egg” dilemma. Consumers might wait on buying stereo receivers until there is a nearby station broadcasting in stereo, or the stations might wait to install a stereo generator until there are enough receivers out there. Neither manufacturers nor broadcasters wanted to make the first move.



By the end of 1961, nearly 40 stations were providing stereo , a year later there were 200, and by the end of 1964 there were 322.

Virtually every new station on the air was stereo, but stereo took a while to become popular due to a lack of recorded stereo music.

Just over 200,000 FM receivers were sold in 1957, and 8 years later in 1965, sales approached 8.5 million. Stereo had quite an impact.

Car radios still lagged in receiver sales, even as late as the 1970s.





1977

1978

1980

FM was doing better, so on July 1, 1964,

the FCC adopted the FM Non-Duplication Rule.

The rule did not ban simulcasting. Instead, it limited it.

The rules forced major-market FM stations to create separate programming.

Stations experimented with: Underground rock, Jazz, Long-form programming, Album cuts, progressive rock, album-oriented rock, educational programming, ethnic programming, beautiful music, classical music, and more.

FM became the place where broadcasters experimented because the financial risk was relatively low.

FM’s audience was small but loyal. Audiophiles loved FM.

By the Late 1970s FM finally surpassed AM for music listening.

FM audiences led AM for the first time in RADAR* radio usage report for spring 1979.

FM had finally arrived. It only took more than 40 years!

Car Radios - FM radios became standard.

Stereo Systems - Home hi-fi exploded.

Rock Music - Albums were designed for FM stereo listening.

Better Receivers -Integrated circuits lowered costs.

AM pivoted toward:

- talk
- sports
- news

Exactly where we remain today.

*(Radio's All Dimensional Audience Research)

By 1986, FM had become the dominant music service.

The FCC concluded that marketplace competition, rather than regulation, should determine programming.

The original AM/FM non-duplication rule was repealed.

Stations were once again free to simulcast if they chose.

Interestingly, very few did, because by then AM and FM had developed distinct audiences and formats.

Broadcast historians rank these FCC decisions as the three events that transformed FM broadcasting:

1. 1940 — Authorization of commercial FM.
2. 1961 — Approval of FM stereo.
3. 1964–1965 — Adoption and implementation of the FM Non-Duplication Rule.

Stereo gave listeners a reason to buy FM receivers. The non-duplication rule forced broadcasters to create unique programming worth listening to. Together, those two developments led directly to FM's rapid growth in the late 1960s and its eventual dominance of music broadcasting in the 1970s.

Unfortunately, Major Armstrong did not live to see the success of FM.

He devoted all of his resources, emotionally as well as financially, to the struggles of patent fights, royalty payments, and court cases. Armstrong and his wife had separated.

On January 31, 1954, at the age of 64, despondent over his ongoing legal troubles, he penned a farewell letter to his beloved wife and stepped out the thirteenth-floor window of his apartment in New York City.

Armstrong's wife kept up the fight in all of his legal cases.

At the end of thirteen years and after defeating companies such as RCA and Motorola, Mrs. Armstrong had won all twenty-one of her husband's lawsuits

Armstrong did have a posthumous opportunity to remind people of the importance of his work.

It was the morning of September 11, 2001.

The World Trade Center buildings had collapsed
and with them the transmitting sites of all of the
TV stations serving NYC.

Armstrong's 400' tower in Alpine, NJ was pressed into service to house the transmitter sites and antennas for five TV stations.

The first station that called for help was WNBC. Which is ironic, considering historically, David Sarnoff had treated Armstrong so badly for years.

Basically, the Major bailed them out that morning.

In the days following 9/11, they built temporary locations for five television stations, an FM station, and a whole host of government services.

Today, the TV stations are back in Manhattan, now on the new One World Trade Center, while the Alpine tower continues to house other lower power transmitters and antennas.



Today, both AM and FM radio are under threat.

Car manufacturers don’t want to put radios in new cars.

Radio station owners are consolidating stations at such a rate that many stations are no longer live or local.

Who knows what the future holds for the medium.

