

# ARMSTRONG AND THE BIRTH OF FM BROADCASTING

*The cover of our May issue carried a striking construction shot of Edwin Armstrong's Alpine, NJ experimental FM transmitting tower. It came from <http://users.erols.com/oldradio>, the remarkable web site of Mike Katzdorn, which is devoted to presenting a priceless collection of photos and graphics covering every phase of Armstrong's career. The materials were preserved by Harry Houck, Armstrong's long-time associate, and later entrusted by him to Mike.*

*Because of our upcoming conference's FM theme, I thought it would be a great idea if we could publish, in this issue, all of the material from Mike's site dealing with Armstrong's development of Frequency Modulation. Mike agreed, and was kind enough to rescan the pictures and graphics for us at the higher resolution required for printing. This is the result, and we hope you enjoy it! For more about Armstrong, be sure to visit the site itself.—mfe*

During the late twenties and early thirties Edwin Armstrong spent a great deal of time studying natural and man-made static, becoming an expert on the subject. His goal was to devise a receiver that would do what nobody else had ever been able to do—eliminate the static. He soon discovered that the disturbances were almost always amplitude modulated. AM was used in all broadcasting at the time and there was no way to eliminate static without destroying or distorting the broadcast signal.

Engineers had been working with frequency modulated (FM) signals for a number of years, but always with narrow bandwidth. They found this mode very unsatisfactory for carrying any type of intelligence. In fact, it had been shown, mathematically, to be useless for broadcasting. Armstrong worked with narrow band FM for some time before giving up on it as so many had before. But instead of abandoning FM en-



*Armstrong's FM exciter equipment set-up in the Empire State Building in early 1934.*

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tirely, Armstrong developed a new variation.

Between 1928 and 1933, Armstrong applied for the four basic patents on what would be his fourth great invention, wide band FM.

In accordance with his agreement to give RCA first right of refusal on future inventions, Armstrong demonstrated his wide band FM system, at Columbia University, to David Sarnoff and RCA engineers in late 1933 and early 1934. The quality was very good, but actual field testing would be necessary to convince the skeptical group that the system could work.

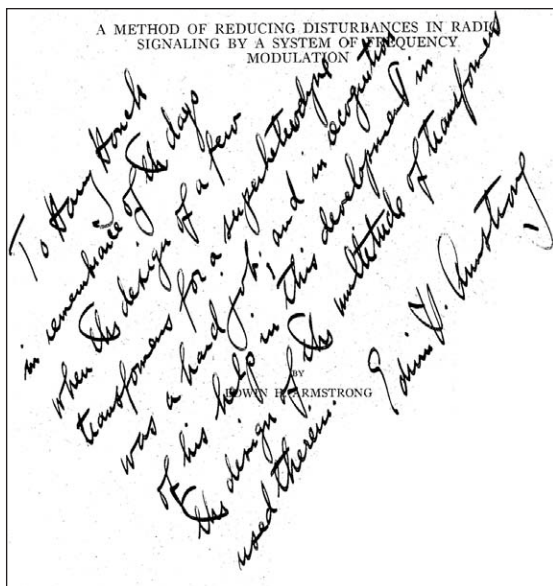
In 1931 NBC, the broadcasting arm of RCA, had installed a television transmitter on the 85th floor of the Empire State Building to conduct experiments with that new medium. By early January of 1934, not yet ready to start television testing, RCA had placed the transmitter at Armstrong's disposal to conduct large scale field tests of his FM system.

On November 5, 1935, before the New York section of the Institute of Radio Engineers, Armstrong presented his paper "A Method of Reducing Disturbances in Radio Signaling by a System of Frequency Modulation." His FM system was thus disclosed to the radio engineering community.

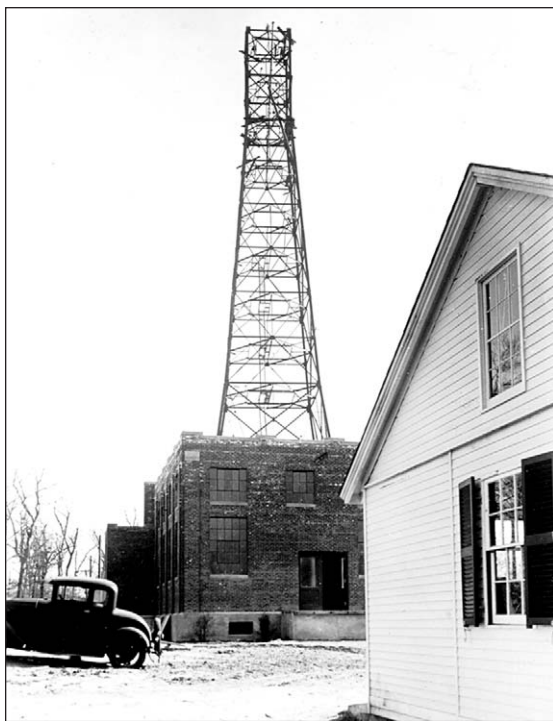
The presentation was accompanied by a demonstration of FM's capability, in which a transmission was received from Randy Runyon's amateur station in Yonkers. While the demonstration was a complete success, the engineering community, in general, was not enthusiastic.

Armstrong's FM tests at the Empire State Building would last from May of 1934 until October of 1935. The results obtained, on everything from microphones to antennas, would prove valuable to future FM development. It was clear to Armstrong that FM was far superior to AM. Surely RCA would jump at the chance to buy the rights to the fundamental patents on which FM depended.

But as the 1930s dragged on, there



*Reprint of Armstrong's epochal FM paper presented to Harry Houch by the inventor.*



*The transmitting tower at Alpine, N.J. under construction on November 10, 1937.*



*Front and interior views of the REL Model 517 receiver.*

would be no offer from Sarnoff, only more delays as additional tests and more studies were called for. In fact FM was getting a cold shoulder from Sarnoff and RCA-aligned engineers. But why?

RCA would talk about the millions of receivers, and the hundreds of transmitters, which would be made obsolete by such a revolutionary system. They said the public did not want, and would not pay for, a completely new system, and FM would waste bandwidth and have a very limited service area. The receivers, they said, would be too complex and expensive for the ordinary listener.

But the real reason was clear. To paraphrase Sarnoff: "Television would replace the radio the way radio replaced the phonograph." All of RCA's research and development would go into

television. Armstrong became convinced he would have to prove the viability of FM himself.

Early in 1936, Armstrong cashed in a large block of RCA stock, netting about \$300,000.00, and undertook to build his own high-power experimental FM station. After listeners had tuned in on it, he was certain they would never return to AM.

An eleven-acre tract of land was purchased on the Palisades in Alpine, New Jersey. From this site he could look across the Hudson River at his boyhood home in Yonkers. From atop his future transmitting tower he would blanket Sarnoff's New York City with radio like no one had ever heard it before.

There would be one more obstacle to overcome—the FCC. Early in 1936 Armstrong applied for what should have been a routine experimental FM broadcasting license. It was denied as "a visionary development." It would not be until the end of 1936, and only after Armstrong threatened to take his invention out of the country, that the FCC issued a license and allocated a band just 3 MHz wide (41-44 MHz) to FM.

Late in 1937, as W2XMN was nearing completion, Armstrong ordered 25 FM receivers, at \$400.00 each, from General Electric. These receivers would be used to demonstrate FM in the New York area. They were the first production FM receivers, and the first FM receivers built outside of Armstrong's lab. G.E. would be the first company to obtain a license to manufacture FM receivers under the Armstrong patents, presenting Armstrong with his first FM royalty check for \$22.66 in December of 1937.

The audio chassis was designed to take advantage of FM's wide frequency response, using push-pull 6L6s working into a huge (for the time) output transformer. The receiver chassis was clearly first run; several types of pre-production GE tubes were used (e.g., XP332 and XP333).

In late 1938 the first commercial FM receiver, the REL Model 517, was produced. According to Frank Gunther, retired REL president, approximately 300 sets were manufactured (in 100 set runs). This set, weighing in at 45 pounds and selling for \$315.00, was of exceptional quality, and was primarily intended as an FM station monitor (40 to 44 mc).

However, the first two units off the production line went not to radio stations but to the FCC. According to Mr. Gunther, the FCC had been searching for a means to monitor the expected flood of new FM station licensees — and the Model 517 was perfect.

For Armstrong, the Second World War started in 1939, when the Signal Corps came to him for advice on adapting FM to mobile military communications. Through 1940 and 1941 he was proud to undertake a number of projects for the Signal Corps at no charge.

Armstrong's fortunes would soon change. With the cessation of all FM station construction and a halt to all non-military radio manufacturing, royalty payments dried up. Armstrong had spent over a million dollars on FM, but had received less than half that from royalties thus far.

In order to support his laboratories at Columbia and Alpine (with personnel now numbering 18), Armstrong took on a number of cost plus fee projects for the military. His primary contribution, although not completed by the end of hostilities, was a complete FM radar system capable of very long range detection.

In 1945 the FCC dealt Armstrong a blow. To make way for television, FM would have to move from the established 44-50 MHz pre-war band to a new  
(continued on page 46)

# Maj. Armstrong Leaps to Death; FM Inventor; 63

## Note Blames Estrangement

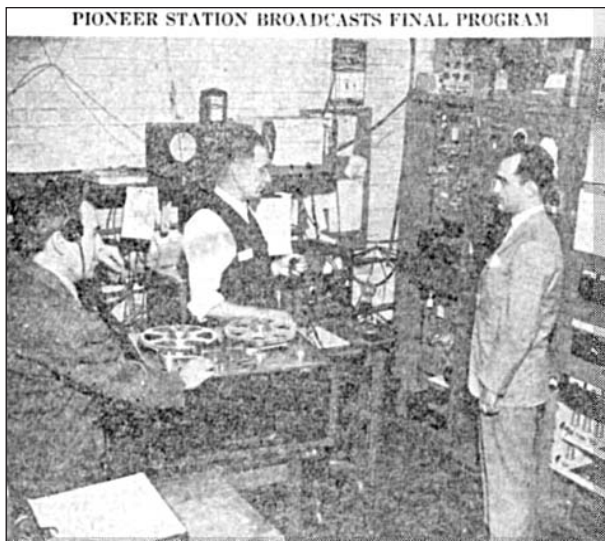


Maj. Edwin Howard Armstrong, 63, the electronics genius who invented FM radio leaped to his death today from his 13th-floor apartment at River House, 435 E. 52nd St.

A note found by the police in the empty Armstrong apartment indicated that Maj. Armstrong had sought death because of a recent estrangement from his wife, Mrs. Esther Marion Armstrong, now visiting a sister in Granby, Conn.

Maj. Armstrong, professor of electrical engineering at Columbia University, who won the Medal of Merit and a Presidential citation for his contribution to military communications by

*The shocking news as reported on February 1, 1954.*



*The Armstrong station's final broadcast, a memorial to the inventor, aired on March 6, 1954. Armstrong's close friend Jerry B. Mintner (far left) assisted.*

like Atlanta and Detroit, the examinations might be given on a weekly basis. In other cities, like Cleveland and Pittsburgh, examinations were given only on a quarterly basis. Taking an examination would usually involve missing time from work or school. It might also require getting up at 5 a. m. to make the trip to the examination office.

Those aspiring to qualify for a First Class Radiotelephone Operator's license, usually began by passing the exam for the Second Class license. A second trip to the FCC office would be have to be made to pass the final element required for First Class status. Though it was possible to take the entire First Class examination at one sitting, only a few hardy people did it.

Besides answering questions on law and theory, those seeking Radiotelegraph Operator's licenses had demonstrate their capability of sending and receiving Morse code. Applicants had to pass the code proficiency test before being allowed to take the written examination.

The written examinations were all "closed-book" and multiple choice. The use of slide rules was permitted, to help in solving solve the mathematical problems. Time limits were enforced. An examination started in the morning had to be finished by the noon lunch break. An examina-

tion started after lunch had to be completed by the end of the business day.

Unfortunately, many people failed an examination on their first attempt. Therefore, additional study and repeat visits to the examination office would be required. Passing these examinations was a major achievement.

In the 1950s, the FCC issued impressive looking Commercial Radio Operator's license certificates which reflected the hard work that went into passing the examination. At commercial radio and television stations, the employees' operator's licenses would be proudly displayed in a large glass frame on the wall.

## ***End of an Era***

In the 1980s, the commercial radio and television industry was deregulated and the First Class Commercial Radiotelephone Operator's license was eliminated. This significantly affected the requirement for licensed commercial radio operators. Then in the 1990s, the requirement for licensed commercial radiotelegraph operators on commercial ships was eliminated.

Today, there is still limited licensing of commercial radio operators but the glory days are long gone and all that remains are the fond memories of an era that will never return. 

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## ***ARMSTRONG, continued from page 43***

band at 88 - 108 MHz. More than half a million FM receivers and some 50 transmitting stations would be rendered obsolete. But the worse fear for Armstrong would be a loss of confidence in FM by the growing number of faithful hi-fi listeners.

This move to higher frequencies, however, proved to be only a temporary setback. By 1950 there were over 600 FM stations on the air and Armstrong had collected close to \$2,000,000.00 in FM receiver royalties. The problem, though, was the personal cost of keeping his Alpine station on the air and funding his research and staff. The money was leaving as quickly as it came in.

The fact was that though many companies were paying FM royalties (G.E., Westinghouse, Zenith and Stromberg-Carlson, to name a few), R.C.A. and its licensees were not. Armstrong needed that income to continue his independent research and remain free of corporate control.

On July 22, 1948, Armstrong instituted a suit against R.C.A. and N.B.C. charging them with infringing his five basic FM patents. This suit

would virtually dominate his life — and in fact would outlast him. In November of 1953 it must have seemed to Armstrong that the world was closing in on him. Marion, his wife of 31 years, could not cope with this final war in the courts and his worsening personality, she left him for her sister's home in Connecticut. It was only later realized what dreadful condition his finances were in. He was facing a real catastrophe.

On February 1, 1954 the depressed Armstrong jumped to his death from his 13th floor apartment on New York City's 52nd St. In a two-page note to his wife, left in the apartment, Armstrong expressed his love for her and blamed their estrangement for his suicide. The station at Alpine remained on the air for awhile but broadcast its last program, a half-hour tribute to the inventor, on March 6th. The program ended with the playing of the Star Spangled Banner and a final announcement: "As we prepare to pull the switch and shut the station down, we salute the memory of Edwin Howard Armstrong." 