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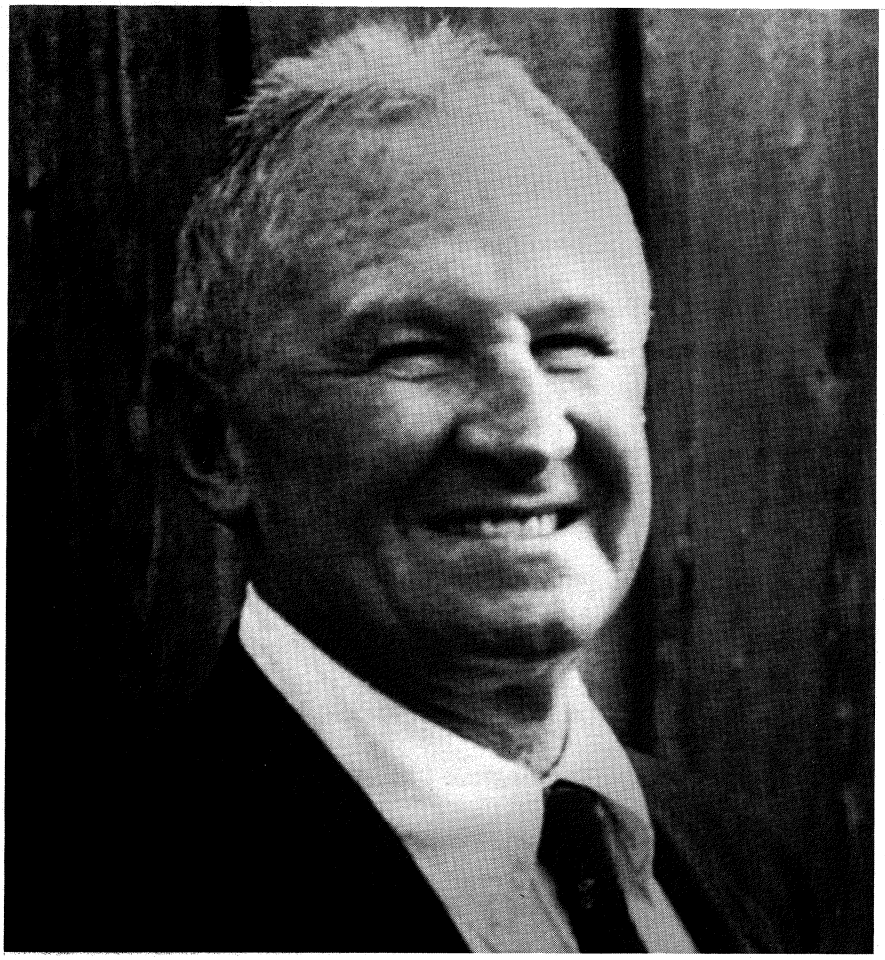

In Memoriam

W. E. D. Stokes, Jr.

1896 - 1992

Proceedings of The Radio Club of America, Vol. 66, no. 1, May 1992

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THE RADIO CLUB OF AMERICA, INC.

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W.E.D. STOKES, JR. - PRESIDENT EMERITUS

Death took William Earl Dodge Stokes, Jr. on the morning of March 10, 1992, and thus took our friend and the first president of The Radio Club of America.

Born in New York City on January 3, 1896, W.E.D. Stokes was in love with life. In his 96 years, he made a difference in the lives of many people. To his neighbors in Lenox, Massachusetts, he became a co-founder of the Berkshire Day School so their children might receive a superior education. To other neighbors, he will be remembered as a founder and trustee of the Berkshire Garden Center. And still other neighbors will remember him as a founder of the Mahkeenac Boat Club. All of these activities were done in his retirement.

Also, after retiring to Lenox, he became a trustee of the Browning School, the elementary school that he had attended as a boy in New York. That schooling was followed by Andover Academy, the Sheffield Scientific School at Yale University, the U.S. Naval Academy at Annapolis, and the University of Chicago Law School.

He was a busy person. At the age of 12 years, he was a founder and first president of the Junior Wireless Club, predecessor of The Radio Club of America. Here is the way it was told in the Club's *Twenty-fifth Anniversary Yearbook*:[1]

"The story of The Radio Club of America begins over a quarter of a century ago, during the really dark ages of the radio art, about 1907.

"Here we find a group of small boys, who according to the true American spirit, were so interested in flying that they formed the Junior Aero Club of the U.S. under the leadership of Miss Lillian B. Todd. The names of the boys, who were in their early teens, were: Frank King, W.E.D. Stokes, Jr., George Eltz and Frederick Seymour. The members of the club made model planes and attempted to fly them at the regular meetings which were held in a convenient armory. Of course the science of flying was in its infancy at that time, and although their tests were not particularly successful, they were none the less commendable.

[1] *The Proceedings of The Radio Club of America*, Vol. 54, No. 3 p 11

W.E.D. Stokes, Jr. (right) with Walter A Knoop at the 50th Anniversary Banquet of The Radio Club of America (1959).

"In conjunction with their experience in aviation, these youngsters had, for some time, also been interested in what was then known as WIRELESS. In fact, the new idea of sending messages without wires had proved itself so fascinating, that they found themselves actually devoting most of their spare time to tinkering with wireless apparatus. There were at this time a small number of so-called amateur wireless experimenters in and about New York City, so the boys decided to form a new club with wireless as an object.

"Accordingly, Mr. W.E.D. Stokes, Sr., called a special meeting of the Aero Club, for the purpose of forming a new club with wireless telegraphy and telephony as its main interest. The meeting was held at the Hotel Ansonia in New York City on January 2nd, 1909. There were present Messrs. W.E.D. Stokes, Sr., W.E.D. Stokes, Jr., George Eltz, Frederick Seymour, Frank King, Faitoute Munn, and Miss Todd, the organizer of the Junior Aero Club.

"It was unanimously decided to form a new organization to be devoted entirely to Wireless. Thus the Junior Wireless Club Limited was founded, and the following officers were elected:

Director General -- W.E.D. Stokes, Sr.
Honorary President -- Miss E.L. Todd
Consulting Engr. -- Prof. R.A. Fessenden
President -- W.E.D. Stokes, Jr.
Counsel -- Mr. Seymour
Vice-President -- George Eltz
Recording Secretary -- W. Faitoute Munn
Corresponding Secretary -- Frank King
Treasurer -- Frederick Seymour

"It was also unanimously decided that these members should be known as Charter Members."

Perhaps his most lasting contribution to the future of Amateur radio came when Stokes was 14. As president of the newly-formed Junior Wireless Club, he organized opposition to the Depew bill presented in the U.S. Senate. This bill, the first of its kind, would surely have spelled the death of all amateur radio had it not been for the quick action of the Junior Wireless Club. The Club opened hostilities with a letter to Senator Depew refuting claims that malicious orders had been sent to the Fleet by amateur radio operators.[2]

For some time, the activities of the amateur experimenters had aroused considerable interest and it was not long before the government began wondering what could be done to control these newcomers. The idea of restricting the free air had not occurred to anyone before, but bill S.7243 to regulate radio communication introduced by Senator Depew in 1910, practically prohibiting amateur experimenting.

The letter was followed by the appearance of a committee of four: Messrs. W.E.D. Stokes, Jr., Frank King, George Eltz, and Ernest Amy, before the hearing of the Committee of Commerce of the Senate, in Washington, DC on April 28, 1910; their efforts succeeded in killing the bill. Key aspects of Stokes' testimony were that..." the Depew bill would discriminate heavily against the amateur and in favor of the commercial wireless companies and that, if passed, it would stifle the ambition and really great inventive genius of American boys."

Key aspects of the testimony had long-run implications for the development of amateur radio and included:

> agreeing "...to the importance of licensing all professional as well as amateur radio operators..."
>
> stating the principle "...that such a license should be revoked forthwith for malpractice at any time such as in the case of war or intentional interference in important messages, and the sending out of false calls for aid, or refusal to answer calls for aid, or to send along such messages..."
>
> calling for license qualifications "...we believe that every person who takes out a license should be either a born citizen of the United States, or should declare himself to be a citizen, and he must understand the Morse code..."

The membership of the club soon increased from the original five and, by April 1911, had more than doubled. In October 1911, the name of the club was changed to The Radio Club of America.

Like each of the club member, Stokes built and operated an amateur radio station. Listed in the first *Call Book* as operating under the call letter "X", his spark transmitter had a power output of ten kilowatts, and transmitted from an antenna atop the Ansonia Hotel where the Stokes family lived. When he was transmitting, the lights of the hotel would dim from the drain of the transmitter on the power source.

W.E.D. Stokes, Jr. left for school at Andover and this hampered his radio experimentation which already had resulted in four patents. Further disruption was provided by war. In 1915, he entered Yale's Sheffield Scientific School but, a year later, left school to join the 10th Militia Field Artillery as an enlisted man and to serve in the Mexican Border War against Pancho Villa. He returned to Yale for a short time but, in 1917, entered the U.S. Naval Academy at Annapolis for training.

[2] *The Proceedings of The Radio Club of America* Vol. 54, No. 3, p 15

In an accelerated commissioning due to World War I, he received the commission of Ensign and was assigned to the USS Delaware, a battleship supporting the 6th Battle Squadron of the British Grand Fleet in the North Sea. Following the Armistice, he was assigned as the torpedo officer aboard the USS Claxton. In 1919, he returned to civilian life with the rank of Lieutenant, Sr. Grade.

He entered the University of Chicago Law School and, during his senior year, sat for the Illinois Bar Examinations wherein he passed with the second highest grades in the state. Characteristically, he left the university a few months before graduation and proceeded to work in a Chicago law firm.[3]

He was asked by his father to return East and to join him in managing the family's companies: Mervyn Realty Company; Chesapeake Western Railroad Company (1926-1937); Kesso Corporation (1926-1937); Onward Construction Company (1926-1947); and Stokes Properties (1938-1989).

His naval experience led to his hobby of sailing and he sailed extensively from Maine to the West Indies in his Seawanhaka schooner "Calliope." With the coming of World War II, he returned to the Navy as navigator aboard the USS Albermarle and serviced in the waters of South America and Africa. On D-Day, his ship transported the F.F.I. (Free French resistance fighters) to the invasion of France. Finally, he was promoted to Central Inspection Officer, Torpedo Program, at Newport, R.I.

While at Newport, he found that U.S. manufactured torpedoes were faulty and sometimes killed U.S. naval personnel. He reported this to his supervisors and was told: "What you're saying is treason," and that he should keep quiet. For blowing the whistle, he lost his promotion to the rank of Commander.

Following World War II, he served for seven years in the Naval Reserve as the Personnel and Administrative Officer of the U.S.N.R. Surface Division 1-14 before retiring as a Lieutenant Commander, U.S.N.R.

Retiring to Thistlewood Farm, Lenox, Massachusets, he became a trustee of the Browning School, co-founder of the Berkshire Country Day School, Trustee of the Berkshire Garden Center, and an author. He wrote *Planetary Configurations and Stock Market Sentiment* (1952).

His early interest in cyclical phenomena approached from the perspective of radio signal extraction through filtering, led him to join the Econometrics Society. He thought that radio interference seemed to be related to sun-spot activities and that it might be possible to model such activities. Stokes believed that changes in back-ground radiation should be measurable and predictable. Since this radiation impacts radio communications, in Stokes' view such radiation might also impact market psychology. Only later was it discovered that the Van Allen belts changed through time.

In the pre-computer era of the early 1950s and before the pioneering work of Tukey on Fast Fourier Transforms, Stokes got the idea that to forecast, one should filter the series of interest by fitting multiple sine and cosine waves to the data. While it was a promising idea, the graphical approach being used at the time was not equal to the task.

W.E.D. Stokes, Jr. interest in the analysis of economic data led his son, Houston H. Stokes, Ph.D. (ex-KN1AQJ) (F), to study economics, econometrics and, finally, to the development of the B34S Data Analysis Program which has occupied his research since 1973 as a professor at the University of Illinois - Chicago.

Again, in retirement, Stokes founded and ran the Mahkeenac Boat Club. In its early days, he donated his boat *The Snail* to the club, and hoped that the families of the club members would grow up together and that good sportsmanship would prevail.

His farm "Thistlewood" had but eleven acres but became a prominent horse breeding farm. His love of horses had led him as a young man to enlist in the horse-drawn field artillery to serve under General J.J. (Black Jack) Pershing in the Mexican Border War.

His early interest in airplanes led to the founding of the Long Island Aviation Club and the ownership of three planes. This together with his work in gold mining resulted in over 2,000 hours of geological aerial mapping. He visited every gold mine in the United States, Canada, and Mexico, and became an authority on the subject. This led to

[3]The law firm of Fisher, Boyden, Kales & Bell (1923-24)

becoming an editor of the publications of The American Mining Institute wherein his writings made major contributions to the aerial mapping of geological formations.

He served for six years as Chairman, Aviation Committee of the American Institute of Mining & Metallurgical Engineers and published technical documents including *AIME Aviation Survey 1937, Free Power, Government Aid to Gold Mines,* and *Origin of the Gold Pennyweight.*

From the late '60s until the 80's, W.E.D. Stokes, Jr. was an editorial writer for the *American Friends of Rhodesia News Letter,* a feature writer for *La Liberte, The New England Journal, The Green Mountain Review* and *The Up-State New Yorker* where he wrote extensively on race relations in Rhodesia and South Africa.

SELECTED LETTERS

At the 1972 banquet, three men were recognized with Honorary Memberships: W.E.D. Stokes, Jr., Frank King, and W. Walter Watts. Regrettably, Stokes was unable to attend, but sent the following letter:

"This is a happy day for me. First, President Nixon is back on the job for four more years. Next you have seen fit to honor me -- for which I am most grateful. Finally, I see the forward momentum of The Radio Club continuing and the organization in strong hands.

"We have come far from the beginning of the Club -- originally a small group of boys in their early teens, making model planes to fly in the Armory. It was when Professor Fessenden suggested that we look into wireless and invent a system to control our models in flight that The Radio Club was brought into being.

"All the members were imaginative, ambitious and active young people. Everyone wanted to invent something and get a patent (I ended up with four). We had a large collection of minerals since my family was interested in mines. I tried all of them as possible detectors, and got my first patent on a bracket to hold galena.

W.E.D. Stokes, Jr. (right) with Harry J. Dannals at the 1977 Annual Awards Dinner at which the Pioneers Citation was presented to Mr. Stokes.

My first transmitter was Station X on the Ansonia Hotel powered with a 3-kW transformer. Every time I pressed the key, the phone would ring and an angry voice say: 'Cut out that noise!' That frustrated normal attempts to exchange calls with friends. I began to study directional beams and made an antenna on the roof of my father's place in New Jersey. It consisted of four wires that led from a pole fastened to the chimney. Each wire sloped gradually downward and had a lead down the chimney to a selective switch. I also received a patent for that idea.

"About this time (1910), there was an uproar against activities of amateur radio operators and the Depew bill, to drive them off the air, was introduced in Congress. A group consisting of Frank King, George Eltz, Ernest Amy, myself, and possibly one other, went to Washington to testify against it before the Commerce Committee. We killed the bill stone dead.

"Next winter, the Club had a demonstration of equipment and ideas at the Armory. There was a large turnout and the quality and appearance of the homemade equipment was truly remarkable. Someone told me that wireless waves were like light. This prompted me to make a small sending and receiving station using ordinary electric heaters. The antennas were the coils set in the large reflectors. The system was decidedly directional, and may have been the first use of parabolic reflectors in radio communication.

"Because the New Jersey coast was afflicted with numerous electrical storms, I tried various ways to control the static. I found that I could take the screen door off the back porch and place it on four glasses to use instead of the conventional rod in the ground. I received a patent for that idea. Everyone was making various designs of loose couplers. I had my own ideas about that and received a patent on my design.

"About this time, I was invited to go to Brant Rock to see Professor Fessenden at work. He showed me his 'wireless telephone,' which consisted mostly of an arc light and a telephone mouthpiece connected to suitable condensers. He let me borrow some 'flaming arc' telephones and take them back to the Ansonia Hotel station. The equipment actually worked and may have been the first of its kind; the disadvantage was that it used too much power and dimmed the lights in the hotel every time it was turned on. Also, the carbons burned out very quickly.

"In later years, I owned three airplanes and experimented with directional beams. I found that I could home in on distant stations by using a long antenna trailing from the back of my plane. I also noticed that the signals weakened when the plane was crossing certain mining areas, and did quite a bit of experimenting over Franklin Furnace, New Jersey, and Battle Mountain, Nevada.

"During World War II, the Navy captured a German torpedo with a rod on the front of the warhead. It was copied and became the Mark 6 Exploder. I was involved in the torpedo program and was selected to write an inspection pamphlet telling how to make the thing work. The warhead contained a receiver which was tuned in balance. When the torpedo passed under a ship, the magnetism of the hull would distort the balance and explode the torpedo. That was the only way we were able to sink any Japanese ships -- if a torpedo struck a ship, it was going so fast that the warhead would be telescoped before it had a chance to fire. The Mark 6 Exploder was set to go 15 feet under the enemy ships.

"Again, let me thank you all for your generous gesture in making me an Honorary Member. I wish you all and the Club, the best of luck."

At the time that the Club published the *75th Anniversary Diamond Jubilee Yearbook, The Proceedings of The Radio Club of America, Vol. 54, No. 3,* W.E.D. Stokes, Jr. was asked to write a message to the membership. This is what he had to say:

"Any history of The Radio Club of America would read like a Jules Verne story. When a handful of boys in 1907 tried to devise a remote control system for their model aeroplanes so they would not be smashed against the walls of the National Guard Armory, the groundwork for Guided Missiles was laid and everything we now know as radio was started. Those early contraptions for transmitting signals and voice with low power begot our modern walkie-talkie sets and those prodigious efforts to eliminate static led to out present day smooth FM reception.

"The important thing to remember is that our boys of The Radio Club were in the forefront of this; they were the leaders in this new field and they had the imagination. Their early technical triumphs, too numerous to mention, were, amongst many others, the Regenerative Circuit, the Hudson Coated Filament, Armstrong's Feedback Circuit and Eltz's Square Law Condenser. Some of the earliest transatlantic messages were received by Club members who in some instances established stations of their own in Europe and elsewhere to exchange signals. The official Radio Club Station and stations established by members chalked up numerous world records in transatlantic tests with low power short wave sets. Only one pipe dream remains, the transmission of power itself without wires, but give the boys a little more time and we will have that disclosure in the *Proceedings*, too.

"The atmosphere of the young club was always calculated to produce Good Fellowship and the Free Interchange of Ideas among all radio enthusiasts. A milestone was reached when on 28th April 1910, a committee of boys appeared before sixteen U.S. Senators of the Commerce Committee in Washington to oppose the Depew Bill S.7243 --

"To Regulate Radio Communication" -- because they believed that, while some regulations might be needed, the bill was unreasonable and unfair to amateurs and students of wireless. Let's hope that we never lose the fruits of that victory. Our delegate to advise Secretary Hoover's Congressional Committee did much to frame present regulations and a notable program of the Club was to popularize pure continuous wave transmission as an aid to the elimination of interference; this was the father of the modern Broadcast Program.

"Much remains to be done. The small body of amateurs has gradually changed to a large scientific organization of recognized standing, before which the leading lights of the radio world are glad to deliver papers. The enthusiastic urge of the member for the original precepts of the founders remains undampened."

In 1985, he was asked to describe how the members of the Junior Aero Club devised the radio remote controls for their aeroplanes. He wrote:

"The problem was to turn the models only when you saw that they were about to strike the wall of the Armory, and rest content that the motive power would let the plane fade out as it began to circle. For this purpose, I had two springs attached on either side of the rudder. When I saw the plane getting close to the wall, all I had to do was to unlatch one spring so that the other spring was free to pull the plane around into a turn.

"As luck would have it, the head carpenter at the Hotel Ansonia was able to produce an electric latch used for unlocking doors by remote control. This very small piece of equipment was fitted into the large model plane that I had put together and, along with the said springs, was able to release one spring when hooked up to the decoherer and battery carried aboard the plane. This was a great idea for saving the plane from damage but did not solve the problem of returning the model to straight flight.

"Various ideas were suggested to produce a system for relatching the spring that had been unlatched. This required more heavy batteries and the use of a small motor to rewind the spring.

"A scheme was concocted to do this after allowing the plane to turn for say 15 seconds, then to flip a switch and reactivate the spring to produce straight flight. It all seemed so simple but never worked. It took one whole month in the summer at my father's summer estate at Little Silver, New Jersey, to put the material together into a very heavy box kit. Then end came quickly when the box kite made a sudden flip to one side and dove into the river never to be seen again."

W.E.D. Stokes, Jr. was a long time Chairman of the Lenox Park Commission, a special police officer in the Lenox Police Department, and was a founding member and secretary of the Lenox Police Association.

In 1977, The Radio Club recognized Stokes' contributions to radio and his services to the Club with the awarding of the coveted Pioneer Citation; in 1984, he was elected to the office of President Emeritus.

On 16 August 1938, W.E.D. Stokes, Jr. married Lucia Hobson. Together, they celebrated their 50th wedding anniversary in 1988. They had a daughter, Sylvia H. Stokes, of Pittsfield, MA; a son and daughter-in-law, Dr. and Mrs. Houston H. Stokes, of Chicago, IL; and two grandchildren William A. and Houston A. Stokes.

On 27 January 1989, Stokes suffered a massive stroke and was moved to a nursing home. Mrs. Stokes, in ill health, joined her husband there, and preceded him in death by a very short time.

THE SPECIAL LIBRARY OF W.E.D. STOKES, JR.

by **James and Felicia Kreuzer**

The late W.E.D. Stokes, Jr. was noted as an editorial writer for the *American Friends of Rhodesia News Letter*, and as a feature editor for *La Liberte, The New England Journal, The Green Mountain Review, and The Up-State New Yorker.* He wrote extensively on race relations in Rhodesia and in the Republic of South Africa. In 1952, he had written the authoritative *Planetary Configurations and Stock Market Sentiment.*

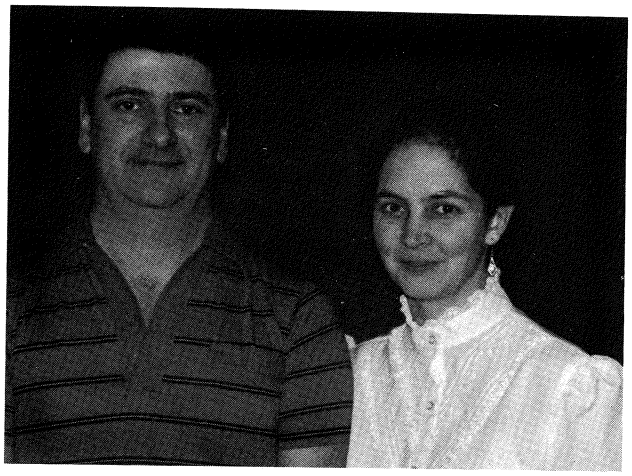
Those writings and his continuing interest in many subjects such as aerial mapping and gold mining led Stokes to gather related papers, and to save most of his notes. These were collated into bound, leather-covered books which were stored in a trunk in his home in Lenox, Massachusets until the house was sold in 1990.

We never had the pleasure of meeting the first president of The Radio Club of America but we did get to know him through his books. Besides his own writings, he owned a collection of the finest pre-1910 wireless books, reflecting upon "Weddy" Stokes as an intelligent and well organized person. The quality of his choices were in line with the portion of The Franklin Institute Library we fortunately obtained a few years ago.

With Reginald Fessenden being an advisor to The Junior Wireless Club, he also may have been Stokes' advisor in selecting the titles. We feel that the books were acquired early in his career and probably shortly before he went to Andover Academy in 1912.

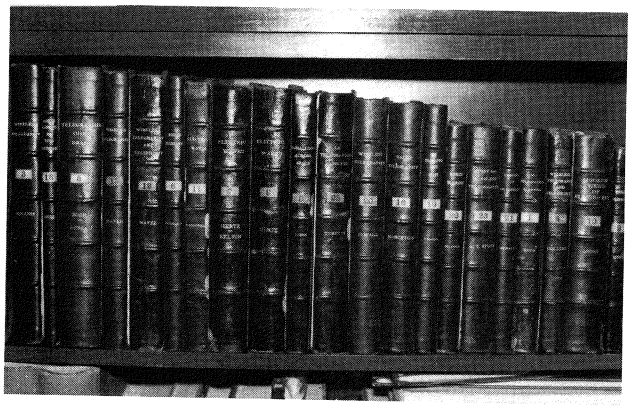
The story of the acquisition of the W.E.D. Stokes, Jr. special library begins with a bit of luck. Intuition had led us to a Brimfield, Massachusets antique market where we went to see a book dealer who, a week before, had mentioned that he had some old radio books he wanted to sell. We had driven all night from Indiana where we had attended an antique radio show, to keep our appointment.

When the book dealer opened the box of books, we couldn't believe our eyes; we were being offered an incredible set of books for the average price of $15.00 per book! We were so excited that we could barely pay for the prize of the show. We knew at the time that someone very special had all of the books bound with fine red leather bindings and embossed in gold with the initials W.E.D.S.Jr., but we had no idea who belonged to those initials.



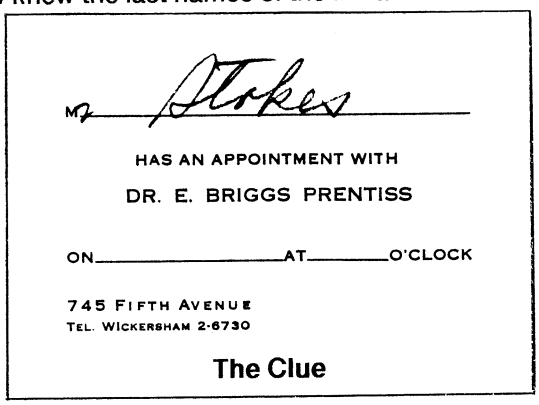
James and Felicia Kreuzer

The set of books, numbered consecutively from 1 to 25, was almost complete. Only volumes 14, 15, and 24 were missing. We may never know the missing titles or how the set came to be divided. However, the volumes were in alphabetical sequence, so we surmise that volumes 14 and 15 began with the letter "M", and volume 24 with an "S" or "T".



The W.E.D. Stokes, Jr. Library

Anxious to know the source of our treasure, we asked the book dealer to try to trace it. Through his receipts, he narrowed the origin to a Lenox, Massachusets estate sale. A short time later, we discovered a doctor's appointment card in one of the books. It gave us the name of a Mr. Stokes -- we now knew the last names of the initials.


Mr Stokes

HAS AN APPOINTMENT WITH

DR. E. BRIGGS PRENTISS

ON_____AT_____O'CLOCK

745 FIFTH AVENUE
TEL. WICKERSHAM 2-6730

The Clue

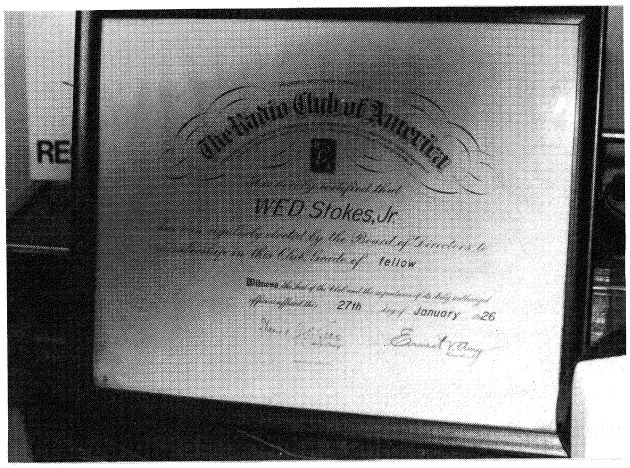
We didn't make the connection until the following year when going through a copy of *The Golden Jubilee 50th Anniversary Yearbook* of The Radio Club of America, and reading George Burkhard's history of the Club. What a thrill it was to learn that the books belonged to W.E.D. Stokes, Jr., a founder and first president of The Junior Wireless Club, precursor of The Radio Club of America.

We received such a thrill out of the April 28, 1910 *Globe* article telling of the lad of 14 creating amusement before the Senate committee by his appearance, but then presenting himself so like an attorney that they were able to defeat the Depew Bill!

Upon learning the identity of the library's owner, we 'phoned Lenox and requested the number for W.E.D. Stokes, Jr. By chance, a real estate agent was at the house and let us know that Mr. Stokes was in a nursing home, unable to speak with us.

In September 1990 while passing through Lenox, we placed an ad in the *Pennysaver* for information on the Stokes' estate sale. Shortly thereafter, Dr. Houston H. Stokes, son of W.E.D. Stokes, Jr., communicated with us and sent literature about his dad. Additionally, an antique dealer who had attended the sale, had the certificate of Mr. Stokes election in 1926 to the Grade of Fellow of The Radio Club, and offered to sell it to us.

The Stokes' Library presently resides on our bookshelves, above which sits the Fellow certificate. The titles of the books include a copy of Hertz's *Electric Waves*, an inscribed copy of Maver's *Wireless Telegraphy 1904*, and Robison's *Wireless Telegraphy For Naval Electricians 1909* - the book in which we found the doctor's appointment card so instrumental in our discovery.



W.E.D. Stokes, Jr. FELLOW Certificate

Another name that we recognize from the listing of the 13 original members of The Radio Club of America was that of Harlowe Hardinge. He was a member of the committee to defeat the Depew Bill in 1910 and, later, was to establish the first radio school for the American Expeditionary Forces in France during World War I. We have two boxes of his correspondence and manuscripts including a few copies of Major Edwin Howard Armstrong's papers issued during the war.

James Kreuzer, N2GHD, is a native of Buffalo, New York. He received three years schooling in technical electronics and then worked for the railroad. He is a member of the Antique Wireless Association, and a Charter Member of the Niagara Frontier Wireless Association (NFWA).

Felicia Kreuzer, KA2GXL, is a native of Minneapolis, Minnesota. She works for Moog Inc. in the white room on missile sub-assemblies. She, too, is a Charter Member of NFWA, and served as its president from 1985 to 1988.

They have built a significant wireless museum containing mainly pre-1920 wireless apparatus such as Marconi, United Wireless, de Forest, and Wireless Specialty Company receivers and transmitters, as well as early vacuum tubes and electrical apparatus. Their substatial library contains many early works on electricity and wireless as well as catalogues, magazines,and autographs. They are authors of many articles on early wireless published by AWA, ARCA, and ARC. Their business, New Wireless Pioneers, was established in 1985 and publishes two catalogues a year for the buying and selling of early books on electricity, telegraphy, X-ray, wireless and early radio. They may be reached at P.O. Box 398, Elma, NY 14059, or by phone at 716-681-3186.

The W.E.D. STOKES, Jr. LIBRARY

Volume	Title	Edition	Author	Date
1	La Telegraphie sans Fils	2nd Ed.	Broca, A.	1904
2	Wireless Telegraphy	3rd Ed.	Bottone, S.R.	1905
3	Wireless Telegraphy	1st Ed.	Collins, A.F.	1905
4	Manual of Wireless Telegraphy	2nd Ed.	Collins, A.F.	1909
5	Telegraphie ohne Draht	1st Ed.	Righi, Augusto	1907
6	Wireless Telegraphy	1st Ed.	Eichorn, Gustav	1906
7	Electric Waves	2nd Ed.	Hertz, Heinrich	1900
8	Electric Waves	2nd Ed.	Hertz, Heinrich	1900
9	Signalling Across Space Without Wires	4th Ed.	Lodge, Oliver	1909
10	Modern Views of Electricity	3rd Ed.	Lodge, Oliver	1907
11	Electric Waves	1st Ed.	MacDonald, H.M.	1902
12	Maver's Wireless Telegraphy (inscribed by Author)	4th Ed.	Maver, Wm. Jr.	1909
13	Maver's Wireless Telegraphy	1st Ed.	Maver, Wm. Jr.	1904
14	*MISSING*			
15	*MISSING*			
16	Radio Telegraphy	1st Ed.	Monckton, C.C.F.	1908
17	Telegrafo sensa Fili	2nd Ed.	Murani, O.	1909
18	Wireless Telegraphy for Electricians	2nd Ed.	Robison, S.	1909
19	Die Telegraphi ohne Draht	1st Ed.	Prasch, A.	1902
20	Wireless Telegraphy	2nd Ed.	Sewall, C.H.	1904
21	Lessons in Telegraphy	1st Ed.	Sewall, C.H.	1909
22	Wireless Telegraphy	1st Ed.	St. John, T.M.	1906
23	Story of Wireless Telegraphy	2nd Ed.	Story, A.F.	1909
24	*MISSING*			
25	La Telegraphie sans Fil	2nd Ed.	Turpain, A.	1908

EDWIN HOWARD ARMSTRONG
HIS LIFE AND BEHAVIOR IN THE FACE OF ADVERSITY

by **Don V. Erickson, Ph.D. (M)**
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On November 9, 1990, Columbia University through its Center for Telecommunications and Information Studies of the Graduate School of Business, presented a conference in recognition of the 100th anniversary of the birth of Edwin Howard Armstrong. Dr. Erickson was an invited speaker. This paper was the basis of his address.

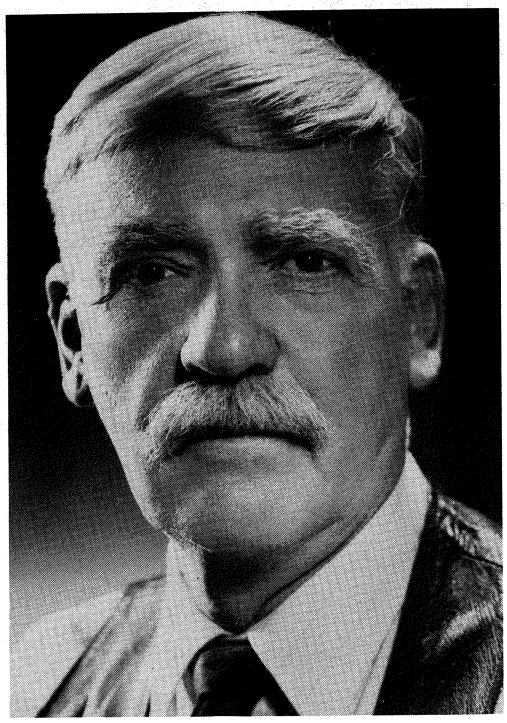
PROLOGUE

Certainly his suicide required planning. It would be out-of-character to do otherwise. ***Why*** would not even be questioned. The reasons were there for all to see, chronicled in court testimony, government records, industry journals, the trade and consumer press...and, somewhat more dramatically, in the hearts of men (certain men, anyway).

When seemed to be only a matter of choosing the time. Soon. Very soon. Today. ***How*** was taken for granted.

> Mother Armstrong is busy in the Yonkers house. Outside, her twenty-year-old son sits atop his 125 foot home-made antenna -- adjusting it in a wind so fierce the top is dangerously bending. The phone rings. "Are you aware that your son is up on that thing in this wind? It makes me nervous to watch."
>
> "Don't look, then!" And mother Armstrong goes back to her work completely confident that her son knows what he's doing. At least she hopes so.

From the thirteenth floor of his Manhattan apartment, he could see, to the north, the place he grew up. And toward Alpine, New Jersey, where he built the world's first high-fidelity FM station. He had lavished on it all the time and money needed to produce a sound-transmitting system of unparalleled and unheard-of quality and beauty.



Dr. Don V. Erickson

> From its 400-foot antenna, overlooking the Hudson River, he spent days happily swinging about the high steelwork, dangling from his bosun's chair, adjusting the antenna and observing the scene below...the Palisades, the river, the skyline. On top of the world. Financially, personally, maritally -- literally on top of the world.

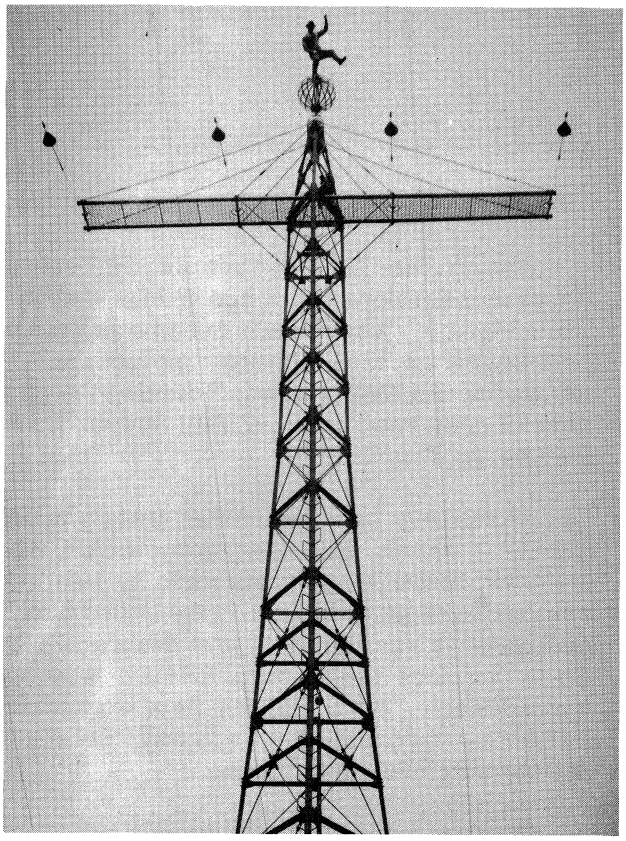
Of course, there would have to be a note. His wife must know how he feels. There must be a plea for understanding his actions. There must be an apology for his actions. After all, she had been with him from the early days. Indeed, she had been in "his" office! "His" personal secretary, no less. Her name was Marion MacInnis...twenty years old, tall, pretty and Scottish. And she was General David Sarnoff's secretary, and he was in love. And it was the "mad" 1920s besides.

The photograph is just fading today. You can see that a stiff wind is blowing and Howard is standing on an open steelwork ball that sits on top of a 50 foot tower that sits on the roof of Aeolian Hall.

The roof tower is 400 feet above 42nd Street. It is RCA's newly-bought radio station, WJZ. Howard is cavorting about for the photo record. Twice today he has gone up there to be photographed. The second time just in case the first time didn't come out.

Sarnoff, horrified by the dangerous antics, issues an edict that anyone allowing Armstrong on the roof will be promptly fired.

No matter. Marion MacInnis has seen the photograph of her daring young man on the flying Aeolian Hall ball. They are married later that year.



In 1923, to celebrate the opening of New York's first radio station -- and to impress his fiancee -- Armstrong cavorted atop the new WJZ transmitter tower. (Photo by George Burghard)

No, the ***How*** was never a question.

Nor as his own justification. His decision was hardly based on rashness. He had spent over forty years of his life, his energies, his personal fortune fighting to prove he was the inventor of electrical circuits that the world had acknowledged. Even the Russians! But not the U.S. legal system. Not his own.

What was a man to do to insure his honor, reputation and fortune in this country? Well, it seems a man must lose fifteen million dollars, lose one's physical and emotional health and one's marriage. ***When*** became **now**.

It is sometime during the night of January 31, 1954. He is completely and neatly dressed in hat, overcoat, scarf and gloves. He does not, however, walk out of the door, but out of the window, thirteen stories above the street.

Heights never did bother him. Height was his friend.

No, the ***how*** was the easiest.

Edwin Howard Armstrong: *Man of High Fidelity*

The above is not only the title of Lawrence Lessing's award-winning biography, but it is the best summary of ***who*** he was. Armstrong's contributions to aural broadcasting, radio and television included, began as a boy fascinated by wireless telegraphy.

While an undergraduate student at Columbia University, he invented his first major circuit: the regenerative or feedback circuit. Such inventive feats continued until his last patent improving FM multiplex (working with his assistant and friend, John Bose), at the time of his death. Multiplexing is one of the extraordinary fringe benefits built into the FM broadcast patent. On one FM-transmitted signal, it is possible to send four separate messages. Indeed, that is what Armstrong did in 1934 broadcasting from RCA's Empire State Building labs. Two separate music programs from NBC, a facsimile of the front page of *The New York Times*, and a telegraph message were sent to Haddonfield, New Jersey (near Philadelphia).

It is multiplexing concepts that allow FM's primary transmitting band of frequencies plus its side-bands to broadcast stereophonic sound. And if we ever decide to use it, we can broadcast discrete quadraphonic broadcasts (four separate channels simultaneously).

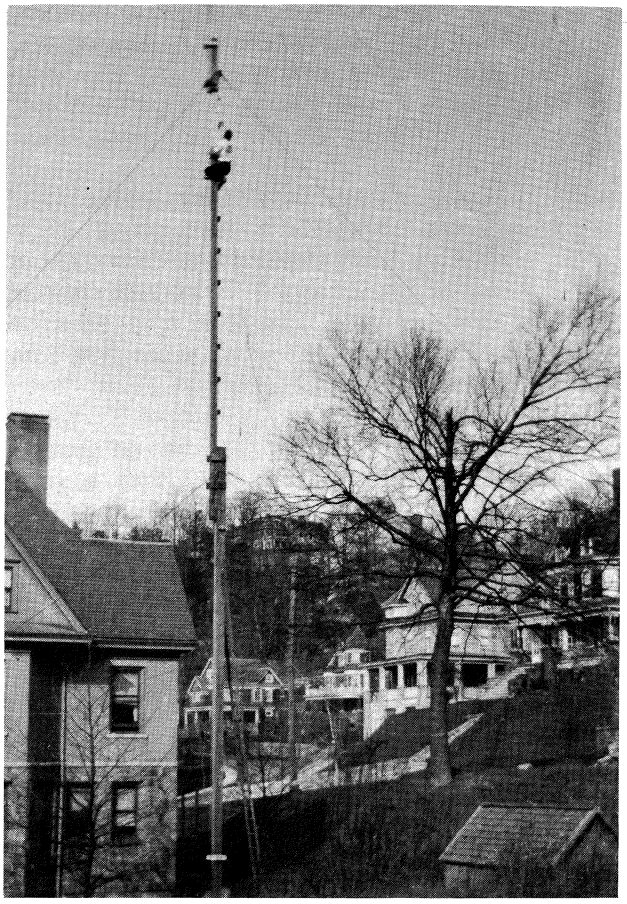
In some forty-five years of tinkering and research, he fashioned and re-fashioned, wrought and re-wrought Nature until the invisible energy exploding out of burning stars carried cymbal and drum, drama and comedy, news and information to the ear with a reproduced fidelity literally indistinguishable from the original sound.

What was the man like? The son? The husband? The friend? The colleague? The millionaire? Not even remotely like the millionaires/billionaires that fill the pages of *People* and fill the gossip columns of what passes for journalism these days!

Edwin Howard Armstrong was born on December 18, 1890. He had a horse-and-buggy boyhood. The Chelsea district of lower Manhattan was his first home. When he was twenty, his family moved to Yonkers, New York, just north of the city. Father John Armstrong had married Emily Smith in 1888. The Smith family got along so well with the Armstrongs, that they also moved to Yonkers -- right next door! Both families had many members in the teaching profession. This had to have something to do with Armstrong's love for curiosity and the subtle training of an analytical mind.

During his first two decades, Armstrong was enveloped in the life of the two families. Of his first ten years, Armstrong's biographer says little survives. "We know this," Lessing states, "the family was neither wealthy, nor poor, but comfortably well off." The Armstrong/Smith enclave on Warburton Avenue was "on the scale of warmth and closeness that has passed almost out of existence, if not out of mind." Multitudes of relatives congregated for almost any occasion and dinners often sat half-a-hundred guests.

The boy, known mostly as Howard, had an especially close relationship with his mother and two sisters, Ethel and Edith (nicknamed 'Cricket'). It was Cricket who helped him raise his first antenna from the Yonker's rooftop. In 1910, it soared 125 feet in the air and became a landmark for miles around...worrying that neighbor when she would see Howard up with the birds, wind and sky.



The young inventor at work on the "1032" pole.

During the first decade of the century, Armstrong developed teen-age friends that would last a lifetime. Many would become professional colleagues as they shared, as youths, first telegraphy and then "wireless." Among the group, three of great importance: William Russell, Carman Runyon, Jr., Tom Styles.

Armstrong had two other passions after "family": tennis and telegraphy which would metamorphasize into amateur radio by 1910. The term *radio* began to be used in the United States to distinguish it from the dots and dashes of Morse Code...wireless telegraphy. *Radio* was voice transmission. The word may be a corruption of "radiant" -- radiant energy, radiating from the Sun and carrying human intelligence.

His early friends will become very important to Armstrong in years to come. Bill Russell will build apparatus for Armstrong to demonstrate his feedback circuit. Russell will be a witness during ensuing court trials and attend his wedding. Carman Runyon, Jr. will, in 1921 and 1922, help

Armstrong with his tests of the superregenerative circuit. Runyon will build his own pioneer FM radio station K2AG, Yonkers. It will be from this station that the first public demonstration will take place.

That first program will be transmitted to The Institute of Radio Engineers in mid-town Manhattan in November 1935 and Armstrong will deliver his historic paper on FM. Runyon will also be one of the last persons to talk to The Major before he died.

Tom Styles, also from the Yonker's days, will spend the bulk of his career working with and for Armstrong. After World War I, Styles took a job working in the Paris branch of Bankers Trust. Armstrong will walk into that bank on a European vacation, be surprised to find Styles and offer him a job back home to help him in research. Of course, Styles accepts.

Styles will end his career, after Armstrong's death, as secretary of the Armstrong Memorial Research Foundation, and he will be a sort of curator of the Armstrong papers and memorabilia that will be housed on 125th Street in Manhattan. It will be Mr. Styles that shows this author around during the eight months of my own research for my Ph.D. dissertation on Armstrong. The two rooms of uncatalogued material are daunting! And Mr. Styles finds treasures for me everywhere.

When Armstrong finally joined The Radio Club of America in his junior year at Columbia (eventually becoming its president), he adds more lifelong friends to his *menage-a-radio*: George Burghard, John Grinian, Ernest Amy, John V. L. Hogan and Paul Godley. All are important.

This group of young men will join in a successful attempt to use short waves for long-distance communications. The broadcast industry, in 1921, had decided that short waves were impossible for broadcast use (frequencies above 1.5 MHz or a wavelength of 200 meters). The magazine of Amateur Radio Hams, *QST*, proposed a test between American and British amateurs.

It was Armstrong and his radio pals who built the special station 1BCG, near Greenwich, CT that got through to the station in Scotland. The signal was heard in England, Holland, and Germany, also. Then they sent messages as far west as Catalina Island. The feat was so impressive that Sarnoff and his aides came out to Connecticut to see how the amateurs with less than $1,000 worth of equipment, did what they could not do with unlimited resources.

All of Armstrong's close friends became professional colleagues. This includes some of his teachers at Columbia. The "radio group" -- (not to be confused with THE "Radio Group": AT&T, Westinghouse, General Electric and RCA) -- mixed their professional life and social life, blurring all lines. They raced each other in fast, expensive cars on the Long Island Parkway, attended each other's weddings, appeared for Armstrong at his court trials and hearings before the Federal Communications Commission, helped him build equipment-to-order for his inventions, founded early experimental and commercial FM stations (Hogan started and operated New York City's WQXR, "The Good Music Station).

Armstrong had equally good relations with his teachers at Columbia -- most of them, anyway. His most famous teacher, then colleague and friend, was Michael Pupin. Pupin was one of the founders of Columbia's Department of Electrical Engineering. He also was a successful inventor in his own right. The two men remained friends until Pupin's death in 1935. Then, Armstrong was named to succeed Pupin as head of Columbia's Marcellus Hartley Research Laboratory.

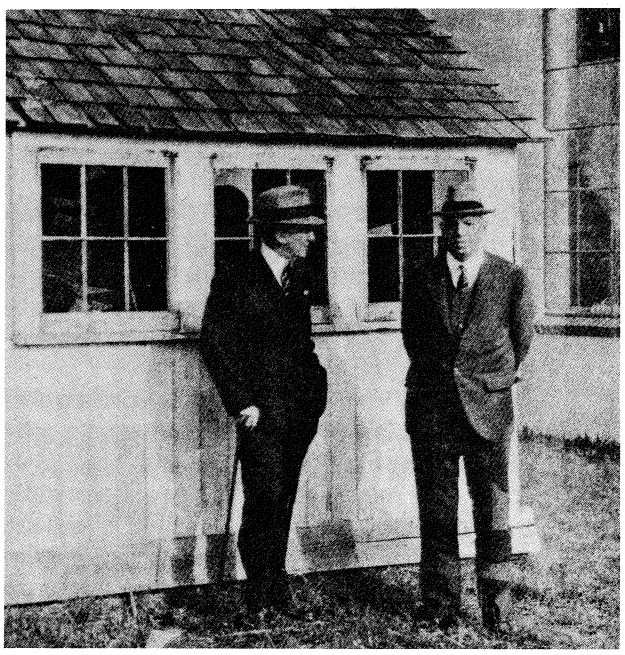
Major Armstrong also knew Reginald Fessenden, a scientist and inventor who is often overlooked -- but certainly should not be. It was Fessenden who managed to broadcast something other than dots and dashes. In 1906, he was the first to astound the world with a broadcast of music. "On Christmas night 1906, wireless operators on ships plowing the North Atlantic were startled to hear in their headphones snatches of music breaking through the dots and dashes, from Fessenden's experimental station at Brant Rock, Massachusetts." (Lessing)

Fessenden became the advisor to The Junior Wireless Club, Ltd., organized by New York schoolboys. It was this club's fourteen-year-old president who went to Washington to lobby for amateur radio rights to the spectrum. The growing commercial industry was attempting to get Congress to remove amateur radio operators from having any rights to broadcast. The Hams won.

Armstrong's idol was, not surprisingly, Guglielmo Marconi. Marconi, building on Hertz's discovery of the electromagnetic radio wave,

succeeded in 1896 to transmit, without wires, signals over a two-mile distance. Marconi's invention was really the discovery of the ground wave. Marconi later discovered the sky wave and, finally, was the discovered of "scatter" transmission (the ability to bend waves by bouncing them off the ionosphere).

And Armstrong met Marconi several times before the great man died. On Marconi's last visit to the United States in 1932, Armstrong had a surprise for him. Armstrong and a radio friend had tracked down the whereabouts of the shack that Marconi had built near Babylon, Long Island, for his historic transatlantic wireless transmission. Armstrong later moved the building, giving it to RCA's David Sarnoff as a gift to be saved for radio posterity.



Guglielmo Marconi and Major Edwin Howard Armstrong at "Babylon Shack", constructed in 1902 for the Marconi Company, after it had been bought by Armstrong and moved to the RCA site at Rocky Point, NY, 1933.

(Photo courtesy of Dr. Harold H. Beverage).

Armstrong's close and continuing associations with his teen-aged friends, radio pals, Columbia teachers and his World War I and II military colleagues all eventually helped him achieve the fruits of his inventive genius. In every case, he solicited, got, and used their help which was given only too gladly. Such help often required long, uninterrupted hours and days of their time -- time away from family and sometimes jobs.

With the help of amateur radio buffs and Professors Pupin, Mason, Morecroft, Baker and Schlichter, he developed his original feedback circuit. With Radio Club friends and former Army Signal Corps colleagues, the superregenerative circuit. And with colleagues from Columbia University and his lifelong radio friends, he brought forth the FM transmitting system. They were all surely his inventions, no doubt of that, but their "births" were attended by excellent mid-wives.

Armstrong returned from World War I as a major...and it is from that point on he is known affectionately as "The Major." During the 1920s, he became a millionaire many times over. Some of his moneys derived from royalties on his early patents but the bulk of his fortune was due to the sale of certain patents (notably to RCA) and from some 80,000 shares of RCA stock given to him as partial payment for his patents, other refinements of his patents, and even favors to RCA (i.e., Sarnoff). Prior to the 1929 stock market crash, his 80,000 RCA shares were worth $549 per share, or forty-four million dollars.

Lessing tells that on Black Tuesday, October 29, 1929, Armstrong was in his broker's office. In the pandemonium that broke out in the office, Armstrong noticed a foreign-looking lady "on the verge of collapse". He told his broker to cover the lady's account "to any reasonable amount." Anonymously. Two years later, the broker received a letter addressed to "...My Unknown Benefactor" from a grateful lady in Warsaw, Poland: Nadine Sobansky. That kind of generosity is almost unheard of today (especially the "anonymous" part).

Armstrong is known to have given regular stipends to colleagues who were down and out. He paid the wages of most of his Columbia assistants in his lab. He footed the bill for wire charges between Washington and New York so that "live" FM music programs would continue to reach New York when FM stations could not pay these charges due to their poor economic conditions during the 1940s and 50s.

Armstrong spent millions of dollars on his own FM station at Alpine, New Jersey. He ordered equipment and tubes that didn't even exist, urging manufacturers to produce products that would make high-fidelity possible. He paid for all of his own research at Columbia and even hundreds of thousands of dollars to show it off at demonstrations. Once he asked his assistant, John Bose, to sit in a rented cottage at Westhampton,

Long Island for the entire summer season. Bose sat at the equipment from 8 AM until 11 PM, seven days a week, for two months taking the exhaustive FM measurements Armstrong felt he needed.

In addition to his expensive River House apartment in Manhattan, he and Marion bought a rambling summer home at Rye Beach, New Hampshire. It was on their expansive lawn that Mrs. Armstrong graciously entertained this author over fresh-caught-lobster rolls and Dubonnet cocktails.

It was here in 1968 and 1969 that I was able to listen to Mrs. Armstrong tell anecdotes about her husband and to have her proudly show me through one of the rooms containing much of her husband's memorabilia (that which was not stored in New York City).

The bulk of his fortune, however, went for almost forty years of court litigation needs, lawyer fees (of a staggering proportion) and such associated costs that go into court battles, including research. And this was for litigation that was to prove he was the inventor of things that everyone knew he had invented! None of his major inventions were ever free of "interference suits", infringers or some kind of legal contest. From the first two-decade-long battle with de Forest over feedback, right on up (and after) his death on FM, Armstrong or his estate was never totally free of courts, lawyers, suits. ***That*** is the adversity this article is about. So much of his personal fortune was paid out for the FM struggle that he was broke by the time of his death.

In the final note he left to his wife, there is a part that says he feels sure she will be taken care of (financially) if "they" come across with what they promised to pay...that is, RCA and other industry manufacturers. If you know the James Stewart classic film, "*It's a Wonderful Life*", you will remember Stewart's character contemplates suicide so that the insurance money will take care of his debts and family. I am assuming Armstrong felt he was worth more dead than alive.

For a millionaire, Armstrong lived plainly, even austerely. "He would wear the same necktie day after day until it frayed away," relates Lessing, "and shoes until they were out at the soles. His luncheons invariably consisted of a cheese sandwich and a glass of milk. Tom Styles, who liked more leisure and variety, once got him into a French restaurant. Armstrong, to mark the occasion, blandly ordered two cheese sandwiches and a glass of milk." Hardly the Trump Era.

The corporations who fought him in court had the ability to replenish their costs simply by tapping the company till. They had, it seems, an unending supply of revenue and needed only to raise the costs of their products to the consumer to cover such costs, or to cut dividends, or even to simply report a decline in profits. Also, these companies who lost in court to Armstrong wanted to keep the money award out of the public record. Part of the eventual settlements to Marion Armstrong included a request that she and her lawyers not divulge the actual cash penalty. It was felt "bad image" to have the stockholders and public know that they "had willfully and wantonly" infringed the patents.

Only General Electric, Westinghouse, Zenith and Stromberg-Carlson (of the well-known companies) paid Armstrong FM royalties. Twenty-two other manufacturers produced FM radio tuners and TV sets (which use FM broadcasting for the audio portion) without any royalty payment. Why? Why should they? If the premier broadcasting company in the U.S., RCA, did not pay, why should they? Among those usurping the Armstrong patents were such giants as Admiral Corp., Emerson Radio & Phonograph Corp., Allen B. DuMont Labs., International Telephone & Telegraph Corp., Bendix Radio, Crosley Corp., and Motorola.

The reader will read elsewhere, or already knows, about the Armstrong vs. de Forest litigation over the feedback circuit. That is a period covered roughly by the years 1914 - 1934. Then World War II and some juicy scandals with the FCC (Federal Communications Commission --- some comments about them later).

As much pain as the de Forest period inflicted on his emotions, his belief in human nature and his bank account, it was, after all, the FM struggle that led to his death. Two major court suits with Emerson and Motorola were in favor of the Armstrong Estate after he died. These were "normal" court litigation -- normal in the sense that a suit is brought against someone or a company, and then a court judge hears the case and decides the issue one-way or the other.

Not so with RCA and Armstrong. It was February 1949 and there began one of the most harrowing and expensive aspects of the FM battle

...a legal procedure known as "Pretrial Discovery". The Discovery procedure is one in which the two parties in conflict are allowed to discuss in detail the evidence and exhibits each side hopes to use in the actual trial (to follow). This procedure is performed in front of a Notary Public. Each side is allowed to requisition from the other all the various papers, documents, witnesses and the like, to see of what use these materials may or may not be, and to decide which will be used in the actual trial.

The reasoning is that Discovery will save time and money during The trial. Discovery allows the parties to forestall any in-trial surprises for which they were not prepared. This procedure is designed to last only a few weeks. To savor RCA's strategy here, realize Discovery was still going on five years later. And then it ended only with The Major's suicide. Five Years in a non-legal proceeding!

Evidence of the more normal time involved in a major Armstrong infringement suit may be seen from the actual trial time of Armstrong vs. Emerson Radio (that did not have the "benefit" of a Pretrial Discovery time-saver!)...not quite five weeks.

RCA's handling of Pretrial Discovery started in February 1949 and ended on February 1, 1954. It was intended to wear-down Armstrong emotionally and financially and it admirably succeeded. RCA managed to keep Armstrong in the witness chair for the entire first year, continuously, with such questions as: "Why did he do his own bookkeeping? Where did he bank? How did he make out his deposit slips? How did he report his income tax? Who appointed him to his Columbia University position? Why did he write letters sometimes on his own stationery and on university stationery at other times? Why did his Armstrong FM insignia have an oval design? What were his total FM royalties?" And on, and on, and on, and on.

Can you imagine the problem of using the transcript of the proceeding and literally trying to publish ALL the questions? This article would be in volumes. Lessing states:

> "The record became so burdened with outrageous and vindictive irrelevances that it was finally appealed by Armstrong's attorney, Alfred McCormack, to the ruling court in Delaware, which summarily cut it off. It then became the turn of Armstrong's legal forces to dig into the RCA record. And, in this pursuit, McCormack secured from the District Court one of the broadest rulings ever made in a suit of this kind...
>
> "The interrogation arising from this monumental flood of paper consumed the next two years (RCA had to produce every written file, letter, report, and finding that had any reference to FM)...and [there plainly developed] from the files...all the shiftings, backings and fillings of RCA policy on FM over the years."

During my own research, I never was able to get an acceptable answer to why the Armstrong legal force took so long to stop the irrelevant questioning or why they allowed a procedure designed for *weeks* to stretch into *years*.

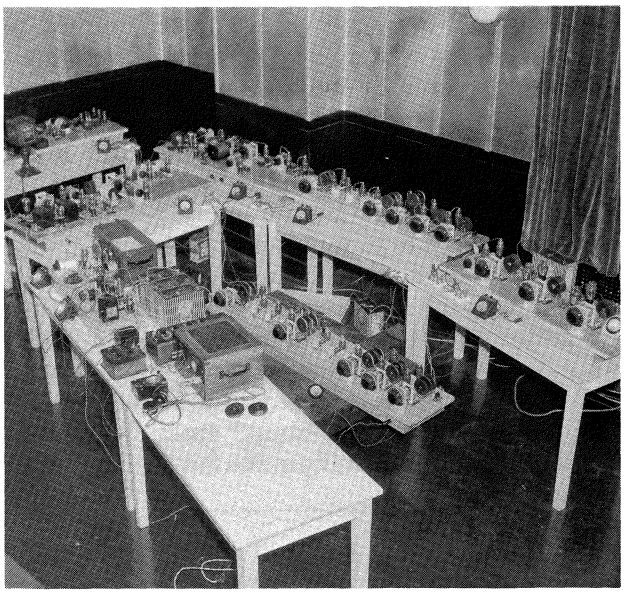
It took until February 1953 to get David Sarnoff on the stand. The testimony began as civil as possible but, eventually, the lawyers had to get down to RCA's alleged thwarting of FM broadcasting and their attempts at consciously trying to keep it from becoming a commercial success. Sarnoff stated that his engineers kept telling him that it was RCA's staff which had discovered the basic law of FM. As the questioning took more of an edge to it, Sarnoff *exploded:* "I will go no further...and I say that the RCA and NBC have done more to develop FM than anybody in this country, including Armstrong."

Lessing states it best: "At this unparalleled assertion, according to the lawyers present, Armstrong's eyes flashed a low flame of pure hatred."

Armstrong and Sarnoff had been friends for some thirty years. During court battles and legal hassles and downright dirty business tricks with RCA and NBC, Armstrong had always (naively) believed Sarnoff was never involved. That these *doings* were the result of lesser executives and that Sarnoff knew nothing about them or relegated such decisions to areas that had nothing to do with friendship. Since Sarnoff's death, biographical material on how he ran his empire indicates nothing could be further from the truth (with the exception of material written by members of Sarnoff's family).

Back in the 1920s and 30s, Sarnoff often had said that he was waiting for someone to come along with "a little black box" that would eliminate static. Major Armstrong, in 1933, invited Sarnoff to come

see "the little black box." He went. He saw. He invited Armstrong to move all the FM apparatus to RCA's Empire State Building labs for further testing. RCA spent the next two years experimenting with FM and finding out all that was said about it was true -- especially its ability to eliminate static. Armstrong had been able to get FM's original signal-to-noise ratio of 100 to 1 down to 1,000 to 1 (eliminating 99% of all electrical static/noise).



Armstrong's frequency modulation exciter equipment, used in the 1934 - 1935 field tests at the Empire State Building.
(Photo courtesy of Antique Wireless Association)

After tying up Armstrong's FM equipment for two years -- effectively putting any further progress of FM "on hold" -- RCA asked The Major to move the stuff out and made no public comment on it.

FM has more than static reduction as part of its virtues...most of them even were not known to Armstrong until the invention was tested and used. Then a number of "fringe" benefits became quite clear. FM can do "multiplexing." This not only allows an FM station to carry a single message but four messages (as described earlier), carry stereo or quadraphonic broadcasts. FM literally eliminates stations interfering with each other..."cross-talk". FM stations placed near each other on the radio dial (on nearby frequencies) or even on the same frequency will not exhibit two messages being heard at once. AM broadcasting is plagued with this.

Given two FM stations on the same frequency but about fifty miles apart, there is a point mid-way where the stronger signal simply overpowers the competing signal and wipes it out. No cross-talk. This means FM stations can be placed nearer to each other without interference, and that more FM stations can be allocated across the nation.

FM is called "high-fidelity" because it can carry the entire human audio potential from 30 Hz (cycles-per-second) -- a low, low sound, to over 20,000 Hz -- much higher, and you won't hear it. FM actually is broadcast up to about 15,000 Hz since very few people can discriminate sound differences above 15 kHz.

FM also has a "range" capability not found in AM broadcasting. Range means the ability to hear, say, the softest note of a musical instrument and the loudest crescendo of the full orchestra without having to "fiddle around" with the transmission controls. Back in the 1930s, an engineer had to physically "ride gain" with AM equipment (adjusting volume controls during a performance). With FM, that was not necessary. Today, all this is done automatically, if you care to buy the equipment.

All this Armstrong brought to Sarnoff, personally, in 1933 as a finished invention. But, in 1953: "...RCA has done more to develop FM than anybody...including Armstrong."

1953 became Armstrong's Nadir Year. Zenith Radio, after having paid him over $1 million in royalties over the years, announced it would pay no more. They, and the entire industry, were waiting to see the outcome of the legal battle. During this year, Armstrong's income all but ceased. By the end of the year, he would be broke.

RCA had offered a settlement (during the last year of Discovery), out of court. They proposed a one-year option in which they would or would-not make a cash settlement for $1,000,000 and would or would-not make another cash settlement for $1,000,000 on behalf of the rest of the industry, and there must be a guarantee by Armstrong that he would not sue anybody else in the future. Armstrong refused. No one was surprised, but his lawyer and his wife strongly advised him to accept. Marion Armstrong was seeing what it was doing to her husband and their marriage. She wished to settle it at all costs.

Armstrong knew that the money owed him through royalties on all FM radio tuners and all TV sets with FM tuners since 1946 would have

amounted to ten times more, perhaps twenty times more. He felt the settlement outrageous. By November of 1953, Marion Armstrong had become, herself, physically ill over the worry and she now knew of their disastrous financial straits. She longed for The Major to take the money and retire to their Rye Beach home where he could set-up his own lab and experiment and invent as far away from New York City, as possible. But Armstrong was now on an "all or nothing" course.

There are some real ironies in Armstrong's life -- more than this paper can tell. One has to do with lawyers. His first lawyer, before World War I, was William H. Davis who handled Armstrong's patent application of the feedback circuit in 1913. Forty years later, Davis would be hired by RCA (his firm would) to fight Armstrong in the Discovery litigation.

Another lawyer, Willis Taylor, helped Armstrong negotiate selling the superregenerative circuit to RCA, gaining The Major 60,000 shares of stock as part of the sale. Then Armstrong got another 20,000 shares for helping RCA score a coup over a competitor, making him the largest stockholder in the company. Another irony; he will use the proceeds from selling that RCA stock to fight RCA in the coming years.

Probably the most intimate lawyer/client relationship was between Armstrong and Alfred McCormack. Lessing tells us that he and McCormack talked to each other in person or by phone almost every day of their lives since they met in 1927. And McCormack was one of three known persons to speak to The Major on the last day of his life.

McCormack had assigned a young lawyer, Dana Raymond, to help him with the Armstrong patent suits as far back as 1941. It will be lawyer Raymond who will, after Armstrong's death, successfully win Marion Armstrong's suits with Emerson and Motorola. Money awards from these two trials have been estimated as high as ten million dollars. In my 1968-69 visits to Rye Beach, Marion Armstrong said that "the government takes eighty cents out of every dollar" that she received from those winnings.

It took until Spring of 1968 for the last FM court battle to be settled. A Supreme Court decision, then, did what it failed to do in 1934 when the Court found against Armstrong and in favor of de Forest. In both these decisions (1934 and 1968) what the Court actually did was to refuse to hear arguments on each case -- they let stand a lower court decision that was pro-de Forest in the 30s and pro-Armstrong in the 60s.

I suspect this also is ironic: back in the de Forest/Armstrong litigation (1914-1934), neither inventor owned the patents they were fighting over. Both men earlier had sold their patents to other companies; those companies were paying for the feedback litigation. The corporations were fighting for more money and profits. Whoever was given the credit for the invention, that is, whichever of the men's <u>date</u> of invention was accepted, would be crucial to future profits. If de Forest won, his patent date would give AT&T ten extra years in which they could charge royalties to companies using the feedback circuit. That would include every company in the U.S. and every nation in the copyright agreement signatories. The feedback circuit was basic to every AM radio set made.

It is only fair to allow some of us to wonder why the courts would, then, find for de Forest when all the evidence and every nation and electrical society in the world had gone on record saying Armstrong was the inventor. As stated earlier, even the Russians. I, myself, simply quote the Bard: "There's something rotten in _____" (the reader may fill in the blank).

The legal battle over FM had been over the infringement of those patents by the companies who knowingly used them and paid no royalty to the inventor. These companies had to find some reason, excuse, legal precedent to explain their actions. The companies contended that <u>they</u> had invented FM (or controlled the patents that did). Or they maintained that there had been no invention at all (that FM was simply an outgrowth of the radio art -- a natural development not assignable to any one person). If that didn't work, they claimed FM was not a patentable invention but merely a slight improvement over broadcasting principles known since the turn of the century.

The courts in the 1960s found to the contrary. But, as far as the inventor was concerned, a little late. Fourteen years late to be exact. Following the 1967 final decision, *Newsweek* magazine sums it up:

> "...Ill and weary of battling manufacturers who had pirated his FM patents, Armstrong died a tragically broken man of 63, who considered himself a failure.

"By any other measure other than his own final desolation, however, Armstrong ranked as the U.S.'s greatest inventor since Edison. One of the last of the free-lance attic thinkers, his inventions provided much of the basis for modern broadcasting.

"For sixteen years, he carried on an ugly patent fight with...Lee de Forest who claimed to have invented the regenerative circuit. While the U.S. Supreme Court twice supported de Forest, engineering societies have given Armstrong the credit. But his fight for his FM patents was the bitterest of all -- and the one that pushed him to suicide (emphasis added).

"When Armstrong discovered static-free FM...in 1933, the radio industry was completely apathetic...But many [in the industry] including Radio Corp. of America ignored his patents and turned out FM sets anyway, contending that...their systems were different.

"Understandably, Armstrong was outraged and threw himself into a nightmarish sequence of complex patent-infringement suits. After five years, he seemed to be making little headway. Physically, emotionally and financially drained, he despaired of ever establishing himself as the undisputed inventor of a revolutionary form of broadcasting. At his death, his major personal legacy was 21 unsettled lawsuits.

"But his widow, Marion Armstrong, pursued them, and [they] began to capitulate. RCA was first in 1954 when it settled out-of-court for $1,040,000. Gradually the others followed for out-of-court settlements of about $5 million...Edwin Howard Armstrong at last had won his full measure of vindication." (*Oct. 30, 1967, p. 70*).

Add to that figure the in-court settlements with Emerson and Motorola and the total may come to $15 million. Marion Armstrong has been dead for many years now. The couple had no children.

The Armstrong Memorial Research Foundation, founded a year after The Major's death, seeks to keep his memory alive through research grants to potentially promising and needy electrical engineering students and others. The present author was one of those "others" who received $1,500 to help in my research for my Ph.D. dissertation. This thesis was part of my University of Illinois, College of Communication degree. My advisors were Dr. Harry Skornia and Dr. Charles Sandage. It was they who turned me on to the story. It was my research challenge to tell the FM story by using primarily *the public record*.

That dissertation (originally titled *The Technical, Political and Economic History of FM Broadcasting*) was accepted for publication by the University of Alabama Press and re-titled *Armstrong's Fight for FM Broadcasting: One Man vs. Big Business and Bureaucracy*. No, I'm not trying to sell the book; it's out of print and not a copy to be found. But I owe Armstrong a debt since it was *his* story that enthused me enough to write the thesis which got me the "Dr." in front of my name.

Both my book and Lessing's discuss the other villain in the story -- left out of this article due to space limitations: The Federal Communications Commission. The history of FM broadcasting **IS** the history of Edwin Howard Armstrong. Likewise, the FM story is the history of the FCC. the two cannot be separated. That agency's role in any broadcast/ telecommunications service (AM, FM, TV, cable, satellite, telephone, telegraph) cannot be understated or overemphasized. The blame for the rather difficult time FM has had (until recently, of course) is laid squarely on the doorstep of the FCC.

In turn, the FCC's failure to do its mandated job (in the *public* interest) is directly the result of its total and complete (yes, I know that is redundant, but I'm making a point!) loyalty not to the public but to the industry it is supposed to regulate. Listen to an FCC commissioner *not* in the grip of industry bribe or background:

"But -- and this is the question -- when we have allowed private corporations to develop a national resource [the airwaves] that elsewhere in the world is government owned and controlled, should not those who are making large fortunes from this resource give us better programs?

> "To anyone who studies the situation from the inside, there is evident a contempt for educational and cultural influences that is most unusual in any field of scientific development.
>
> "A far more disagreeable aspect, and a more sinister one deterring [broadcasting] from living up to its promise, is the fact that the [broadcast] lobby in Washington has filled the "industry" with the novel idea that they control the government.
>
> "For two-and-one-half years I have watched the operations of this lobby which has endeavored to dictate the actions of the Federal Communications Commission."

And this same commissioner, Henry Payne, addresses himself to another topic -- the role of the individual inventor in modern research. On this, Commissioner Payne has this to say:

> "Of the forty-three scientists who, since 1912, have contributed most to [broadcasting's] scientific development and progress, only two have received compensation in any way commensurate with their achievements.
>
> "We have here a complex and serious economic phenomenon. Great discoveries are made and the discoverer profits little. The public, which owns the ether...profits little. A third party steps in and, discovering nothing, inventing nothing, and owning nothing, never-the-less makes great fortunes.
>
> "...(the) president of American Telephone and Telegraph went so far as to say in a paper brought out by the FCC telephone investigation (that) "if anyone tries to tell me that he is acting in a business capacity in the public interest, I am inclined to say: 'Oh, bunk!'
>
> "...those who are organized for selfish and greedy purposes have been stronger than we thought and more arrogant than it is possible to believe."

FCC Commissioner George Henry Payne made that speech in 1936! The word "broadcasting" was substituted for the original word "radio" so the reader might not guess just how long ago such "arrogant" lobbying was taking place -- sounds contemporary, doesn't it?

Another FCC Commissioner with no industry loyalties whatsoever, was Nicholas Johnson (term in the late 1960s). In a 1968 speech to the broadcasting industry, Johnson says: "Witness the disreputable record of the FCC that continues week after week. [Mind you, he sits on the commission.] You've always had a majority at the FCC and you always will. [Presidents appoint commissioners.] The only thing you have to fear from the FCC is it permitting such low standards to this industry...You have enough power in our country that you are beyond check, in my judgment, by any institution in our country today -- the President, the Congress, the FCC, the academic institutions..." Good Grief! (said Charlie Brown). (*Broadcasting*, Nov. 18, 1968, p. 40)

With very little exaggeration, then, we can say that Adversity began for Armstrong about 1914 with the beginnings of the de Forest contests, and ran almost continuously for the next forty years ending with his death. Considering the pressures and stresses of deep emotional and financial difficulties, I find this Gentle Giant of a Man to have exhibited exemplary behavior and uncalled-for patience above and beyond my understanding. I would have been a wreck.

EPILOGUE

> "Armstrong was literally killed by a society on whose terms he strove valiantly and with high purpose to serve, but which reneged on those terms and solemn contracts in the end to bedevil, betray and, ultimately, to destroy him."

That is Lawrence Lessing's final pronouncement on the tragedy and glory that is Edwin Howard Armstrong. I could not disagree with him more! His use of the word "society" is truly bothersome. "Society" had no real idea of what was going on at any time during this debacle and charade. Those actually involved, without exception, were a tiny handful of men who were industry giants, government leaders and managers, and all of them have names and party loyalties firmly attached.

Thus, if we are to take seriously Lessing's "...Armstrong was ... killed by..." and *Newsweek's* "Armstrong was pushed to suicide", then we can with great ease fill-in names of real people, real politicians, real judges, real companies and their CEOs. No spread-the-blame-on-society technique. That is the same technique used today in the Save-the-Planet campaign. "Man does these things; Man can stop these things." The average Man or Woman has had little or nothing to do with it. Small groups of the powers-in-charge must take the major responsibility (or, using the word everybody hates today: "blame").

A reviewer of my own book on Armstrong made it quite clear that what happened to The Major is as common as the head cold and as ubiquitous as music videos, and as pervasive as unethical behavior..."The Armstrong story is a prototype of illuminating the interaction between big business and the inventors who supply it with money-making ideas, and big business and the federal regulatory commissions created to protect "the public interest." (Doris Graber, University of Illinois/ Chicago Circle, quoted in *Perspective*, Dec. 1973)

Armstrong's character contained every positive quality and virtue that centuries of philosophy and religion have extolled as ideal. He is not known for his sense of humor but for everything else, he seems to have "had it in spades", to use a term of his period: loyalty, generosity, genius, warmth, thought of others, sharing his wealth (straight out of the Bible), and pursuit of truth. I suppose you can add any I've forgotten. Unfortunately, also, stubborn, doggedness and a naive belief that Truth Will Out victorious and shining. Well, we believed in Santa Claus at one time or another.

Lawrence Lessing died in 1990. But he is certainly here in more than spirit. It is to his research that I owe a great debt in understanding Armstrong's character and behavior. Part of my contribution to the 100th anniversary of The Major's birthday is to make sure Mr. Lessing gets much of the credit, and I have borrowed from him liberally. I wrote him for permission to use material from his book in 1971. Part of his answer goes: "You are welcome to quote from the book to whatever extent serves your purposes. It is an interesting subject and one worth wider analysis and understanding."

The reason I was encouraged to do my dissertation on Armstrong was because my advisors at Illinois' College of Communications felt the real story had not been pulled together and that it had, by conspiracy or coincidence, been so hidden from public scrutiny.

If any reader can find the original hardback, by Lessing, from Lippincott Publishers, or the Bantam Book paperback reprint which came out in 1969, you will find the Armstrong story written in far better prose than in my own. And the story is exciting and infuriating to one's sense of what is right and wrong.

I used Lessing's closing paragraph to end my own book and I feel it remains as the best epitaph to The Major. Notice the immense and difficult task he sets for Society, therein called "a people":

> "The lonely man listening to music in the night, the isolated farmer hearing nightly news of the world, the airplane pilot guiding his aircraft safely through the ocean of the sky, the astronaut now in his capsule gathering in the whispers of space, the Earthbound emergency crew contending with some mission of mercy or disaster, the army on the move and the man in his armchair -- charmed by a great play, a symphony, a speech, a game of ball -- all owe a debt to this man who, in some forty years of high fidelity, fashioned the instruments illimitably extending the powers of human communication.
>
> "History in its long course is already beginning to correct many of the injustices beset him. FM is assuredly on its way to becoming the leading broadcasting system of the country and the world.
>
> "And someday not too distant, a people grown wiser, will put down the arrogance of monopolies (emphasis added) and insure to itself a radio-television system at least as free as its press. But when that day comes, it will be well to remember that in this twentieth century as in all others, these advances were won only at great cost in blood and travail."

Well, I told you that he wrote better than me...I...whatever.

Indeed, remembering is the least we can do.

MOBILE RADIO IN THE NETHERLANDS

by **Louis Meulstee, PA0PCR (M)**

SUMMARY

A brief history of mobile radio developments by the Dutch PTT[1] is given, starting from the mid-thirties through the gradual postwar revival, to the present day.

The Dutch National Radiotelephone Network, inaugurated in 1949, was the world's first nationwide public radiotelephone system.

Some mobile radiotelephones and base stations with significant historical importance are briefly discussed.

Although specialized mobile radio equipment is developed and made for PTT by the industry at home, much material is purchased from manufacturers abroad.

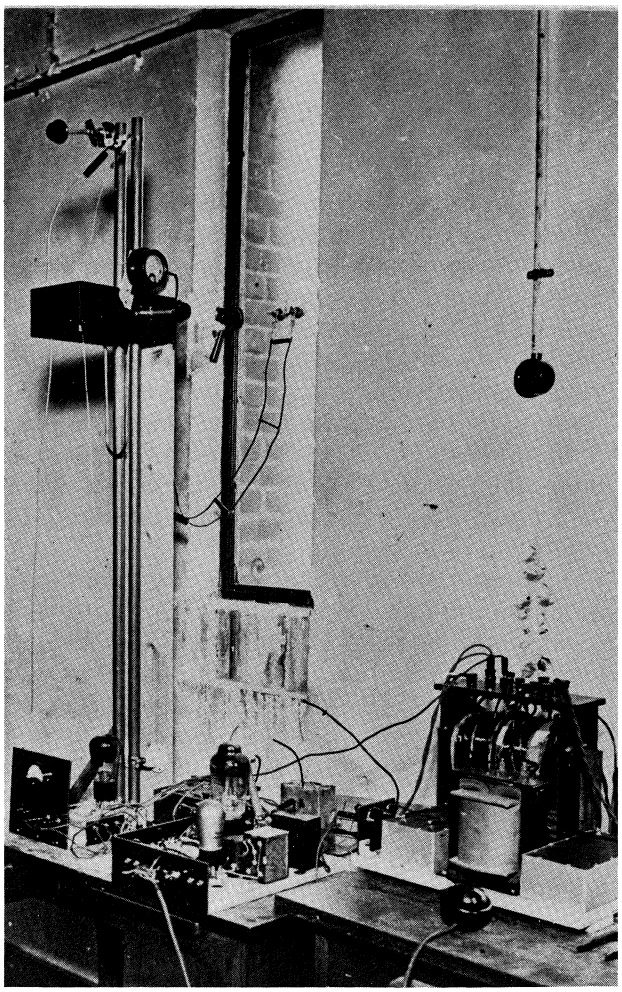
The exploitation of private and public networks and mobiles differs from that used in other countries.

INTRODUCTION

During the early 1930s, the Dutch FCC, a department of the PTT, operated a number of radio direction finder (RDF) vehicles in order to locate clandestine transmitters. Communication between the RDF parties, needed in order to exchange cross bearings, was by telephone only and often resulted in long delays.

Designs of simple 5 meter super-regenerative equipment, as published in *QST*, brought attention to the problem and eventually a solution appeared. In 1934, the Dutch PTT radio-laboratory was asked to provide two of these sets for radio-communication between RDF vehicles. The trials with the rather crude and simple sets were successful, especially because the required operating ranges generally did not exceed more than a few miles.

[1]**PTT**, the Dutch Post and Telegraph organization, recently privatized into PTT-Post and PTT-Telecom.



(1934) Experimental base station developed by the Dutch PTT radio laboratory, installed in the attic of the PTT GHQ building in The Hague. Note the use of symmetrical feeder lines through the glass window to the aerial system.

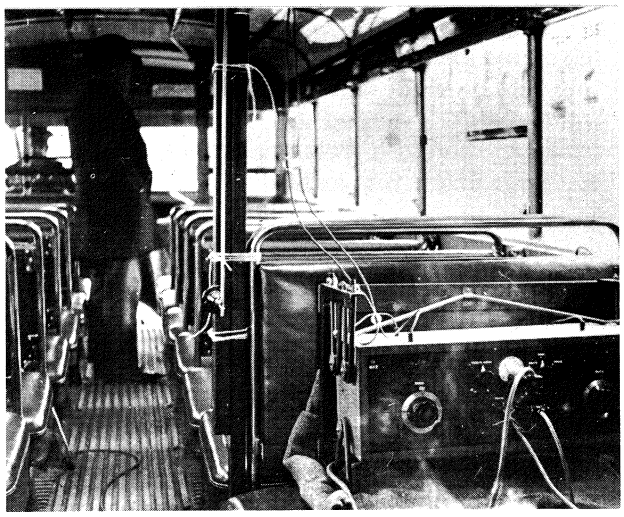
THE EARLY YEARS

The trials which involved demonstrations for other potential users, roused much interest. In 1936-1937, a national commission in which PTT and representatives of poiice, fire brigade, etc. took part, laid down specifications for a more practical radio-telephone system operating on VHF. The national industry was invited to produce a prototype of this equipment.

Of the eight manufacturers who participated, the design of the Nederlandse Seintoestellen Fabriek (NSF), a subsidiary of Philips-Eindhoven, was chosen as most suitable. A prototype was tried early in 1938, and the first sets of a series of 200 were delivered mid-1939.

The NSF design came in two versions: a mobile station **DR38a** operating from a 6 volt vehicle battery and a fixed station **FR38a** powered by AC mains -- the only difference being the built-in power supply unit. Special features were the Kolster automatic frequency-compensating circuit of the transmitter master oscillator and an RF amplifier in front of the super-regenerative detector. The design resulted in a highly successful set.

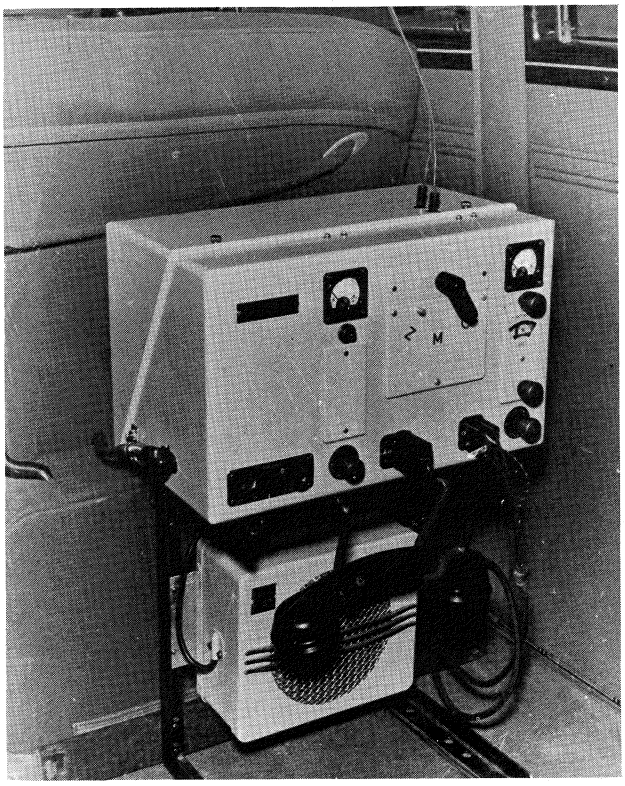
Most of the **DR/FR38a** equipment went to large municipal fire brigades, ambulances and police. A number of the sets were reserved for internal use by the FCC. A special FCC branch arranged for the installation and service of the radiotelephones. During the mobilization of the armed forces due to the outbreak of hostilities in Europe, a number of sets were ordered by the Dutch War Office.



(1935) The early years. Trials with a PTT VHF radiotelephone installed in a city bus. Having a separate receiver and transmitter, provision was made for full duplex operation.

GERMAN OCCUPATION

When the Germans invaded the country in May 1940 during the early morning following the capitulation, the **DR38a/FR38a** sets were requisitioned and taken to Germany. It is interesting to note that a number of the sets were used for short-range communication by the hated German security force "Ordnungs-Polizei". Only a very few sets survived the war; one now being on display at the Dutch PTT museum in the Hague.



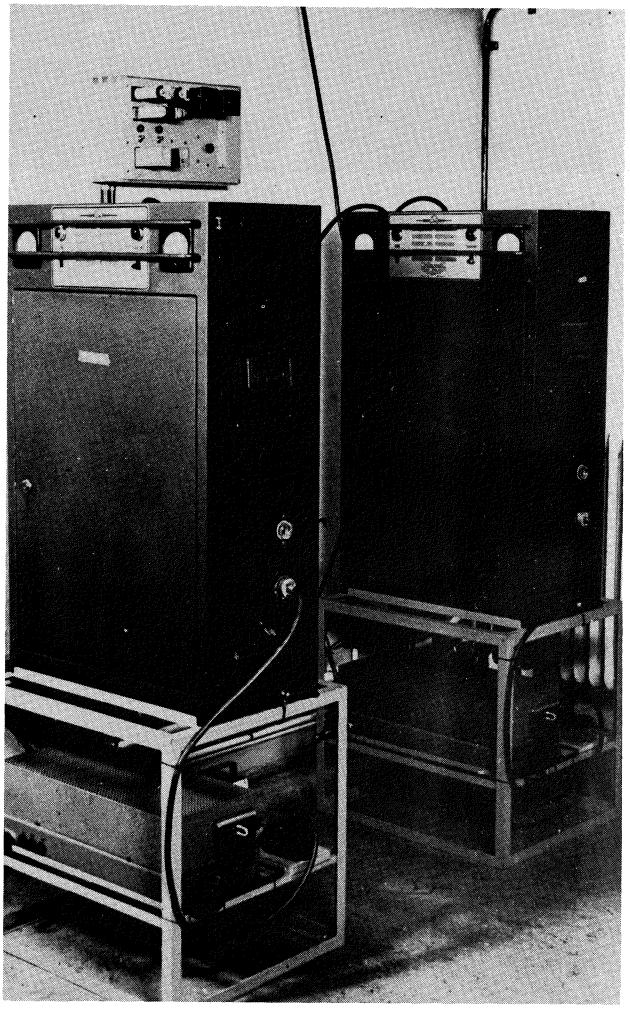
NSF Type DR38a transmitter/receiver was the first practical mobile radio telephone in Holland. The set was developed in 1937 from PTT specifications and saw use from 1939 onwards. It operates in the frequency range between 66-75 MHz having a rf power output of approximately 4-5 Watts. Change-over from receive to transmit is effected by the large lever on the front panel. The transmitter is pre-set on a single frequency while the receiver is tunable over the frequency range.

REVIVAL

After the liberation by the Allies in May 1945, much effort was made to restore the heavily damaged communications network in the country. This was not an easy task as many of telephone exchanges were either looted or seriously damaged by the retreating Germans. On top of this was a virtually wrecked railway system, large numbers of destroyed bridges, and a water-flooded countryside which made traveling very difficult.

The Government in exile (in London) had already taken steps to prepare for such a situation and had ordered from the U.S.A. 200 **VHF/FM**

radiotelephones for fixed service. As it was anticipated that the Germans would destroy all telephone exchanges in the country at their retreat, the initial plan was to build an emergency radio-network based on the telephone trunk network. Therefore, frequencies were ordered for a star-shaped net, with extensions to local networks.



The 1498 transmitter/receiver manufactured from 1943 onwards by the Link Radio Corporation was the backbone of the post-war (mobile) radio communication in the Netherlands. It proved to be of much value especially in the early months after the liberation of the country, where the sets were used for vital point-to-point communication, at times being the only means of communication. The set had a rf output of approximately 50 watts and operated on one fixed crystal-controlled channel in the range of 70-100 MHz. The equipment proved to be very reliable and is recorded to have been used up to the early 1960's. In this picture are two Link base stations of the Dutch phase 1 National Network, installed in the main Post Office of Rotterdam. Special PTT-developed audio agc amplifiers are mounted in trays under the Link sets.

However, in 1945, knowing that many exchanges had survived, the plan was abandoned and the 200 Government sets were put in the hands of the Dutch PTT (to whom, later, the bill was presented....). It then was decided to use the sets for vital interim communication at places where telephone lines and exchanges had been put out of service.

Within a few months, a number of these radiotelephones were installed, providing point-to-point communication until wireline communication had been restored, for a variety of official organizations including the War Office.

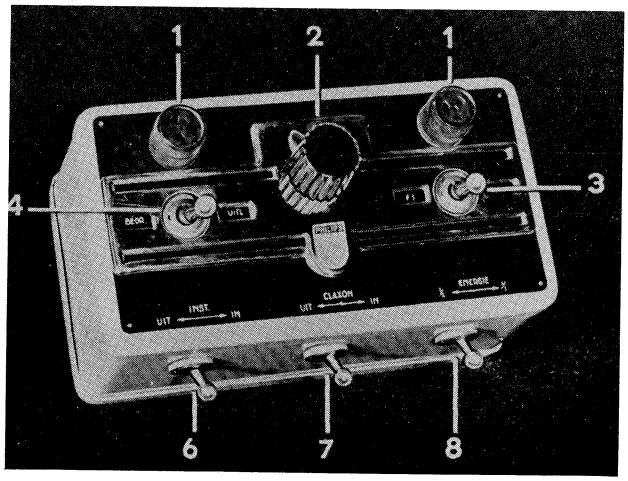
(1947) Link set in operational use on board a vessel. Not being specially designed as a mobile station and operating on 110 volt ac only, it was powered from a special generator or by a separate petrol-electric generator. One particular sentence in the US War Department handbook of the set is very striking, and has never been repeated in any US Signal Corps handbook: **"...the equipment utilizes the Armstrong frequency-modulation method of transmission and reception...".**

"LINK" EQUIPMENT

The American equipment was affectionately known as "Link" sets, named after the manufacturer Fred M. Link Radio Corporation. Service and alignment of the Link sets appeared to be straight-forward as the equipment was built into an easy accessible rack, comprised of separate units.

Their installation became a difficult task for the PTT employees concerned because of the bad roads, insufficient clothing and food, and bad accommodations. Nevertheless, in September 1945, more than 50 Link sets were installed, all giving much satisfaction to their users.

The Link **Type 1498** transmitter/receiver and associated **Type 1504** remote control unit remained in service by the Dutch PTT until the early 1960s; the author recalls having seen Link remote control units in operational use as late as 1967. The equipment not only was used as base stations; it is recorded that the Link sets had been installed in icebreakers operating on the major Dutch waterways and on tug-boats in the harbor of Rotterdam.



(1949) The Philips type SRR192 was the first Dutch postwar mobile radio telephone using frequency modulation. It operated on two crystal-controlled channels in the frequency range of 70-87.5 MHz having a rf output of 15-20 watts. The Dutch PTT primary used the set during phase 1 in the National Network. The transmitter receiver unit was usually installed in the back of the vehicle, the control unit mounted under the dashboard.

NATIONAL PUBLIC NETWORK

After the conspicuous successes of the initial Link nets, the equipment started to be used for commercial closed-networks. Additionally, a growing need was felt for a nationwide public radio network, connecting a mobile to any telephone subscriber.

As early as 12 April 1949, the first base station in the first phase of the National Network was inaugurated, using two semi-duplex radio channels with frequencies repeated throughout nationwide-installed Link **type 1498** base stations. Additional separate receivers were installed to increase coverage in rural areas. The two-channel mobiles, type **SRR192**, manufactured by Philips, were developed from a British design.

THREE MINUTES

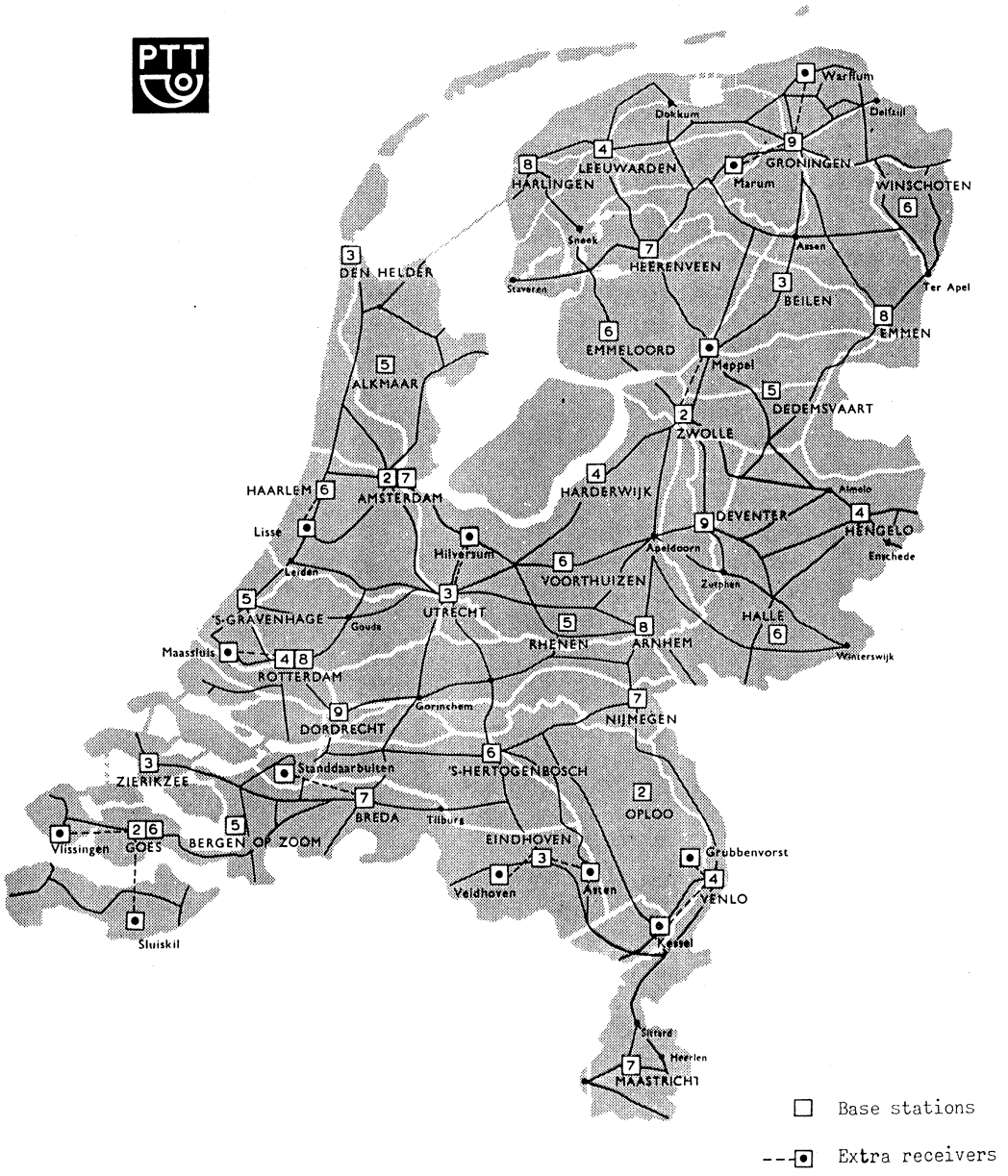
When making a radio-telephone call, the subscriber drew the operator's attention by pressing the microphone button for approximately five seconds. After requesting the mobile's identification number and the telephone number called, the operator closed down, calling the mobile again when the connection had been completed.

Calling a mobile by dialing the OO5 National Network operator was a bit more complex. The operator needed the approximate whereabouts of the mobile. A mobile was expected to switch to the frequency of the nearest base station. Additionally, he had to listen to the traffic until his number was announced by the operator. Due to the relative small number of base stations, the duration of a call was limited to only three minutes. Within a few years, the traffic load had grown gradually and further expansion was urgently needed.

SECOND PHASE

During the second phase, in 1955, the National network was expanded with six frequency channels. In close cooperation with Philips Telecommunications Industries, - PTI formerly NSF - new equipment was developed, comprising custom-made base stations, telephone terminal equipment and eight-channel mobiles.

The new eight-channel network provided an improved nationwide coverage having almost doubled the number of base stations.



Base stations of the National radio-telephone network in the Netherlands during the early 1960s, phase 2 completed.

In Holland, a country with many rivers and canals, many subscribers of the National network are owners of inland freight vessels. One unhappy day, a Master had a set installed and proudly made his first radio telephone call to his wife. As he was rather far away from the nearest base station, the conversation faded away now and then. On one occasion, the wife of the Master said:" I can't hear you anymore, Dear", to which the helpful operator cut into the line saying:" Your husband is sinking away, Madam". The reaction was a loud cry, then silence...

In 1950, the special FCC branch changed to a special nation-wide PTT department "Mobilofoon-service" with 17 branches. This organization exists today, and now is named PTT-Telecom Mobile Communications department.

PAGING

Continuous listening to the traffic was a great strain for many subscribers of the National network. This was rectified in the second phase, when a

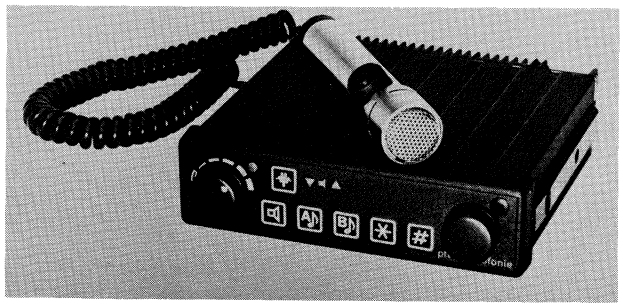
loudspeaker paging system was adopted allowing the operator to switch on and off the loudspeakers of all sets in a area in order to broadcast the call list. Additionally, tone-calling was introduced to reduce the spurious operator calls, caused by interference.

In December 1955, PTT started an experimental selective paging system to investigate the viability of such a system. The success of the trials led to the inauguration of the *SEMAPHONE* a nationwide selective paging system, the first of its kind in the world. In a future article, the historical developments and brief technical details of this remarkable system will be given.

DIRECT DIALING

For cost saving reasons, no attempts were made to provide direct dialing and selective calling as used in some European countries at that time.

A PTT-developed experimental direct-dialing system, which was actually an improved version of the Regional public network installed in the early 1970s in Rotterdam, was highly satisfactory. It was abandoned in 1980 when a fully-automatic radiotelephone network became operational. This network, still operational at the time of writing, is compatible with the German, Luxembourg and Austrian obL-B net, thus having a semi-European coverage.



(1981) The Condor 16 radio telephone has been developed exclusively for PTT Telecom. This mobile set is primarily used in private networks. It operates on VHF or UHF, depending the model, having 80 radio channels. All functions and parameters are programmable, including rf output. Recently a low-cost version has been introduced having a reduced number of channels.

Presently a second direct-dialing network (cellular, operating on 460 MHz) and a third (cellular) network (working on 900 MHz), have been installed while a future pan-European network is in preparation.

The operator-controlled National networks, which had been expanded in the late 1960s by a large number of channels and base stations, and the Regional public networks in Amsterdam and Rotterdam, were closed in 1985.

CLOSED NETWORKS

Next to the National and Regional networks, a considerable number of commercial closed-networks have been installed by the Dutch PTT. Equipments made by a variety of manufacturers, depending the customer's operational demands, have been used throughout the years. In this field, PTT-Telecom still works closely with the international manufacturers; e.g., in the early 1980s, the versatile Condor 16 radiotelephone was

(1991) PTT Telecom, in close cooperation with the customer and manufacturer, developed and installed a nationwide covering radio network for the Dutch Tourist Association ANWB. It provides speech and data communication between dispatcher and road-patrols of the breakdown-service, having direct access to the customers data-system. Photo shows mobile control unit and display. (Photograph courtesy ANWB, Royal Dutch Tourist Association)

developed to PTT specifications. In the recent years, PTT-Telecom developed and installed comprehensive maritime VHF radio networks along the river Maas extending to Rotterdam and the Scheld estuary from the North Sea, towards Antwerp. Very recently, large nationwide networks were delivered providing complex communication facilities for Dutch Rail and for breakdown-service patrols of the Royal Dutch Tourist Association ANWB.

EXPLOITATION

In most countries, public radiotelephone networks are exploited by the Government (usually the PTT or the Post & Telephone administrations). Approved mobiles are sold to subscribers by a third party, usually a manufacturer or agent. Until very recently (with privatisation), the Dutch PTT considered a mobile more or less as an extension of a telephone trunk. A subscriber was only allowed to lease equipment from the PTT. The advantages of renting a mobile -- low initial costs and no obligation to continue when no longer needed -- made the National Network very popular at the time.

CONCLUSIONS

After a slow initial start, the number of radiotelephones increased considerably, having a remarkable resemblance to the growth of radio-telephones in the USA but with a time-lapse of approximately 10 years.

In 1950, the year of the completion of the Dutch National Network, the world's first public mobile- radio network offered complete nation-wide coverage. This was, of course, not only due to the innovative work of PTT but also the fact that Holland is a relative small country and has a fairly flat surface.

PTT, independent from the early days until the present, purchased equipment either to specifications laid down by PTT, or use standard equipment adapted for PTT use.

It is remarkable to see Major Armstrong's inventions as the backbone of mobile communications: in the early **DR38a** with its super-regenerative detector and, after the war to the present and probably well into future, frequency and phase-modulation being employed using super-heterodyne receivers.

ACKNOWLEDGMENTS

The author wish to thank Mr H.Lubsen, late PTT Telecom, for his information on early developments; without his help this paper could not have been so complete and accurate.

Thanks are due to Mr J.W.M.Caspers of the PTT Museum, The Hague, Holland, who kindly provided historical information and most of the photographs published in this article.

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THE VOICE OF AMERICA

by **Lt. Gen. Walter E. Lotz, Jr., Ph.D.** (USA Ret.) (F)
Chairman, Radio Engineering Advisory Committee, Voice of America

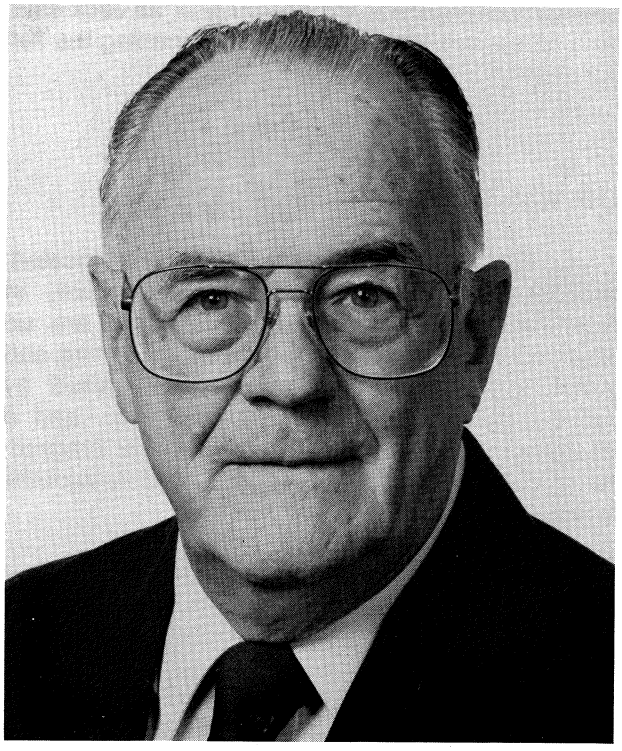
A BRIEF HISTORY OF THE VOICE OF AMERICA

We are living in an age when communication has achieved fabulous importance...There is a new and decisive force in the human race, more powerful than all tyrants. It is the force of massed thought -- thought which has been provoked by words, strongly spoken..."

Off hand, you would think these words were written in recent years but, as hard as it is to believe, they were written by the great American playwright, Robert Sherwood, over 50 years ago. Several years later, Sherwood became the "Father" of the Voice of America.

In 1940, Sherwood was the speech writer for President Roosevelt and became the head of the newly-formed Foreign Information Service, the predecessor of the present day United States Information Agency. After Pearl Harbor, Sherwood became concerned about the flood of German, Japanese and Italian propaganda inundating the United States. He invited John Houseman, then a writer, director and producer in Hollywood, to take charge of a new Radio Service to counter this propaganda. On February 14, 1942, the first broadcast of this new Service was made in German, beamed on Europe. The announcer opened the 15 minute program with the words: "Here comes a voice from America." With that, the "Voice of America" was born and named.

The Voice was not created as an outlet for an America Axis Sally or Tokyo Rose -- it was charged by Congress to broadcast the news factually and without bias. Under Houseman, the Voice told the truth even though the news during the early war years was almost all bad from the point of view of the United States. As the War progressed, the news became more favorable and the Voice grew rapidly, eventually broadcasting in 41 languages. At the end of the War, it was permitted to languish until 1948 when, prophetically, the Berlin Blockade and the onset of the Cold War brought its vital services back to life.



Lt. Gen. Walter E. Lotz, Jr.

During the Korean War, the VOA's worldwide network was expanded by Congress on the recommendation of RCA Board Chairman David Sarnoff. The Voice has continued to this day to broadcast the news accurately, objectively and timely. It has gained worldwide respect for reporting, in the native languages of its listeners, such important events as international crises, the Soviet-American summits, the Space Age, the Vietnam War, and the Watergate Affair. To millions of overseas listeners, the broadcasts of the VOA reflect American thoughts and American institutions.

An American businessman has written that he has visited 86 countries and has been surprised to learn that many foreigners consider the United States' best known products to be Coca Cola, rock music, Hollywood movies, and the Voice of America.

Amongst the VOA's 22 Directors is one of special interest to us. He was Jack Poppele, radio pioneer and distinguished member of The Radio Club of America. He served the Club as a Director, Vice President, and Director Emeritus for Life. Jack was appointed by President Eisenhower to be the Director of the Voice of America from 1952 to 1956 during its Korean War expansion and, as Jack said, "at a time when the Russians were jamming the hell out of us."

THE VOA TODAY

The headquarters of the VOA is located, appropriately, on *Independence Avenue*, in Washington. Included in its facilities are an ultramodern news room for collecting, sorting and translating the news; 29 studios staffed by native-speaking announcers/newscasters; and a Master Control Center which routes the program material to the transmitter stations, and designates the frequency and power to be used.

There are 15 VOA transmitter stations; four are within the United States. These are located at Delano, CA., Bethany, OH., Greenville, NC., and Marathon, FL. All of these stations broadcast to overseas target areas. Program material is transmitted from Washington to the Greenville station which distributes the material to the other transmitter stations over a satellite network. Greenville has the largest antenna fields occupying three sites with a combined area of nearly ten square miles or about half the area of Manhatten Island.

The VOA operates eleven overseas transmitters in Central America, Europe, Africa, and Asia. Last June, the station in the Philippines was showered with volcanic ash during Mount Pinatuba's eruption. Although it still is operating, a second eruption or a change in the attitude of the Philippine Government could cause its permanent loss.

The Voice operates medium-frequency transmitters at a number of sites in close proximity to target areas. For example, a 50 kW medium-wave radio station at Marathon beams Spanish language programs to Cuba. Television programs also are broadcast from this station. For the signals to reach Cuba, the transmitter and its antenna are elevated on an aerostat -- a large balloon tethered to the station.

THE RADIO SPECTRUM

The technical objective of the VOA is to provide intelligible voice signals throughout areas that are typically 3,000 km wide, 1,500 km deep, and 3,000 km from the transmitter site. This requires carefully selected frequencies. The VOA has developed its own frequency prediction model, VOACAP. It is based on IONCAP which commonly is used in point-to-point service. Because the VOA is interested in satisfactory signals over a large area, computer runs of IONCAP are made along successive radii from the transmitter station until the total area within the range of the station is covered. There may be several thousand radii in the iteration requiring about 24 hours of time on a VAX 8250.

Until May 1987, the signals of the VOA were jammed by the Soviets, their satellite nations, and China. Even in today's jam-free European environment, the VOA's high-frequency broadcasts are significantly degraded by interference. In the late 1980s, the number of 500 kw broadcast transmitters and the number of countries using them more than quadrupled. Today, frequency piracy and signals from unlicensed sources are everyday occurrences. For the transmissions to reach its foreign listeners, the VOA has high-gain antennas.

ANTENNAS

At the VOA transmitter station in Delano, California, TCI Corporation , Technology for Communications International, has constructed for the Voice an electronically-steerable high-frequency antenna, capitalizing on technology used on many Earth satellites -- phased-array dipoles.

This array delivers a high-frequency beam capable of being steered vertically from 4 to 20 degrees above the horizon, and azmuthally from +30 to -30 degrees relative to its boresight. The antenna, under optimum conditions, when fed by three 500 kw co-phased transmitters provides an effective radiated power of 2.3 billion watts. The installation consists of two separate radiating structures, one covering 6 to 12 MHz and the other 13 to 26 MHz. The low-frequency structure consists of three adjacent sections, each section consisting of 24 dipoles arranged 4 wide and 6 high. The 72 dipoles in the structure are fed through computer-driven switches that control the power and phase of the radio energy fed each of them.

Because of the wavelength of the high frequencies, the physical dimensions of the VOA array are of orders of magnitude greater than those in orbit. The whole antenna is a quarter-of-a-mile long and requires towers that are up to 410 feet high. Impractical as these antennas may be for Amateur radio operation, they give the VOA great flexibility in laying down maximum signal strength into targets that arise in unpredictable areas throughout the world.

In December 1989, the Delano antenna was being used with a rather broad beam directed to South America when the U.S. initiated military operations against President Noriega in Panama. On instructions from the VOA headquarters in Washington, the station personnel electronically slewed the pattern 12 degrees to the east and narrowed the beam. This increased the intelligibility of the signal in Panama six-fold and provided Panamanians their only source of news of the progress of the military operations in their country.

MODERNIZATION

During the first 40 years of its operation, the Voice added new equipment to provide additional coverage and additional power but little of the older equipment was replaced. Still in use today in Munich are four transmitters captured by the Army Signal Corps in 1945. The VOA inventory has become a mixture of equipment of the vacuum tube era up to the solid state era. Because training, maintenance and parts replacement have become major problems, the Congress, in 1983, authorized a $1.3 billion modernization program.

As part of this modernization, a new medium-wave station in Belize was completed last year. The construction of a new short-wave station in Morocco was started in 1985. The station has ten newly-developed 500 kw, variable power, high-frequency transmitters. In full operation, the station will need 8 - 10 Mw of power -- enough to meet the demands of a small city. The antenna field will have 12 steerable antennas of the type used in California, oriented in different directions to provide coverage in Eastern Europe, Western Soviet Union, the Middle East, Southwest Asia and Central Africa.

When this station goes on the air in 18 months from now, it will have cost more than $210 million and will be the most advanced state-of-the-art high-frequency broadcast station in the world. A somewhat smaller but similar station is in the early construction phase in Thailand to provide much needed coverage in East Asia.

OTHER NETWORKS

Other governments -- principally the British, German, French, Dutch and Canadian -- operate world-wide broadcast news networks -- and the Voice of America is not the only "Voice of America". During the Cold War, the Congress funded two other radio networks, smaller than the VOA and under separate management. They are Radio Free Europe, directed at Eastern Europe since 1950, and Radio Liberty, directed at the Soviet Union since 1953. Since 1958, the U.S. Information Agency has also been broadcasting television programs over its WORLDNET satellite networks -- one serving the Atlantic area and the other, the Pacific Basin.

EFFECTIVENESS OF THE VOICE OF AMERICA

For 47 of its 50 years, the Voice of America remained virtually unknown to America audiences since Federal laws bar VOA broadcasts to within U.S. borders. But, in June 1989, the operations of the Voice erupted into public view like a volcano, spilling lava into China and from there into the worldwide press.

Leaders of the pro-democracy revolt in Tiananmen Square had been inspired by VOA broadcasts into China. In fact, several of the leaders had been newscasters for the Voice while they were students in our country. As soon as the revolt got underway, WORLDNET added its television programs to supplement the short-wave radio programs. China retaliated by sending two VOA correspondents home and jamming the frequencies of the VOA high-frequency radio and TV channels. The VOA responded by transmitting its programs over million-watt medium-wave transmitters in the Philippines, in Thailand, and in Sri Lanka.

The Chinese revolt, though unsuccessful, stimulated a second eruption of of the Voice several months later with its lava flowing over Eastern Europe this time. Dissident groups, following the lead of the Chinese students, successfully established democratic governments in Czechoslovakia, Poland, and Hungary in almost

bloodless revolutions. Shortly thereafter, East Germany and the Soviet Union ousted their Communist leaders

On February 20, 1990, Vaclav Havel, the newly-elected president of Czechoslovakia, arrived in Washington and, at his request, visited the headquarters of the VOA. As he toured the Voice's facilities, he stopped at each studio used for broadcasting to his country, shook the hands of the newscasters, and thanked them for bringing about the downfall of the Communist government of his nation. After the tour, Havel attracted world attention when he publicly stated to the Voice of America personnel and to the press: "You informed us truthfully of events around the world and in our country as well and, in this way, you helped bring about our peaceful revolution. Now your work has taken a new meaning. You will have to inform us how to create democracy. We have a lot to learn."

Arpad Guncz, the new president of Hungary, and Lech Walesa of Poland, also visited VOA facilities to praise the broadcasts for promoting and sustaining the opposition movements in their countries. They, like many other political leaders of the newly emerging democracies, asked for assistance in forging their new governments. The VOA is responding by informing them how to convert from a military to a democratic economy, how to write a constitution, how to run a free press, how to set up small businesses, how to run a meeting under *Roberts Rules of Order*, and similar democratic processes. And people are listening! In Eastern Europe, VOA has by far more listeners per broadcast hour than any other international broadcast service.

The VOA volcano erupted a third time right in your living rooms on November 15, 1990. On *ABC Prime Time Live*, Peter Jennings noted, after an exclusive interview with Saddam Hussein in Baghdad, that the Iraqi leader, who speaks only Arabic, seemed exceptionally well-informed about events in the Middle East. Saddam's interpreter confided to Jennings that the Iraqi president had just come from listening to the news in Arabic on VOA. Diane Sawyer, anchoring the program in Washington, exclaimed: "What a great scoop for the Voice of America."

During Desert Shield and Desert Storm, the Voice of America, along with CNN, became the news centerpiece of the world -- CNN broadcasting in English and VOA broadcasting in 45 languages including English. During Desert Storm, over 1,000 foreign radio and 100 foreign television stations picked up VOA news feeds and rebroadcast them to their listeners in their native languages.

At 11:30 PM, Sunday, August 18th, this year, the volcano erupted again when the VOA newsroom broke the news to the world that Soviet President Mikhail Gorbachev had been ousted from power. The leaders of the attempt to overthrow the government of Russia made a fatal error. They closed the Russian radio and television stations but they failed to jam the signals of the Voice of America and its companion network, Radio Liberty. By 7:00 AM the following morning, the VOA broadcasts in Russian and the other eight languages of the USSR were virtually all news, dropping other scheduled cultural programs. That day, CBS correspondent Jonathan Sanders, calling from Moscow, told Dan Rather: "It will now be up to the VOA to get the news to the Soviet Union."

In the early hours of the coup, President Yeltsin wrote an address to the Russian Armed Forces appealing for their support in his opposition to the coup. He handed a copy to his aides and instructed them to get it to the Voice of America to broadcast to the Russian people. The VOA had increased its transmitting hours, added new frequencies and strengthened its signal to the Soviet Union. VOA correspondents in Moscow kept the world informed of the events as they occurred. At the height of the crisis, two of them reported live from the Russian Parliament, using portable cellular phones.

Although the VOA does not have primary coverage in the Crimea, President Gorbachev was able to keep informed on the events by listening to the BBC, Radio Liberty and the VOA from his dasha in the Crimea. President Yeltsin was confident of the success of his counter coup from VOA broadcasts that reported a large segment of the Russian people were behind him. In a post-crisis letter to the VOA, the All-Russian State Television and Radio Broadcasting Company stated that: "Millions of Soviet people, denied the possibility of receiving information from Russian sources, listened to the Voice. It inspired them with faith and determination to fight dictatorship."

THE FUTURE

The President's Advisory Commission on Public Diplomacy, in its 1991 report to the President and the Congress, concluded that: "A global U.S. Government radio and television capability is a necessary instrument of American policy," and that

"Direct short-wave and medium-wave broadcasting will be needed for some time to come in the Soviet Union, China, Africa and the Middle East." It also recommended that the three networks, Radio Free Europe, Radio Liberty, and Voice of America, be examined to determine the extent to which they should be combined.

The President has appointed a Commission that currently is studying the last recommendation. Its report should be submitted to the President, soon.

CONCLUSION

On September 27th, President Bush, in his address to our nation and the world, announced the stand-down of our nuclear alert forces and proposed mutual reductions in the nuclear arsenals of the major powers. He noted that "the flags of democracy are flying all over the world."

On February 24, 1992, the VOA will complete 50 years of service to our Nation. It has done its job well: it has proven that communication is indeed more powerful than tyrants; and it has provided our Nation with a comparatively inexpensive, non-lethal weapon that, without firing a single shot has:

torn down the iron curtain;

broken the hold of Communism in Eastern Europe and Western Asia;

planted and nurtured the seeds of democracy in other nations; and

opened the doors of the World, just a crack, to international peace and understanding.

There is more yet to be done.

Ladies and gentlemen, this is
YOUR VOICE OF AMERICA!

Walter E. Lotz, Jr., graduated from the U.S. Military Academy in 1938. He then received an MS in EE from the University of Illinois and a Ph.D. in Physics from the University of Virginia. He served on the staff of the Ninth Air Force in Europe during World War II, was Signal Officer of the Eighth Army in Korea, and directed communication and electronics for all Military Forces and other agencies in Vietnam. In 1967, he was appointed to serve the Army as its first Assistant Chief of Staff for Communications and Electronics, a newly-created staff position formerly known as the Chief Signal Officer. Later, he was assigned to Fort Huachuca as the Commander of the Army's Strategic Communication Command, and then to Fort Monmouth as the Commander of the Army's Communications and Electronics Command. His last military assignment was as Deputy Director and Chief Engineer of the NATO Integrated Communication System. He retired from the Army as a lieutenant general in 1974.

Since his retirement, he has served in the Office of the Secretary of Defense as the Director of Testing and Evaluation, in the Treasury Department as the Deputy Assistant Secretary for Advanced Technology and, in civil life, as a consultant to industrial concerns. He has been a member of the Radio Advisory Committee to the Voice of America since 1987. He was commended by President Reagan for this service which still is continuing. He is a Fellow of The Radio Club of America and a Life Fellow of the IEEE. He was awarded the Sarnoff Citation by The Radio Club, at its annual awards dinner on November 22, 1991, for "significant contributions to the advancement of electronic communications."

Because of illness, General Lotz was unable to receive the Sarnoff Citation in person or to deliver the address ***A Brief History of the Voice of America*** *as the keynote speaker. He requested his friend, Mr. Jerry S. Stover, P.E. (F), to represent him and to present the address.*

HONORS AND AWARDS — 1991

PRESENTATION OF THE ARMSTRONG MEDAL AND CITATION TO E. KING STADOLA

by **Frank A. Gunther, W2ALS** (Fellow & Director Emeritus)

The Armstrong Medal award was initiated in 1935 by the Directors of The Radio Club of America. It is awarded to any person within the Club's membership who shall have made, in the opinion of the Board of Directors, an important contribution to the radio art and science. This medal with accompanying Testimonial Scroll is our Club's most prestigious honor. The Board does not make this award annually, but only when it has found a worthy candidate.

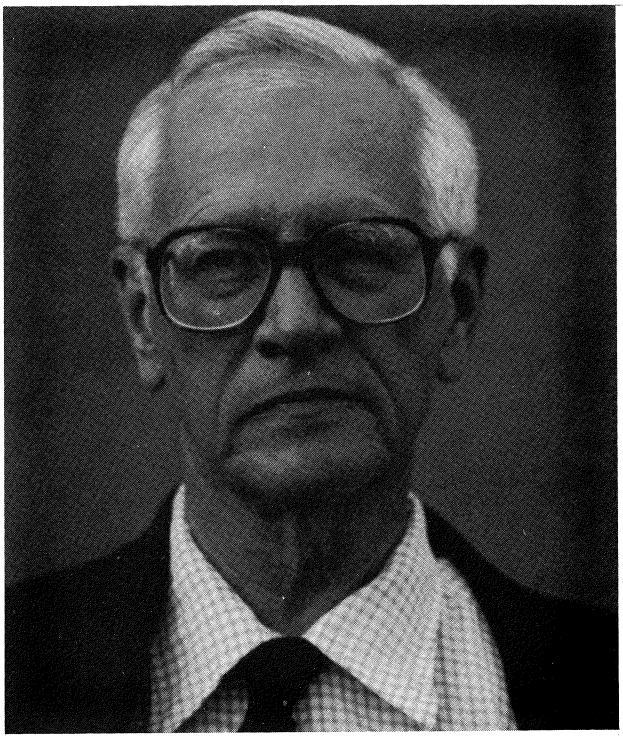
This year, I am happy to say, we have selected E. King Stadola, of Melbourne, Florida, who was elected to the Grade of Fellow in 1964. His name now joins the list of prior awardees -- all Radio Club of America members -- whose careers embody a large portion of the important contributions to the Radio Art.

King holds a Bachelor of Science, and Professional Degrees in Electrical Engineering from Cooper Union, and has both government and industrial experience in the technical areas of communications, radio, radar and aerospace systems.

During World War II, he was a radio engineer at the U.S. Signal Corps' Camp Evans Laboratory, responsible for the development of special radar equipment including coherent pulse radars out of which grew one of the first operational moving-target detection systems. This led to the Signal Corps Moon Project appropriately called *Diana*, for which he was the Technical Director, and which achieved the world's first radar moon detection.

King's group proved for the first time that radar signals actually could pierce the ionosphere and be detected when they punched through on the return trip. Before space ships could be rocketed into orbit, scientists had to know whether communication with the rocket and/or its pilot was possible. Project *Diana* provided the proof.

King received the Fellow award of the IEEE for his work in developing extended-range radar systems. He also is an Associate Member of the A.I.A.A., and is a member of many other organizations.



E. King Stadola, P.E., W2AXO

He holds a commercial pilot's and a professional engineer's license. He has been issued twenty U.S. patents, and has contributed numerous articles for publication to *The Proceedings of the IEEE*, and to other technical journals. In 1987, he was presented with the Cooper Union Distinguished Alumni Citation for outstanding attainments and contributions to his profession.

Now, it is my extreme pleasure to award to you, King Stadola, -- a true pioneer in the spirit of Major Armstrong and our Club -- the 1991 Armstrong Medal and this Testimonial Scroll which reads:

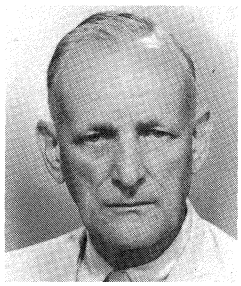
E. King Stadola
Armstrong Medal of Honor
from
The Radio Club of America
November 22, 1991

Awarded in recognition of your major contributions in *Project Diana* -- the world's first radar communications to the surface of the Moon by the U.S. Signal Corps -- and in other advanced radar techniques.

HONORS AND AWARDS – 1991

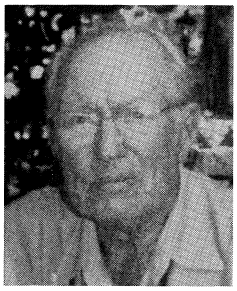
SARNOFF CITATION
Lt. Gen. Walter E. Lotz, Jr.

Awarded in recognition of his major contributions to worldwide military communications.



PIONEER CITATION
William G. Russell

Awarded in recognition of his pioneer service to progress in Radio and Electronics.



JACK POPPELE BROADCAST AWARD
Frank L. Marx

Awarded in recognition for his many years of contributions to radio and television broadcasting.

FRED M. LINK AWARD
Gaetano (Tom) Amoscato

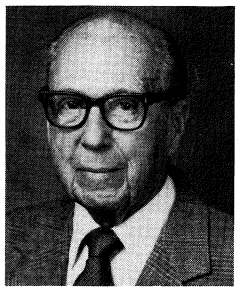
Awarded in recognition of his complete installation of the Link mobile and helicopter units for the New York City Police Department.

RALPH BATCHER MEMORIAL AWARD
Ralph O. Williams

Awarded in recognition of his preservation of radio history as a publisher and museum curator.

HENRI BUSIGNIES MEMORIAL AWARD
Raymond E. Lafferty

Awarded in recognition of his major contributions to the design and development of electronic test equipment.



ALLEN B. DuMONT CITATION
Loren F. Jones

Awarded in recognition of his pioneer contributions to TV broadcast engineering and development.

LEE DeFOREST AWARD
Louis Rabinowitz

Awarded in recognition of his dedication to the visual communications industry and long service to the frame-by-frame discovery process of DeForest Phonofilms.

SPECIAL SERVICES AWARD
Maurice H. Zouary

Awarded in recognition of his dedication to providing the excellent calligraphic embellishments on all the Radio Club of America awards and certificates.

PRESIDENT'S AWARD
Connie M. Conte

Awarded in recognition of her dedication to the Radio Club of America and to the many details of the Annual Banquet.

FELLOWS -- 1991

The following members were elevated to the Grade of Fellow in The Radio Club of America in recognition of their achievements in furthering the goals of the Club, and are here Cited:

Robert B. Barnhill, Sr., W4OXI, Baltimore, MD., (M 1970, F 1991). President of Barnhill & Associates, Inc., marketing and engineering representatives. Member of IEEE, ERA, and the Radio Old Timers Association.

Steven J. Beeferman, K2VWI, Atlanta, GA., (M 1977, L 1977, F 1991). Marketing Manager of DataRadio, the source for Radio Datalinking Technology.

Ms. Jane Bryant, Overland Park, KS., (M 1988, F 1991). Staff Editor of *Mobile Radio Technology* published by Intertec Publishing Corporation. Active in the Junior League of Kansas City, KS.

Alan Burton, Ashland, OR., (M 1985, F 1991). Editor and Publisher of *9-1-1 Magazine*. Former telecommunications manager of Public Safety Department of East Bay (CA) Regional Park District. Member ARCO, IACP, and California Peace Officers Association.

Norman C. Colby, Claysville, PA., (M 1981, F 1991). Retired engineer formerly responsible for design and development of RCA Manufacturing Company's microwave communication systems. Financial consultant to local township Board of Supervisors.

Mrs. Kay C. Craigie, Ph.D., KC3LM Paoli, PA., (M 1986, F 1991). Educator in fields of high school English and Word Processing, active as Vice Director of the Atlantic Division of ARRL. Editor of Eastern PA. ARRL Section news letter.

Stuart F. Crump, Jr., N4EGX, Herndon, VA., (M 1983, F 1991). Editor and Publisher of *Cellular Sales & Marketing* news letter and author of several books on cellular radio communications. Member of ARRL and Toastmasters International.

Harold C. Davis, Newton, MA., (M 1985, F 1991). President of CES, Inc. Broad communications background with Royal Canadian Air Force, Collins Radio Company, Harris Corp., and Aerotron, Inc.

Jack M. Davis, White Plains, NY., (M 1987). Executive Director of Hotel Gorham, NYC. Inventor of television circuitry. Active in Antique Wireless Association, Antique Radio Club of America, and other radio historical associations.

Paul Dillon, P.E. W5GT, Irving, TX. (M 1987, L 1987, F 1991). President of Dillon Design Services, consulting engineers. Broad background in communications including radio broadcasting. Member of IEEE, and National Society of Professional Engineers.

Alex F. Dolgosh, K8EUR, Middleburg Heights, OH. (M 1983, F 1991). Director of Sales & Marketing Services for the Antenna Specialists Company. Expert on theory and applications of antennas. Member of ARRL and QCWA.

Richard B. Frey, P.E. K4XU, Quincy, IL. (M 1983, F 1991). Responsible for development of high-power solid-state FM transmitters at Harris Corporation. Member of IEEE, ARRL, and National Society of Professional Engineers.

Samuel F. Gargaro, Roseville, MN. (M 1989, F 1991). Manager of Electronic Communications, Minnesota Department of Transportation. President of APCO, and leader in field of public safety communications.

Edward J. Goodwin, Fordham, Ely, Cambs, U.K. (M 1988, F 1991). Business Planning Manager, Philips Radio Communication Systems, Ltd. Broad background in mobile communications with British armed forces and in industry.

Mrs. Dorothy L. Jubon, Falls Church, VA. (M 1982, L 1982, F 1991). Communication consultant to domestic and international manufacturers and operators of common carrier systems.

John C. Kanode, N4MM, Boyce, VA. (M 1984, S 1986, F 1991). Senior Laboratory Specialist - IBM Federal Systems Division. Vice Director of ARRL Roanoke Division. Member of QCWA, and AMSAT.

Barry M. Kaufman, KB2AG, Pine Brook, NJ., (M 1977, S 1985, F 1991). Consulting electronics engineer and formerly Vice President & Corporate Director of RFL Industries, Inc. Author of technical papers on data transmission, and short wave broadcasting. Member of Audio Engineering Society and Senior Member of IEEE.

Bennett Z. Kobb, KC5CW, Falls Church, VA., (M 1983, F 1991). Editor of *Federal Communications TechNews* which reports on FCC technology. Member of ARRL, IEEE, and communications coordinator for American Red Cross.

Ralph W. May, Los Altos, CA., (M 1985, F 1991). Retired Vice President of Systems Marketing for E.F. Johnson Company. Formerly Vice President of International Operations for Northrop/Page. Leader in two-way and mobile radio-telephony.

Michael J. Orofino, W2KO, Freeport, NY. (M 1980, F 1991). Industrial real estate broker. Retired Vice President and Director of Allen Dental Medical Corporation, and former engineer with WABC/TV. Member Society of Wireless Pioneers, QCWA, and Metaphysical Society of America.

John N. Palmer, Jackson, MS. (M 1985, F 1991). President and CEO of Mobile Communications Corporation of America (MCCA). President of the Cellular Telecommunications Industry Association (CTIA), and past president of Telocator Network of America. Serves on Board of State of Mississippi Institute of Technological Development.

Theodore S. Rappaport, Ph.D., P.E., N9NB, Blacksburg, VA. (M 1990, F 1991). Educator, assistant professor and director of Mobile & Portable Radio Research Group, Virginia Polytechnic Institute and State University. Author of papers and organizer of seminars on personal communications. Member of ARRL, American Society for Engineering Education, and National Society of Professional Engineers.

Rowland G. Shears, G8KW,, Wrotham Heath, Kent, U.K. (M 1986,F 1991). Managing Director of K.W. Communications Ltd.. Expert in antennas and radio propagation. Served with rank of Major in the Royal Corps of Signals. Member of the Radio Society of Great Britain (Special 50 year continuous membership), and Deutscher Amateur Radio Club (Germany).

Raphael Soifer, W2RS, Glen Rock, NJ. (M 1983, F 1991). Manager of Brown Brother Harriman & Company, investment bankers. Formerly served as Vice President and Group Head of Bankers Trust Company. Currently Executive Vice President of the Radio Amateur Satellite Corporation (AMSAT). Member of ARRL, QCWA, and Radio Society of Great Britain.

Richard G. Somers, W6NSV, Hidden Hills, CA. (M 1977, F 1991). Vice Chairman of American Mobile Systems, Inc., operators of private land mobile radio systems. Serves as a director of the American SMR Network Association, and as chairman of the American Youth Radio Network.

David Sumner, K1ZZ, South Windsor, CT., (M 1984, F 1991). Executive Vice President and Secretary of ARRL, and Editor of *QST*. Formerly employed as an engineer at Collins Radio Company. Life member of ARRL and AMSAT.

John H. Swafford, W4HU, Arlington, VA. (M 1974, F 1991). Program Manager (Radio), Office of Communication, U.S. Department of State. Formerly chief engineer of U.S. Army's radio communication facilities in Europe, and communications engineer with North West Airlines and NBC.

Frank A. Thatcher, P.E., San Francisco, CA., (M 1986, F 1991). President of Frank Thatcher Associates, Inc., telecommunications consulting engineers. Formerly was an engineer for Raytheon Manufacturing Company, the Pacific Telephone Company, and served as a communications officer for the U.S. Air Force. Member of IEEE, APCO, the Association of Federal Communications Consulting Engineers, the National Society of Professional Engineers, and the San Francisco Press Club.

Ms. Rhonda L. Wickham, Raytown, MO., (M 1987, F 1991). Editor of *Cellular Business*, the journal of cellular telecommunications of the Intertec Publishing Company. Previously served as associate editor for *Broadcast Engineering, Video Systems, Electronic Servicing and Technology* and other electronic communication publications.

Roger L. Williams, W0WUG, Willmar, MN. (M 1982, F 1991). Educator, and instructor in charge of mobile communications technician training. Member of ARRL.

The Annual Meeting and Banquet commemorating the 82nd anniversary of The Radio Club of America was held on Friday, November 22, 1991, at the New York Athletic Club. Two hundred and seventy-five members and guests attended.

In the absence of Lt. Gen. Walter E. Lotz, Jr, the keynote speaker, due to illness, Mr. Jerry S. Stover (F) read the address reporting upon the 50th anniversary of the Voice of America.

The annual meeting held during the afternoon included a technical seminar directed by Stuart F. Meyer, Executive Vice President. The speakers were Mr. Rowland G. Shears, G8KW (F), who spoke on "Under Cover Radio During World War II"; also, Mr. Maurice Zouary who discussed "De Forest's Accomplishments in Bringing Sound to Motion Pictures"; and Mr. Stuart F. Meyer who spoke on "The Super Power Days of Radio Station WLW in Cincinnati." A reception for members and guests followed. The meeting concluded with the formal announcement of the election of officers and directors for the 1991 - 1992 tenure.

The achievements of 30 members of the Club were recognized by their advancement to the Grade of Fellow. Twenty-one were present at the Awards Dinner and received plaques from President Fred M. Link.

Awards and Citations were made to Club members for distinguished services to the art and science of radio communications; those receiving recognition were: Gaetano (Tom) Amoscato (F) - Fred M. Link Award; Mrs. Connie M. Conte (F) - President's Award; Loren E. Jones (F) - Allen B. DuMont Citation; Raymond E. Lafferty (F) - Henri Busignies Memorial Award; Lt.Gen. Walter E. Lotz, Jr. (F) - Sarnoff Citation; Frank L. Marx (F) - Jack Poppele Broadcast Award; Louis Rabinowitz (F) - Lee de Forest Award; William G. Russell (F) - Pioneer Citation; Ralph O. Williams (F) - Ralph Batcher Memorial Award; and Maurice H. Zouary (F) - Special Services Award.

Again, the success of the meeting, reception, and banquet resulted from the generous contributions of 29 industry sponsors and friends of the Club, plus the hard work of the Banquet and Meetings Committees.

THIRTY MEMBERS BECOME FELLOWS

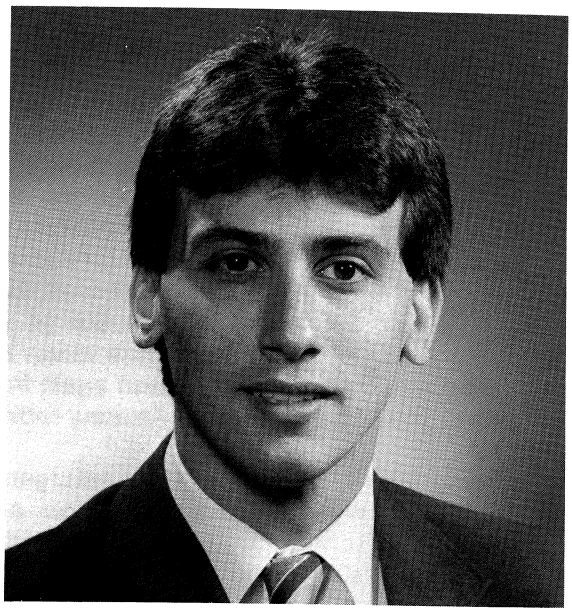
Twenty-six of the thirty members who were elected to the Grade of Fellow were present at the Annual Awards Dinner and received their plaques from the Club's President, Mr. Fred M. Link.

Twenty-one of those attending the Awards Dinner appear in the photograph above. From Left to Right : Bennet Z. Kobb, Falls Church, VA.; Frank A. Thatcher, P.E., San Francisco, CA.; John H. Swafford, Arlington, VA.; Theodore S. Rappaport, Ph.D., Blacksburg, VA.; Raphael Soifer, Glen Rock, NJ; John C. Kanode, Boyce, VA.; Mrs. Kay C. Craigie, Ph.D., Paoli, PA.; David Sumner, Newington, CT.; Mrs. Dorothy L. Jubon, Falls Church, VA.; Alan Burton, Medford, OR.; Ms. Jane Bryant, Overland Park, KS.; Stuart F. Crump, Jr., Herndon, VA.; Robert B. Barnhill, Baltimore, MD.; Roger L. Williams, Willmar, MN; Alex F. Dolgosh, Middleburg Heights, OH.; Barry M. Kaufman, Pine Brook, NJ.; Rowland G. Shears, Wrotham Heath, Kent, England; Richard G. Somers, Hidden Hills, CA.; Michael J. Orofino, Freeport, NY.; Jack M. Davis, White Plains, NY.; and Paul Dillon, P.E., Irving, TX.

1991 Fellows not in photograph: Steven J. Beeferman, Atlanta, GA.; Norman C. Colby, Claysville, PA.; Harold C. Davis, Newton, MA.; Richard B. Frey, P.E., Quincy, Il.; Samuel F. Gargaro, Roseville, MN.; Edward J. Goodwin, Fordham, Cambs. England; Ralph W. May, Los Altos, CA.; John N. Palmer, Jackson, MS.; and Ms. Rhonda L. Wickham, Raytown, MO.

DR. THEODORE S. RAPPAPORT RESPONDS FOR FELLOWS

Dr. Theodore S. Rappaport, N9NB, Assistant Professor and Director of the Mobile and Portable Radio Research Group, of the Bradley Department of Electrical Engineering, Virginia Polytechnic Institute and State University, was elected a Fellow of The Radio Club of America in June 1991 in recognition of his outstanding leadership in the research of personal communications. He is the author of a paper on that subject which was published in the November 1991 issue of **The Proceedings of The Radio Club of America.**



Dr. Theodore S. Rappaport

Dear members of The Radio Club of America, Ladies and Gentlemen. It is an honor and privilege to be here tonight, responding for the 30 newly-elected Radio Club of America Fellows of 1991.

Our club, the oldest communications society in the world, has played a major part in molding the future of radio. I'm sure that I speak for all of this year's class of Fellows in saying that just to be privy to the goings on of such a club through its occasional mailings is a privilege. To be recognized by The Radio Club of America for our accomplishments is truly an humbling honor and, at once, renews our commitment to the art and science we love.

Notice that I called *radio* an art as well as a science. Perhaps I should have said engineering, manufacturing and publishing, as well. All of us here tonight have a broad range of interests with radio as a common thread.

Amateur radio played an important role in my teen-age years. And I'm happy to report that while I still can say it, that wasn't too many years ago. It was through Amateur radio that I learned to experiment, to research, to teach and to build. It also led me to study electrical engineering at Purdue University where, during my sophomore year, I met my wife who, by the way, is the most tolerant person I know. *(Who else would stand for radio gear and all-night Morse code in the bedroom of a two-room, married-students' apartment? Brenda bought me headphones for our first anniversary.)*

We started a family during my senior year of college and I worked three jobs to support our family. We lived very frugally and worked hard. And then something happened -- something that made a real difference in our lives.

I'll never forget the day that Hugh Turnbull, the Respondent of last year's Fellows, called me to say that I had won The Radio Club of America scholarship through the Foundation for Amateur Radio program. The scholarship, although only $500, was nearly 20% of our income. More importantly, it encouraged me to stay involved with the field I grew up with.

I suspect that all of us have been surrounded with wonderful colleagues who have played major roles in helping us to carry out our work. I have been blessed with talented colleagues and excellent graduate students at Virginia Tech. In the Mobile and Portable Radio Research Group (MPRG), students are being transformed into radio enthusiasts, and it is fun to see.

However, I am amazed that, of 18 graduate students in the group, only one is a Ham radio operator. Perhaps this is a sign of the times. Never-

the-less, the students are conducting research in a manner similar to the early researchers of radio. They tinker, they build, they experiment and, of course, they theorize -- but only after obtaining some intuitive feel for what is real.

When I stay up late, reading about the activities of the Club during the days of Armstrong, Hazeltine and others, I am convinced that this is the way to do research. And although the tools used today are expensive network analyzers and complex integrated circuits -- not coherers or regenerative receivers -- the ingredients for success remain the same. To quote Professor Alan Hazeltine: "Ingenuity and success are due to 1% inspiration and 99% perspiration." These values are tool-independent, as we learn time and again from our heroes in The Radio Club and in Amateur radio.

Radio is enjoying a wonderful resurgence throughout the world.. Miniaturization and high-speed switching will make wireless communications ubiquitous during the next two decades. Radio also is enjoying a comeback on the campuses of many of our universities. It is up to us as members of the world's first radio club, to help the next generation of radio enthusiasts to know the lessons learned so far.

These lessons can be taught through Amateur radio, or at community colleges, or by visiting grade schools and showing children a bit of radio art -- I like to say "radio magic."

A very effective method of perpetuating our field is to support scholarships at various schools. The Radio Club of America already has made an impact on high school and college campuses and it is important that we continue to do so. We have a great heritage and one that can be used to produce future American successes as wireless personal communications evolves.

All thirty of us are greatly honored for the recognitions that you have bestowed upon us as Fellows of The Radio Club of America. We thank you for this recognition, and we vow to work hard to continue to promote our profession and the Club.

THE AMATEUR-SATELLITE SERVICE: 30 YEARS OF OSCAR & AMSAT

by **Ray Soifer, W2RS** (F)

December 12, 1991 marked the thirtieth anniversary of Amateur Radio's full entry into the Space Age.[1] On that date in 1961, a U.S. Air Force Agena-Thor launch vehicle lifted off from Vandenberg Air Force Base, California, carrying the first Orbiting Satellite Carrying Amateur Radio -- or OSCAR I, for short. OSCAR I, whose identical flight-backup unit now is on permanent display in the Smithsonian Air and Space Museum in Washington, DC, transmitted the Morse letters "HI" for three weeks on 144.983 MHz before its batteries ran out; its code speed corresponded to the temperature recorded by an on-board sensor.

OSCAR I was conceived, designed and built by the Project OSCAR Association (now, Project OSCAR, Inc.), a group of West Coast radio amateurs with close ties to the local aerospace industries, that had been formed two years earlier in response to a suggestion by Don L. Stoner, W6TNS (F). OSCAR I was the world's first privately-constructed, non-government satellite of any kind. Its launch as a secondary payload was the first time that two or more independent spacecraft had ever been placed into separate orbits by the same launcher. Stoner's suggestion also began another tradition which has continued to the present day: that of leadership and deep involvement in the amateur radio satellite program by members of The Radio Club of America.

Let's now fast-forward thirty years to December 12, 1991. As I write this, AMSAT-OSCAR 10 and AMSAT-OSCAR 13 -- internationally constructed satellites in high elliptical orbits -- are providing radio amateurs with virtually worldwide single-sideband (SSB) and continuous-wave (CW) two-way communications for hours at a time, from their orbital apogees of approximately 36,000 km.

Five satellites constructed by amateur radio groups in the United Kingdom, the United States, Argentina, and Japan -- are in low Earth orbit, providing digital store-and-forward communications using packet radio.

The Russian amateur radio spacecraft RS-10/11 and RS-12/13, also in low Earth orbit, are providing SSB/CW communications for many amateur stations throughout the world which are not sufficiently powerful or elaborate to make full use of AMSAT-OSCARs 10 and 13; even so, the point-to-point communication range obtainable through the Russian satellites approaches 7,000 km.

WEBERSAT-OSCAR 18 and UoSAT-OSCAR 22, built in the U.S. and U.K., respectively, are sending back pictures from space. These spacecraft also contain the most powerful packet-radio storage-and-forwarding system yet orbited for use in the amateur bands.

And, let us not forget the human dimension. From the MIR space station, two cosmonauts -- Aleksandr Volkov and Sergei Krikalev -- are talking directly with radio amateurs throughout the world via FM voice and packet radio. Three other Soviet cosmonauts, eight U.S. astronauts and several nationals of other countries have already preceded them in operating amateur radio from space. These manned space stations particularly emphasize the educational aspects of amateur radio, working closely with schools around the world to inspire and motivate youngsters to potential careers in electronics, aerospace engineering and related fields.

As this is being written, radio amateurs around the world are planning their most ambitious project yet. Tentatively named Phase 3D, this high-altitude, elliptical-orbit spacecraft is currently scheduled for launch by the European Space Agency (ESA) in 1996 when it is expected that AMSAT-OSCAR 10 (which entered service in 1983) and AMSAT-OSCAR 13 (1988) will be nearing the end of their useful lives.

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[1] Although OSCAR I was amateur radio's first satellite of its own, radio amateurs had long been active in space communications by the time OSCAR I was launched. The first amateur radio signals were bounced off the Moon in 1953, and tracking reports from radio amateurs were of vital significance in the early days of Sputnik I, in 1957. Marginal amateur communication took place via passive satellite reflection in 1960. Radio amateurs were amongst the earliest students of satellite signal propagation, publishing their findings in journals such as *QST* and *The Proceedings of the IRE* during the late 1950s and early 1960s.

Phase 3D will relay CW, voice and digital communications in the 29, 144, 435, 1260, 2400, and 10,500 MHz bands with high-gain antennas and ten times the power of earlier OSCARS. In addition, amateur radio groups in the United States, Italy, France, Mexico, Israel, South Korea and South Africa, amongst others, are building still more store-and-forward packet radio satellites for low-earth orbit, which they expect will be needed to handle a rapidly growing volume of message traffic.

AN IMPRESSIVE RECORD

To date, 36 amateur radio satellites have been placed into orbit since 1961 by NASA, ESA, the U.S. Air Force, the Japanese Space Agency (NASDA) and the former Soviet Union. In addition, amateur radio equipment has been carried aboard numerous U.S. shuttle flights while the Russians have established a permanent amateur station using FM voice and packet radio, aboard their space station MIR.

Direct two-way communication via amateur radio satellite has taken place in well over 150 countries while "gateway" Earth stations have made digital store-and-forward satellites an integral part of the amateur radio service's world-wide packet radio network. The amateur radio satellite program has produced an impressive array of achievements in addition to those noted above. Amongst them:

- The first direct satellite communications between the U.S. and the U.S.S.R. in any radio service. (OSCAR IV -- 1965).

- Development of radiolocation technology that made possible the present COSPAS/SARSAT program of search and rescue satellites. (AMSAT-OSCAR 6 -- 1972).

- The first direct satellite-to-satellite communications in any radio service. (AMSAT-OSCAR 7 to-and-from AMSAT-OSCAR 6 -- 1975).

- Innovations in high-efficiency linear amplifiers for space use (HELAPS), licensed to industry by AMSAT-Deutschland.

- Development and implementation of digital store-and-forward packet communication technology using on-board computers in low Earth orbit.

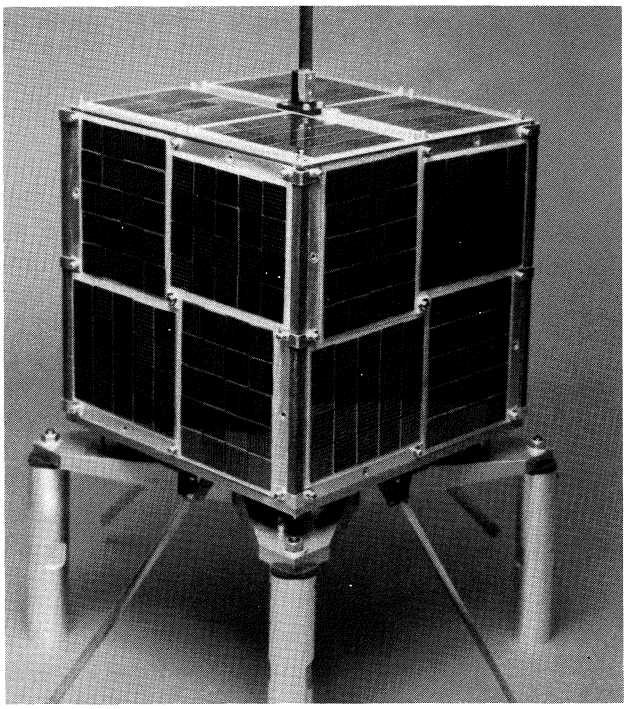

Figure 1. Microsat

AMSAT-OSCAR 16, also known as PACSAT, a digital store-and-forward packet radio satellite (Microsat), only nine inches on each side, designed and built by AMSAT North America. One of four AMSAT Microsats placed into low Earth orbit on January 22, 1990 by the European Space Agency (ESA), all are presently operational.

- Design and construction of two modular Lightsats (UoSAT-OSCARs 14 and 22 -- 1990 and 1991), and four Microsats (1990) with numerous potential applications inside and outside of amateur radio.

FOCUS ON MICROSAT

Let's focus on the first four Microsats (Figure 1). They are indeed "micro" with each having been built into a modular stack measuring 230mm x 230mm x 213mm or approximately a 9 inch cube (excluding antennas).

At the core of each Microsat is the modular stack itself whose unique standardized design incorporating the Motorola MC14469F addressable asynchronous receiver/transmitter chip (AART), will accommodate numerous types of equipment and experiments while greatly reducing the size and complexity of the wiring harnesses. The bus connecting each module needs only five wires!

Each Microsat is controlled by an on-board, AMSAT-designed central processing unit (CPU) including a NEC V-40 microprocessor with 8 megabytes of RAM disk storage and several sections of bank-switched, full-speed memory. The four satellites each include slightly different modules, providing mission capabilities as follows:

- AMSAT-OSCAR 16, also known as PACSAT, serves as a digital store-and-forward packet radio bulletin board or flying mail box. PACSAT has four uplink channels in the 145 MHz band and two downlink channels in the 437 MHz band, switchable between 1200 and 4800 baud PSK. A 2401 MHz beacon transmitter also is included.

- DOVE-OSCAR 17 was constructed for AMSAT-Brasil. DOVE is an acronym for Digital Orbiting Voice Encoder. Its primary mission is to provide a satellite that is easy to receive, for use in schools worldwide as well as by a large number of radio amateurs. Its digital telemetry is in the 145 MHz and 2401 MHz bands, using AX.25 packets, and FM transmission compatible with the Bell 202 standard. Hundreds of thousands of radio amateurs, equipped for terrestial packet radio, are able to copy DOVE's digital transmissions on 145.825 MHz and decode them automatically. DOVE's synthesized voice transmissions are expected to begin shortly.

- WEBERSAT-OSCAR 18 was constructed for Weber State University in Utah. The primary payload is a CCD camera whose pictures are placed in the on-board computer's memory and downlinked to Earth as standard packets. It also contains experiments designed by high school students in the Ogden, Utah area. WEBERSAT's two 1200 baud PSK downlink channels are in the 437 MHz band.

- LUSAT-OSCAR 19 was constructed for AMSAT-Argentina. LUSAT is nearly identical to AMSAT-OSCAR 16 excepting that it also includes a Morse code CW telemetry channel in the 437 MHz band that enables users to derive telemetry values without the use of a computer.

The four Microsats were placed into orbit on January 22, 1990 by an ESA Ariane launcher. Their orbits are approximately polar and sun-synchronous, passing over virtually every place on the globe around 10:30 AM and 10:00 PM local time each day at an altitude of about 800 km.

Although designed primarily with amateur radio in mind, AMSAT's Microsat technology has numerous potential applications in commercial and government use. These include remote data acquisition and storage, and worldwide digital communication using small, portable terminals. Under agreement with AMSAT, Microsat technology is marketed outside the amateur services through Interferometrics, Inc., of Vienna, VA.

Digital technologies such as packet radio and Microsat are growing rapidly in amateur radio as they are throughout the radio spectrum. However, not all in the amateur-satellite service is digital. SSB voice remains the most-used mode of communication through amateur radio satellites; FM is employed for voice contacts with manned spacecraft and CW retains a lively popularity as well.

AMSAT-OSCAR 13: Worldwide SSB/CW Communication Through a Single Satellite

The first active transponder satellite for radio amateurs was OSCAR III built by the Project OSCAR Association, which operated in low Earth orbit for 18 days in 1965. Twenty-three years later, an international consortium of AMSAT organizations placed aboard an Ariane launcher the most ambitious linear transponder spacecraft yet flown: AMSAT-OSCAR 13 (Figure 2).

Unlike a repeater or a digital store-and-forward satellite, a linear transponder receives signals from the ground at one set of frequencies (the uplink passband) and retransmits them to Earth at another set of frequencies (the downlink passband) without demodulation.

AMSAT-OSCAR 13 was launched into a geosynchronous transfer orbit on June 15, 1988, from which its own on-board rocket motor placed it into a highly elliptical trajectory with an orbital inclination of 65.6 degrees to the Equator, a perigee of 2,545 km and an apogee of 36,265 km. It completes this elliptical, so-called Molniya-type orbit about twice each day. When at or near perigee, AMSAT-OSCAR 13's communication range covers about half of the Earth's surface.

For amateur radio applications, Molniya-type orbits such as this are highly advantageous when compared with the geosynchronous orbits used for

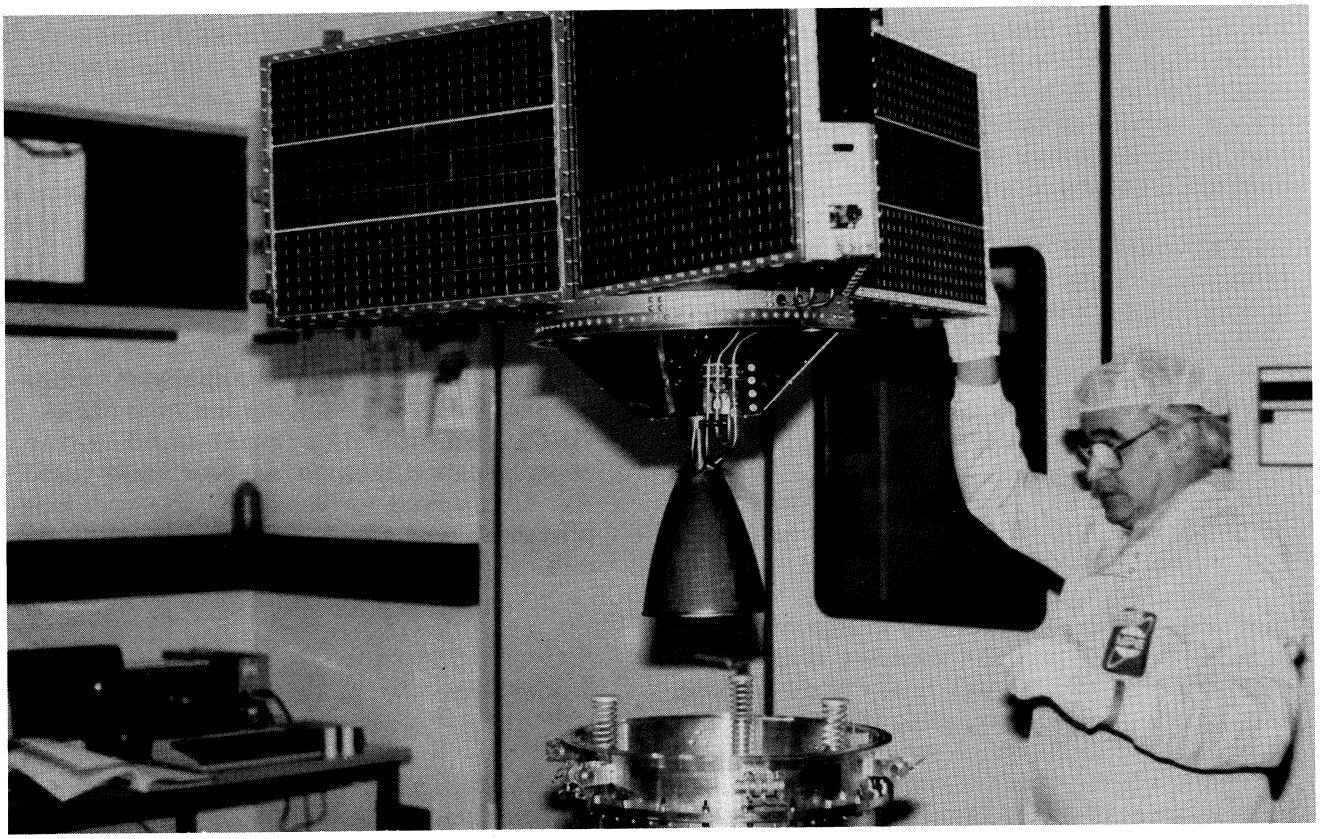

Figure 2. AMSAT-OSCAR 13

AMSAT-OSCAR 13, a linear transponder satellite currently providing worldwide SSB and CW communications in the 145, 435, 1269 and 2400 MHz bands. Designed and built by an international consortium of AMSAT organizations, it was placed into a highly elliptical Molniya-type orbit by ESA in 1988.

many commercial and broadcast services. One Molniya-orbit spacecraft can cover the entire Earth, albeit for less than 24 hours per day, while it would take three of the far-more expensive geosynchronous satellites to cover the Earth for all 24 hours.

Most communication paths in amateur radio tend to be east-west rather than north-south. A Molniya-orbit spacecraft such as the AMSAT-OSCAR 13 typically reaches apogee at high latitudes rather than near the Equator as do geosynchronous satellites, facilitating east-west paths in highly-populated parts of the world. Regularly occurring orbital drift enables all parts of the world to be covered within a relatively short time.

AMSAT-OSCAR 13 contains three linear transponders which receive and retransmit SSB and CW from the ground within several bands of frequencies. The most popular of these, known for historical reasons as Mode B (although it has nothing to do with damped waves!) has an uplink passband of 435.423 - 435.573 MHz, and a downlink passband of 145.825 - 145.975 MHz. The second transponder, referred to as Mode JL, has two uplink bands: 144.423 - 144.473 MHz and 1269.351 - 1269.641 MHz. Its downlink passband is 435.715 - 436.005 MHz; signals from both uplink bands are relayed simultaneously. A third transponder, called Mode S, has its uplink passband at 435.602 - 435.638 and its downlink at 2400.711 - 2400.747 MHz.

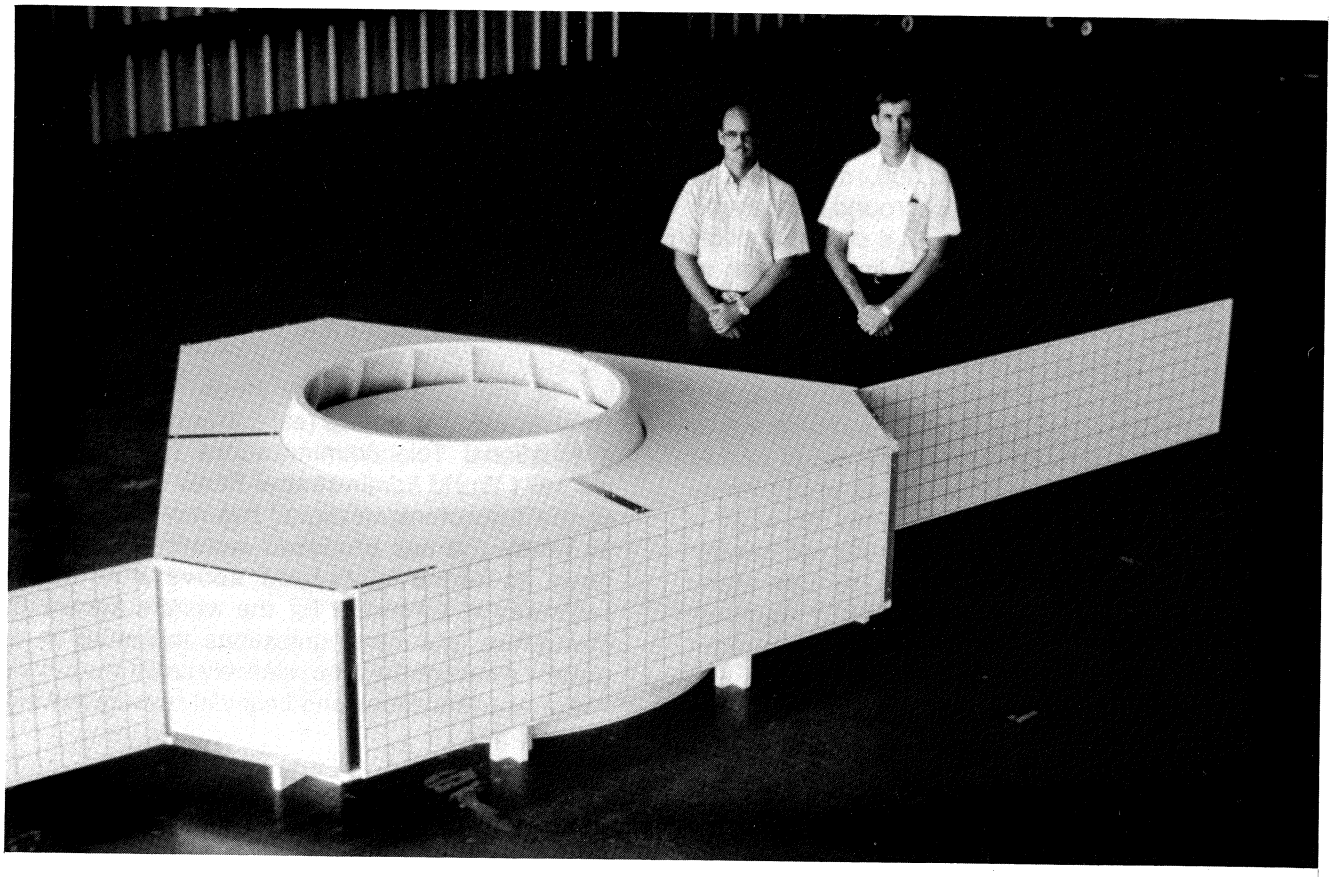

Figure 3. The Phase 3D Spacecraft

A full-size mock-up of AMSAT's Phase 3D satellite, now under construction and scheduled for launch be ESA in 1996. It will provide approximately ten times the power and capacity of AMSAT-OSCAR 13 which it is intended to replace. Phase 3D will carry Amateur-Satellite service into the 21st Century.

THE NEXT (Giant) STEP: PHASE 3D

Radio amateurs in well over 150 countries have operated so far through AMSAT-OSCAR 13; over 60 of these have each contacted stations located in 100 countries, or more. However, orbital studies show that AMSAT-OSCAR 13 will probably re-enter the Earth's atmosphere in 1996 after eight years of service. To replace it as well as to introduce a new generation of capabilities, AMSAT is now hard at work on its next major space venture, a project known as Phase 3D.

The Phase 3D spacecraft (Figure 3) which will be assigned a name in the AMSAT-OSCAR series when once placed in orbit, is scheduled to be launched by ESA aboard Ariane 502, currently expected to be sometime in 1996 -- about the time that AMSAT-OSCAR 13 is likely to re-enter.

Phase 3D will be much larger than its predecessor -- about 500 kg versus 142 kg -- enabling Phase 3D to carry solar arrays and antennas substantially more powerful than those aboard AMSAT-OSCAR 13. For most users, Phase 3D is expected to improve signal-to-noise ratios by as much as 10 dB over those of AMSAT-OSCAR 13.

This improved performance, it is hoped, will enable thousands more radio amateurs, especially those in relatively poor countries, to afford to assemble effective satellite ground stations. Today, the typical ground station utilizing AMSAT-OSCAR 13 consists of a multiband SSB/CW transceiver, low-noise receiving preamplifiers, and solid-state transmitting amplifiers typically providing 50 to 100 watts output for each passband, plus

circularly-polarized directive antennas with azimuth/elevation controls, resulting in an effective isotropic radiated power (eirp) of around 1kW at 145 and 435 MHz, and 10kW or more at 1269 MHz. If all of that equipment were to be purchased new, it would easily cost $3,000 to $5,000, or more, per ground station. With this background, it may be readily appreciated how much of a cost reduction for the user this planned 10 dB improvement in spacecraft performance might permit.

Unfortunately, however, nothing in satellite communications comes free of charge. Including expenses related to launch, purchased components and other costs of construction, the out-of-pocket cost of Phase 3D is expected to approximate $4 million -- still less than a tenth of what a commercial or government satellite of similar capabilities would cost, owing to the many thousands of hours donated by AMSAT's volunteer managers, engineers and technicians throughout the world.

But even $4 million is a long way from the estimated sixty dollars out-of-pocket that OSCAR I was said to have cost to build back in 1961! Of course, in 1961, OSCAR I's launch was provided free by the U.S. Air Force while Phase 3D will have to pay ESA approximately $1 million for its secondary payload status.

WHAT IS AMSAT ?

After the completion of OSCARs III and IV in 1965, the Project OSCAR group stopped building satellites although it still remains in existence today. In 1969, George Jacobs, W3ASK (F), spoke to a group of amateur radio clubs associated with aerospace companies and government agencies in the Washington, DC area, and suggested that they form a new organization that would take up the satellite construction activity where Project OSCAR had left off. They took him up on his idea and the result became AMSAT -- the Radio Amateur Satellite Corporation.

AMSAT today has far outgrown its Washington roots although it still maintains a headquarters office in Silver Spring, MD. The original AMSAT corporation, sometimes referred to as AMSAT North America (AMSAT NA), has more than 6,000 members worldwide, mainly concentrated in the U.S. and Canada. Cooperating but independent AMSAT organizations in many other countries bring the total membership to approximately 20,000 radio amateurs. Amongst the more active international affiliates, all of which have built or are building amateur radio satellites, are AMSAT-UK, AMSAT-Deutschland, Japan AMSAT (JAMSAT), AMSAT-Italia, AMSAT-Southern Africa, AMSAT- Brasil (BRAMSAT), and AMSAT-Argentina. The word AMSAT itself is a registered trademark of the Radio Amateur Satellite Corporation.

A VITAL RADIO SERVICE

In the 30-plus years since OSCAR I, the amateur-satellite service (established as such by the International Telecommunications Union (ITU) at the 1971 World Administrative Radio Conference on Space Telecommunications) has more than proven its worth. It has produced technical innovations such as those discussed above and trained professional personnel for the world's aerospace, electronics and communications industries in far greater measure than the relatively small amounts of frequency allocations and financial resources which it consumes.

Meanwhile, the educational uses of amateur radio satellites have inspired countless young people throughout the world to career in electronics and aerospace engineering -- many of these have already emerged amongst the industries' leaders.

This paper has necessarily given only a brief glimpse of the immense variety of projects going on within this vital activity. For further information, you are invited to contact AMSAT Headquarters at P.O. Box 27, Washington, DC 20044, telephone (301) 589-6062.

In addition to a professional career of 25 years in investment banking, Ray Soifer serves in a volunteer capacity as Executive Vice President of the Radio Amateur Satellite Corporation (AMSAT), whose business and financial affairs he has helped to look after since 1969. He has been a licensed radio amateur since 1955 and has published articles in numerous amateur radio journals throughout the world, primarily on satellite and moon-bounce communications. Mr. Soifer is a graduate of MIT with a BSEE degree and received an MBA from Harvard University.

THE AMATEUR RADIO FREQUENCY-MODULATION STORY

by **John C. Geist, N3BEK**

"All the favoring factors have jelled into what amounts to a revolution in amateur radio communication."

John Huntoon, Editor, *QST* July 1969.

BACKGROUND

Throughout the 1930s, Major Edwin Howard Armstrong, the inventor of much of the basic radio technology in use to this day, was promoting the acceptance of a new static-free broadcast service using frequency modulation in the VHF portion of the radio spectrum. He installed the first FM radio broadcast facility at Alpine, New Jersey. W2XMN (later KE2XCC) on 43.1 mHz[1] went on the air in 1939 with an output of 40 kw. The Armstrong high-fidelity, wide-band FM system used phase-modulation of an approximately 200-mHz, crystal-controlled oscillator followed by frequency-multiplication of several thousand to result in a frequency-deviation of +75 kHz. The modulating signal was filtered so as to be inversely proportional to its frequency to compensate for the rising frequency-response characteristic inherent in phase-modulation (pre-emphasis). In this way the frequency-response characteristic of the transmitter was made flat so that a receiver with flat audio response would provide high-fidelity reproduction. The present 88 to 108-mHz FM broadcast service has a channel width of 200 kHz, +75 kHz frequency deviation, and a base-band frequency response of 15,000 Hz with 6 db-per-octave pre-emphasis above 3000 Hz and with provision for higher-frequency sub-carriers.[2, 3, 4]

John C. Geist

By 1938, a number of two-way police VHF/AM radio systems were in operation. In 1939, the Connecticut State Police were planning to install a state-wide two-way system. Daniel E. Noble, Assistant Professor of Electrical Engineering at the University of Connecticut and consultant to the State Police, recommended a VHF/FM system using an adaptation of Major Armstrong's phase modulator. Link Radio Corporation in nearby New York City had built AM two-way mobile radio equipment. Link was contracted to develop, design, manufacture, and field test the prototype FM system. Field tests were highly successful, and Link was awarded the production contract for the state-wide system.[5]

The Connecticut State system was designed for the telephone-system voice bandwidth of 300 to 3000 Hz. This limited band-width along with the inherent pre-emphasis characteristic in phase modulation allowed the transmitters to be greatly simplified.

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[1] It was cps, kc, and mc in those days. The minutes of the January 1940 meeting of the Washington (DC) Radio Club describing Major Armstrong's demonstration of FM, records the frequency of W2XMN as 42.8 mHz.

[2] *Radio Club of America Seventy-Fifth Anniversary Diamond Jubilee Yearbook*, Fall 1984, pages 111, and 124.

[3] *The Legacies of Edwin Howard Armstrong*, Radio Club of America, November 1990, pages 32, 40, and 54.

[4] "The Evolution of Frequency Modulation", Edwin H. Armstrong. A paper presented to AIEE in December 1940 included in the RCA *Legacies of Armstrong*, pages 179-187. See Note 3.

[5] *Proceedings of The Radio Club of America*, November 1987. Pages 8-11.

In 1946 after World War II, some ten-meter stations in urban areas were using FM because it generated less interference on AM broadcast receivers. The FM signals were demodulated in AM superhet receivers by detuning so that the incoming carrier frequency falls on the sloping skirt of the receiver selectivity curve (slope detection -- Fig. 3). Slope detection, of course, does not provide the full advantages inherent in FM. The Armstrong low-noise system requires a receiver with IF-amplifier hard limiting and sufficient overall receiver gain to saturate the limiters on receiver noise.

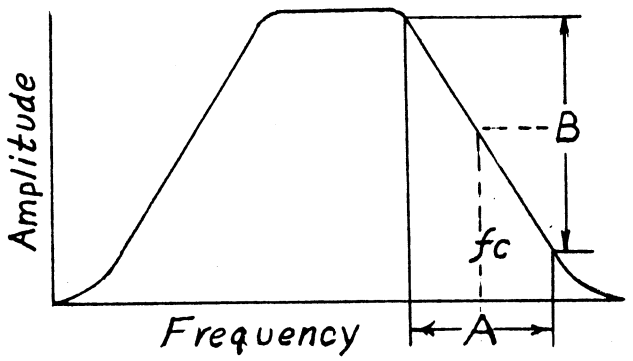


Fig. 3 SLOPE DETECTION

The (idealized) receiver response converts the received frequency-modulated signal, A, to an amplitude-modulated signal, B, which is then demodulated by the conventional AM detector. A Kenwood R1000, general-coverage receiver in the WIDE AM mode provides remarkably good quality audio from +5 kHz FM signals.

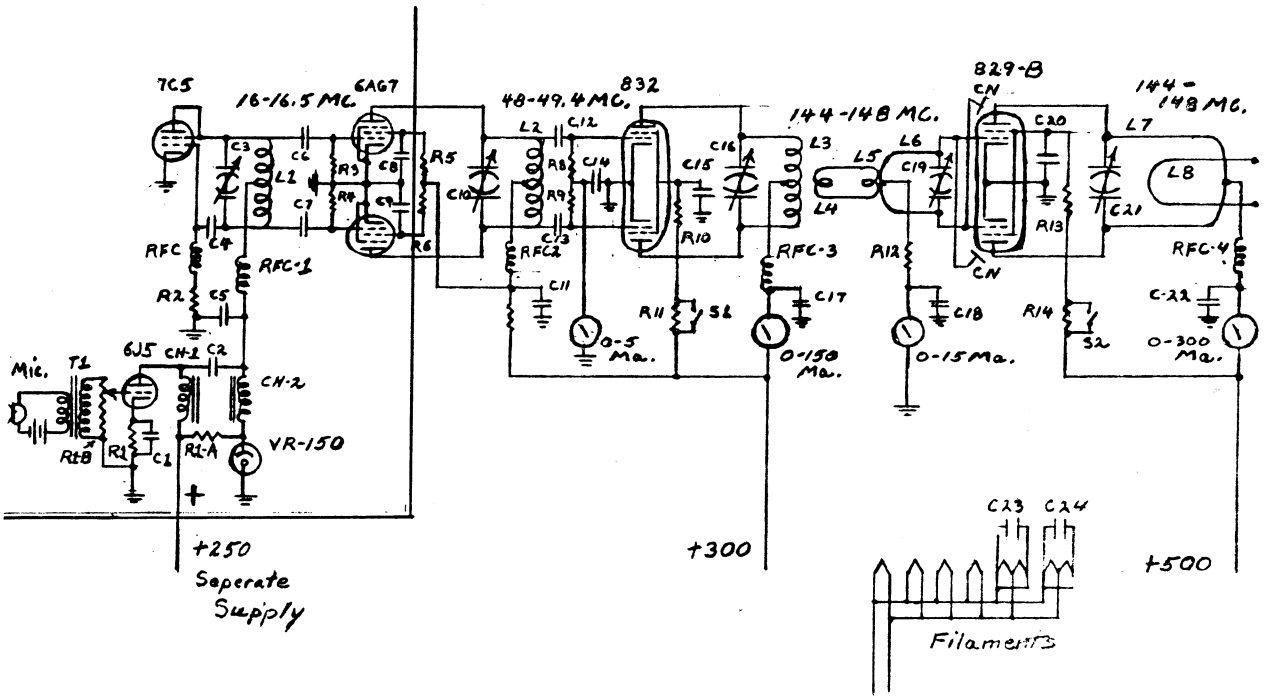


Fig. 4 EARLY FREQUENCY MODULATOR

The diagram is part of the original sketch dated 12/11/46 submitted to ARRL with the article referred to in Note 6. Modulation of the oscillator plate voltage results in amplitude and frequency modulation of the oscillator. The level of the modulating signal is adjusted to stay within the linear portion of the oscillator voltage/frequency characteristic and a low level of amplitude modulation. The following frequency-multiplying, limiting amplifiers removes the amplitude modulation, leaving a frequency-modulated carrier.

In the February 1947 *QST*, George Grammer (Technical Notes) reported on ARRL comparison tests of AM vs. narrow-band FM. It was clear that FM was not the solution to the problem of over crowding in the HF bands (Amateur bands within the spectrum of 1.8 to 30 mHz). Grammer, then Technical Director of ARRL, concluded that the only solution would be to adopt single-sideband techniques. In the ensuing years, ARRL promoted replacing AM with SSB in Amateur equipment by providing a continuing flow of technical SSB information in *QST* and up-dated editions of the *ARRL Handbook for Radio Amateurs.*

The two-meter (144 mHz) band became popular soon after the World War II. Since FM was being relegated to VHF, this became a convenient band in which to carry out FM experimentation. During 1946-47, tests were conducted with a variety of different wide- and narrow-band superhets, superregenerative, and wide- and narrow-band FM receivers. Reference[6] presents one program of this experimentation, diagrammed in Fig. 4. There was no sustained interest in two-meter FM.

Numerous articles on FM technology and equipment construction appeared in *QST* until 1950. Nearly all the construction articles presented the author's concept of a simple narrow-band frequency modulator. In January, 1946, George Grammer explained what came to be the controversial, but much used, ratio detector, a circuit combining the functions of FM demodulation and some degree of amplitude limiting.[7,8] In July 1947, Byron Goodman presented a tutorial article on phase and frequency modulation that gathered together the bits and pieces that had appeared in numerous articles since 1939. The remaining articles were, for the most part, related to establishing standards for frequency response and frequency deviation. After some tests using a true FM receiver, Nathaniel Bishop recommended, for above 50 mHz, a maximum peak deviation of +5 kHz with flat frequency response in the transmitter (no pre-emphasis).(*QST*, May 1947).

[6] J. Geist, "FM on Two Meters", *QST* June 1947 p48.

[7] G. Grammer, "The Ratio Detector", *QST* Jan 1946 p26.

[8] E.H. Armstrong, "A Study of the Operating Characteristics of the Ratio Detector and Its Place in Radio History", The RCA *Legacies of Armstrong*, pages 217-232. See 3.

The Hallicrafters Company was the only manufacturer pushing FM for a few years after the war. While several general-coverage, VHF-AM/FM receivers were available during and after the war , in 1947, Hallicrafters introduced the Model HT-18 HF Amateur-band, 125-watt, narrow-band FM transmitter, with a variable-frequency oscillator. The crystal-controlled Model HT-19 followed in 1948.

The only other FM equipment advertised in *QST* was a plug-in +2.5 kHz ratio detector introduced in 1947 for the Radio Mfg. Engineers HF general-coverage receiver. In view of what happened in the next few years, it is obvious that none of the commercial Amateur-band equipment received popular acceptance.

After 1949, information in *QST* on FM technology and advertising for FM equipment came to an abrupt end. It was as though the Amateur community and the radio equipment manufacturers had lost all interest in FM. The FM heading in the annual *QST* index was discontinued after 1949 and there was little, if any, FM information in *QST* for the next ten years.

THE BREAKTHROUGH

By the end of the 1950s, the growing demand for business and public-service two-way radio systems was causing over-crowding in the allocated frequency channels. The Federal Communication Commission (FCC) announced that, in order to make more channels available, it would be necessary to reduce channel bandwidth, and that industry should prepare to provide VHF land-mobile systems with frequency deviation limited to +5 kHz. As a result, there was a move to replace existing 15-kHz equipment with 5-kHz sets.

Large quantities of surplus commercial 150-mHz, +15-kHz equipment became available to Amateurs at affordable prices. The vacuum-tube circuits used at the time were familiar to Amateurs, and were relatively easy to retune to the Amateur two-meter band. For the first time, matched FM transmitters and receivers (completely compatible systems) became available in quantity to radio Amateurs. The operation of commercial land-mobile systems, however, differed from Amateur-radio operation in an important way.

From 1957, with the introduction of the vacuum tube as a continuous-wave (cw) generator, until Collins Radio introduced the KWM-1 SSB Transceiver, Amateur stations mostly called on a fixed transmitter frequency and then tuned the receiver across the band listening for a response. When contact was made, the two stations usually transmitted on different frequencies. In the land-mobile systems, the transmitter and receiver were both on the same crystal-controlled frequency. (This came to be known as "rock bound".) Some of the commercial sets either included, or were easily modified to include, a channel switch to allow switching to an alternate frequency by switching to a second crystal in the transmitter and receiver. The convenience and effectiveness of predetermined channelized frequencies (as opposed to continuous-frequency tuning), particularly for mobile and emergency service, soon became apparent to the Amateurs. Channelized tuning became and remains the standard for Amateur VHF FM transceivers.

Amateurs were also introduced to FM receiver "squelch muting". (Fig. 5) The FM receiver's characteristic loud, rushing noise in the absence of signal was reminiscent of the superregenerative "rush box". But, in the FM superheterodyne receiver, the rushing noise is muted in the absence of a received signal. The squelch control allows adjustment to keep the audio muted in the absence of signal, but unmuted while a signal is being received. With this feature, a channel can be monitored with a quiet receiver, but received signals will be heard.

The commercial equipment provided a new level of performance to Amateur VHF mobile operation. In addition to the inherent advantages of FM, noise from the vehicle electrical system was easier to suppress, and transmitter power of thirty or more watts was a big advantage over the several-watt output provided by most of the Amateur AM transmitters. The disadvantages were that the heater current for all the vacuum tubes and thirty or more watts of transmitter output was an excessive load on a passenger car's standard electrical system, and the vacuum-tube transmitter, receiver, and necessary power supply occupied a large part of the trunk space. During the 1960s and early 1970s, *QST* carried several articles with instructions for the two-meter modification of different makes of two-way FM radio sets. An article by J. Aagaard in the July 1960 *QST* presented information on the use of surplus commercial equipment, and reported that members of the Northwest Indiana civil-defense (RACES) net were operating about 90 mobile and 35 fixed stations using modified Motorola sets. Some of the members of that organization published a booklet (out of print) summarizing pertinent technical information on wide-band FM and specific details on the modification of the Motorola line for Amateur-band use.

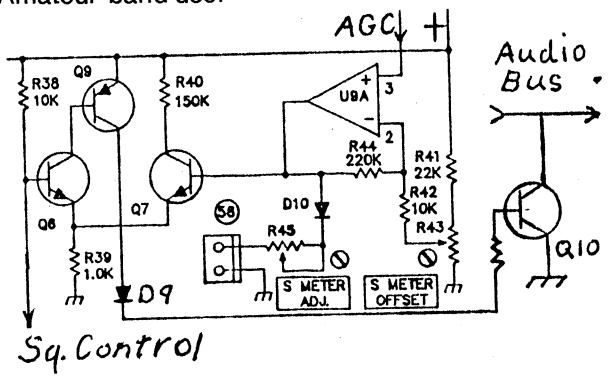


Fig. 5 SQUELCH MUTING CIRCUIT

Late 1980's squelch circuit in Ten-Tec, Inc. transceivers. Q7 and Q6 compare the AGC voltage with the voltage set by the front panel SQUELCH control. When the AGC voltage is lower than that set by the control, Q9 and D9 are forward biased and Q10 is saturated to mute the receiver by shorting the audio signal to ground. When a carrier is received, the AGC voltage rises above that set by the control, Q10 is turned off, and the receiver is unmuted.

Unlike the breakthrough in Amateur single-sideband modulation (SSB) that was announced with a great fanfare[9], the FM breakthrough sneaked in quietly. The editorial in the July 1969 *QST* explained the situation in this way: "Apparently most FM and repeater enthusiasts have been too busy solving their gear problems to take time to put their ideas into form for *QST* [articles]. . . .We finally have some fine material in the works, and all indications point to more to come." The editorial also announced that "The World Above 50 Mc" monthly column would set aside a special section for FM and repeater news.

In June 1971, an article pointed out that early models of mobile-phone transceivers were being made surplus by telephone companies. These were five-channel, vacuum-tube sets with deviation limited to +5 kHz. The multichannel flexibility made these sets more useful than the previous single or two-channel sets. But now the Amateur FM community was encountering system incompatibility, with some groups using +15 and some using +5-kHz deviation.

[9] J. Geist, "The Amateur Radio Single-Sideband Story", *Proceedings of The Radio Club of America* Nov. 1991

ENTER THE REPEATER

Interest in automatic VHF relay stations dates back to at least 1932 when T. F. Cushing set up a five-meter, AM relay on an eighty-foot tower near Springfield, Massachussets.(*QST*, July 1934). After the war, increasing the range of VHF mobile stations by the use of automatic relays was a concept waiting to be implemented. Automatic relay stations came to be known as repeaters. The Federal Communication Commission (FCC) defines a "repeater" as "a station that automatically retransmits the signals of another station".

Two-meter AM repeaters were in use in several parts of the country in the late 1950s. An article in the July 1962 *QST* discussed the operation of an AM repeater near San Diego, CA. The author pointed out that FM repeaters would be more desirable because [in addition to noise immunity] the FM receiver's constant audio-level with varying signal levels eliminates the sophisticated automatic-level-control circuits needed on AM repeaters. An additional advantage is the FM "capture effect".(See sidebar). In other words, FM is a natural for two-way mobile systems using repeaters to extend the coverage area.

By 1969, a number of Amateur radio clubs scattered across the country had installed +15 kHz FM repeaters built around surplus commercial gear. (*QST*, Oct. 1964). Shortly thereafter, an obstacle was encountered. The FCC issued more specific requirements for repeater operation. The more restrictive requirements were: a designated control operator was required to be on duty to monitor the repeater whenever it was in operation, cross-band operation was forbidden, and only two repeaters could be linked together.

The first of these was a definite drag. It eliminated the possibility of continuous, unattended operation. ARRL and the repeater operators continued to try to convince the FCC to allow "automatic control" of repeaters. Little technical information about repeaters was published by ARRL until the *FM and Repeater Manual* was announced in the December 1972 *QST*. The manual was in print until 1986. By that time subsequent issues of the *ARRL Handbook* included current information on construction and operation of repeaters.

By 1970, ARRL was assisting the use of FM repeaters by maintaining a volunteer repeater registry. In 1971, a *Repeater Directory* was made available for the cost of mailing. The first *Directory* listed 298 repeaters. Since then, updated versions have been published annually. The *Repeater Directory* listed the location, input and output frequencies, licensee, and operation details of all registered repeaters.

In mid 1975, FCC finally approved repeater operation under fully-automatic control (without operator monitoring). By the end of the year, linking of more than two repeaters, and cross-band linking of repeaters was permitted. Now Amateur VHF/FM could be fully exploited. The *1976 Directory* listed 3000 repeaters. The 1979 issue included over 4500 listings on the 10, 6, 2, 1-1/4 meter and 23 cm bands (29, 50, 144, 220, 440, 1240 mHz). Starting with the 1979 issue, the *Directory* was put on the ARRL publications-for-sale list.

NEED FOR STANDARDIZATION

During the early 1970s, different Amateur organizations were operating AM, +15 kHz FM, and +5 kHz FM repeaters. The AM operation faded away as FM became the accepted mode for repeater-enhanced VHF mobile communication. There remained the frequency-deviation incompatibility. The editorial in the June 1972 *QST* recognized the accelerating growth of mobile FM and repeaters. It was announced that the ARRL VHF Repeater Advisory Committee (VRAC), established in 1968, would be recommending frequency allocation plans for different modes of operation (band plans), and repeater-frequency coordination plans. Curiously, no mention was made of the need to establish frequency-deviation, receiver band-width, and pre-emphasis/de-emphasis standards needed for manufacturers to proceed with logical equipment designs.

By 1970, manufacturers appear to have awakened to the fact that there really was a potential market for VHF/FM transceivers. The back cover of the September 1971 *QST* announced the "Drake ML2 Marker Luxury FM Transceiver. The best of the Japanese, the Marker Luxury VHF/FM Transceiver was built for, and distributed and backed by the R. L. Drake Co." The November 1971 *QST* included a product review of the Hallicrafters HC-100, a twelve-channel, 132 to 174 mHz hand-held transceiver for the commercial market. This was a precursor of the frequency-synthesized, full-band coverage "HTs" that later became one of the most popular Amateur-radio products.

By 1973, new-product reviews had appeared in *QST* for two-meter transceivers from Hy-Gain/Galaxy, Regency Electronics, Clegg, Sonar, Gladding, US Drake, and Inoue-Varitronics\ Icom-Inoue (Japanese).

The technical information included in these reviews is sketchy with respect to IF bandwidth and, particularly, pre-emphasis/de-emphasis which was completely omitted. They all had mic-gain adjustable frequency deviation; some had stated bandwidths of 15 kHz, and some used phase modulation and, therefore, must have anticipated receiver de-emphasis. They all had transmitter outputs in the 10 to 25-watt range, and were "all solid state" except the Japanese Drake which used vacuum tubes in the transmitter final amplifier, and the Gladding which used a combination of tubes and transistors. The design objective seemed to be to adopt a compromise between "narrow" and "wide" IF bandwidth, and to allow adjustment of the transmitter deviation to accommodate the bandwidth of the receiving station. (Neither fish nor fowl, but lots of flexibility.) The low current drain and small size of these 12-volt solid state transceivers made them a great improvement over the vacuum-tube sets for mobile operation; they could be mounted near the driver, needed no power supply and could obtain power from a cigar-lighter plug. The introduction of the solid-state, VHF/FM transceiver was an important factor in increasing the popularity of mobile VHF operation.

The need for standardization surfaced when, in late 1972, the California Amateur Relay Council requested ARRL to help make equipment manufacturers aware that, [since many repeaters had been built with surplus narrow-band equipment] (see sidebar), it was time for Amateur FM receivers to meet commercial narrow-band specifications, and that Amateur transmitters required better harmonic suppression. ARRL sent a letter to all US and Japanese Amateur-band radio manufacturers advising that:

> 1. VHF/FM receivers should have IF bandwidths appropriate for frequency deviation of between +5 and +7 kHz.
>
> 2. VHF transmitters require output filtering to reduce all harmonics to a level no greater than 30 db below the fundamental frequency.

The Drake Co. was the first to respond to the ARRL standards request. In October 1973, the Drake TR 22-C was advertised as having a "modulation acceptance" of +7 kHz. In the following year, several other advertisements included this parameter. The term "modulation acceptance" seems to have been invented and forgotten in a few years. In any case, there was a move toward the final standard frequency deviation of +5 kHz. Again a standard for pre-emphasis and de-emphasis was ignored. It must have been "taken for granted", without mention, in following the design of commercial systems.

Another issue that needed to be standardized was the difference (offset) between the repeater transmitter and receiver frequencies, and whether the receiver frequency was to be higher or lower than the transmitter's. An offset of 600 kHz had achieved general acceptance as the greatest difference that could be achieved without retuning the resonant stages of early two-meter transmitters. But some repeaters had negative offset, and some had positive; and some had negative offset below 147 mHz, and positive above 147 mHz. Two-meter transceivers were provided with selectable positive or negative 600-kHz offset. Further coordination was in order and would be achieved.

After the ice was broken in 1970, everyone got into the act. By 1973, full-blown mobile, VHF/FM operation had arrived. By 1974, about fifteen manufacturers were advertising VHF/FM transceivers. Equipment was offered for the 144, 220, and 440-mHz bands, and included base-station, mobile, and hand-held transceivers, power amplifiers, and complete repeaters. The Japanese already had their foot in the door. They had introduced frequency-synthesized, digital-frequency-readout transceivers well ahead of U.S. manufacturers.

STANDARDIZATION ACHIEVED

An editorial in the January 1976 *QST* acknowledged the approaching chaos resulting from the rapid growth of repeater installations, announced ARRL sponsorship of a National Repeater Frequency Coordination Plan, and again called on the VRAC to establish band plans and standards for repeater-frequency allocation.

In February 1975, Clegg introduced a full-band coverage, frequency-synthesized two-meter transceiver. The digital frequency display provided a frequency readout of 800 channels in 5-kHz steps. The frequency was selected with four switches. A +5-kHz deviation had already been established by the general use of surplus 5-kHz commercial equipment in repeaters. With a frequency deviation of +5kHz and an audio bandwidth of 300 to 3000 Hz, the deviation ratio was 1.67. This ratio is a compromise between noise suppression and capture vs. bandwidth with emphasis on narrowing the bandwidth to provide more channels in a given band of frequencies.

In January 1977, ICOM, a Japanese manufacturer, introduced full-band coverage in 5-kHz steps with single dial control. This was the beginning of adding "high-tech features" to VHF/FM transceivers and, probably, the beginning of the Japanese domination of the U.S. Amateur-radio market. However, strong competition would continue for another three or four years. In the period from 1977 through 1979, transceivers were introduced with keyboard channel selection, Touchtone(R) for dialing through repeater telephone interconnections ("autopatch"), programmable channel-frequency memories, band scanning, memory scanning, and adjustable subaudible tones for repeater actuation (PLL). In 1979, microprocessor-controlled, synthesized, handheld transceivers became available with all of these features. In 1979, no less than eleven manufacturers were advertising VHF/FM transceivers in *QST*. The Japanese generally were ahead of U.S. manufacturers in introducing advanced features.

Standardization procedures for frequency allocation within amateur VHF bands had been evolving for a number of years. As suggested in reference[10,1]: "Potential chaos is the mother of coordination." Allocation of frequencies for different types of emission (CW, AM or SSB phone, FM, Teletype, etc.) is established by FCC regulation after comments from interested parties. ARRL maintains an active relationship with FCC concerning allocations within Amateur-frequency bands. After renewed emphasis in 1976, the ARRL VHF and Repeater Advisory Committees took the lead in working with volunteer frequency-coordinating committees. The advisory committees and local coordinating committees representing all parts of the the US, established frequency- allocation band plans including the allocation of repeater pairs of frequencies. Specific frequency pairs for each repeater were approved after negotiations between the repeater sponsor and the local-area repeater coordinating committees. Frequencies were coordinated to prevent adjacent-channel interference and to minimize stations in one area activating repeaters in adjacent areas. The sponsor of each repeater supplied information to the ARRL repeater registry. In all, a tremendous volunteer effort. There were some rough spots along the way when coordinating committees didn't respond as promptly or in the way the repeater sponsor desired. And there was, inevitably, some interference with repeaters when coverage areas proved greater than calculated, particularly during periods of anomalous extended propagation. A few uncoordinated repeaters continued to operate from time to time. Coordination and standardization, on the whole, was effective as attested by the fact that the *ARRL Repeater Directory* published annually became and remains the published record of the band plans and repeater frequencies.

Throughout the 1970s, pieces had been falling into place. By 1979, a truly amazing development had come to fruition. The Amateur-radio community, on a strictly volunteer basis, had created a nation-wide, VHF/FM mobile communication system. In very nearly every urban area and much of the surrounding countryside, any properly licensed operator, with the help of a repeater-frequency directory published by ARRL, could access a two-meter repeater from a vehicle using a standard mobile or, for shorter distances, a hand-held transceiver manufactured by any one of several companies. Repeater communication was becoming the most popular activity in Amateur radio.

TEN-METER FM

From the time that FM was introduced, it was permitted on the HF Amateur bands, but only with a bandwidth no greater than that of double-sideband AM (see sidebar). However, wide-band FM was permitted in the ten-meter band above 29 mHz. With the growing popularity of VHF/FM repeaters, FM enthusiasts, with the backing of ARRL, urged FCC to permit FM repeaters on the ten-meter band. There was also an interest in cross-linking ten meter and VHF repeaters. Cross linking, or "cross-banding", would allow a VHF transceiver to

[10] M. Wilson, "Spectrum Management in the '90s and Beyond" Part 1, *QST* Aug. 1991 p43. Part 2, *QST* Sept. 1991 p50. Part 3, *QST* Jan. 1992 p67.

THE OLDEST AMATEUR CW TRANSMITTER ?

by **Bruce L. Kelley, W2ICE (LF)**

A superlative like *first* or *oldest* tends to be controversial but here, I believe, one is justified.

It was shortly after the turn of the century that the first continuous-wave signals were generated by RF alternators and arc transmitters. The vacuum tube was not used in transmitters until shortly before World War I, and little is recorded of their use by Amateurs. Because of mechanical limitations, the Alexanderson alternator was generally limited to 200 kHz or less,[1, 2] leaving only the arc which, under certain conditions, could oscillate at the higher frequencies being investigated by the Amateurs.

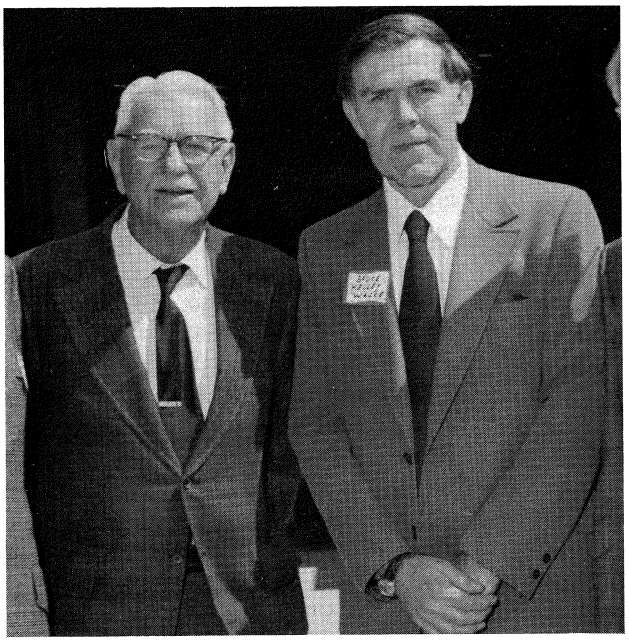
The arc transmitter, developed by Poulsen and improved by Dr. Leonard Fuller[3] at Federal Telegraph Company, would work up to 500 kHz but functioned better at lower frequencies. Would an arc oscillate near the Amateur wavelength of 200 meters (1,500 kHz.) ? I didn't think so until one day several years ago when I talked with Ken Ehret, W5APG, who said that he had designed and built an Amateur arc transmitter in 1914. In surprise almost amounting to disbelief, I questioned him for more information.

Ken built his transmitter from commercial designs and information from Gernsback publications. In the Summer of 1914, having access to the school's machine shop with its lathes and milling machines, he fashioned all of the necessary components except the alcohol drip cup, and went on the air that Fall. Initial tests were made at the University of Oklahoma Electrical Engineering Laboratory which had a 220 volt DC power source[4] and an 800 foot antenna.

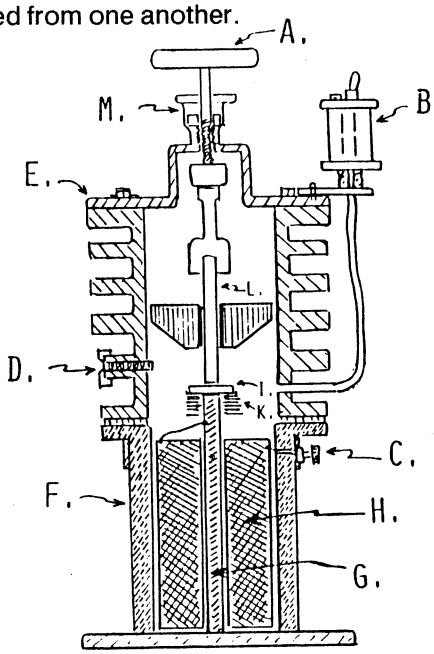
CONSTRUCTION

The transmitter is centered around a metal enclosure with carbon (L.) and copper (I.) electrodes in a hydrogen-vapor-filled chamber. Hydrogen vapor is created by alcohol dripping from a small container (B.). The hydrogen and a magnetic field (H.) improves the efficiency of the arc.

(A.) is an insulated handwheel used to lower the upper carbon electrode to strike the copper anode. (D.) is a "pop-off" valve to exhaustthe initial explosion of the hydrocarbon vapor when the arc is struck. The upper (E.) and lower (B.) sections are insulated from one another.



Bruce Kelley, right, with the late Dr. Fuller who indicated that the arc was not practical for Amateur use.

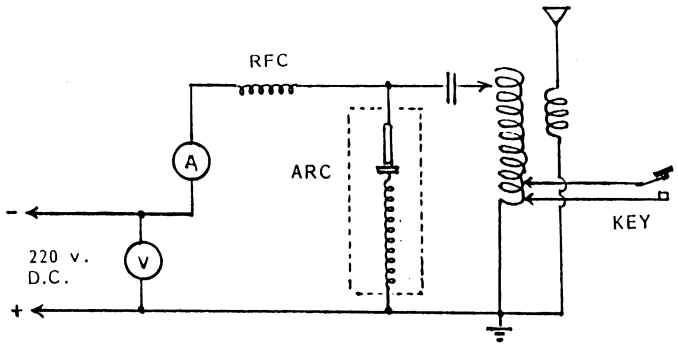


ARC HOUSING (Chamber)

OPERATION

To start the arc transmitter, one depresses the upper carbon electrode (A.) and (L.) which is adjusted to barely touch the lower copper electrode (I.). This completes the DC circuit whereupon the operator immediately raises the electrode to a predetermined distance, leaving an oscillating arc. Since the arc remains in operation during transmitting, keying is accomplished by shorting several turns of the RF inductance. This is an unwanted feature since it creates two transmitting frequencies (or signals).

Ken told me that, in making the initial adjustments at 900 meters, he could light a 300 watt lamp across several turns. Removing the lamp, he decreased the number of turns on the inductance (in affect, lowering the wavelength) until a point was reached around 450 meters at which point the arc would no longer oscillate. It was near this wavelength that he established Amateur contacts.



BASIC CIRCUIT

RESULTS

Although Amateur contacts were possible, they were limited for several reasons:

1. In 1914, most Amateur receivers were using crystal detectors. Only a regenerative receiver could copy an unmodulated arc CW signal.[5] This could have been overcome if a chopper wheel had been placed in the RF circuit to produce a modulated note (ICW).

2. The transmissions (on 450 meters) were above the normal 200 meter wavelength used by the Amateurs. This may not have caused a real problem since both transmitters and receivers tuned broadly in those early days.

3. With the key open in the "up" position, the transmitter still radiated a signal (backwave). This unwanted signal was both annoying and confusing to anyone tuning in for the first time.

Ken accomplished his goal in building an operable 1914 CW transmitter.[6] In 1915, he took it to his home where it remained for over 50 years. It now is on display in the AWA Electronic Communication Museum.

Do you know of another 1914 Amateur CW transmitter ?[7]

NOTES:

[1] Spark signals (damped) were not continuous wave (undamped).

[2] A 200 kHz Alexanderson alternator is on display in the Ford Museum at Dearborn, MI.

[3] Leonard Fuller was chief engineer for the Federal Telegraph Company, and designed transmitters up to 1,000 kW capacity.

[4] Unlike spark transmitters which operate with high voltage, the arc functions with low direct current (DC) between 200 and 500 volts.

[5] Receivers using crystal detectors could receive CW signals with an adjacent heterodyne oscillator or tikker wheel.

[6] Arc and spark transmitters became obsolete in the early 1920s with the development of high-power transmitting tubes.

[7] There are two 1906-1907 vintage commercial arc transmitters at the Ford Museum.

Bruce L. Kelley, W2ICE, is Curator of the Antique Wireless Association (A.W.A.) Museum which is located in Bloomfield, New York. He is a Director of the A.W.A.and a Contributing Editor to its publication The Old Timers Bulletin, *and active in the Quarter Century Wireless Association, the Old Timers Club, the Bloomfield (NY) Scientific Club, and other technical and scientific organizations. He is a retiree of Eastman Kodak Company. He joined The Radio Club of America in 1965, was elected to the grade of Fellow in 1972, and became a Life member in 1989. He was awarded the Ralph Batcher Memorial Award in 1978. He also was presented with the A.W.A. Houck - Documentation Award in 1972, and the A.W.A. Houck - Preservation Award in 1989 by the Antique Wireless Association. He is the author or co-author of many papers relating to radio communications.*

READING, 'RITING AND RADIO

by **Mrs. Carole J. Perry, WB2MGP** (M)

Most children, today, are ambivalent about schoolwork -- they muddle over math, fret over foreign languages, and sigh over social studies. I have been privileged to witness the exception to this rule. These youngsters are eager, attentive, and enthusiastic about their learning time in my ***Introduction To Amateur Radio*** program.

In 1980, after working for 16 years as an executive for an electronics manufacturing company, I decided to return to my first love which was teaching. A principal seeking a teacher with innovative ideas asked me to create a pilot program for Intermediate School 72 in Staten Island, New York. I proceeded to write a curriculum which uses amateur radio to motivate children in all areas of the school's curricula. For twelve years, I have been teaching *Introduction To Amateur Radio* to over 400 sixth, seventh, and eighth graders every term. This includes eleven different classes with 30 to 40 children in each class.

Every term, the course has expanded and attracted more children and parents. What began as an experimental course is now a program in the Industrial Arts/Technology Department of the school. Thousands of youngsters have come through this program and each has provided a new insight into how best to present this curriculum. In almost <u>every</u> class there are non-English speaking children, special education students, and youngsters with varying levels of ability. Amateur radio gives the facility to appeal on some level to <u>all</u> of them.

It is my job to make sure that every child leaves the program feeling good about himself or herself. They also leave knowing that they have been exposed to something very different -- something that most other children don't get a chance to experience. In fact, when the course ends, a whole new world opens up to the children going through the program.

The goal of the class is not to grind out FCC license holders. Rather, it is to ensure that a stimulating and highly-motivating environment is provided in the classroom. Everyone starts out on an equal footing. All the material is presented in such an unique fashion compared to what the

Carole J. Perry, WB2MGP

children are used to in other classes, that they grow to have confidence in their own abilities to succeed. It's very important to provide a challenge to the brighter students, and a way to master skills for those youngsters who've never succeeded at anything else in their school careers. This is accomplished by having a good rapport with the kids, doing a great deal of group work, and by making the lessons fun and exciting.

Every term, I spend a great deal of time in preparation of materials that will be appropriate and meaningful to the students that I have. In the area of enrichment, I am always on the lookout for enthusiastic and interesting guest speakers. The Quarter Century Wireless Association (QCWA) is an amateur radio group made up of operators who have a great deal of experience and tradition to offer young people. Many members are retired and have the time to visit classrooms. Through the years, I have been able to have some of these retired Hams provide real quality time with the children. It excites me to observe the children listening with rapt attention as retired Ham friends share their experiences and expertise with us.

The rewards work in both directions; not only do the students benefit from the presence of these people but the retired Hams leave the classroom with a feeling of pride and satisfaction.

OPERATING THE CQ ALL SCHOOLS NET

Another exciting activity in which the amateur-radio students participate is the ***CQ All Schools NET*** every Tuesday and Thursday at 12:30 PM New York local time, on 28.303 MHz. Gordon West, a Fellow of The Radio Club of America, is the West Coast Net control. I pick up those schools and radio operators from the East Coast who can hear me. For the past five years, we have made many interesting contacts, and have encouraged thousands of young people to get on the air and to enjoy communicating with each other.

One of the most memorable contacts was made with astronaut Jay Apt, N5QWL, from the Johnson Space Center in Texas. He checked into the net and actually conducted a lesson on the air, by having students go to the chalkboard and list the items that they thought should be included on a space suit. It was a fantastic lesson which lead to a study unit on space travel and communications..

When Apt went into space a week later on the *Atlantis* with the all-Ham crew, he gave every youngster in the class a reason to follow the shuttle's launch, and to keep track of the important findings of the mission. Before the Shuttle Amateur Radio Experiment (SAREX) program was made available to school children all over the world, many of them had become jaded to the incredible technology and achievement of launching a manned space shuttle. After several years of watching launches on TV, people were getting a "ho-hum" attitude toward space travel. Let me assure you that there's nothing "ho-hum" about kids talking on the radio to a real, live astronaut.

The children get so excited about their contacts with different astronauts that they quickly spread the word about it at home and to the community. My principal invites the parents and community leaders to visit the ham radio classroom and to see for themselves what all the excitement is about. I encourage the children to study at home with their parents. The parents love the idea of being able to become involved in an exciting area of study with their children and one that can lead to all of them becoming licensed, and being in a hobby together. And my students know the value of studying with the persons who have the money -- so they can be sure of getting ham radio gear at home. There are countless benefits for everyone.

One year, we had so many parents who wanted to get involved that I organized an evening class. A local Ham radio club provided the instructors. Many parents and members of the community participated and got their FCC licenses. There are so many ways that local clubs, or a single Ham radio operator can help out at a neighborhood school. Our society needs more more of this kind of sharing. The eagerness and curiosity of youth coupled with the wisdom and experience of age is a winning combination.

Three years ago, we had a reunion at a local college. I tracked down as many of the former Ham radio students as I could. All received invitations to come to the reunion and to let us know what they were doing. Many still were licensed. I was especially interested in those of whom I had lost track through the years. It was gratifying to learn that several former students had selected college courses based on an interest sparked back in a Ham radio class. One young man was pursuing a course leading to a career in radio astronomy due to exposure to the material in one of my classes. It's true that a teacher's influence can reach into infinity.

Within the school itself, I work with teachers in other subject areas to provide high-motivational lessons. For example, if a social studies teacher is beginning a unit of study on a particular region of the country, he or she will prepare the students with a list of interview questions to use when we make a contact with a citizen of that area. The kids love it. It's a great way to learn geography on a need-to-know basis. It is the most natural thing in the world to want to pin point on a map where the voice you're hearing is coming from. This is much more exciting for children than to simply open books and start reading.

LEARNING THE BASICS OF ELECTRONICS

Language skills are bountiful in the Ham radio program. Students learn to organize their thoughts and to speak clearly and succinctly on the air. Responding to letters from Hams and filling out *QSL* cards is good writing experience. Practicing the Morse Code aids the children in their reading and auditory skills. Almost all of the students are able to develop some degree of competency on the telegraph key. For them, it's a secret language that their teachers and parents don't know. It's presented in a fun way, so it's accepted as a fun thing to do.

In the course, every student is able to use math and science at a level at which they are comfortable. The material is presented in such a non-threatening way that the youngsters often surprise themselves with their achievements. Children who never would consider entering the school's science fair will eagerly create a project about earthquakes and emergency communications because they've spoken to students of a school in California where the children had just experienced the tremors. How else could children have an opportunity to participate, except via live radio contacts, with people all over the world who were actually engaged in emergency situations and world events?

Many of our contacts provide us with friendships that have lasted through the years. The children become pen pals with students to whom they speak; this is learning at its best. The free flow of information between schools all over the world is a terrific activity.

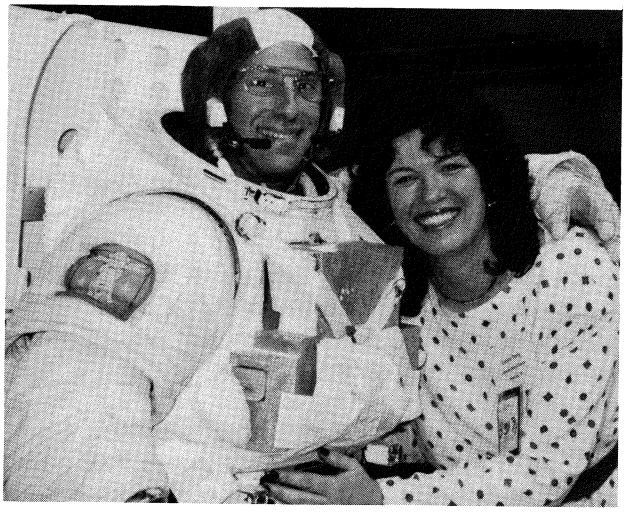
I have the children produce their own video program for many of the schools that check into our net. The kids love to see their pen and radio pals on a video tour of a school that usually looks different from ours. We've observed, however, that a busy school cafeteria looks and sounds the same no matter where it is located -- the decibel level is always away up there.

No school term would be complete for us without a visit from a Handi-Ham; so-called handicapped amateur radio operators provide inspiration for all of us. No one in my classes can tell me they "can't" do something after they've listened to stories of courage and determination, and the triumph of the human spirit. I always do a lesson on the sign language and the Braille Alphabet. It's good to let youngsters know that there are many ways that people can communicate with each other. The important thing is that they do communicate.

Approximately 75% of my students pass the Novice license exam on the first try. Of that group, about 10% upgrade, thanks to the help of the local Ham radio clubs and the many friends of our program who work with the children on a one-to-one basis.

In 1990, one of my 7th graders, Mary Alestra, KB2IGG, was chosen as the Yaesu/Westlink *Young Ham of the Year*. It's terrific to have peer role models for the children. The youngsters who become actively involved in the Ham radio program at our school continue to bring pride to themselves, to the school, to the community, and to other amateur radio operators.

I am thoroughly convinced that an amateur radio program would be an asset to every school in the country. Besides being a motivational tool for a teacher to use, it opens doors to interests in electronics, computers, space, world events, and human communications of all kinds. Asked the question: "How can Ham radio help create world peace?" one of my 6th graders responded: "If we're all on the radio talking with each other, we'll be too busy to fight."



ASTRONAUT JAY APT, N5QWL, WITH CAROLE PERRY, WB2QWL, AT THE JOHNSON SPACE CENTER PRIOR TO THE LAUNCH OF THE ALL-HAM CREW OF THE SPACE SHUTTLE *ATLANTIS* IN APRIL, 1991.

If you believe as I do that children are our most important natural resource, then I encourage you to pick up the challenge by donating time to help a school set up a Ham radio program or by becoming a mentor to one youngster. If each of us adopted just one young person, we could bring a tidal wave of new vitality, energy, and talent into our dynamic hobby and service.

Mrs Carole J. Perry, WB2MGP, has an MS degree in Education and, for 16 years, served as Executive Vice President of Avant-Guard Devices, Inc., an electronics manufacturing company in New York. In 1987, she began a publishing and marketing company called Media Mentors, Inc. that sells her multimedia curriculum package and other educational materials.

She was the recipient of the prestigious 1987 Dayton **Ham of The Year Award**, *the 1987 ARRL* **Professional Instructor of the Year Award**, *and the 1987 CONEX (QCWA Northeast Chapters)* **Teacher of The Year Award.** *In 1991, she received the* **Marconi Memorial Award** *from the Veteran Wireless Operators Asociation. NASA's Education Department selected Carole Perry to attend a special Educators Conference and a VIP viewing of the launch of the Space Shuttle Atlantis, in April 1989.*

She is an Assistant Director of the ARRL Hudson Division and is Chairperson of the division's Educational Task Force. In 1988, she was selected to be an educational advisor to the ARRL Education Department. In 1991, she began the "Hams With Class" column in 73 Magazine *and is a columnist for* Radioscan Magazine *and for* Radiofun Magazine.

HELP WANTED!

EDITORS, PUBLISHERS, AND WRITERS

The Radio Club's principal organs of communication between the membership are *The Newsletter* and *The Proceedings*. Both publications are necessary.

The Newsletter is edited and published by Gil Houck (Director & Fellow) from news items and other bits of information supplied by our members. Just how interesting *The Newsletter* may be depends to a great extent upon the help given by the membership in supplying information. The articles: *Happenings; Book Reviews; News Briefs* and, yes, even *Obituaries* are sourced through you.

The publication of *The Proceedings* is another story. Here, we're fully dependent upon papers submitted by members who are experts in their fields. Some are in academia, others in business, and quite a few are historians. Each submitted paper is read and judged for its appeal to a majority of our membership; it then may be edited -- sometimes for brevity and sometimes to lengthen its story. Once in awhile, changes are made to make the story more suitable for our readers.

The Proceedings have a long history. The date of the first issue is subject to questioning. Six papers were read before the Club prior to 1913, and each was published albeit without the periodical having a title other than that of the paper. The first article published in *The Proceedings of The Radio Club of America* was "Theory of Tuned Circuits" by Edwin Howard Armstrong; the issue was dated May 1913. The current issue of May 1992 is identified as Volume 66, Number 1.

That identification doesn't really indicate the number of years that *The Proceedings* have been published. For a few years, each Volume consisted of twelve issues; sometimes those twelve issues extended over two or more years. In fact, *The Proceedings* have been published continually since 1913 excepting for a few years during World War I when many members were serving in the Armed Forces and there weren't a sufficient number available at home to produce a publication. We haven't reviewed the Minutes of the Club over these last 83 years so we can't say how many editors have served but we'd guess that there have been quite a few.

Each has left an imprint. Some were successful in obtaining papers long before they were published in the technical journals. Armstrong's papers were typical. Oftentimes, the articles were published immediately after the presentation of the papers at a Radio Club seminar. Other editors and publishers determined the formats of their editions, and we find that at least four sizes have been published. But in every instance, *The Proceedings* did reflect the philosophies of its editors and publishers.

Now it is again time to reformat the publication. Your present editor and publisher began his work on *The Proceedings* in 1982 with the initial work on the Club's *75th Anniversary -- Diamond Jubilee Yearbook*. In that period, 13 issues of *The Proceedings*, 3 issues of the *Membership Directory*, and *The Legacies of Edwin Howard Armstrong* have been published. It is in the interest of the Club that a new editor and publisher be found.

Now, the jobs pay no money. But there's a lot of satisfaction in receiving the compliments of your peers for a job well done. And there's not much money to pay for the production of the publications -- really, just enough comes from the advertising to pay for the printing. The mailing costs come out of the annual dues and, sometimes, they must be tapped to augment the advertising income.

That means that if you'll accept the job, you'll probably be soliciting papers from the experts, editing those papers, and sitting before your computer preparing camera-ready copy for the next issue. But not to worry; you'll get a lot of help and encouragement. Why not apply for the job? Drop a line to our president and tell him that you're interested.

TREASURER'S REPORT FOR FISCAL YEAR 1991

(October 1, 1990 — September 30, 1991)

REVENUES

Dues Collected & Applied	$14,229
Other Member Fees	1,246
Sections Operations - net	(907)
Banquet - net	1,604
Advertising Sales	4,271
Pins & Plaques Sales	1,330
Interest on General Funds	1,559
Publications Sales & Misc.	4,702
TOTAL Revenues	$28,034

EXPENSES

Publications	
Printing & Supplies	$16,838
Mailing Expenses	4,761
Meeting Expenses	3,466
Office Expenses	
Printing & Stationery	385
Postage	847
Telephone	84
Computer Expenses	616
Consulting Fees	0
Legal & Accounting	900
Pins & Plaques	3,263
Miscellaneous	476
TOTAL Expenses	$31,636
NET Revenues less Expenses	($3,602)
Other Adjustments (net) (see note -->)	15,354
Net Increase in Fund Balance	$11,752

BALANCE SHEET

ASSETS

Inventory & Receivables	$1,714
Section & Banquet Funds	16,138
Cash in Bank - Operating	24,911
Investments - Securities	31,983
GNMA Certificates	90,591
Fed Home Loan Mtge	25,000
Putnam fund	32,393
TOTAL Assets	$222,730

LIABILITIES

Prepaid Dues	$11,945
Prepaid Banquet Tix-91 Banquet	2,330
Prepaid Advertising	325
Fund Balances:	
Scholarship Funds - Principal	125,199
For Distribution	14,143
General Funds - Op'g Balance	31,421
Reserve for Oprt'g Deficits	13,800
Life Member Fund	16,734
Legacy Fund	3,581
Other Assets & Liab-Net	3,252
TOTAL Liabilities	$222,730

N.B. Other adjustements include contributions to funds, scholarships and grants awarded, earnings on funds and changes in values of investments.

SCHOLARSHIP & GRANTS FUNDS

	Capital	Available for Distribution	Totals
Opening Balance Oct. 1, 1990	$118,434	$13,994	$132,428
Contributions	6,765		
Interest Earned		11,749	
Scholarships & Grants Awarded		(11,600)	
Ending Balance Sept. 30, 1991	$125,199	$14,143	$139,342

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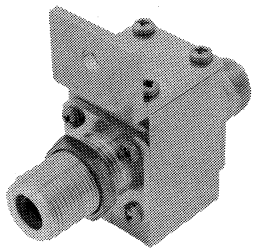
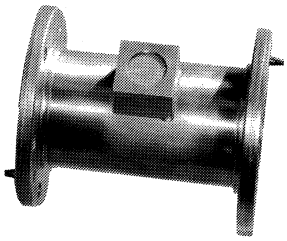
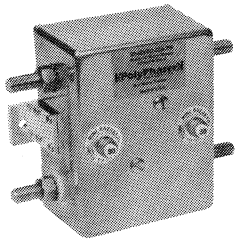


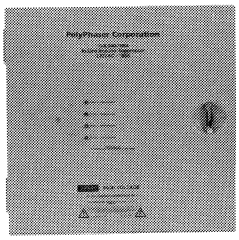
COAX TO 6GHz



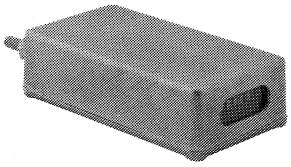
BROADCAST & MILITARY TO 80 KW



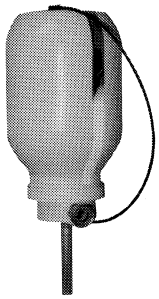
12-80VDC @ 50A



3ø POWER TO 480VAC



STRIKE COUNTERS TOWER/POWER/PHONE



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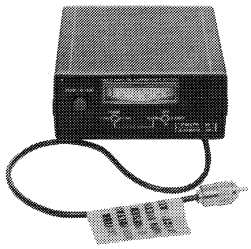

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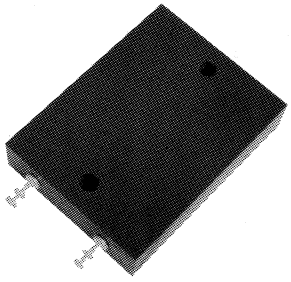
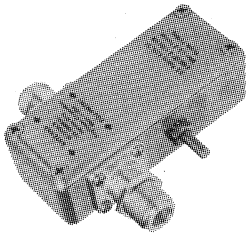
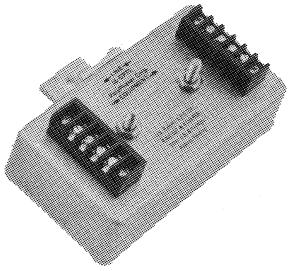


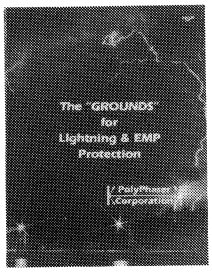
HIGH CURRENT/ENERGY LOW CAPACITANCE SHUNT



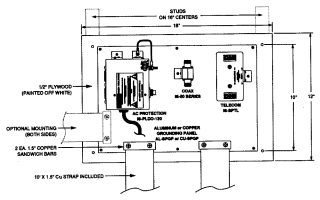
4-23 GHz MICROWAVE DOWNCONVERTERS



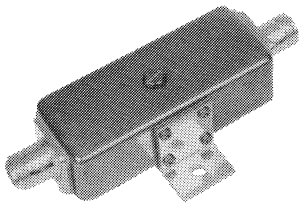
TWISTED PAIR (TO DS-3 RATES)



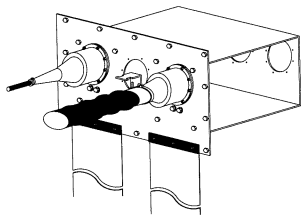
VIDEO & TUTORIAL BOOK



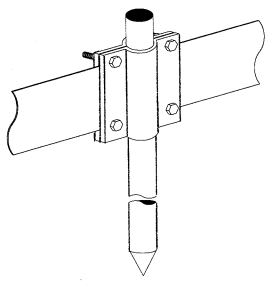
SINGLE POINT GROUND PANEL



LAN/VIDEO



ENTRANCE PANELS



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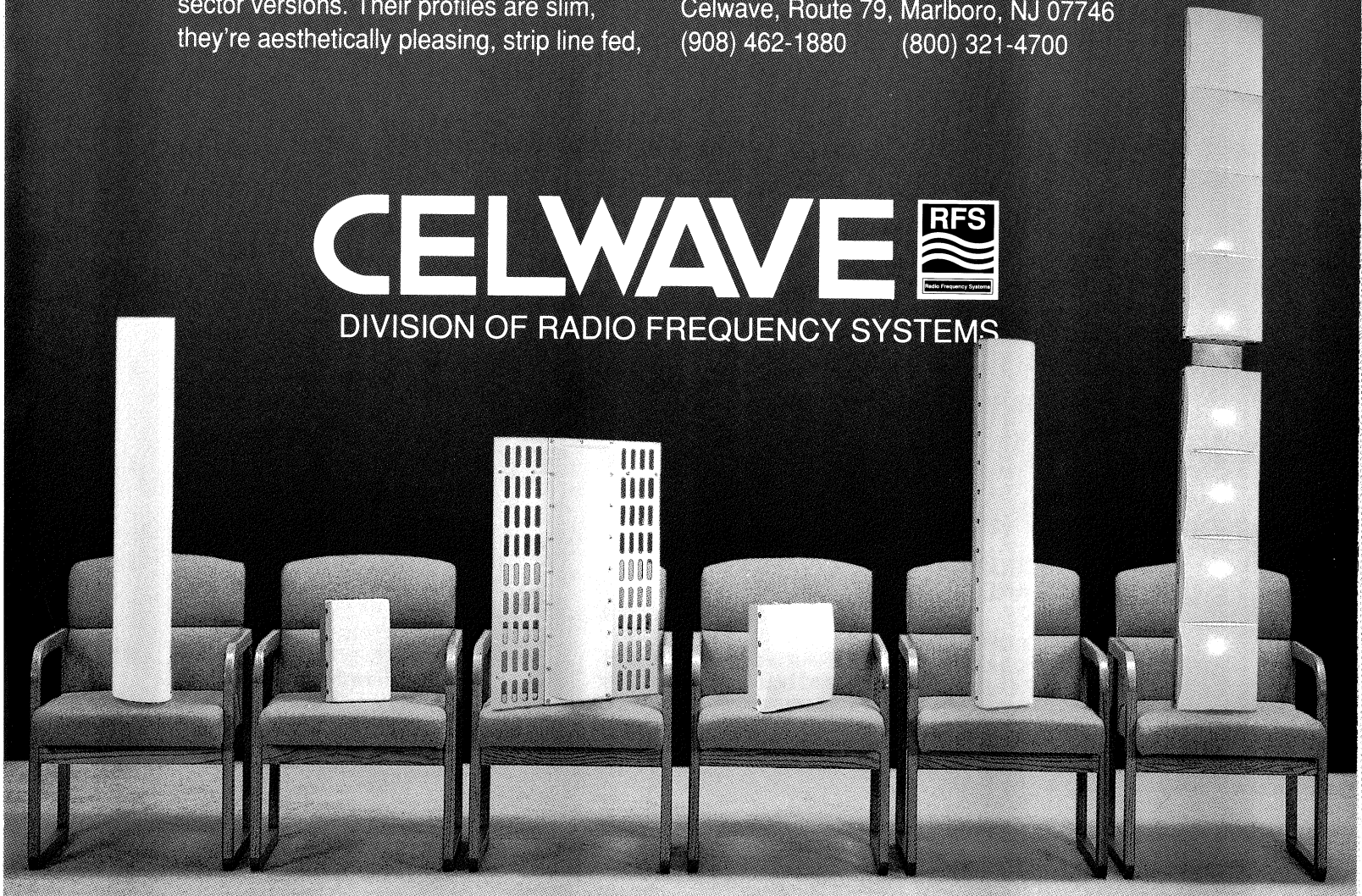

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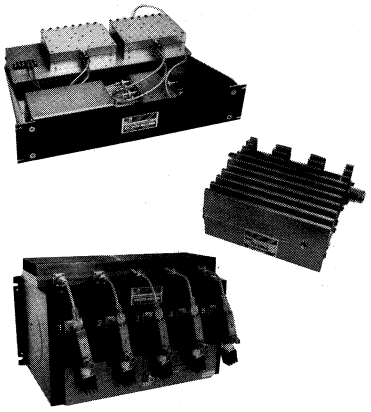

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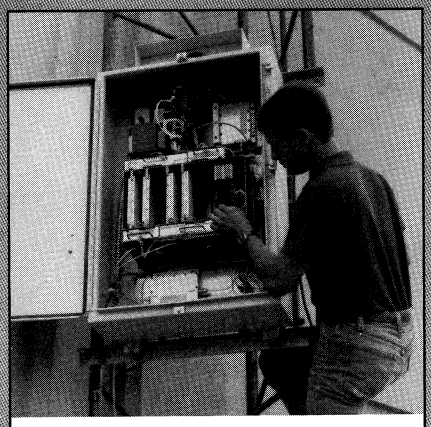

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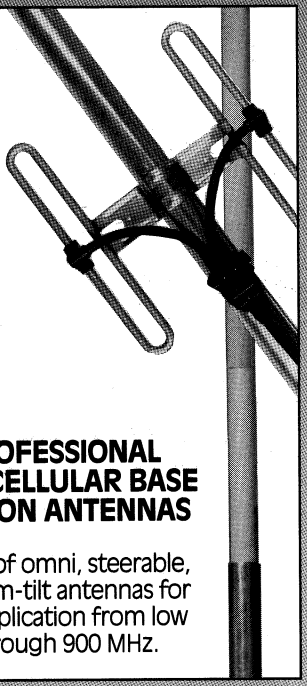

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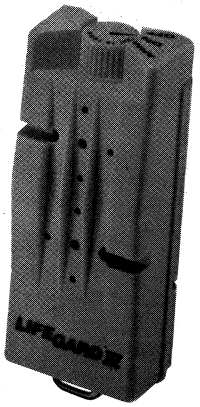

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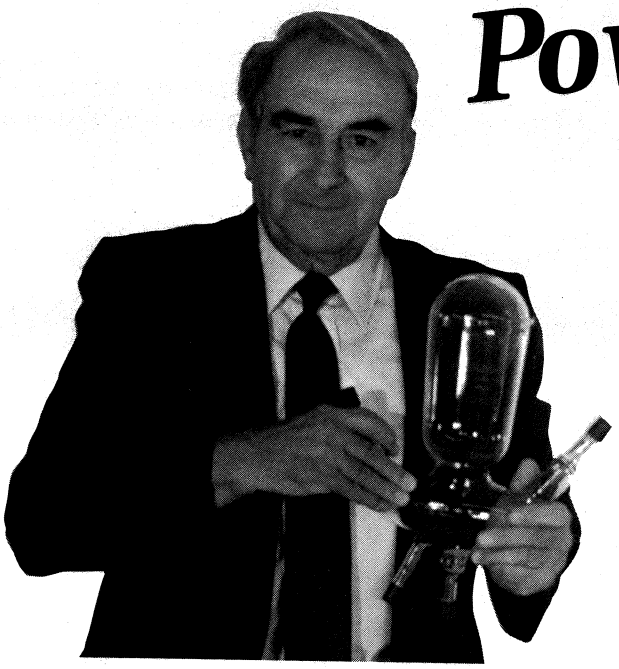

Ray Minichiello has built power supplies more than 58 years! Initially W1HBR in 1933, later as W5RCQ.

The photograph is of Ray, President of Lapp Company, holding his treasured mercury-arc rectifier that once powered his early 1 KW CW transmitter.

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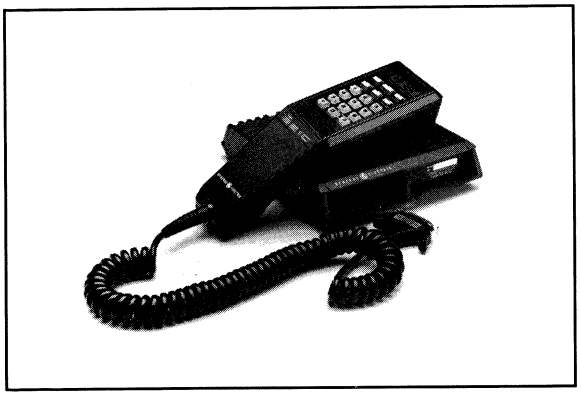
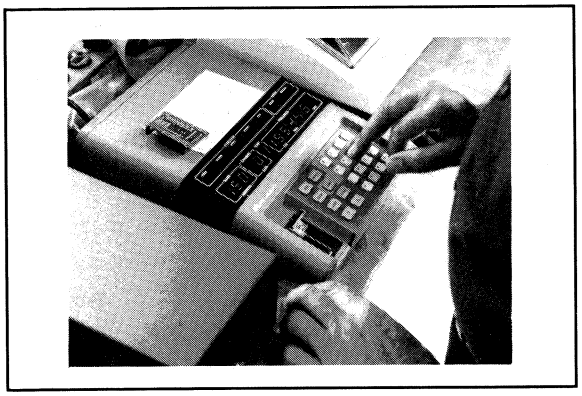


Experts in Design,



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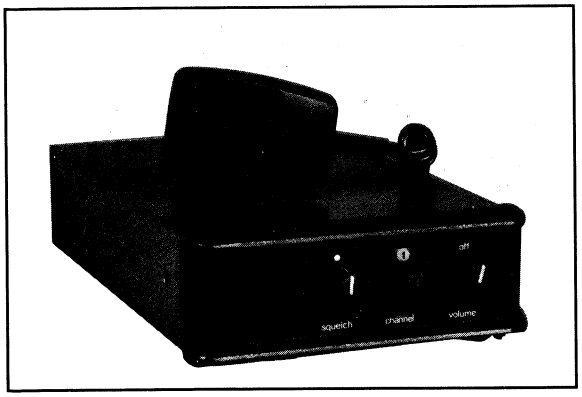

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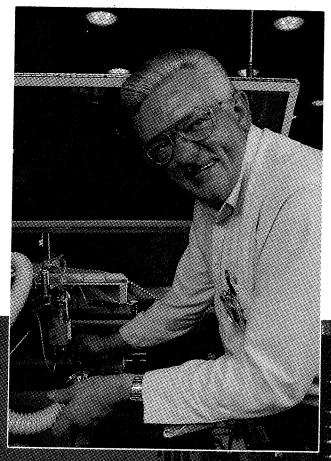
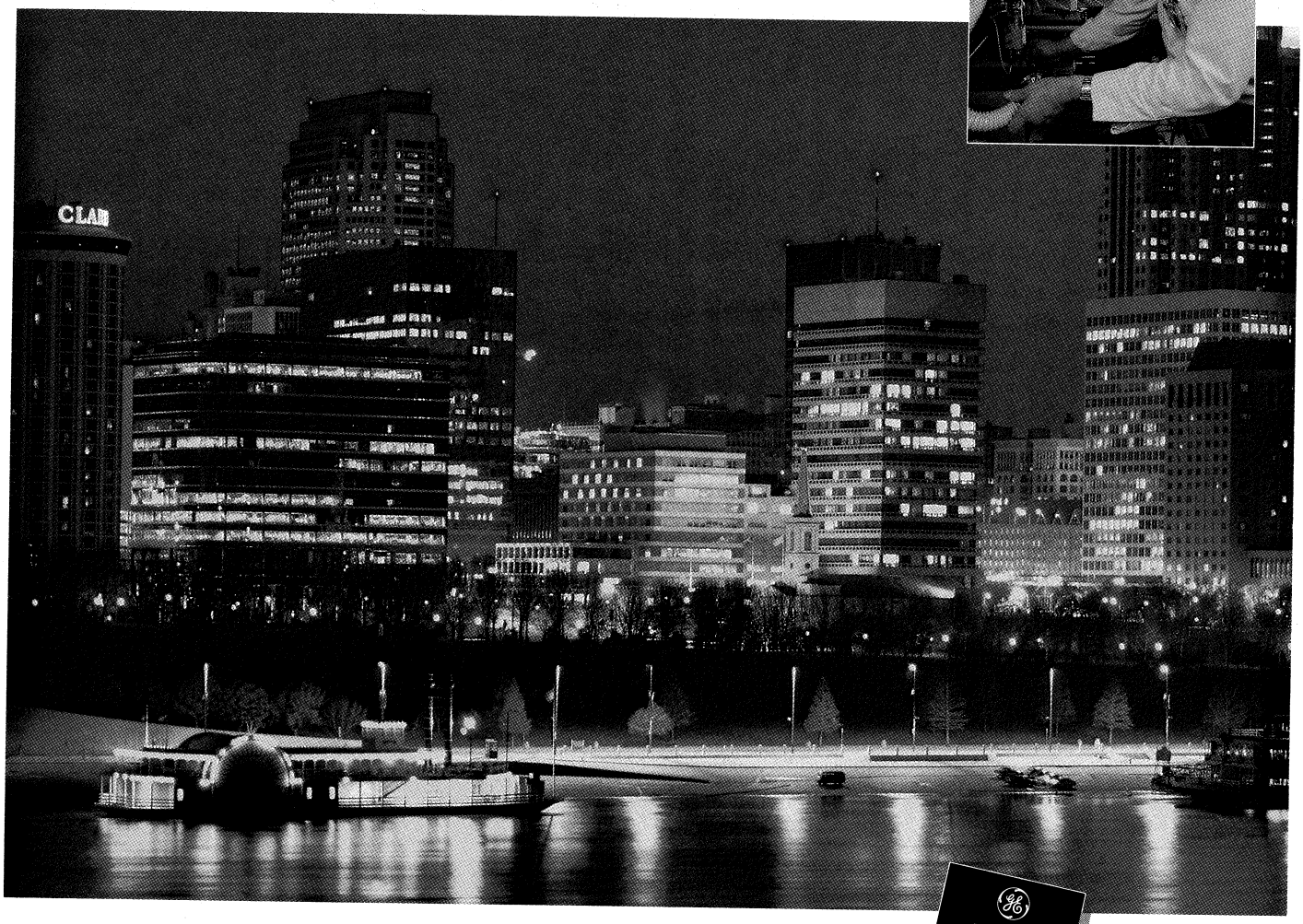
Why two million men, women and children in the St. Louis area depend on Frank Smith of Lynchburg, VA.





Frank is helping Union Electric keep the lights on in St. Louis.

As an Ericsson GE Production Planner, Frank helps turn out components for EDACS (Enhanced Digital Access Communications System).

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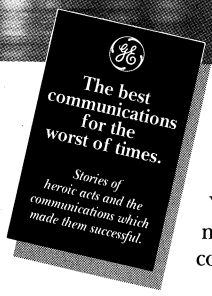
For facts about EDACS, plus a free booklet with true-life case histories, call Ericsson GE Mobile Communications Inc. at 1-800-GE-12345 or 804-528-7643.



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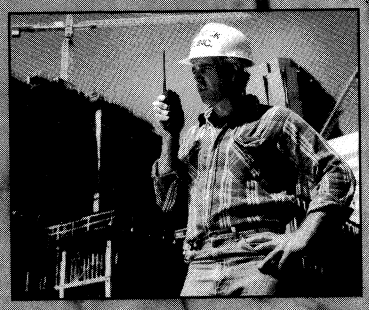

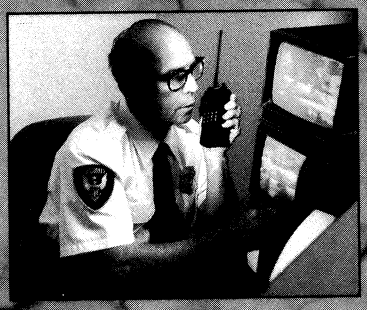

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