DIAMOND JUBILEE

THE RADIO CLUB OF AMERICA INC.

Volume 54 No. 3 Fall 1984

A HISTORY OF THE
RADIO CLUB OF AMERICA, Inc.
1909 - 1984

Dedicated to:

"The Spirit of Good Fellowship

and the Free Interchange of

Ideas Among All Radio Enthusiasts"

SEVENTY-FIFTH ANNIVERSARY DIAMOND JUBILEE YEARBOOK

1984

1909

RADIO CLUB OF AMERICA INC.

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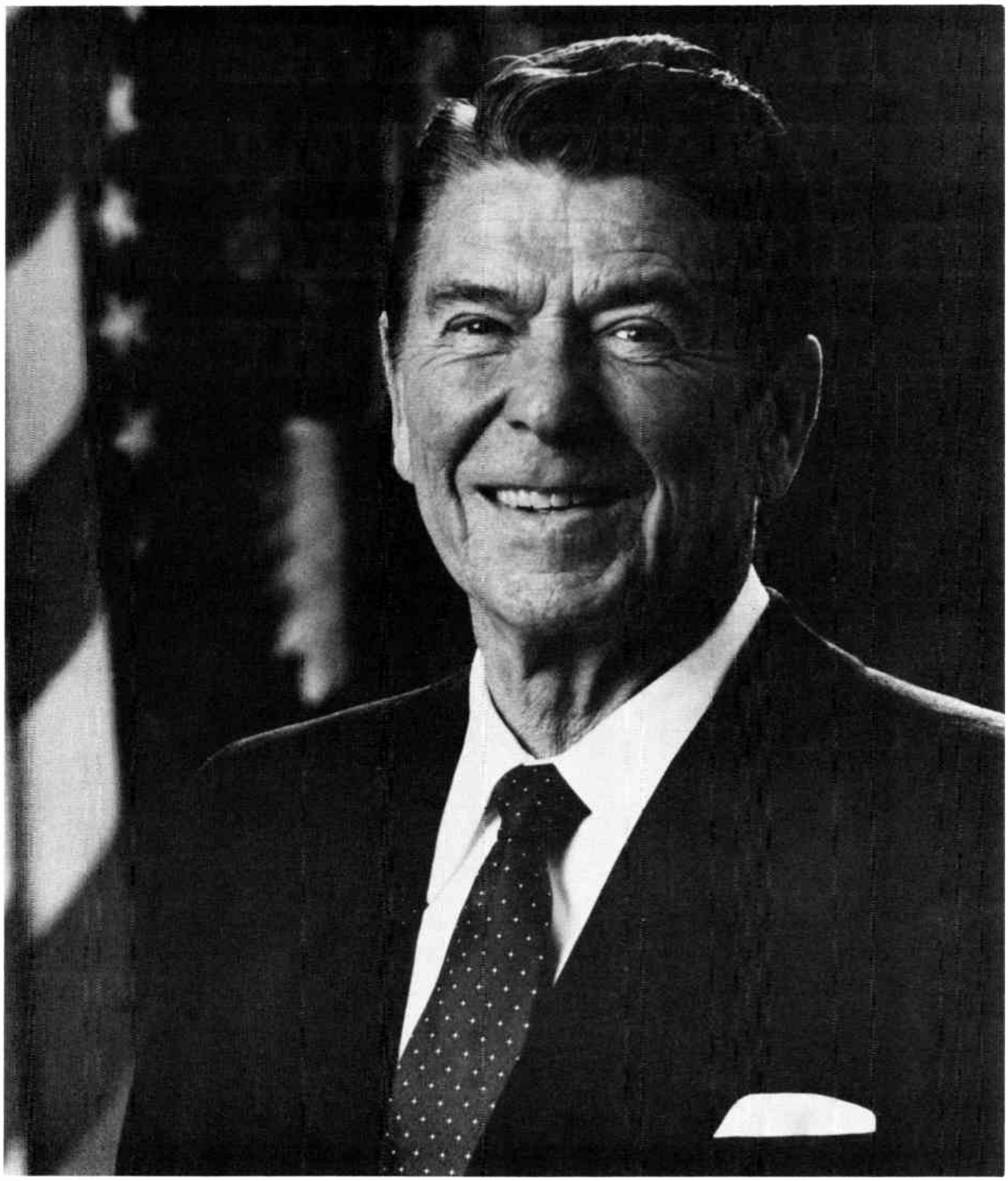


The Honorable Ronald Wilson Reagan
President of the United States

THE WHITE HOUSE

WASHINGTON

October 10, 1984

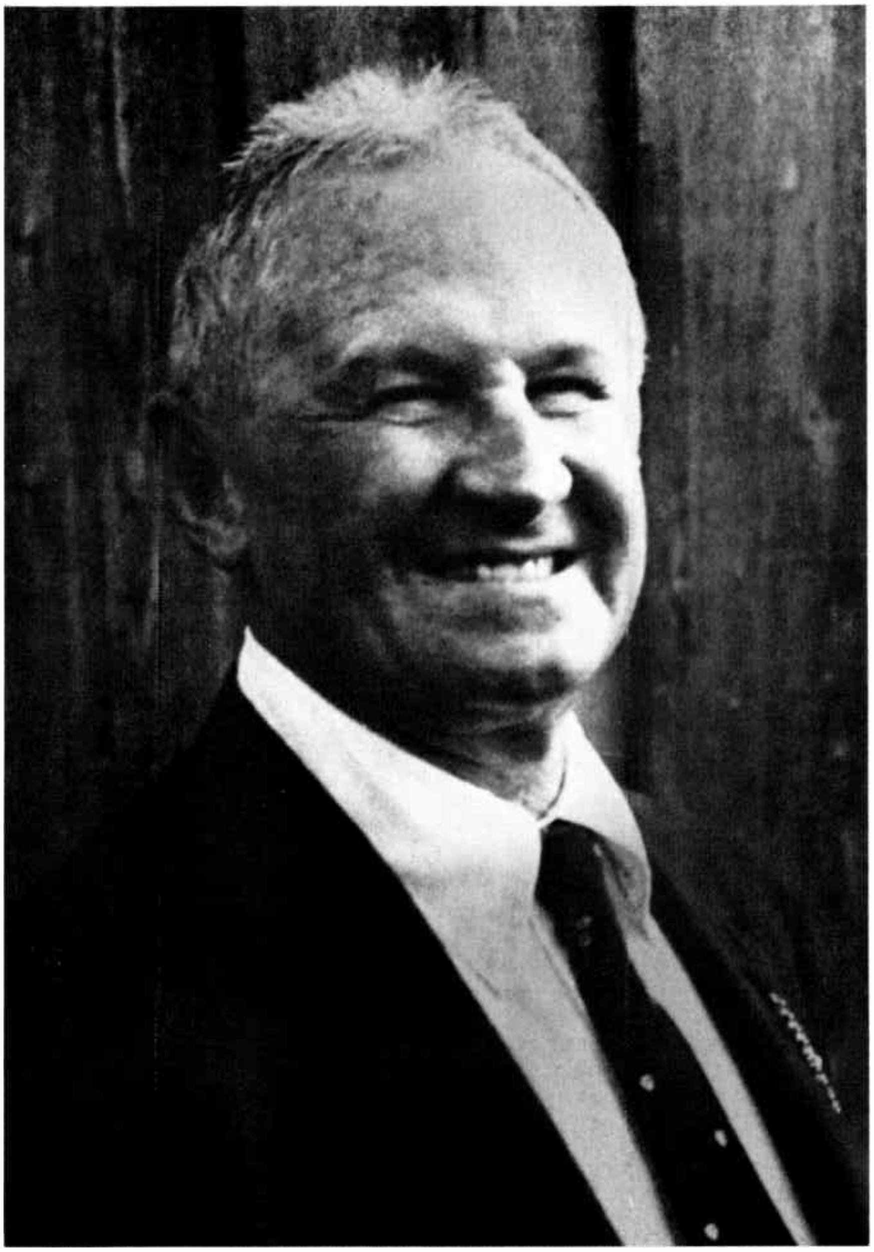
It is with the greatest pleasure that I extend warm greetings to the members of the Radio Club of America. Just seventy-five years ago, your members were mostly teenagers interested in airplanes and wireless radio. Today, many of you are the foundation of our communications industry.

Although still a relatively small group, your interest in promoting cooperation among those interested in scientific investigation and amateur operation in the area of radio communication is to be commended. With members including amateur radio operators, inventors and scientists, you hold a vast repertoire of communications expertise.

I encourage you to continue to accept the challenges of the telecommunications industry. The importance of telecommunications cannot be overemphasized in present and future business and society. It is an industry that holds the key to successful information sharing and planning across great distances.

I commend you on your accomplishments in the past and look forward to your continued success. I am happy to send my best wishes as you celebrate your organization's Diamond Anniversary.

Ronald Reagan



A MESSAGE FROM THE FIRST PRESIDENT OF THE JUNIOR WIRELESS CLUB LTD.

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 walky-talky sets and those prodigious efforts to eliminate static led to our present day smooth FM reception.

The important thing to remember is that our boys of the Radio Club were in the forefront in all 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 Condensor. Some of the earliest trans-Atlantic 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 Trans-Atlantic 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 the 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 members for the original precepts of the founders remains undampened.

W. E. D. Stokes Jr.

A MESSAGE FROM THE PRESENT PRESIDENT OF THE RADIO CLUB OF AMERICA, INC.

In his messages as the first president of The Radio Club of America, W.E.D. Stokes, Jr. has briefly told the history of The Club more aptly than could be written by any present member. These messages will be found in this year book.

As the president of The Radio Club of America for the past fifteen years, I have witnessed its continued growth and its international acceptance as one of the foremost wireless and radio associations. We pride ourselves in the claim to be the 'World's First Communications Society' — a statement that has been an important element of our club as long as I can recall. Since no one has contested that claim during the fifteen years of my presidency, I am certain that it must be a fact.

Much has happened in these last twenty-five years since our Fiftieth Anniversary Golden Yearbook was put together in 1959 to record the history of The Radio Club of America. Key items from that year book and from the one published in 1934 to commemorate the Silver Anniversary of The Club are being included in this current publication. It should cover the major events from the founding date of January 2, 1909 to the present.

While there have been vital changes in The Club during the past decade, there was an earlier period when the organization was beset with problems. In 1968, the Club's finances were almost non-existent, and the officers and members covered expenses by personal contributions whenever creditors became noisy. It was simply a matter of importance to those staunch supporters that The Club must survive and go forward. To them, we owe a debt of gratitude.

Fortunately, today The Club is fiscally strong and enjoys an excellent standing in the financial community. In addition, with special efforts by our officers, we have obtained a tax-exempt status that has made possible our successful Grants-in-Aid scholarship program which has become a major objective of The Club. This program, now in its fifth year, has already provided in excess of $19,500 in grants for scholarships and research . . . made possible through donations of members and friends.

That program was initiated by a major contribution from Director Emeritus William G.H. Finch in 1977 that generated a swell of individual contributions that have built the Grants-in-Aid Fund to $74,600 through May 1, 1984 — an amount that generates enough interest from its investment to support the current level of awards. Many of those contributions came in response to solicitations enclosed with the annual dues notices sent by our Treasurer who, in 1980, had suggested that the Grants-in-Aid Fund should become self-perpetuating as was the Finch Fund.

Our membership of approximately 1,000 includes both men and women, and a substantial number of overseas members. We are proud of our group and their achievements, and of those many leaders of the past who no longer are with us. Their accomplishments can be found everywhere in our writings and activities. The claim that *almost every important personage in the history of radio communications was or is a member of the Radio Club of America* is factual.

It is the wish of the Diamond Jubilee Committee supported by the Officers and Directors of The Club that this effort to put into one place a Story of The Club will bring as much enjoyment to you, the Reader, as it has to us who have been involved in this wonderful sphere of activities over these many years.

Fred M. Link

BARRY GOLDWATER
ARIZONA

COMMITTEES:
INTELLIGENCE, CHAIRMAN
ARMED SERVICES
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PREPAREDNESS
STRATEGIC AND THEATRE NUCLEAR FORCES
COMMERCE, SCIENCE, AND TRANSPORTATION
COMMUNICATIONS, CHAIRMAN
AVIATION
SCIENCE, TECHNOLOGY, AND SPACE
INDIAN AFFAIRS

United States Senate

WASHINGTON, D.C. 20510

September 24, 1984

The Radio Club of America, Inc.

Congratulations on the occasion of the 75th Anniversary of the Radio Club of America.

The field of communications has changed tremendously since I was a young man putting together my first amateur radio station. We can now be in touch with other radio operators around the world in a matter of seconds and the importance of this was recently demonstrated by the role played by amateur radio in Grenada.

As a recipient of the Sarnoff Citation and a "Fellow" of the Radio Club of America, I salute you on this special occasion.

Sincerely,

Barry Goldwater

Barry Goldwater

PREFACE:
The Genesis of a Yearbook

The dream of publishing this Yearbook began in mid-December 1974 when Leo G. Sands (M 1960, F 1969, L 1983) proposed that the Club plan to issue a 248 page book in recognition of the Club's 75th Anniversary. One hundred sixty-eight pages of the Diamond Yearbook would be from the successful Golden Jubilee Yearbook, and that would be supplemented with updated listings of officers, honorees, deceased members, etc., together with historical information on the Club's activities since 1959.

The March 1975 issue of the **Proceedings** carried a short announcement of the proposed year book, which brought two dozen replies from members interested in ordering. By mid-May 1975, Sands submitted a proposal to the Club's president, Fred Link, that a Yearbook Committee be appointed, to consist of:

Leo G. Sands, *Chairman*
Arthur Salsberg, *Editorial Content (current)*
Harvey Gersnback, *Editorial Content (historical)*
Kenneth Bourne
Robert Tall, *Editorial Content (FCC chronology)*
Rhett McMillian, *Editorial Content (public safety)*
Edward Minderman, *Production*
James Morelock, *Club Activities & Papers since 1959*
Harry Boyle, *Directory Tabulation*
David Talley, *Directory Verification*
Arthur Collins, *Editorial Review*
Jerry Stover, *Editorial Review*
Alfred Menegus, *Advertising Sales Manager*
Stuart Meyer, *Advertising Sales (East)*
Loren McQueen, *Advertising Sales (West)*
William Bitcon, *Advertising Sales (Canada)*

Perhaps ten years was too long a time to sustain interest in a project like a year book and, for some reason, no further references are made to the project until the Minutes of the Meeting of the Executive Committee of September 16, 1982 reported that President Link had requested Jim Morelock and John Morrisey to serve as Co-Chairmen of a Diamond Jubilee Yearbook Committee. A week later, David Talley also was invited to serve as a Co-Chairman.

Now the question became: "What had been done before?" A search began for historical data. It was suggested that the 25th Anniversary and Golden Jubilee Yearbooks, back issues of the **Proceedings** and **Newsletters**, and the minutes of the meetings of the Board of Directors and the Executive Committee should be reviewed.

The decision was made. The contents of the 25th Anniversary Yearbook would be published in their entirety, and the 50th Anniversary Golden Yearbook would be edited a bit removing only material which was of a little interest: items such as photographs of the annual banquets wherein it was difficult to identify individuals. Some parts, such as the listings of officers and honorees and of the **Proceedings**, were continuing features of each era, and those parts could be consolidated into one covering the full 75 years.

But where does one get a copy of the 25th Anniversary Yearbook? Although 1500 were printed, only two could be located: one in New Zealand, and one in the files of Joseph J. Stantley. He loaned us his.

Our Executive Secretary and Jerry Minter brought forth a complete set of the **Proceedings** for the last 25 years plus two cartons of copper halftone cuts used to illustrate the Golden Yearbook. But 25 years had taken toll of the halftones and most were pitted with copper sulfate. That loss together with the absence of the original photographs left our recourse to photocopying the pages of the year books.

The texts of the Silver and Golden Yearbooks related the history of the Club in a chronological sequence. Dates and events followed in neat order to record what had happended in each quarter century. At that time, the contents of each **Proceedings** usually consisted of a single technical paper, so the year books supplemented the technical information with "gossip" about the members.

Then the October 1959 issue of the **Proceedings** set a new pattern, and published a letter from Lloyd Jacquet suggesting ways to improve the Club. The matrix had been broken and, by the Fall of 1961, the **Proceedings** carried the obituary of Harry Sadenwater, a salute to the deceased, an editorial, a letter from a member, and notes on the activities of the Club. And from there, each issue of the **Proceedings** has traced the month-to-month history of the Club. No longer was a year book needed to record the stories of the Award Dinners and other events.

Then what should the contents of the Diamond Jubilee Yearbook include? It was decided that many of the stories told in the **Proceedings** were worth repeating — that they were milestone in reporting the progress of radio technology and allied sciences — so we culled the last 25 years to pick those which seemed outstanding. Then we published an article in the April 1983 issue of the **Proceedings** titled "A Touch of Immortality" inviting the membership to write original articles on their specialties. Some submittals were autobiographical; some related to historical events; and some documented data important in the affairs of the Club. You'll read those articles in this year book.

Finally, decisions had to be made whether published articles should be edited to fit the plans for the yearbook. The consensus was: "We won't take anything out of context nor will we make a better speller out of the original author." So what you'll read is complete with warts and all. There are grammatical errors, spelling errors and, possibly, errors of facts but we left those exactly as the manuscripts were approved by their authors. We did, however, consult with the living authors when we questioned something, and sometimes suggested changes to clarify the writing, or omissions when data wasn't pertinent.

Who put the Yearbook together, and why isn't there a masthead listing their names? Well everyone in the Club had a part: certainly those who contributed their money — their names are listed as Sponsors; then there are those who wrote articles — and here we encouraged the use of by-lines introducing the authors. The editors and those who collected data seem to remain incognito as is the case in most publications; and the remaining unsung are those who do the nitty-gritty jobs like proof reading, the page layouts, and the mailing of the year book to you. A year book succeeds only because there are many self-effacing people who volunteer to do a job because it's there to be done.

And all that has resulted in the tome that you're holding. We hope that you enjoy it.

THE RADIO CLUB OF AMERICA, INC.
1984

OFFICERS

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MAL GURIAN	*Vice President*
JOSEPH ROSENBLOOM, Esq.	*Vice President/Counsel*
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FRED SHUNAMAN	*Executive Secretary*

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JOSEPH F. WALKER, Sr.

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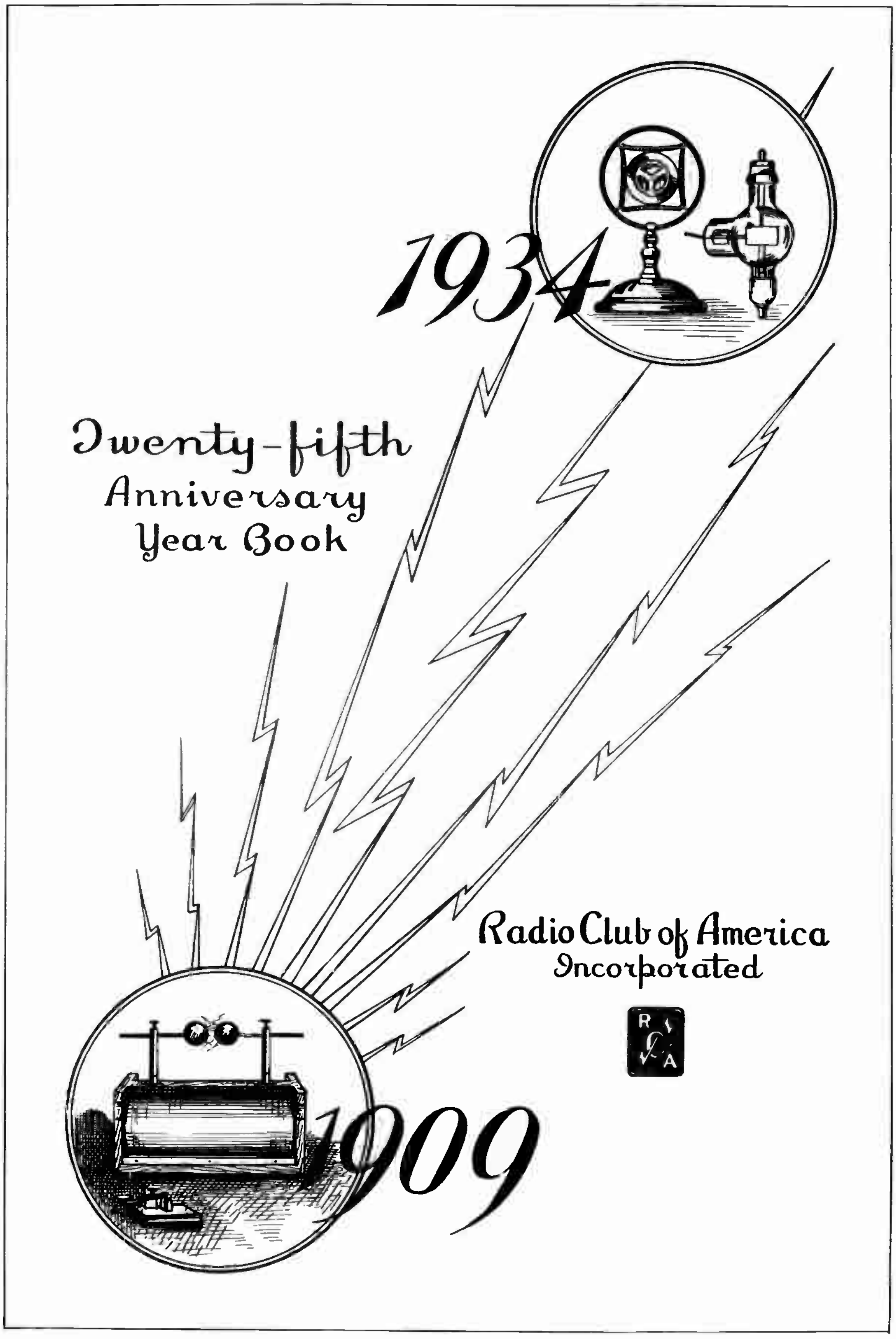
JOHN W. MORRISEY	*Co-Chairman, Yearbook*
O. JAMES MORELOCK	*Co-Chairman, Yearbook*
DAVID TALLEY	*Co-Chairman, Yearbook*
JERRY B. MINTER	*Awards*
JACK R. POPPELE	*Banquet*
JOSEPH ROSENBLOOM, Esq.	*Constitution & By-Laws*
WILLARD D. ANDREWS	*Finance*
JOSEPH F. WALKER, Sr.	*Grants-in-Aid*
VIVIAN A. CARR	*Membership*
SAMUEL N. HARMATUK	*Nominations*
O. JAMES MORELOCK	*Publications*
ERO ERICKSON	*Publicity*

Planning Conference of Yearbook Staff with Radio Club Officers

Seated (L. to R.) Yearbook Co-Chairmen: Jim Morelock, Dave Talley, John Morrisey. Standing (L. to R.): Frank Shepard (Secretary), Tom Amoscato (Director), Fred Link (President), Jack Poppele (Chairman-75th Anniversary).



Cover design of Silver Year Book 1934.

RADIO CLUB OF AMERICA

Incorporated

Founded 1909

TWENTY-FIFTH ANNIVERSARY

YEAR BOOK

1934

Executive Headquarters

11 West 42nd Street

New York City

TWENTY - FIFTH ANNIVERSARY YEAR BOOK COMMITTEE

George E. Burghard, *Chairman*
Ernest V. Amy
Edwin H. Armstrong
George J. Eltz, Jr.
John F. Grinan
Lawrence C. F. Horle
Frank King
Robert H. Marriott
Fred Muller
Joseph J. Stantley
W. E. D. Stokes, Jr

PREFACE

In preparing this, our twenty-fifth anniversary number, the Committee have a keen appreciation of the responsibility imposed upon them by the membership.

Twenty-five years represent practically the entire life span of that most fascinating of the communication arts,—Radio. Our membership has contributed more than its share to the perfection of the science as it is known today. Statistics are therefore available in vast array ready for sorting, sifting, and compilation into neat paragraphs,—that no one will read.

The committee had to decide whether we should prepare a statistical type of anniversary number or whether we should attempt, to the limit of our poor powers, to incorporate in the book some of that spirit which led to the foundation of the club and to which can largely be attributed its continued existence.

To the members of the committee the answer seemed more than obvious, statistics could not be ignored, they were important, yes, but only as the limbs of a tree are important. Statistics are the result of growth just as are the limbs of a tree, it is the spirit, the upward urge that is responsible for both.

In no engineering association is the spirit of growth, the urge to seek new pastures as strongly emphasized as in the Radio Club of America, Inc. Founded in 1909 by a group of school boys whose sole bond, when the club was formed, rested in their interest in "Wireless", the club has continued ever since with that bond as its strongest and greatest asset.

The school boys have grown up, they are now middle-aged men, but when they meet, as they do very frequently, the same spirit, the identical urge to find something new in "Wireless" is always present. If the founders of this club and its early membership bequeathed anything to the club it was this spirit of unrestrained curiosity and willingness to reveal to others without hesitation the results of personal experiments in the beloved art.

There is something big, something cosmic, about radio that washes away the petty things that so trammel other arts and sciences. The rich and the poor, the wise man and the student, meet through the medium of the ether and are comrades. This is the spirit of your club, treasure it, foster it, for when it dies the club dies with it.

When the club was founded radio was an unknown quantity, almost a plaything. How it has developed, the part it played in the World War and the position it holds in the world today is known to all of us. It has been exploited by big business, fortunes have been made and lost in it but the bond that founded the Radio Club is still good. Radio, to those who truly understand its spirit, is above exploitation.

There is no other radio association quite like the Radio Club, no other group quite so free of the commercial taint, old and young, we are amateurs when we meet in the Radio Club, let us remain so.

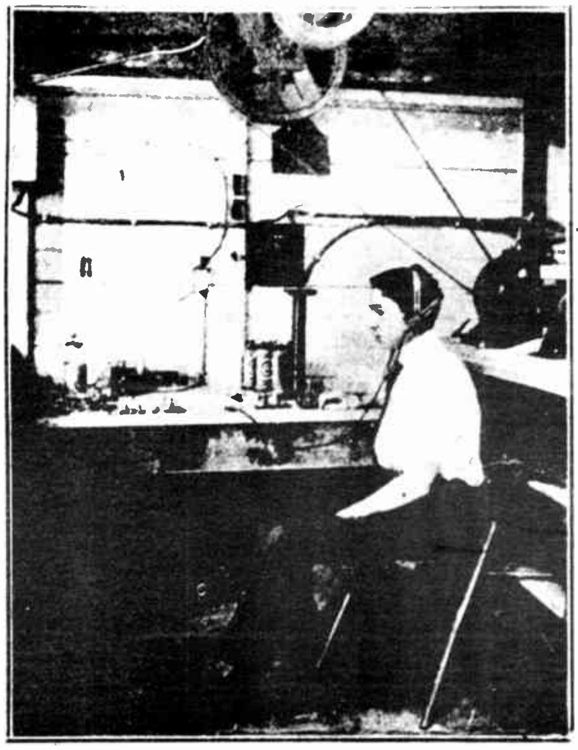
The statistics on our membership have been cut to the barest possible outline. A glance through the membership list will reveal the reason for this. To do full justice to the achievements of some of our members would require a volume many times thicker than we could afford. It is our desire to slight no one, rather are we actuated by that amateur bond which attributes to each in equal measure, the same spirit, the same desire for development, regardless of past achievements.

It is in this spirit that your committee present to you your twenty-fifth anniversary year book.

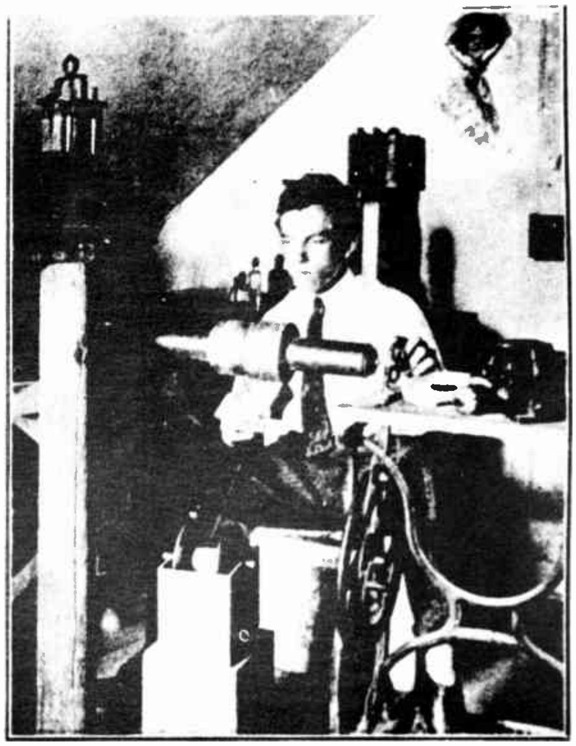
GEORGE ELTZ, JR.

INSPIRED BY THE SPIRIT OF SCIENCE

Enterprising Boys Who Make and Operate Their Own Wireless

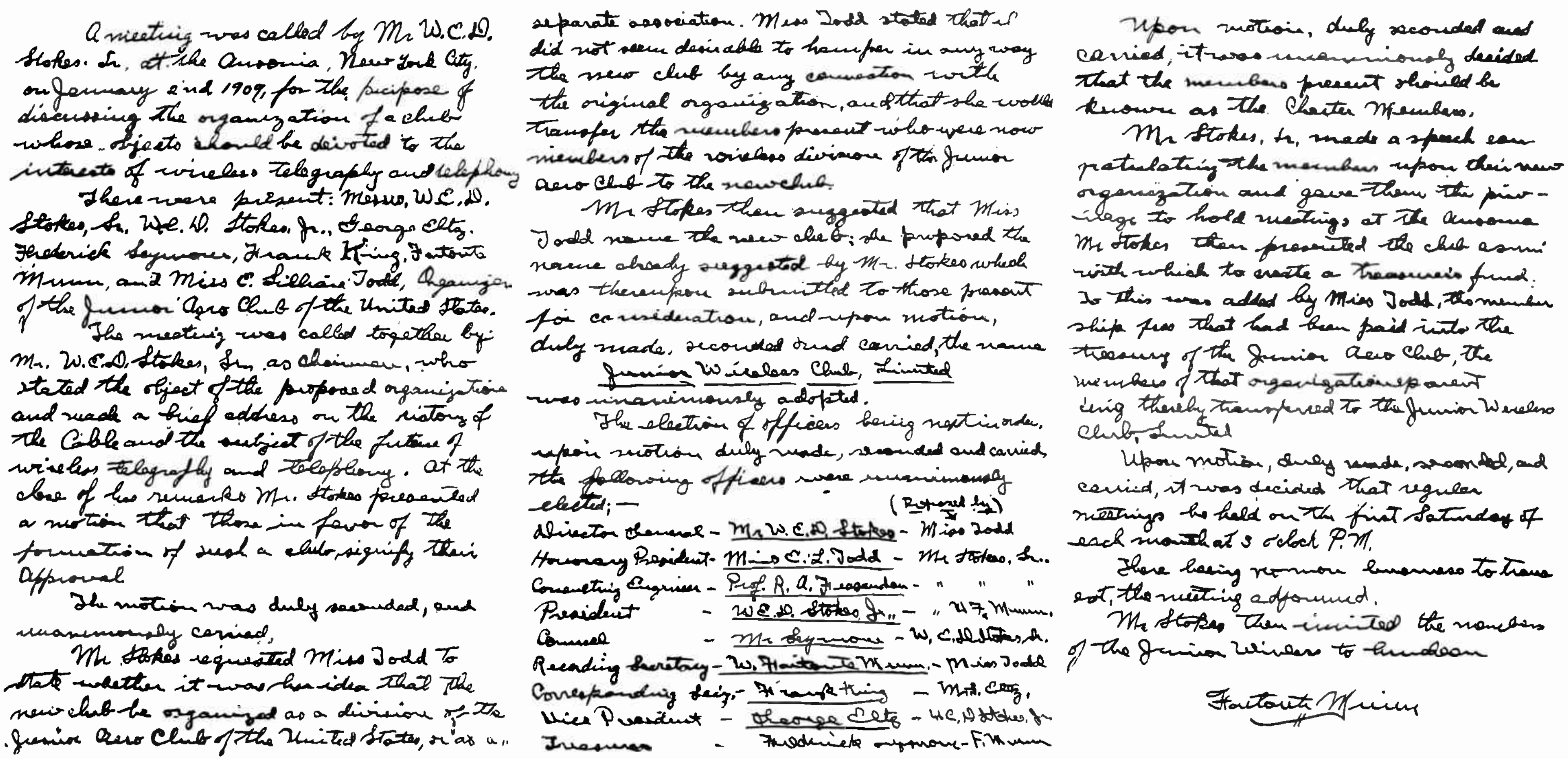


FRANK KING, AGE SEVENTEEN, OF NEW YORK, HAS MASTERED THE MORSE CODE AND IS STUDYING THE CONTINENTAL.



FAITOUTE MUNN OF EAST ORANGE, N. J., AGE SEVENTEEN, IS HERE SEEN USING AN OLD SEWING MACHINE TO WIND HIS COIL.

These pictures appeared in The Saturday Evening Mail of July 24, 1909. Both Frank King and Faitoute Munn were founders of The Junior Wireless Club, Ltd.



A meeting was called by Mr W.E.D. Stokes. Sr. at the Ansonia, New York City, on January 2nd 1909, for the purpose of discussing the organization of a club whose objects should be devoted to the interests of wireless telegraphy and telephony.

There were present: Messrs. W.E.D. Stokes, Sr. W.E.D. Stokes, Jr., George Eltz, Frederick Seymour, Frank King, Faitoute Munn, and Miss C. Lillian Todd, Organizer of the Junior Aero Club of the United States.

The meeting was called together by Mr. W.E.D. Stokes, Sr. as Chairman, who stated the object of the proposed organization and made a brief address on the history of the Cable and the subject of the future of wireless telegraphy and telephony. At the close of his remarks Mr. Stokes presented a motion that those in favor of the formation of such a club, signify their approval.

The motion was duly seconded, and unanimously carried.

Mr Stokes requested Miss Todd to state whether it was her idea that the new club be organized as a division of the Junior Aero Club of the United States, or as a separate association. Miss Todd stated that it did not seem desirable to hamper in any way the new club by any connection with the original organization, and that she would transfer the members present who were now members of the wireless division of the Junior Aero Club to the new club.

Mr Stokes then suggested that Miss Todd name the new club; she proposed the name already suggested by Mr. Stokes which was thereupon submitted to those present for consideration, and upon motion, duly made, seconded and carried, the name

Junior Wireless Club, Limited

was unanimously adopted.

The election of officers being next in order, upon motion duly made, seconded and carried, the following officers were unanimously elected; —

		(Proposed by)
Director General	Mr W.E.D. Stokes	Miss Todd
Honorary President	Miss C.L. Todd	Mr Stokes, Sr.
Consulting Engineer	Prof. R. A. Fessenden	" "
President	W.E.D. Stokes Jr.	W.F. Munn
Counsel	Mr Seymour	W.E.D. Stokes, Jr.
Recording Secretary	W. Faitoute Munn	Miss Todd
Corresponding Sec'y	Frank King	Mr G. Eltz
Vice President	George Eltz	W.E.D. Stokes, Jr
Treasurer	Frederick Seymour	F. Munn

Upon motion, duly seconded and carried, it was unanimously decided that the members present should be known as the Charter Members.

Mr Stokes, Sr, made a speech congratulating the members upon their new organization and gave them the privilege to hold meetings at the Ansonia. Mr Stokes then presented the club a sum with which to create a treasurer's fund. To this was added by Miss Todd, the membership fees that had been paid into the treasury of the Junior Aero Club, the members of that organization present being thereby transferred to the Junior Wireless Club, Limited.

Upon motion, duly made, seconded, and carried, it was decided that regular meetings be held on the first Saturday of each month at 3 o'clock P.M.

There being no more business to transact, the meeting adjourned.

Mr Stokes then invited the members of the Junior Wireless to luncheon.

Faitoute Munn

Facsimile of original minutes of the Junior Wireless Club, Lmtd., 1909.
This was the special meeting of the Junior Aero Club of the United States, held in the Ansonia Hotel, Jan. 2nd, 1909, at which the Junior Wireless Club Limited was formed and the first officers were elected.

JUNIOR WIRELESS CLUB, LTD.

EACH MEMBER MUST HAVE MADE HIS OWN STATION.

W. E. D. Stokes, Jr., Its President—Headquarters at the Ansonia Contains Much Apparatus—Club to Go to Washington to Oppose Pending Bill.

It is somewhat dangerous to attempt to enter the clubroom and experimental station of the Junior Wireless Club, Ltd. without a guide, for the officer in charge dispenses with the necessity of lock and key by having the knob charged with electricity to give the unexpected—and unexpecting—visitor what he terms a "nice little shock."

But when proper guidance is secured from the club's young president, who maintains headquarters at his home, the Ansonia, many marvels and intricacies may be observed with some degree of security. W. E. D. Stokes, Jr., president, aged 14 years, points out the pitfalls.

"Look out. Don't step on that zinc plate!" says he. "It's charged!" And you look out and don't step.

The clubroom and receiving station is imposing, almost formidable despite its somewhat small extent. In addition to the wireless telephone instruments at one side of the windows, the sending station across the way and the aerials connecting with three conduits above many other things more or less electric add to the effect. A big electric turning lathe occupies one side of the room; numerous vari-colored models of aeroplanes—which the manufacturer asserts really go when wound up—hang from wire complexities overhead; zinc plates, worse than they look, are not to be ignored.

In fact it is not safe to put a hand to the most innocent looking object unless first reassured. A big box beneath the battery and motor table filled with perfectly staid appearing earth and plants which thrive on the rays of a makeshift sun specially arranged out of a 100 candle power electric bulb is not what it would seem. Those plants—roots, branch, leaf or blossom—are electrified and emit sparks when invited. On the side walls high and low, on the ceiling and suspended therefrom, bulbs of every conceivable variety, shape and power transform the little room into an Aladdin cave of brilliancy.

"I'm always looking around at bulbs," says the president, "and when I see a new kind I try it."

So there they are, long and slim, short, fat and round, but all shining and bringing out dazzlingly the blueprints of scientific aspect which adorn one side of the wall, posters of the Postal Telegraph and Cable Company variety, illuminated letter placards bearing such legends as "No Smoking," "S. W. Co."—Stokes Wireless Company—and last but not least printed lists of wireless signal stations and steamers with wireless equipment.

These steamers and signal stations are all intimately acquainted with the experimental station of the Junior Club—too much so at times, it seems, when the Manhattan Beach station has to ask it to stop receiving for a time; for the Manhattan Beach station is less powerful and is retarded in receiving.

The young president puts the receiving headgear on your head.

"Listen," he says. "They're talking to Manhattan Beach."

"How can you read it?" you ask.

"Listen," he says. "The spaces—da—da-da-da—da—can't you hear it?" And he becomes a trifle impatient at your stupidity. He discusses condensors, detectors, sensitive points and other appropriate topics for your enlightenment, but you are a poor subject.

Then the president tells how the Junior Wireless Club came to be, how it operates and what it intends.

About two years ago the Junior Aero Club, under the direction of Miss E. L. Todd, participated in the toy exhibition held at Madison Square Garden. Three of these youthful members, Frank King, Faitoute Munn and Frederick Seymour, specialized on wireless telegraphy and frequented Miss Todd's studio on West Twenty-third street to experiment. Each of them made his own wireless apparatus, and through the newspapers they invited any other boy to come and show a mechanical set he had made himself.

W. E. D. Stokes, Jr., then aged 12, had rigged up a wireless outfit which he brought forth to display and which Frank King helped him set up. Such books as the "A B C of Wireless Telegraphy" and "Electricity of Everyday Life" and possibly, the random assistance of a random electrician were the principal sources of information.

The father of W. E. D., Jr., met the boys and invited them to his home to form a club. There the Junior Wireless Club, Ltd., came into being with headquarters at the Ansonia, there being just enough offices to go around among the charter members. W. E. D. Stokes, Jr., was made president; George Eltz, 441 West Forty-seventh street, vice-president; Faitoute Munn, East Orange, N. J., recording secretary; Frank King, 326 West 107th street, corresponding secretary, Frederick Seymour, East Orange, N. J., treasurer. Miss E. L. Todd was made honorary president, Prof. R. A. Fessenden of Brant Rock, Mass., was chosen as consulting engineer, and Seymour, Seymour & McGrath, 71 Broadway, as general solicitors and patent attorneys. Thus from the start the club's letterheads presented a complete and dignified appearance and are as yet unchanged, although the club has extended its membership to thirteen.

At 10 A. M. the first Saturday of each month from October to May the club holds meetings at the Ansonia, goes through the regular preliminary business, acts on the business letters received and the applications for membership, talks over schemes and, most of all, works with the wireless. The necessary qualification for membership is that the applicant has himself made his own wireless apparatus; later he may have assistance and more elaborate mechanical contrivances, but the first rule is inviolable.

They first memorize the Morse code until they are able to think in dots and

W. E. D. STOKES, JR., AND HIS WIRELESS TELEGRAPH.

This article appeared in the New York newspapers early in 1910. The illustration shows "Weddy" Stokes, first President, at the official Junior Wireless Club station in the Hotel Ansonia.

A HISTORY OF THE RADIO CLUB OF AMERICA, Inc.

By George E. Burghard

Part I

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 U. S. under the leadership of Miss Lillian E. 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.

In conjunction with their experiments 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.

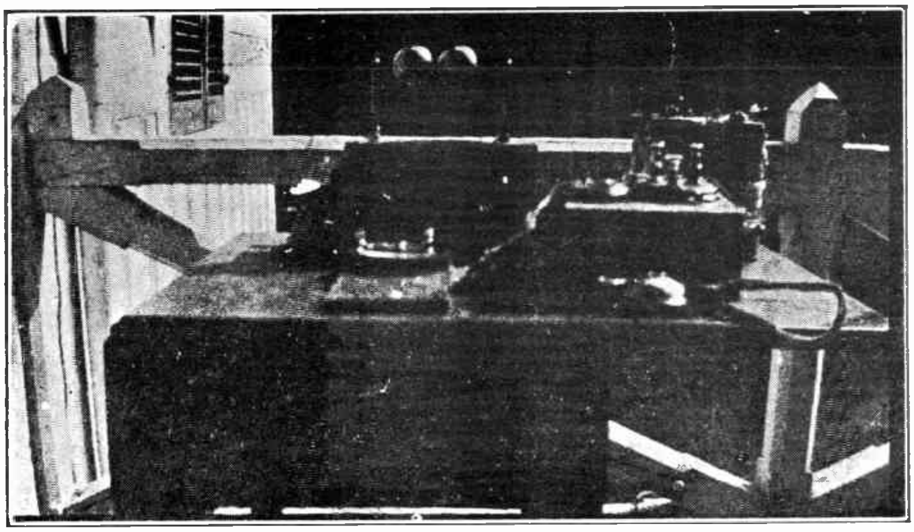
Accordingly, Mr. W. E. D. Stokes, Sr., called a special meeting of the Aero Club, for the purpose of forming a new club, with wireless telegraphy and telephony as its main interest. This meeting was held at the Hotel Ansonia in New York City on January 2nd, 1909. There were present Messrs. W. E. D. Stokes, 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 Engineer—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 the Charter Members.

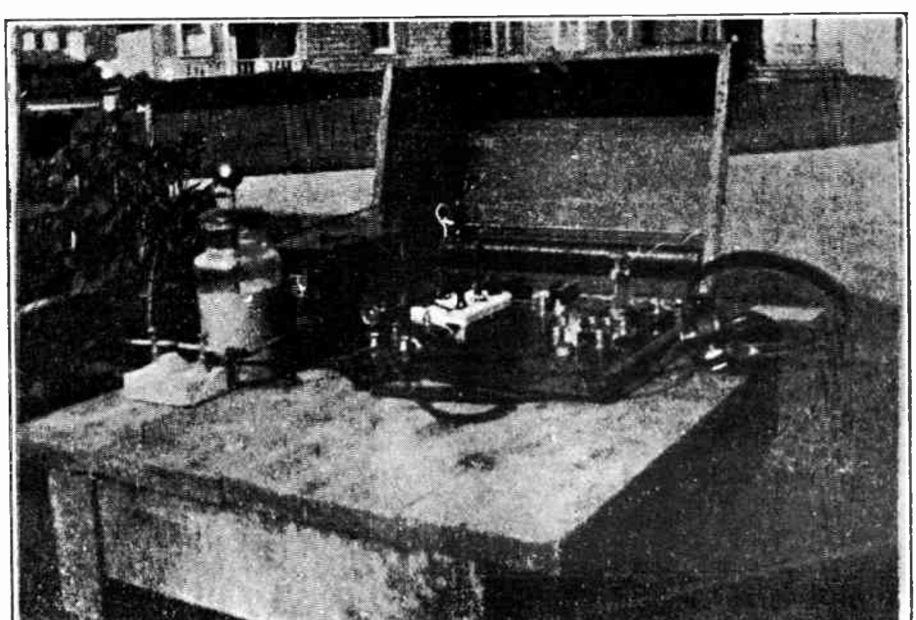
Of course, the early days of Radio were indeed days of pioneering and darkness,—Days when traffic had to be handled with a coherer and a straight gap spark transmitter. There were no books or magazines to guide these boys, but they held regular monthly meetings at the Ansonia, where "Weddy" Stokes lived, on Saturday afternoons, and by swopping information gained the necessary knowledge to build their own receivers and transmitters. The fascination of sending messages through space without wires, readily took hold of the younger generation, and small boys began to enveigle their parents into giving them money with which to buy wire and other material to build sets in imitation of those used by the commercial companies. Their efforts were gallant indeed, and the results were successful in some cases, where the frequency of the transmitter happened by chance to be somewhere near that of the receiver, or someone had gained expert knowledge from the operators at Manhattan Beach or the Waldorf Astoria, where the main commercial land stations were located. With



Ernest Amy's station, "EA", at Rumson, N. J., 1907.
A typical station of the old Coherer days, with one inch spark coil and round ball spark gap.

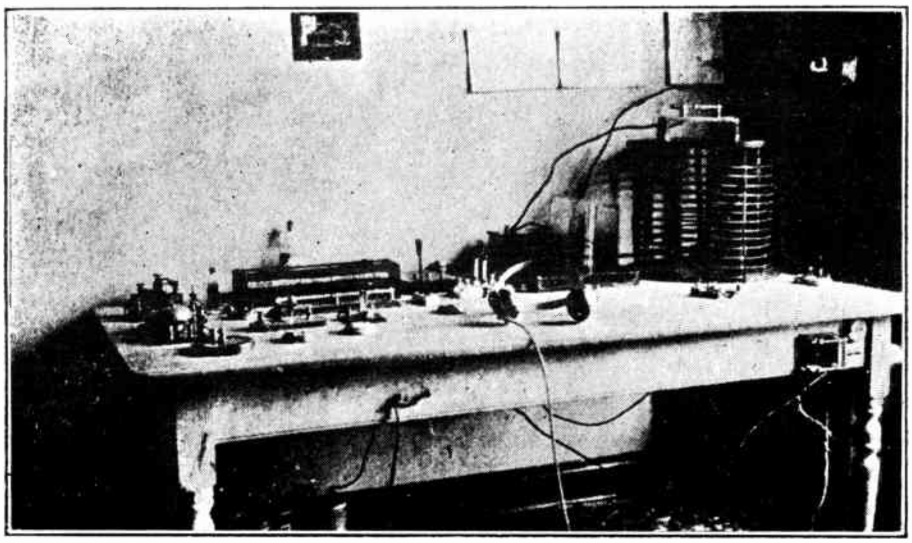
the crude apparatus and the embryo knowledge available, it was really remarkable that these boys could communicate at all, but almost any night one could hear messages being exchanged between stations in New York City, covering distances of at least a mile or two.

The amateur in these days, of necessity, had to build his own set, since there were no manufacturers other than the Commercial companies. Occasional articles on commercial stations, as they then existed, appeared from time to time,



Frank King's portable "FK" at Long Branch, N. J., 1907.

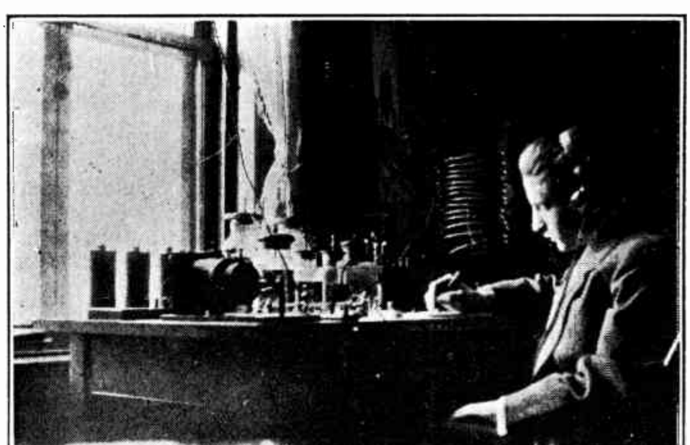
and each new idea presented, was added to the experimenter's stock of knowledge. The success of each experiment was passed by word of mouth to the other amateurs and eagerly followed. The Coherer, and in a few cases the Marconi Magnetic Detector, were the detectors in use at that time. All tuning was accomplished by means of sliders on coils of wire wound on the handiest form obtainable, very often being nothing more nor less than a broomstick, rolling



Station "EA", E. V. Amy, 48 West 70th St., N. Y. C., 1909.
Dry batteries, with a mechanical interrupter, were used as a power supply. Note the slide-wire tuner, potentiometer, and the glass plate transmitting condensers.

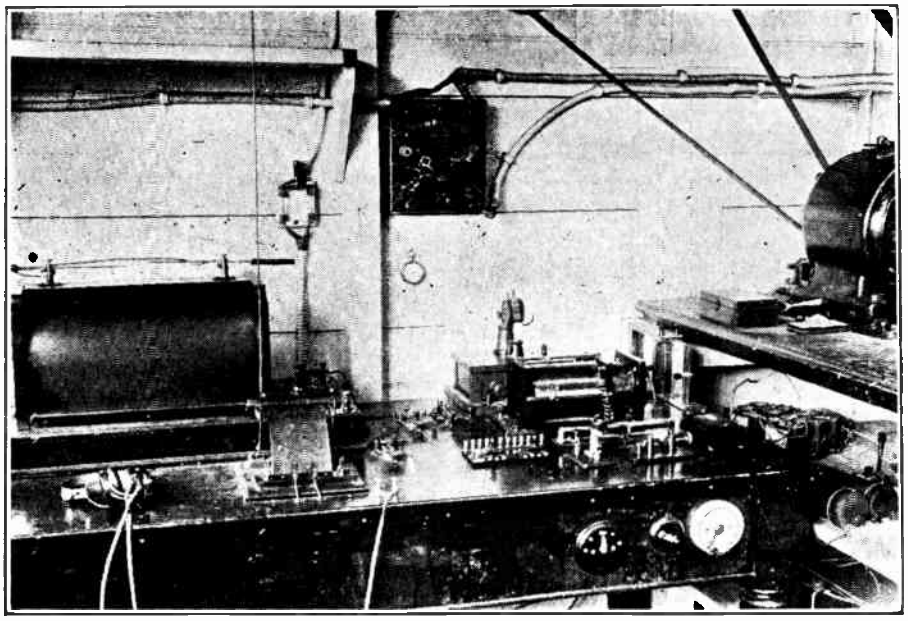
pin, or convenient carpet pole. Variometers and variable condensers were then unknown to the amateur.

The transmitters consisted of spark coils, mostly home made, and operated with a mechanical interrupter which was subsequently replaced by the electrolytic type. Most of these interrupters were home made, and lucky was the boy who could boast of the possession of a platinum point neatly sealed in a glass tube.



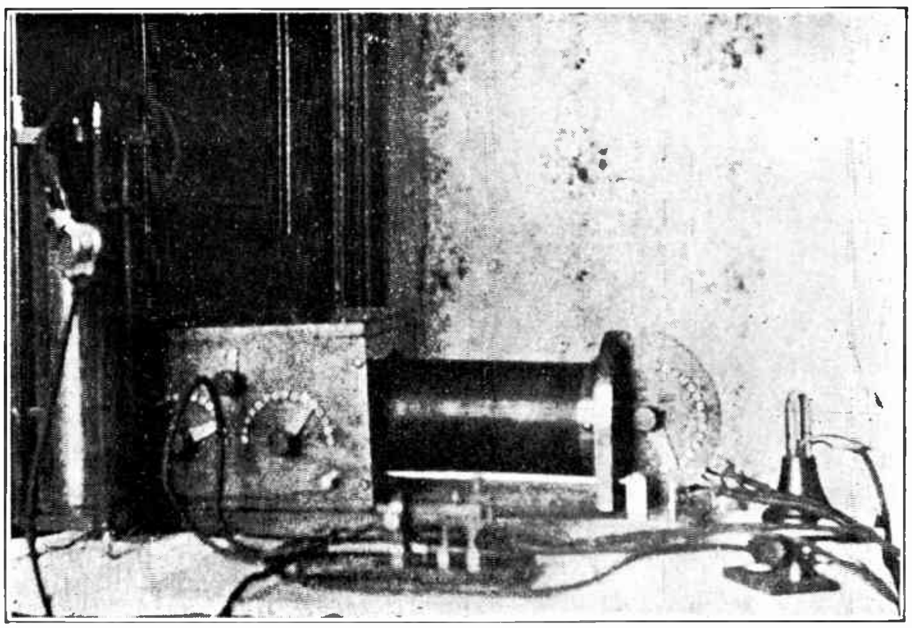
George Burghard at station "EB", 1 East 93rd St., N. Y. C., 1910.
The apparatus was mostly home-made, the "Helix" in particular, which was suspended from the ceiling by a string to insure good insulation.

Many were the amusing incidents which occurred. One boy desiring to erect the best possible antenna, ran across an article describing the aerial used by the Marconi Co. at its station on Cape Cod. It was in the shape of a huge



Station "FK", Frank King, 326 West 107th St., N. Y. C., 1911. The birth place of the Radio Club of America, Inc. The station was located in the shack in Frank's back-yard where the special meeting of the Junior Wireless Club was held on Oct. 21st, 1911, at which the name was changed to Radio Club of America, Inc.

square funnel, the upper ends or rim of which were insulated. Accordingly, he very carefully built a miniature copy only four feet on one side, and six feet high, not realizing the difference in electrical constants between the Cape Cod



Harry Houck's station, New York, 1910. Note the home-made loose coupler, which was a prized possession at that time.

aerial and his miniature model. Needless to say, the small imitation of the real thing didn't work very well, and it was only by chance, that the amateur discovered that, a stretch of bell wire was far more efficient.

Several experiments were also made with kite aerials. A kite was flown from the roof of a city house. When the kite had reached a height of several hundred feet, a severe static shock was received by the young man holding the wire, much to his chagrin and the amusement of the party. One member proudly announced that he wouldn't get a shock from the wire because he had on rubber heels, and walked about the tin roof with his toes in the air. The manipulator of the kite rather doubted the insulating qualities of rubber heels as against static charges, and at a favorable moment brought the wire in contact with the boastful young man's ear. The result was a neat little spark and a resounding yelp from the wise young fellow, despite his O'Sullivans. Irrespective of shocks and static, however, the kite antenna proved a great success for reception.

Naturally the activities of these amateur experimenters 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 never occurred to anyone before, but the result was a bill introduced by Senator Depew in 1910, practically prohibiting amateur experimenting. This bill, naturally 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 by the following letter to Senator Depew in reply to his letter of March 17th, 1910:

New York, March 19, 1910.

Hon. Chauncey M. Depew,
U. S. Senate,
Washington, D. C.

My Dear Sir:

Yours of March 17th to our President is before us. We think you must have been misinformed that malicious orders were sent to the Fleet by Amateur Wireless Operators.

In the 1st place,—All messages and orders to the Navy should be in cypher.

2nd. Any skilled government operator knows the touch and tone of every other government operator, just as you know the voice of your wife from the voice of your son, or a Bank Cashier recognizes the signature of Smith from the signature of Brown.

3rd. If our Government used only certain wave lengths, they should be able to tune out all other interferences, except their own wave length provided they were supplied with an up-to-date plant.

At the Narraganset Bay there were certain Naval tests made about two years ago, and the various so-called Wireless Companies wanted to get the first news to the newspapers of these tests, so as to boom their companies' stocks, and to say the news was received first through their Company, and when some of them found they were unable to cut out interference between themselves, in order to prevent other Wireless Companies from getting the news first they sent a lot of fake messages of confused dashes.

Only a few of the so-called Wireless Companies have efficient methods of cutting out interferences, and these are the Companies that are now crying the most for protection.

You probably have heard of the tests made last year between Glace Bay, N. S. and Clifton, Ireland, when the National Signaling Co. picked up the messages, which Marconi, on the test, was unable to deliver between their own stations, from both Glace Bay and Clifton, Ireland, in spite of the fact that the Marconi Company kept up a constant interference of dash, dash, dash from their Cape Cod station for 48 hours without interruption, but the National Signaling Co. paid no attention to such interference and picked up all the messages, which Marconi was unable to exchange between their own stations, and all these messages were handed over to Lord Northcutt at the Hotel St. Regis.

What the Navy needs is an up-to-date plant and system that will operate at all seasons of the year, at all times of the day or night, and under all atmospheric conditions of the weather, and will send not less than 1000 miles and receive not less than 200 miles.

Our Government should have a well paid intelligent staff of operators, and a secret cypher system of communication like that of the British Admiralty,—then there would be no talk of amateur interference.

Since the day that boy at Portsmouth, Me., received the first news from the Connecticut of the return of the Fleet from its trip around the world, these so-called stock-jobbing Wireless Companies have been unable to sell their stock, and have done nothing but pound us boys.

We, the undersigned, a Committee of The Junior Wireless Club Ltd. of America, would like to be heard on this proposed bill, and we will come to Washington, if we are allowed to do so, and if it can be arranged so that we can come on a holiday.

Yours respectfully,
THE JUNIOR WIRELESS CLUB, Ltd.,
GEORGE ELTZ, Jr.,
W. FAITOUTE MUNN,
FRANK KING,
FREDERICK SEYMOUR,
HARLOWE HARDINGE,
Committee.

TO REGULATE RADIO COMMUNICATION

HEARINGS

APRIL 28, 1910

ON THE BILL (S. 7243) TO REGULATE RADIO COMMUNICATION

BEFORE THE

COMMITTEE ON COMMERCE OF THE SENATE OF THE UNITED STATES

SIXTY-FIRST CONGRESS, SECOND SESSION

CONSISTING OF

WILLIAM P. FRYE, of Maine, *Chairman.*

STEPHEN B. ELKINS, of West Virginia.	JONATHAN BOURNE, Jr., of Oregon.
KNUTE NELSON, of Minnesota.	THEODORE E. BURTON, of Ohio.
JACOB H. GALLINGER, of New Hampshire.	THOMAS S. MARTIN, of Virginia.
BOIES PENROSE, of Pennsylvania.	WILLIAM J. STONE, of Missouri.
CHAUNCEY M. DEPEW, of New York	F. M. SIMMONS, of North Carolina.
GEORGE C. PERKINS, of California.	JAMES P. CLARKE, of Arkansas.
SAMUEL H. PILES, of Washington.	FRANCIS G. NEWLANDS, of Nevada.
WILLIAM ALDEN SMITH, of Michigan.	JOHN H BANKHEAD, of Alabama.

WOODBURY PULSIFER, *Clerk.*
FREDERICK D. SAXTON, *Assistant Clerk.*

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

TO REGULATE RADIO COMMUNICATION 17

communication. Why to-day most all the ocean-steamer messages are transferred or relayed from ship to ship within a radius of 500 miles at most.

I think, gentlemen, I have shown that there are strong reasons why this bill should be contrary to the best interests of the United States as a world power. All this interference complained of by the navy operators was due to the commercial companies, not to amateurs.

Sixth. We feel that the greatest objection against this bill is that if it is passed it will stifle the ambition and great inventive genius of American boys. We boys of to-day are the citizens of to-morrow. We have, many of us, already chosen wireless as our line of work. There are vast possibilities, great discoveries, and marvelous inventions yet to be revealed in the study of radio communication. We boys want a try at the great rewards that are sure to come to the successful experimenter and inventor in these lines. Wireless is not mere play for us boys, as some seem to think. We love the work. hence the name amateur, but it is always the amateur or lover of a line of work who produces results.

A few years ago only a very few boys were studying wireless. To-day there are between 25,000 and 40,000 in the United States alone. As I said, it is not mere play for them. It makes them thoughtful, observant, and trains them in the laws of cause and effect, and is, in short, an education and discipline for them.

Believe me, they are all keenly interested in the attitude of our Government toward wireless, and they expect fair play

Gentlemen, this Government is on record as a protective Government. You protect our cotton factories, our steel-rail mills, and our tobacco growers. Why not at the same time protect our amateur inventors? The returns to the Government from such protection will surely equal or exceed those from the protection given to the wool-growers of the land.

Article I, Section VIII, clause S, of the Constitution of the United States says that Congress shall have power "to promote the progress of science and useful arts," etc With this power, gentlemen, goes the responsibility for promoting the progress of science and useful arts, and wireless is bound to be one of the greatest.

The people who are to-day using and paying to the great "communication trust" unreasonable toll for the use of wires will then have only to buy a wireless instrument for a few dollars and then will be able to talk to their friends with little cost. Most every State in the Union has done away with "tollgates" on land. Does our Government now propose to pass an act to establish tollgates in the air? Soon the paths to heaven will be beset by tollgates.

The men and women of the United States will be able to typewrite a message and have a duplicate made of it at the same time in the Morse code on chemically prepared paper, which can be placed in a clock mechanism and be sent out and received by the desired person on his own special wave lengths. He or she also will be able to communicate within a radius of 400 miles by wireless telephony. We boys ask only for a chance to work these things oot. Do not hamper us. I have wireless applications in our Patent Office for small patents which have been granted. I hope some day to discover something that will be a great use to the world and to my own personal benefit.

I have a telephone plant which will operate within a radius of 50

41275—s a c—10——2

TO REGULATE RADIO COMMUNICATION.

STATEMENT OF MR. W. E. D. STOKES, JR., REPRESENTING THE JUNIOR WIRELESS TELEGRAPH CLUB OF AMERICA.

Mr STOKES. Mr. Chairman and honorable members of the Committee on Commerce of the Senate, we appear before you as delegated representatives of the Junior Wireless Club of America (Limited), an organization of boys who have devoted much earnest study to radio-communication and who have already contributed to the development of this science with the firm belief that they still have more to contribute and who want the help and protection of your honorable body.

As president of this club, I wish to register with you our opinion of the bill now in your committee, known as No. 7243, introduced by Senator Depew, of New York, for the purpose of regulating wireless communication.

We agree as to the importance of licensing all professional; as well as amateur, wireless operators, but only upon the basis of a merely nominal fee of 50 cents or $1. We also believe that such a license should be revoked forthwith for malpractice at any time, such as in 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.

We would even go further than does this bill in regard to the qualifications necessary for securing a license. For instance, 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—for many, especially the ocean-going steamer operators, understand only the continental code, and must agree to obey all government regulations.

Every licensed amateur operator must promise to forward government messages when requested so to do, and to state every year what kind of apparatus he has in use, the wave length he uses, and any other information deemed necessary, and the Government should issue with the license its regulations and instructions, how and what the operator is to do in case he receives a call for aid on matters important to the Government.

However, we feel there is more in this bill which arouses our protest than there is which meets with our approval.

We protest against the bill for these reasons:

First. We believe that in actual practice the provisions of this bill would discriminate heavily against the amateur and in favor of the commercial wireless companies, which are for the most part only stock-jobbing corporations and members of a great trust.

Second. It is impossible and impracticable in some of its features.

Third. It is ambiguous and capable of interpretation unfair to amateurs and students of wireless.

Fourth. It is unjust to a large body of manufacturers.

Fifth. It is contrary to the best interests of the United States as a nation.

Sixth. If passed, it will stifle the ambition and really great inventive genius of American boys.

Seventh. Should proposed Senate bill No. 7243 or House bill No. 23495 become a law, it would require, to enforce it, a force of at least 1,000 to 5,000 expert wireless engineers, whose salaries would not be less than $200 a month each, with a system of double stations in each locality to get triangulation, scattered all over the United

TO REGULATE RADIO COMMUNICATION. 19

just as easy to conceal the aerial as it is to conceal the operator. With the new methods of radio transmission, the location of the operator could be absolutely concealed. There would be no noise, no spark to indicate his location. He might have a dozen aerials, a mile apart, which would only cost from $2 to $5 each, connected to some one locality, or a dozen localities, where the operator could be concealed, and while the engineers were trying to locate one apparatus by triangulation the offender could be operating another one a mile away, or 2 miles away. And it would require the cooperation of several skilled radio engineers to locate each apparatus.

To substantiate this statement, any of us would guarantee to prove that it will take at least a month for the government aerial engineer detectives to discover our locality, for the engineering calculations would be so intricate it would take days to locate the exact position of the offender.

Is our Government prepared to establish a detective bureau of wireless police, which will be fully as expensive, if not more expensive, to carry on as the United States customs-house?

We desire to file with your honorable committee copies of this our argument against this bill; also a copy of circular issued by P. S. Kullman & Co., stock jobbers in wireless stocks; also an analysis of the financial condition of the United Wireless Company made by the Financial Review.

We thank you for permitting us to appear before you

The CHAIRMAN. Whom do you represent?

Mr. STOKES. The Junior Wireless Telegraph Club of America.

The CHAIRMAN. Where is it located—in New York?

Mr STOKES. Yes, sir. I will present Mr. Eltz.

STATEMENT OF MR. GEORGE ELTZ.

The CHAIRMAN. Whom do you represent, sir?

Mr. ELTZ. I represent the Junior Wireless Clubs and Engineers of America.

Gentlemen, I may add a word to this interference with which we are charged. There is a lot of interference caused by the amateurs in New York City. It is not intentional, however, in any way. We all have instruments, and whenever a commercial station or the navy or any big station in the city requests us to keep off, we do so, but there is a lot of interference because the naval stations and the other stations can receive greater distances than the amateurs, and an amateur coming on at night goes up to his instrument and listens and hears nobody working. It may be the navy-yard has told everybody to be quiet; so he starts to operate; he breaks up the navy-yard and the navy-yard says he interferes. It is entirely unintentional, and if the apparatus of the navy was up to date, as some of the Fessenden apparatus is, there would be no such interference. I think the bill is entirely unnecessary.

The CHAIRMAN. How many more desire to be heard against the bill?

Mr BOTTOMLY I would like to say a few words.

Senator PENROSE. Shall we sit for an hour longer, or meet again? I am only asking for information. I am going to the Senate to report a bill

Reproductions from the Congressional Record of 1910, showing parts of the statements made by Weddy Stokes and George Eltz at the hearing before the Committee of Commerce on the Depew Bill in Washington, April 28th, 1910.

Subsequently, a committee was appointed to go to Washington and plead the cause of the amateur before Congress. This committee consisting of Messrs. W. E. D. Stokes, Jr., chairman, Frank King, George Eltz, and Ernest Amy, appeared before the Committee of Commerce of the Senate in Washington on April 28th, 1910, as is evidenced by the accompanying reproduction from the Congressional Record, and through their efforts succeeded in killing the bill. The importance of their work cannot be stressed too greatly, because without this timely intervention by a handful of mere boys, who are to be most highly commended for their indominatable spirit, the amateur would certainly have ceased to exist right then and there.

Globe Advertiser. EST'D 1797.

...EST NEWSPAPER.

...RK, THURSDAY, APRIL 28, 1910

BOY WARS ON THE AIR TRUST

"Buster" Stokes, 14 Years Old, Talks to Senate Committee.

WIRELESS CHAMPION

Bill to Curb Amateurs Is Earnestly Denounced by Him.

(From a Staff Correspondent.)

WASHINGTON April 28.—W. E. D. Stokes, Jr., fourteen years old, of New York City and known to his friends as "Buster," appeared before the Senate committee on commerce to-day and made a plea for the amateur wireless telegraphers of the country.

The committee was considering the bill providing for regulations of wireless communication when the youthful advocate spoke. He said that he was president of the Junior Wireless Club of America, and represented 60,000 American boys. After young Stokes's plea, Frank King and Ernest Amy, two other boys representing the same club, addressed the committee.

There was much amusement when Senator Frye presented young Stokes. He stands about four feet five, wears short trousers, and does not assume to be more than the boy he is. He rushed into his argument in great seriousness, and told the committee in the language of a practiced attorney that the provisions of the bill were "not feasible but will discriminate heavily against the amateur and in favor of the commercial wireless companies, which are for the most part stock-jobbing corporations and members of a great trust.

"The bill," he went on, "is ambiguous and capable of interpretation unfair to amateurs and students of wireless. It is unjust to a large body of manufacturers, it is contrary to the best interests of the United States as a nation, and it will stifle ambition of the really great inventive genius of American boys."

Young Stokes declared the bill would compel the public to pay toll to the Western Union trust for all wireless messages, whereas, if we amateurs are left undisturbed and allowed to experiment we are sure that within ten years at little or no cost every one in the land will be able to communicate with any person he desires to reach within a limited radius. For instance, within ten years, a man in his automobile meeting with an accident twenty-five miles from home will be able to signal on a specific wave length, call up his own home by ring a bell there, bring his butler the telephone and tell him the cause of his delay, and that he will not be home for dinner."

The other youths who appeared declared that the Western Union Telegraph Company was absorbing all the other companies. "Soon some vast trust will be organized to corner the very air we breathe," spoke one of the associates of President Stokes.

Other advocates and opponents of the bill appeared before the committee. Commissioner of Navigation E. T. Chamberlain urged the committee to report the measure favorably, saying that the army, the navy, the treasury, and the agriculture departments should be protected by regulating the use of the air.

Joseph H. Hayden and F. W. H. Clay of Pittsburg, representing the National Electric Signal Company, took exception to the provisions of the bill, which give the army and navy priority in the use of the air. They contended that new and improved instruments would effect the very thing the bill proposed to regulate, and that the legislation was wholly unnecessary. Representatives of the Marconi and United Wireless companies were also present, and urged practically the same objections offered by the signal concern.

What the papers had to say about the trip to Washington.

By 1911 the interest in amateur radio was beginning to grow by leaps and bounds and while the original membership of the club consisted of some five active members, by this time it had more than doubled. These young boys were the leaders of amateur Radio in and around New York City at that time, and soon drew all the live operators into the organization. Due to this increase in membership it was decided on April 22nd, 1911, to hold all subsequent meetings at 326 West 107th Street, N. Y. C., the home of Frank King. It was there at a special meeting on October 21st, 1911, that it was unanimously decided to

October 21, 1911.
Special meeting.

The meeting was called at 3.00 P.M. Mr Eltz presiding in the absence of the president.

The purpose of the meeting was to elect the officers of the club. The following officers were duly elected:—

President — Mr Frank King
Vice President — Mr George Eltz
Corresponding Secretary — Mr George Burghard
Treasurer — Mr Ernest Amy

Old Business.

After all the suggestions of the members had been duly considered, it was decided upon that the name of the Club be changed from "The Junior Wireless Club of America" to "The Radio Club of America".

The matter of the Club pin was again brought up. A motion was made, seconded and passed, that Mr Butler, who had been doing some designing of late, should look over the suggestions of the members, and make his report as to the best design, at the next regular meeting.

Two dollars was appropriated, in order to buy Postals for the use of the corresponding Secretary.

The meeting was adjourned at 4:00 P.M.

G.E. Burghard.

November 4, 1911

The first regular meeting of The Radio Club of America was held at 326 West 107th St at 3.00 P.M. Mr King presided.

Old Business

A motion was made, seconded and passed that, on account of the absence of Mr Butler, the matter of the Club pin, be postponed until the next meeting.

The matter of imposing fines for absence from the meetings was again brought up. It was decided upon that henceforth this rule be strictly enforced.

New Business

A motion was made, seconded, and passed that the annual dues of the Club be raised from 25¢ to 50¢.

In order to increase the membership it was voted that D.V.; R.D.; P.N.; P.M.; F.H.; V.N.; and J F be asked to join the club.

A motion was made that the Club have stationary printed. This motion was duly seconded and passed. Mr Eltz was appointed a committee of one to attend to this business.

J. G. and R. S were voted members of the club.

The meeting was adjourned at 4.00 P.M.

G.E. Burghard

Facsimile of the original minutes of the Radio Club of America, Inc., 1911. This was the special meeting of the Junior Wireless Club held at Frank King's house on Oct. 21st, 1911, at which the name was changed to Radio Club of America, and is followed by the first regular meeting of the Club held at the same place on November 4th, 1911.

change the name from JUNIOR WIRELESS CLUB LIMITED to THE RADIO CLUB OF AMERICA. This was in fact the birth of The Radio Club of America and a list of the members at that time, who are the original Charter members, follows:

W. E. D. Stokes, Jr.
George Eltz, Jr.,
W. Faitoute Munn,
Frank King,
Frederick Seymour,
Harlowe Hardinge,
E. V. Amy,
Graham Lowe,
Max Bamberger,
Edwin N. Rhodes,
Frank Whitehouse,
L. S. Shaw,
George E. Burghard.

The following officers, who are the first officers of The Radio Club of America, were also elected at this meeting.

President—Frank King.
Vice-President—George Eltz, Jr.
Corrs. Secretary—George Burghard.
Treasurer—Ernest Amy.

These are the events which led up to the beginning of the present RADIO CLUB OF AMERICA, and its first regular meeting was held at Frank King's House 326 West 107th St., N. Y. C., on November 4th, 1911.

By the end of 1911 the membership had increased considerably and the first typewritten membership list was issued, on which appeared the following names:

MEMBERS OF THE RADIO CLUB OF AMERICA

EA	Ernest Amy, 48 W. 70th St.
EB	George Burghard, 1 E. 93rd St.
GZ	George Eltz, 441 W. 47th St.
GX	Harlowe Hardinge, 410 Riverside Drive
FK	Frank King, 326 W. 107th St.
CB	L. C. Butler, 30 E. 72nd St.
	Faitoute Munn, 518 Main St., East Orange, N. J.
	Frederick Seymour, 55 Prospect St., East Orange, N. J.
X	W. E. D. Stokes, Jr., The Ansonia, N. Y.
	Edwin N. Rhodes, West Point, N. Y.
SA	Graham Lowe, 262 W. 77th St.
RS	L. Spangenberg, 406 E. 18th St., Paterson, N. J.
DR	Dr. Hudson, 312 W. 109th St.
JG	John Grinan, 808 West End Ave.
JF	James Fagan, 143 W. 95th St.
ABC	Louis Gerard Pacent, 218 Young St., Blissville, L. I.
SF	W. F. Ruth, 125 Newton Ave., Astoria, L. I.
WA	Randolph Runyon, 37 Locust Ave., Yonkers, N. Y.
BG	Daniel McCoy, 45 Lee Ave., Yonkers, N. Y.
VN	Irving Vermilya, 24 Chester St., Mount Vernon, N. Y.
MP	B. Doland, Midland Park, N. J.
FY	Fred Young, 416 Grand Ave., L. I. C.
	J. A. Fried, 525 Lockewood St., Astoria, L. I.
AM	William R. Helme, 454 Lockwood St., L. I. C.
	Frank Whitehouse, 227 W. 71st St.

AMATEUR CALLS.

AB	Geo. Jorgensen	1283 Hoe Ave., Bronx.
AH	Arthur Hebert	138 W 133 St.
AR	Albert Rice	606 W 113th St.
ARK	Graham Lowe	262 W 77th St.
BA	W. Smyth	437 E 137th St.
BF	Brace Filler	40 W 129 St.
BO	Buddie Overton	157 W 98th St.
BS	P.S. Fitzgerald	382 St & St. Nicholas Av.
BX	Vincent Lamarche	Locust Point, Red Bank, N.J.
CB	Lyman Butler	30 E 72 St.
CH	John Myers	315 W 40th St.
CH	Curtis Huebner	Rutherford, N.J.
CP	Clarence Rice	1496 Vice Ave. Bronx.
CS	Chas. Schaffer	495 E 147th St.
CT	Clinton Taylor	15 Ave. Mt. Vernon
DA	F. De Cordova	362 Riverside
DF	Hendrick Boble	441 North Broadway, Yonkers
DG	Kenneth Underwood	259 Mt. Prospect Av. Newark.
DH	Lawrence Morle	142 Fairmount Av. Newark.
DR	Dr. W.C. Hudson	312 W 109th St.
DS	J.C. Steiner	596 Jackson Av. L.I. City
DU	Daniel McCoy	45 Lee Ave. Yonkers. N.Y.
DV	Albert Sonn	150-2nd St. Newark.
EA	Ernest Amy	48 W 70 St.
EB	George Burghard	1 E 93 St.
EW	Everet White	1199 Boston Road
FA	Jack Farrington	139 St & Riverside Drive
FAH	Frank Hahnel	431 W 131 St.

FH	Arthur Boeder	3145 Duncomb Av. Williamsbridge.
FG	Frank Gould	834 Fifth Av.
FK	Frank King	326 W 107th St.
FV	A.H. Grebe	10 VanWyck Av. Richmond Hill.
FW	F. Tompkins	Hawthorne, N.Y.
GH	Dr. Goldhorn	54 11th Ave. Mt. Vernon.
GB	Dr. Stein	144 W 123 St.
GP	George Pierce	4 & 6 W 100 St.
GW	G. Bartlett	8 W 108th St.
GZ	George Eltz	441 W 47 St.
HAA	Homer Black	6 E 128th St.
HEM	H. Martin	20 Morningside Av.
HN	Howard Newman	362 Riverside Drive
HN	John Nash	3039 Valentine Av.
HR	H.P. Searing	18 Washington Av. Bronx.
HW	H. Willis	75 Maple Av. Flushing, L.I.
HX	Paul Bismark	Casino Theatre 39 St & B'way
HX	Henry Leeb	South Orange, N.J.
HX	Arthur Winners	699 E 18th St. Flatbush, BKLYN.
JA	J. Arnold	136 Alexander Av.
JB	Louis Bahr	1929 Amsterdam Av.
JC	J.C. Tompkins	453 W 164 St.
JF	John Farrington	467 W 159 St
JF	James Fagan	143 W 95 St.
JG	John Grinan	808 West End Av.
JS	Robert Hartman.	449 W 124 St.
KF	Ferdinand Kuehn	168 E 89 St.
LF	F. Jameson	127 W 145 St.

LS	Louis Schulman	310 W 106 St.
MB	F. Burhans	White Plains Rd & 242 St.
MIS	Milton I. Strauss	1449 3rd Ave (82nd St)
MP	J.A. Totton	Plainfield, N.J.
MS	Leslie Sherwood	159 W 145 St.
NWA	Fred Carlick	Montclair
NF	Morris Flanner	112 W 111th St.
NXP	W.H. Marshal	167 E. Chestnut St Plainfield, N.J.
PC	Percy Corwing	5 W 107 St.
PD	Howard Barrett	343 E 158 St.
PI	John Ellis	106 W 89 St.
PM	Robert Johnson	53 Governeuer Ave Rutherford, N.J.
PN	Jacob Weiss	Port Washington, L.I.
PN	Fred Gittebauer	East Rutherford, N.J.
PX	P.H. Beucheron	307 E 48 St.
Q	Pringle	354 College Av.
QO	A. Lopez	51 E 105 St.
QS	Jule Keen	179 St & Wash. Av.
QT	G. Slow	16 W 138 St
QW	C. Winslow	1985 Amsterdam Av.
QX	Johnson Bros.	1086 2nd Av.
RD	Clarence Pfeiffer	346 Prospect Ave. Ridgewood, N.J.
RQ	Captain Snow	Tug Merritt.
RQ	Jos. Hopfenberg	442 E 86 St.
RS	F. Spangenberg	406 E 18 St. Paterson, N.J.
RSO	Roy Schomp	Edgewater, N.J.
RWN	Robert Munn	85 Lincoln Ave. Ridgewood, N.J.
RX	H. Trinkhaus	496 E 138 St.

SA	R.A. Schoen	455 W 140 St.
SC	Frank Ballard	331 W 83 St.
SF	Columbus Institute.	Hawthorne, N.Y.
SK	Fred Skinner	Mount Vernon.
SS	Crosby Sewell	21 W 126 St.
SY	T.J. Styles	159 Bee St. Yonkers.
TF	T. Field	Clinton Place, Newark.
TH	Robert Livingston	Hackensack, N.J.
TR	George Post	393 Riverside Drive
UH	Ernest Hubner	1657 First Ave (86th St)
VM	C. McPherson	130 W 91 St.
VN	Irving Vermilya	24 Chester St. Mt. Vernon.
WA	Randolph Runyon	37 Locust Av. Yonkers.
WC	Walter Cohen	2071 Fifth Av.
WHK	Harry Conner	176 St & Audubon Av.
WI	Arthur Davis	611 W 114 St.
WL	Walter Lemmon	94 St & Broadway
WP	Walter Pfeiffer	550 W 144 St.
WR	K. Russell	240 W 104 St.
WX	Donald Pieri	703 E 137 St.
WX	Harold Schwab	2 W 86 St.
X	W.E.D. Stokes, Jr.	The Ansonia Hotel.
XA	J. Pipple	326 E 57 St.
YN	C. Popper	763 Beck St. Bronx.
YX	Donald Pieri	703 E 137 St.
YP	Fred Parsons	764 Beck St. Bronx.
ZB	Marshall Rewick	28 W 129 St.

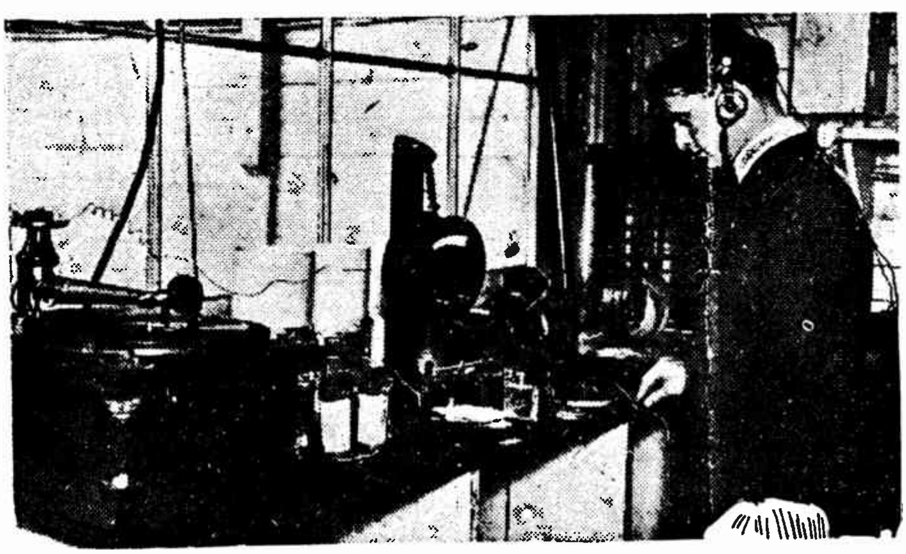
The first amateur radio call book 1912.

The number of amateur operators was increasing daily now, so that the club decided to be of further service to the art by issuing a call list of amateur stations. Through the painstaking efforts of the members, and particularly Frank King and Dr. Hudson, a List was compiled by contacts through the air, since this was the only means of getting calls and addresses. The list was blue-printed and sold to all operators at 10 cents a copy upon application to Frank King. This was the first amateur call book ever issued and photographs of the original appear elsewhere on these pages.

At a regular meeting on January 20th, 1912, the club emblem and a club pin designed by Frank King, were unanimously accepted. The pin as illustrated below, was gold on a black background.

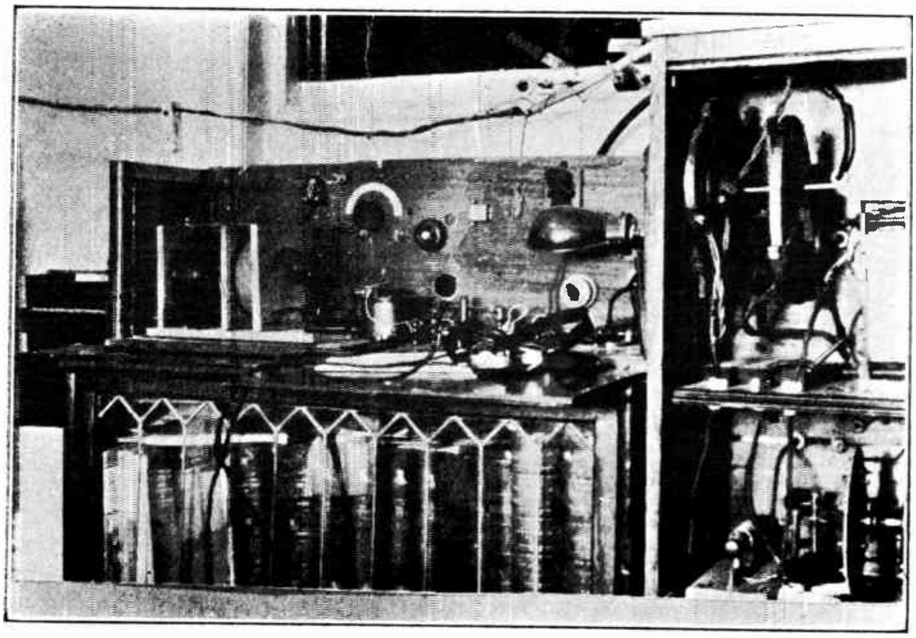
In 1912 the Alexander Wireless Bill was introduced in another attempt to stifle the amateur. This bill purported to do everything that the Depew Bill had failed to accomplish and even more. The Club again took immediate action, killed the bill in committee, and in later years, through the concerted action of its members in the U. S. service after the Armistice, definitely settled the matter.

By this time books and other literature on various radio topics began to appear, so that the knowledge of the Club members was greatly increased and papers were delivered at their monthly meetings, which were held at the home of Frank King, who was elected first President of the New organization. The first papers consisted of short talks describing the various stations operated by the members, and various they were indeed. It is almost useless to attempt descriptions, but perhaps the accompanying photographs will serve to give an idea of the types of apparatus used and the great handicap under which communication was maintained in those days when it was considered a great event to work Yonkers from New York City direct But still, even this was a great advance over the



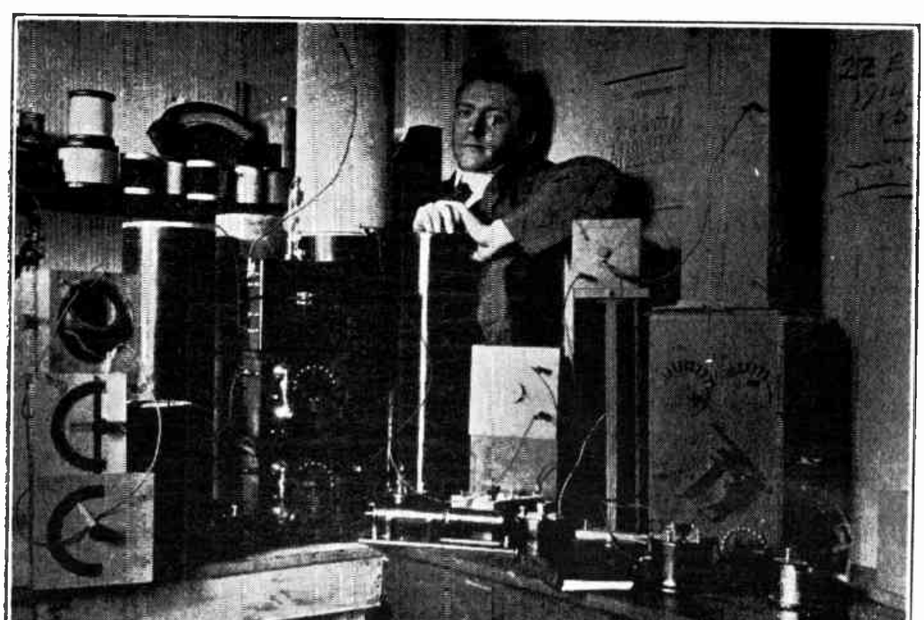
George Eltz at arc radio telephone station "FK", Frank King's house, 326 W. 107th St., 1912. This was probably the first radio broadcasting station on record. Note the phonograph for producing "canned" music.

old coherer days. Now there were crystal detectors, microphone detectors, and even electrolytic detectors. Boys were busily engaged in breaking up chunks of rock in an attempt to find a good piece of carborundum, copper pyrites, or zincite, or groveling on hands and knees diligently searching the floor for the missing



Dave Brown's station, New York City, 1914.
This shows a considerable advance in design over the old days. We now have pancake tuning inductances loose coupled, and rotary spark gaps.

piece of Wollaston wire which was always diminutive and hard to find. These new detectors together with the advance in knowledge enabled the amateur operator to establish quite reliable communication within the city limits and occasionally



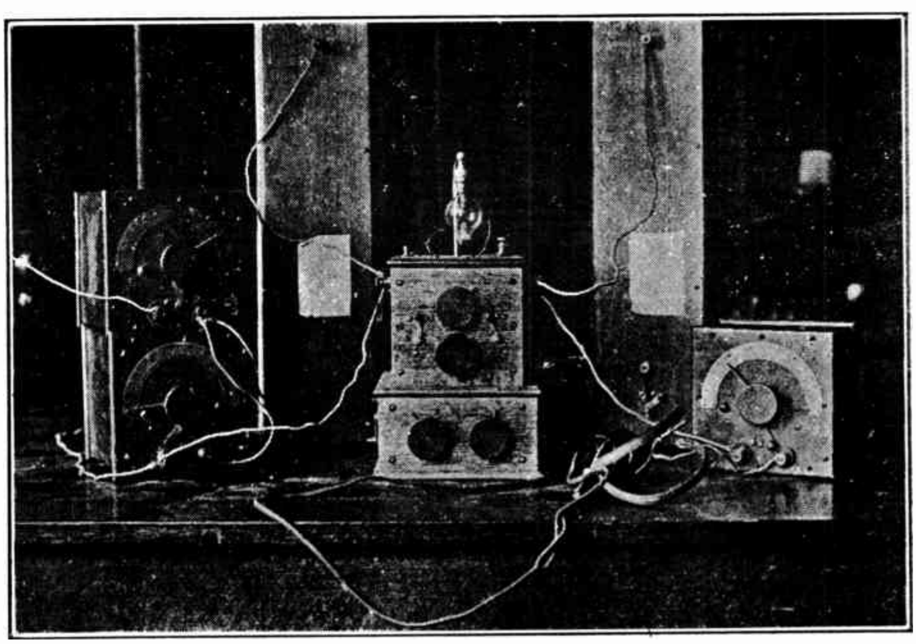
Paul Godley station 2ZE, Montclair, N. J., 1914.
Typical of the Audion and regenerative circuit period. Note the variometer and miles of tuning inductances.

a superhuman feat such as working Yonkers, a distance of about fifteen miles was accomplished, but for some unknown reason it was impossible to get any signal across to Brooklyn.

And yet the strivings of this handful of boys led to great things and great things were discussed at the meetings. No one thought of the far-reaching possibilities of the Hudson coated filament at the time when Dr. Hudson delivered his paper describing this very useful invention over the pool table at Frank King's house in 1913, nor were the stupendous results of the regenerative circuit in any way apparent at the time E. H. Armstrong told us all about it at one of the meetings in 1915. Who could have dreamed of the extent to which radio telephony would grow when, in 1911, George Eltz and Frank King constructed and operated an arc telephone transmitter at 107th Street and actually played music for the benefit of the fleet in the Hudson River when the alcohol didn't explode in the arc chamber and cause a violent break-down without any time for an apologetic "one moment, please." This may be said to constitute the first real broadcasting station ever operated with any degree of success.

Equally prophetic, was the disclosure of the Square Law Condenser before the club, by George Eltz in 1913, for the first time in history; since this very instrument was later to become a most important part of all radio frequency measuring apparatus.

The serious nature of the organization thus evidenced, soon attracted the attention of the early radio workers, so that aside from papers prepared by its own members, the Radio Club was soon honored by addresses by such well known radio men as: R. H. Marriott, Dr. A. N. Goldsmith, J. V. L. Hogan, F. Lowenstein, Dr. J. Zenneck, F. Conrad, W. C. White and others, all of whom subsequently became members.



Original apparatus with which E. H. Armstrong discovered the regenerative circuit in 1912.

By this time the three-electrode vacuum tube had appeared on the scene. Audions they were called, and cost $5.00 a piece, but every amateur had to have one. So down to the Metropolitan Tower he would go, up to the DeForest Radio Company's laboratory, leave his five and go home with his most precious possession. Of course the number of identical new circuits and inventions developed by these boys was great, but nevertheless communication was greatly benefited and messages could be sent and received over distances of approximately 50 miles, quite regularly. This marked a great advance in amateur radio.

In 1912, one of the most illustrious members of the Radio Club, E. H. Armstrong, developed the feed-back circuit which has made possible the broadcasting of today. This, of course, did wonders for the amateur. All kinds of tuning coils and couplers were put into use, and sets were operated to the Nth degree of regeneration until finally real communication with the Western amateur stations was established and amateur radio came into its own.

Harry Sadenwater and Louis Pacent listening for trans-Atlantic signals under the Palisades, N. Y., 1914. The angelic expression was probably due to atmospherics.

This also opened another field to the amateur, namely trans-Atlantic reception. Perhaps the first attempts at hearing the stations of Europe were made by Paul Godley, Harry Sadenwater, and Louis Pacent, who in 1914 strung an antenna from the Palisades on the Hudson River and with a specially constructed receiver listened patiently for what they had never heard before. Little did Godley think at that time that some years later he would be listening just as attentively, under different conditions, in a tent in Scotland for the signals of his brother amateurs in America.

In those days, of course, there were no licenses and no regulations for amateurs. Everyone used whatever wavelength he happened to hit upon, and the great difficulty of getting a wave meter left that unknown in most cases. The only way to find out whether the set was in tune was by inserting a carbon filament lamp in series with the antenna and adjusting the helix (antenna tuning inductance) for maximum brilliancy. Some stations had aerials of as many as eight or ten wires, one to two hundred feet long, and spark gaps directly coupled. This, of course, could not continue, so the Radio Club welcomed the new license regulations and did a great deal toward assisting Radio Inspector Marriott and later Harry Sadenwater in cleaning up the mess. In fact, the relationship of the Club with the Department of Commerce has always been most friendly. On one occasion the two organizations combined to track down an amateur station in Brooklyn with a loop mounted on an automobile. The boy had for no apparent reason been sending out distress calls, and after a whole night's searching the station was finally located and the culprit called to account.

This was going a long way toward the right system of cooperation, especially in those days when the notion of free air still prevailed and it was actually necessary for the operators of one commercial station to invite certain amateurs to go swimming at Coney Island so that the relief operators could handle their traffic without interference!

The WORLD'S ADVANCE

Vol. 31 JULY, 1915 No. 1

TIME was when the wireless operator was considered a nuisance. In the old days he caused more than one commercial and Government operator to employ profane language in voicing his opinion of some one particular amateur, and all of them in general, especially when endeavoring to read a long distance message with a nearby amateur indulging in a friendly conversation with another amateur, or, worse still, holding down his key in order to adjust the spark gap. Conditions are entirely different today The amateurs, thanks largely to the Government regulations now enforced, have developed into serious experimenters, with their hobby and the interests of others at heart. On more than one recent occasion the amateurs have come to the rescue of Government and commercial wireless operators when both the latter required assistance. A most typical instance of this fraternal co-operation was witnessed a few weeks ago during the visit of the Atlantic Squadron to New York City. The Radio Club of America installed a model radio station in the Hotel Ansonia, the headquarters of Admiral Fletcher and his officers, enabling the visiting Admiral and his staff to communicate with the vessels of the fleet. But the installation of the apparatus did not complete the commendable undertaking. Club members operated the instruments during the entire period of the naval visit, and handled no little amount of wireless traffic for the naval officers The station proved a great convenience to Admiral Fletcher and his officers, and this deed on the part of the Radio Club of America will no doubt serve to bind still closer the tie of friendship between the amateurs and the Government and commercial operators.

The press comments on the Club station at the Ansonia in 1915.

The Club soon outgrew its quarters at Frank King's home in 107th Street and it was not long before the attendance at meetings grew so large that it became necessary to use the large lecture halls of Columbia University for the monthly gatherings. As the art grew and radio knowledge was more readily obtainable, the character of the papers also changed. The small body of amateur operators gradually changed to a large scientific organization of recognized standing, before which the leading lights in the radio world were glad to deliver papers on their newest discoveries. But in spite of these changes the club idea and spirit of comradeship was never lost and even today the Radio Club of America is as proud of its congenial club spirit as it is of its scientific standing.

In 1915 the Club installed and operated a transmitting and receiving station in the Hotel Ansonia where Admiral Fletcher had made his headquarters. The station operated by the Club members handled all of the Admiral's traffic with the fleet in the Hudson River. Several hundred messages were handled, and

President Wilson himself sent a message from the *Mayflower* commending the good work. The Navy League also presented the Club with a banner in recognition of its services.

Radio Club station at Hotel Ansonia, N. Y. C., operated in conjunction with the Navy League in 1915. Operated entirely by club members, this station handled all the traffic for Admiral Fletcher and his staff, while the fleet was in the Hudson in 1915.

Up to 1915 the club had been operating under the original constitution of the old Junior Wireless Club, but it soon became apparent that conditions had changed and the old By-laws had become antiquated. Consequently a new Constitution was drafted and submitted to the members with the following letter:

TO THE MEMBERSHIP OF THE RADIO CLUB OF AMERICA:

It has become quite apparent that the present Constitution of the Club, adopted in 1909, is wholly inadequate in fulfilling the present needs of the Club. The Board of Directors has therefore drafted a new Constitution which it believes allows each individual member ample participation and representation in the Club government but eliminates a large portion of the inefficient and impractable procedure which has tended to characterize much of the Club business of late.

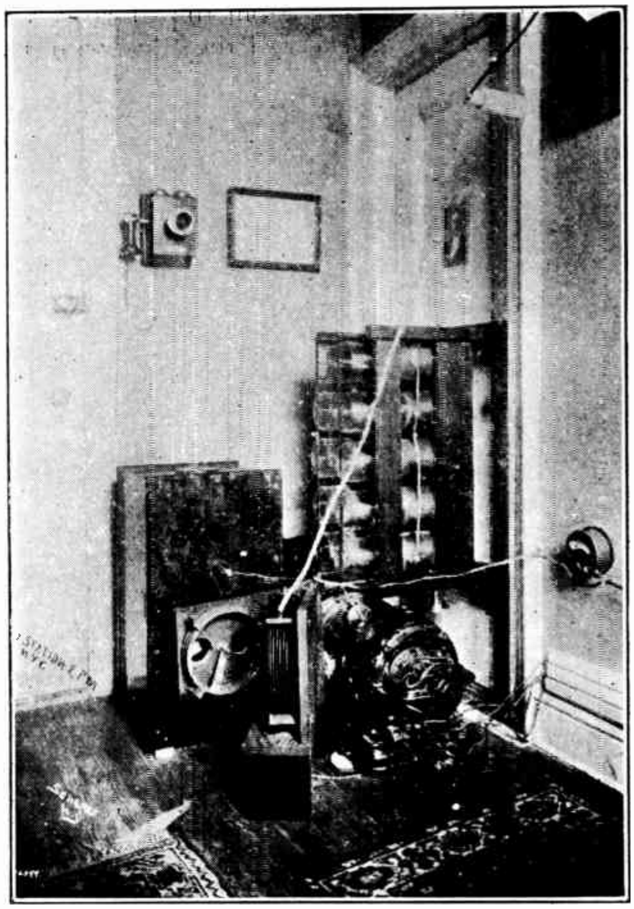
A decided increase in the amount of Annual dues was deemed necessary due to the coming expenses of securing meeting halls, publishing a year book and proceedings, and many other current disbursements which are rapidly increasing due to the extension of Club activities.

Under the present Constitution amendments may be made "at any regular meeting of the Club by a two-thirds vote of the Members present." The Board of Directors considers more expedient the submitting of the proposed Constitution to each individual Member for vote by letter ballot. It is urged that each member will fill in the attached ballot at his earliest convenience and forward it to the Corresponding Secretary.

At 8 P. M., May 15, 1915, the accompanying Constitution shall be considered adopted if two-thirds of the votes received by that time are in favor of such action.

Respectfully submitted.
THE BOARD OF DIRECTORS,
GEORGE ELTZ,
L. G. PACENT,
E. V. AMY,
D. S. BROWN, Jr. (Corres. Sec.)
T. JOHNSON, Jr.,

The new constitution was duly adopted and has remained unchanged to date.



Transmitter, Station "2PM", which producted the first transcontinental signals in 1916. Note the synchronous rotary gap mounted between motor and generator, large plated Leyden jar condensers and 1 K.W. United Wireless coffin transformer. This was the very latest equipment at the time.

Record-breaking station, "2PM", John F. Grinan and Adolph Faron, 808 West End Ave., N. Y. C., 1916.

This was the most famous amateur station of its time. A short wave regenerative receiver with one stage of audio frequency amplification was used with great success.

A year later, amateur station 2PM which has gone down in history as one of the most famous of all amateur stations, owned and operated by John Grinan and Adolph Faron, succeeded in breaking all records by sending the first transcontinental relay message from New York to California. This affair was not prearranged but was accomplished during the ordinary transmission periods and the answer was received back in New York in one hour and forty minutes from the time of transmission. Several weeks later the same station and the same operators succeeded in getting signals to California, a distance of some 2,500 miles over-land, a feat which had heretofore been deemed impossible with an input of one kilowatt on amateur wavelengths.

This bring us up to the period of the Great War in 1917, when the activities of the club had to be suspended, due to the fact that all the members who were of age enlisted in one branch of the service or another. The following extract from the minutes of the directors' meeting of October 6th, 1917, gives an idea of the policies pursued by the club during this period.

POLICY TO BE PURSUED DURING THE WAR

Question of administration of Club's affairs during existence of extraordinary situation created by the War discussed. A letter from Director T. Johnson, Jr., at present in the service of the Radio Division at Washington and unable to attend, was read. In view of the fact that all but three of the directors (Godley, Pacent and Styles) are now doing military or naval duty, Mr. Johnson's suggestion that Mr. Styles be assigned, pro tem., the duties and powers of the officers and directors engaged in such service and therefore unable conveniently to execute them themselves, was approved. It was the sense of discussion which followed that the arrangement be further approved and ratified by the membership, the situation to be briefly explained to them on the postal card notice of the next meeting, requesting each member to be present thereat to state his approval, or if unable to attend to signify his approval in writing to the Corresponding Secretary. In view of the impossibility of carrying out to the letter the terms of the Constitution and By-Laws and of getting proper representation of membership votes under the present war conditions, it was also the opinion of the directors that, for the duration of the war, the present personnel of the Board and of the Club's officers should be retained intact, the matter also to be called to the attention of the members for their approval in the notice of the next meeting.

The following letter was then sent to the membership in an attempt to be of service in organizing the radio men of the country, and needless to say it proved very fruitful.

February 21, 1917.

To the Membership of The Radio Club of America:

The radio amateurs of the Country are a potential source of aid in the national defense. To realize these possibilties in the most effective way it is necessary that the various organizations be co-ordinated through a central body.

At this grave moment in the affairs of our nation The Radio Club of America is preparing to co-operate with the Committee now engaged in organizing the radio engineers of the country. The Board of Directors is about to submit to this Committee a classified list of the Club members, specifying the particular abilities of each. As it is desired to complete the list **immediately**, you are urgently requested to **fill out the enclosed blank form in detail** and forward it to the Corresponding Secretary **by return mail.**

It is pointed out that the filling out of this form does not involve any obligation, but is for the purpose of obtaining information regarding the qualifications of our membership for possible service in the defense of the nation.

THE BOARD OF DIRECTORS.
THOMAS J. STYLES, Corresponding Secretary.

The war records of those members who enlisted have been chronicled elsewhere, and would make too lengthy a proposition for this article. It suffices to say, that practically all were officers in Radio capacities and in charge of important operations, such as: radio aircraft, radio schools, laboratories, field service, etc. Notably, E. H. Armstrong, while with the allied forces in France, in 1918, invented the Superheterodyne receiver which was used in the intelligence service at the front, and as we all know, has since become the universal circuit for broadcast reception.

After the Armistice had been signed and things began to assume a more normal appearance, the club activities were again resumed. The first meeting of the board of directors was held at Keen's Chop House on October 13th, 1919. As a result of this meeting the following letter was sent to the membership.

October 30, 1919.

To the Membership of The Radio Club of America:

Now that the national crisis is at an end, the period of suspension of the Club's activities which became operative in the Fall of 1917 has been terminated by the Board of Directors. At a meeting of the Directors held on Oct. 16, 1919, the following important decisions with regard to our future programme were made:

(1) That a dinner be first tendered to our President, Mr. Edwin H. Armstrong, in his honor as a token of our regard and in appreciation of his splendid achievements as a Major in the Signal Corps of the Army and of the honor he has brought to The Radio Club of America.

(2) All dues prior to January 1, 1920, whether in arrears or otherwise, to be stricken from the records, dues to be payable and to date from January 1, 1920.

(3) Recommendations made to the Committee on Papers to avoid, in future, presentation of what might be termed "highly technical" papers. This Committee has in store a treat for the members in the forthcoming delivery of lectures bearing on the tremendous amount of research conducted, and the actual practical results obtained in the radio field during the War, supported by data on construction of apparatus, and, whenever possible, by exhibition of apparatus.

(4) A time to be appointed by the Chairman at each meeting to provide for informal discussions on any radio subjects.

Arrangements are now in progress for the resumption of our regular monthly meetings. Statements of dues will be mailed by the Treasurer, Mr. E. V. Amy, at the proper time. Further notice with respect to the next meeting of the Club will be sent you.

The following items are bulletined herein as they will undoubtedly prove of interest to many members:

National Service Committee, Engineering Council, 10th and G Sts., Washington, D. C.—This body is sending regularly to the Club bulletins which are of general interest to all engineers throughout the country. It obtains the latest information on all Government engineering activities of any character. It extends a cordial invitation to all our members to make use of its service. The Council is, in effect a coordination of all engineering efforts of the country. Such bulletins as have been received will be displayed at the next Club meeting.

U. S. Employment Service—Professional and Special Section, 16 East 42nd St., New York—Wishes to interest our members in the work it is doing in placing highly trained professional and technical employees who have been released from the Army, Navy and war work.

Engineering World, New York and Chicago—The publisher will gratuitously devote 30 to 40 words in its want columns to each engineer who has been in the service of the country and who seeks employment. It will put a small star at beginning of each want ad, and replies must be addressed in care of the Club.

The Directors are desirous of obtaining from the members a brief record of their activities during the World War, their present addresses, etc. Will you therefore fill out and return **at once** the form below?

Respectfully,

THOMAS J. STYLES, Corresponding Secretary.

The dinner, with Major Armstrong as guest of honor, was scheduled for November 19th, as per the following announcement:

Announcement of

DINNER AND RECEPTION

To Be Tendered by the Membership of The Radio Club of America to Its President

MR. EDWIN H. ARMSTRONG

Major, Signal Corps, U. S. Army

To the Members:

The name of Edwin H. Armstrong is known, by reason of his invention of the Armstrong Regenerative Audion Circuit, not only to the members of The Radio Club of America, but in every corner of the world where radio communication is used. When the radio amateurs of the United States were confronted with the discouraging restrictions of the Act of 1912, there was apparently no alternative left to them but to abandon practice of the art. How the then existing gloom was dissipated, and how the amateur was rehabilitated by Mr. Armstrong's introduction of his circuit and his invitation to all amateurs to freely use it for their own purposes, needs no repetition.

Mr. Armstrong recently returned to the United States and to civilian life after long and continued service in France with the United States Army. The opportunity is ours to show our appreciation of him as a fellow-amateur and as President of our Club—one who has rendered distinguished service to the nation, and brought honor to the Club by reason of the nature of that service, during the World War. A Committee composed of members of the Board of Directors was formed for the purpose of having the membership tender Mr. Armstrong a Dinner. The expenses will be defrayed by subscription of the membership. The cost will be approximately four dollars ($4.00) per plate. The Dinner, which will be **strictly informal**, will be given at the HOTEL ANSONIA, BROADWAY and 73rd STREET, NEW YORK CITY, on WEDNESDAY EVENING, FEBRUARY 19, 1919, at seven-thirty o'clock. Tickets are four dollars ($4.00) per person.

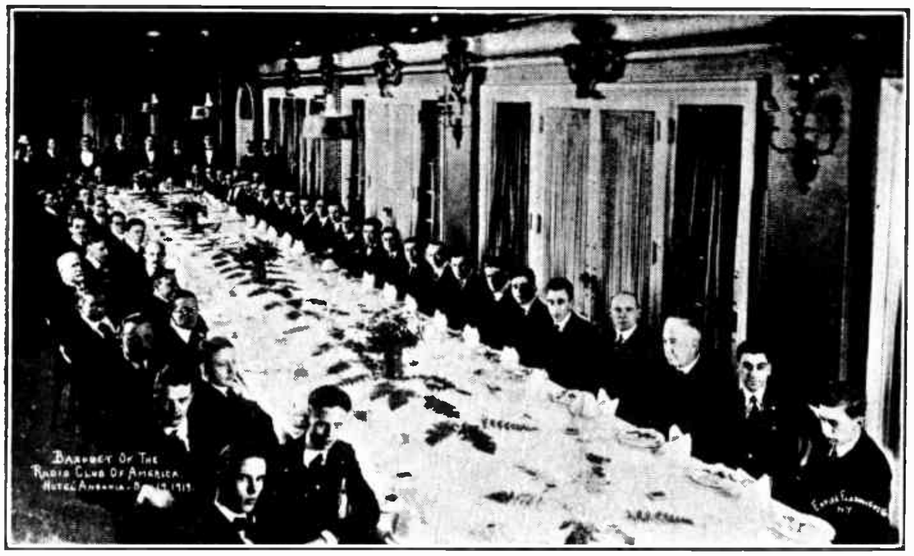
Will you make every possible effort to insure the success of the Dinner by being present YOURSELF. Let this be an after-the-war "get together" occasion. Set everything else aside just this once, and, if you may be thinking of the cost of the ticket, consider the saving in dues which resulted from their suspension in 1918 and 1919. Bring your friends and relatives if you wish.

Please indicate how many tickets you desire by filling out and detaching the blank below, forwarding it to the Treasurer with your remittance (payable to him) **at your earliest convenience** so that the Dinner Committee may make proper reservation, using the enclosed stamped addressed envelope. Send check, money order or express order.

Very respectfully,

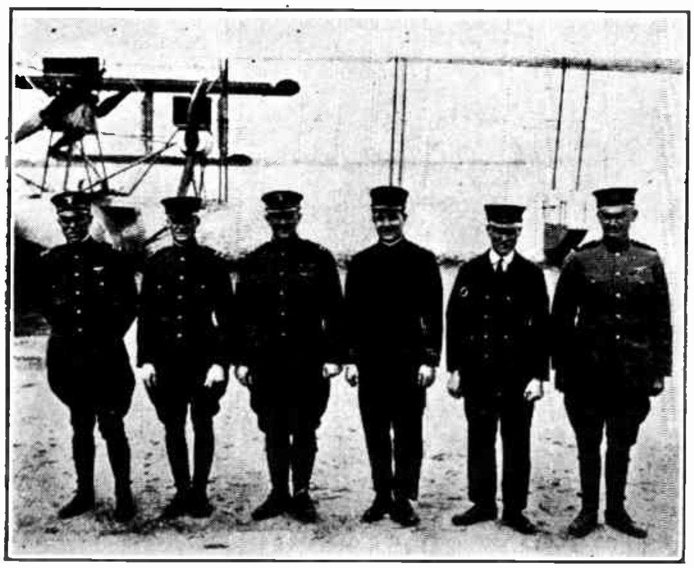
THOMAS J. STYLES, Corresponding Secretary
for the Dinner Committee.

The affair was a great success. Many prominent men were present, and due homage was paid to Armstrong for his outstanding work with the Expeditionary Forces, as well as his many other worthy achievements.



Radio Club Banquet given in honor of Howard Armstrong at Hotel Ansonia, 1919.

In 1919 the first successful flight across the Atlantic was made by the U. S. Navy, from Halifax to Portugal. Three planes were used and of course radio was a very important part of the equipment and the operators had to be of sterling worth. Lieutenant Harry Sadenwater, a Radio Club member, was chosen to operate the set on the NC1. Unfortunately this ship was forced to the water within twenty miles of the Azores and it was due to the valiant efforts of Lieutenant Sadenwater that the storm-tossed crew were finally rescued by a destroyer which responded to his calls after some fifteen hours of gruelling work.

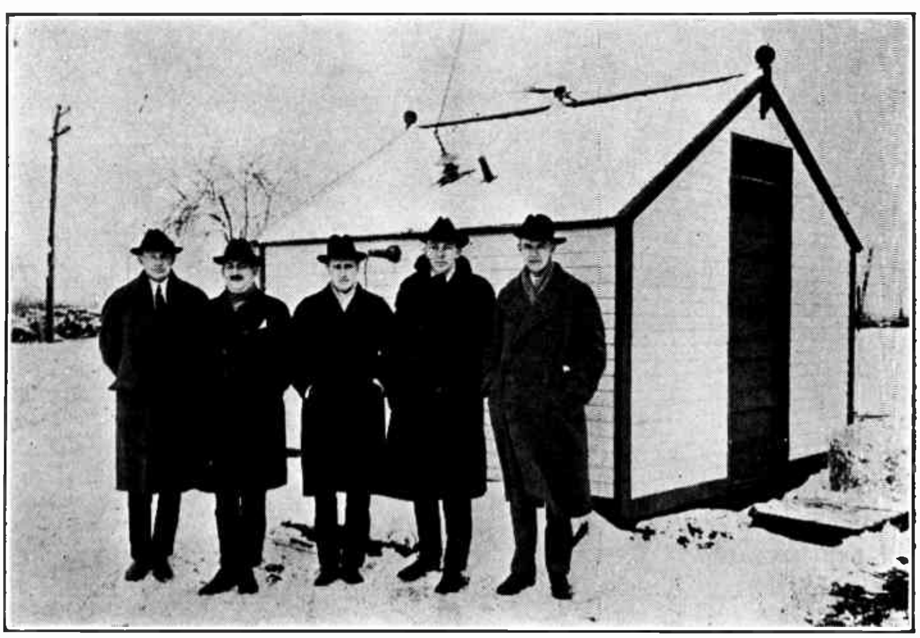


Trans-Atlantic flight 1919.
Crew of the NC1, Harry Sadenwater, third from right.

Now that all war restrictions had been lifted, the amateur came into his own once more, and bent to the work of reconstruction with a vim. Old poles and antennas were once more erected and transmitters revamped. To be sure things were not like the good old days, for the Department of Commerce regulations had to be rigidly adhered to, but with new developments and experience gained during the war, amateur communication became even bigger and better. The advent of the tube transmitters opened the field of radio telephony and a good many of the erstwhile telegraph hams were already embracing this new development. Three of the club members, Ernest Amy whose call was 2VK, Harry

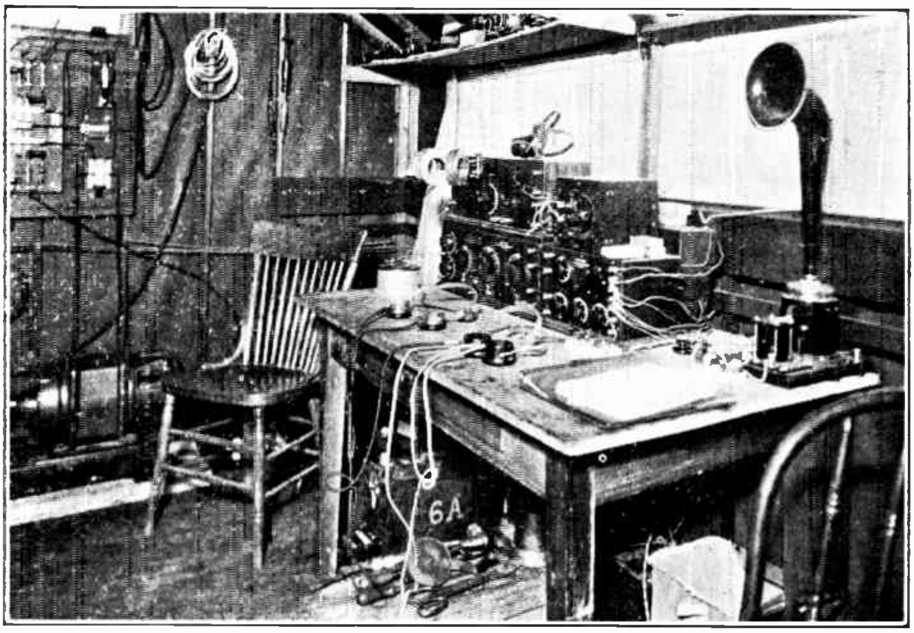
Postcard sent by "Harry" from the Azores.

Sadenwater, 2PZ, and George Burghard, 2SS, maintained very reliable telephone communication across the city using exceedingly low power on 200 meters. In fact on several occasions these stations were picked up at a distance of 50 miles. Regular musical programs were transmitted through the medium of a phonograph, and this constituted the first real amateur radio broadcasting with tubes.



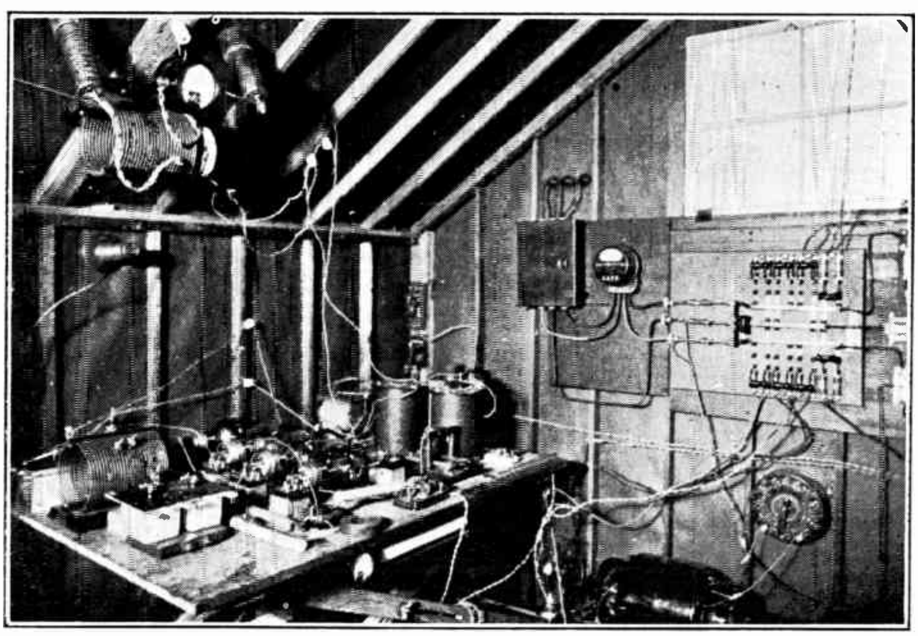
Operating staff, station "1BCG". Left to right: Amy, Grinan, Burghard, Armstrong, Cronkhite.

The idea of transmitting American amateur signals across the Atlantic originated with one of the prominent members of the Club before the world war, when Louis Pacent presented the matter for the consideration of the board of directors. Nothing definite was accomplished, however, and several later attempts



Receiver at station "1BCG", Greenwich, Conn., 1921.

were abandoned as too costly at the time. In 1921 the American Radio Relay League decided to run a transatlantic test and send a representative to England to receive the American signals. Paul Godley, one of our oldest members, was selected as the logical man to carry on the reception.

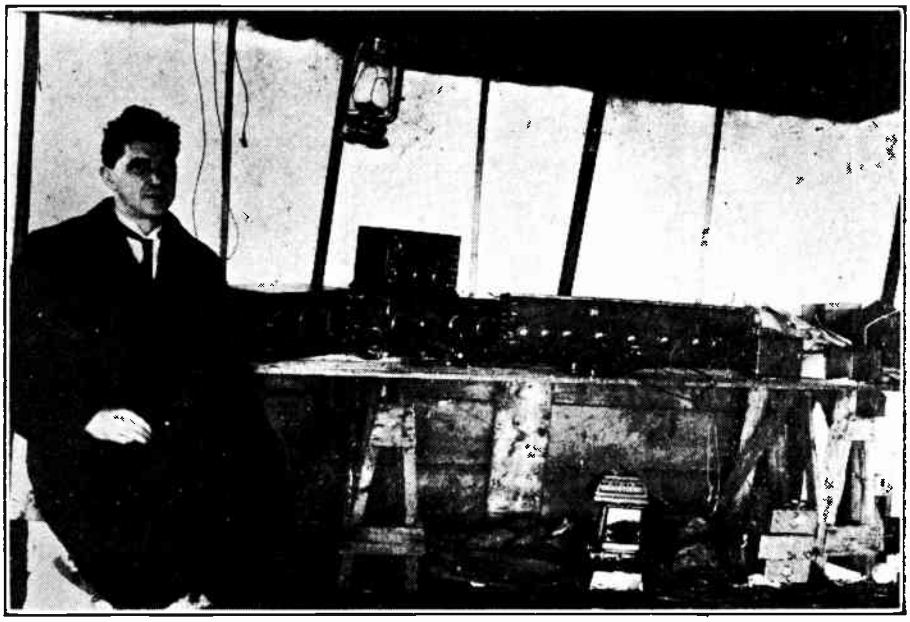


Transmitting apparatus at station "1BCG", Official Radio Club of America station, which established two World records in the amateur Transatlantic tests in 1921, by transmitting a twelve word message to Ardrossan, Scotland, and three messages to Catalina Island, Calif., direct.

On November 18th, 1921, six members of the Radio Club of America at an informal meeting, decided to build a transmitting station that would be heard in Europe. The six men were: E. H. Armstrong, Walker Inman, E. V. Amy, John Grinan, Minton Cronkhite, and George Burghard. Much discussion as to the locations of the station followed, but it was finally decided to build at Greenwich, Conn., on the site of Cronkhite's present station 1BCG.

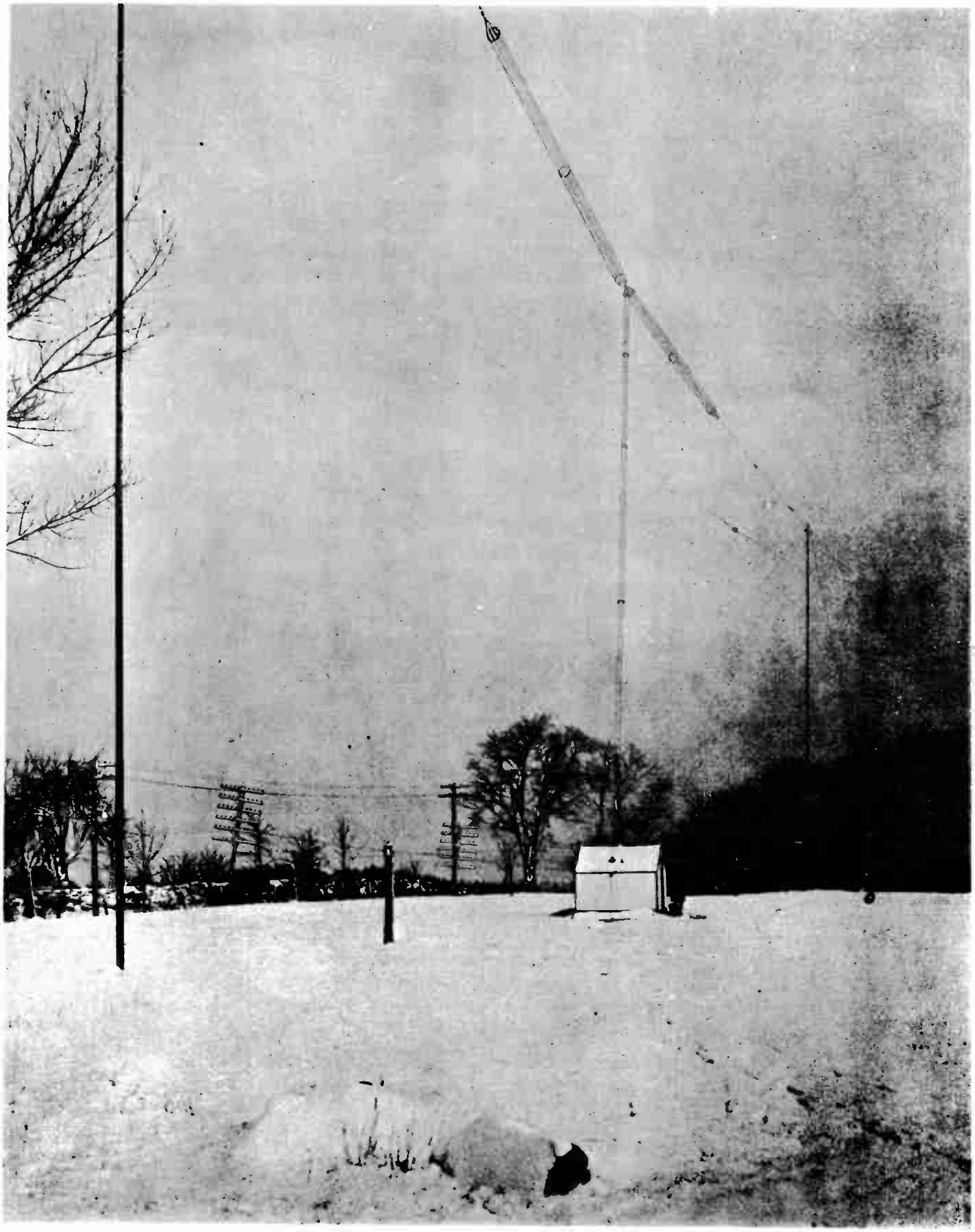
The construction of the station and all technical data has been recorded elsewhere, and a description would be too lengthy for this article. It suffices to say that, the antenna system consisted of a "T" type cage with a 100 foot flat top 70 feet high, and a radial counterpoise in place of a ground. Four type U.V. 204 Radiotrons were used in the transmitter, one as the master oscillator and three in parallel as amplifiers with a 2500 volt direct current power supply.

The station was a great success, and was awarded the prize offered by Mr. Burnham, of England, for the best station in the test. 1BCG's signals were heard in every state in the Union, in Scotland on December 9, 10 and 11; England,



Trans-Atlantic receiving apparatus installed and operated by Paul F. Godley at Ardrossan, Scotland. Ass't. Operator Piersen. 1921.
In this tent, which was blown down on one occasion by a high wind, Paul received the now famous message from the Radio Club station 1BCG at Greenwich, Conn.

Germany, Holland, Porto Rico, Vancouver, B. C., California and the State of Washington. The greatest distance covered was to Amsterdam, Holland, approximately 3800 miles, mostly over water, and 2600 miles over land to Smith River, Calif. Last but not least 1BCG sent three complete messages to 6XAD in Avalon, Catalina Island, Calif., and one 12 word message to Paul Godley in Ardrossan, Scotland, at 9.45-10.00 P. M. on December 11, 1921; all with an input of 990 watts and a wave length of 230 meters. This was the first time in history that an amateur station sent a complete message across the continent or across the Atlantic, and perhaps the first time that this feat had ever been accomplished with less than a kilowatt input and a wave length of 200 meters. This aroused such interest, in view of the low power and shortwave used, that such prominent men as Professor M. I. Pupin of Columbia University, and David Sarnoff, General Manager of the Radio Corporation of America, went to Greenwich to visit the station, and as Professor Pupin put it, in his inimitable way, "To see what you boys are doing"



"1BCG"

RECOLLECTIONS OF A MEMBER OF THE ENGINEERING STAFF OF 1BCG

by

EDWIN H. ARMSTRONG

The engineer without experience with the transmitter art of 25 years ago may well look at the wiring diagram of 1BCG and express wonder at the weird arrangements that were used. The engineering staff of 1BCG might well counter with the remark: "Who else up to that time had ever built a transmitter to cross the Atlantic on a 200 meter wave length in less than one week's time?"—a good enough answer under the circumstances. Better answers lie among the recollections of the engineering staff to account for the things that were done.

The writer of this section became actively interested in the transmitter design shortly before the 5th of December, when an observation made in New York City of the roughness of the tone of the "self rectified A.C. self oscillator" used at 1BCG recalled the success of a master oscillator power amplifier CW network that had been installed in the A.E.F. The superiority of the steady C.W. beat note over the I.C.W. and C.W. self oscillators then in use in all other nets had been observed throughout the Allied Armies.[1]

Discussion of these results led to the serious decision to switch over to a master oscillator-power amplifier with DC motor generator power supply, despite the major operations that would have to be carried out in the three days left before the tests began.

The first step was taken without difficulty. A 2000-volt motor generator was quickly obtained from the Electric Specialty Company located in the nearby town of Stamford, and a P-tube master oscillator circuit tuned roughly to 200 meters put into operation. After some trouble caused by heating and a few burnouts of components, a proper selection was made which gave fairly steady operation (over short periods of time, as we were to learn later). A couple of open iron core choke coils, located amidst the stores of the Hartley Research Laboratory at Columbia University, formed the filter which removed commutator ripple, so that the oscillator gave a clear, steady beat tone when listened to at an amateur receiver located in the neighborhood.

The second step was the one that was to cause the trouble. Bear in mind that at this time the art of neutralization was unknown, and that parasites, while known to exist, were looked on as a mysterious visitation of trouble which obeyed no known laws. The addition of two P-tubes in parallel as amplifiers produced all the strange effects that our present knowledge would enable us to anticipate. Tubes ran extraordinarily hot with much smaller plate currents than that current with which at other times they ran quite cool. Grid leads within the tube became suddenly incandescent, necessitating split second operation of the plate voltage switch to save the tube. Sometimes even the split second operation failed to save a tube.

For a period of about 36 hours of erratic behavior, the power stubbornly refused to appear in the antenna, but dissipated itself internally among the circuits, as evidenced by repeated component heatings and failures. None of us recall the number of "cut and try" changes that were made, but some time during the second day the important step was taken of including a series tuning condenser in the plate circuit of the multi-tube amplifier. Adjusting this condenser below a critical value produced an immediate stabilizing effect due, of course, as everyone now knows, to the introduction of a positive resistance reaction into the system through the medium of the plate-grid capacities.

From this point on the system was gradually stabilized and the power developed in the antenna rose steadily to an estimated 600 watts by the third day of the tests. The somewhat odd tap-on points of the various grids and plates shown in the diagram were arrived at experimentally, the test being the particular adjustment which stopped a particular parasite from playing around in the circuits.

The final problem was the keying of the transmission without spoiling the note. Attempts to key the master oscillator (with fixed bias on the amplifier grids) resulted in instability of the beat note due to heating, surges, etc. The oscillator was therefore kept permanently in operation and keying carried out by opening the amplifier grid leak circuit. A residual antenna current for open key conditions of about one-third that obtained with closed key conditions due to feed-through of oscillator power via the amplifier grid-plate capacity rendered the signal hard to read. This difficulty was solved for purposes of the test by arranging an auxiliary keying relay to alter the frequency of the master oscillator during the key-up conditions, the change in frequency being adjusted to carry the beat note out of the audible range of a receiver tuned to the main wave.

[1]This was the first instance of master oscillator sets used in military communications.

During the third day of the tests, after steady operating conditions had been established, our concern was principally with the steadiness of the note, and various troubles due to poor contacts caused by heating and the like were located. Information about the steadiness of the note was obtained by working various stations during the day, and the conflicting reports worried the staff no end. Finally it was observed that the reports of a good note came from stations at a distance, while the reports of a poor note were almost uniformly from stations in the local area. Subsequently the reason became clear—the high level of the signal was pulling the frequency of the self-heterodyne receivers into step with it! After that we rigged up to observe the frequency within the station on the third harmonic of the monitoring oscillator.

Of course after 1BCG got across three days running, the engineering staff were on top of the world. They let it be known that they were the boys who knew how to design transoceanic transmitters. Period! However, when for two days running the reports of no signals came through from Godley, the operating staff became critical. Suggestions were made that the transmitter must be wearing out, or that the signals must somehow be getting out of the groove that we thought we had worn through the ether to Ardrossan.

With the few days remaining of the tests, something had to be done quickly. Recalling again that the CW net in the A.E.F. had been set up by connecting two motor generators in series to give twice the voltage on the plates of the tubes used for which they were rated, it was suggested that perhaps the tubes presently in use might also operate more "efficiently" if higher voltages were applied to the plates of the amplifier. Another motor generator was rushed in from Stamford—this time a *2500* volt affair. It was duly connected in series with the motor generator then operating, and the resulting 4500 volts applied to the plates of the P.A. It worked—and held together throughout the balance of the tests. It appears that the transmitter did operate more "efficiently", but no check could be made due to the failure of the antenna hot wire ammeter to hold its calibration after a severe case of overheating.

However, the engineering staff received its first lesson in the vagaries of North Atlantic short wave propagation. The forces of Nature were not to be overcome by mere brute force methods, at least not by such amounts of power as could emanate from an "10 X 14 hut". I believe the transmitter demonstrated its increased efficiency during the post-test period and that the engineering staff regained its standing with the operating staff when they were able to work every State in the Union without difficulty.

Station 1BCG

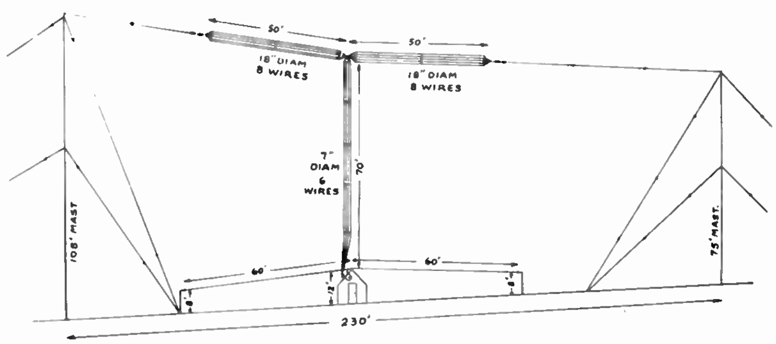
A Paper Presented by George E. Burghard at meeting of Radio Club of America, Columbia University Dec. 30, 1921.

BEFORE going into the description of station 1BCG it may be well to consider for a moment the history of transatlantic amateur communication.

The idea of transmitting American amateur signals to the Continent originated with one of the prominent members of the Radio Club of America before the world war when Mr. L. G. Pacent presented the matter for the consideration of the board of direction. Nothing definite was accomplished, however, and when Mr. Thomas Styles went to France after the war, Mr. Pacent suggested that the club erect a station to attempt communication, but the proposition was abandoned as too costly at the time. Some time after this Mr. Philip Coursey of "The Wireless World" took up the matter with Mr. White of the Wireless Press with like result, everyone being sceptical as to the success of the affair. Then Mr. M. B. Sleeper, at that time radio editor of "Everyday Engineering", took the mission longer, and to send a representative to England to receive the American signals. Mr. P. F. Godley was selected as the logical man to go to England. He sailed for England in November, 1921, and it is here that the story of 1BCG begins.

On November 18th six members of the Radio Club of America at an informal meeting decided to build a transmitting station that would be heard in Great Britain. The six men were E. H. Armstrong, E. V. Amy, John F. Grinan, Walker Inman, Minton Cronkhite, and G. E. Burghard.

Various locations for the station were suggested and it was finally decided to build at Greenwich, Conn., on the site of Mr. Cronkhite's station 1BCG. Thru the courtesy of Mr. E. P. Cronkhite the necessary land and facilities were obtained. The antenna and transmitter were designed and decided upon and work was begun at Greenwich on November 19th. The



Antenna at 1 B C G

idea up in earnest and laid the plans for the first amateur transatlantic test but was later forced to give it up. The American Radio Relay League took up the task at Mr. Sleeper's request, where he left off, and the first test was run under their auspices. The periods of transmission, however, were too short and no signals were heard in Europe. Then it was decided oy the League to have another test the following winter, making the periods of trans- staff worked night and day in snow and rain until finally on November 30th the antenna and counterpoise were in place. The transmitter, which at that time was of the self-rectifying type, was also well under way and the first signals were sent out at 10:40 p.m. November 30th, with expectedly poor results. Much trouble was experienced from then on until on Dec. 5th it was decided to supplant the A.C. system with a D.C. master-oscillator set.

Editor's note:

This paper was read before the Radio Club of America by its president, George E. Burghard, at the December 30th meeting at Columbia University in 1921. It gives a complete description of the station with circuit wiring diagrams of the transmitter and drawings with full dimensions of the antenna and counterpoise systems. The operation of the master oscillator power amplifier transmitter is fully explained and operating data such as input and output power together with circuit constants are accurately recorded. The distances covered and the various records established by 1BCG are also set forth in detail.

This system, which will be described in detail later, was made permanent and was used in the transatlantic tests and is still in use at 1BCG at the present time.

The antenna system used is of the type T cage with a radial counterpoise. The dimensions are as shown in Fig. 1. The antenna proper is hung between two pipe masts 230 feet apart and 108 and 75 feet high, respectively. The two horizontal sections of the cage are each 50 feet long, 18 inches in diameter, and consist of eight phosphor-bronze wires. The vertical section is 70 feet over the top of the counterpoise, 7 inches in diameter, and consists of 6 wires. The counterpoise wires can be seen in relief stretching from the top of the transmitting shack which was located directly under the middle of the antenna, thus placing the transmitter in the center of the system. A bird's-eye view of the counterpoise is shown in Figure 2.

As can readily be seen the system is divided into two fan-shaped halves, each containing 15 wires all of equal length, i.e., 60 feet, and radiating from the transmitter as a center. The reason for this division of the counterpoise is of no importance since it was intended to prevent harmonics in a predesigned system which was never put into practice. The natural period of this system of antenna and counterpoise from actual measurement proved to be between 190 and 195 meters.

The resistance of the antenna and counterpoise thru a range of wave lengths from 200 to 330 meters was found to be as follows:

Wave Length Meters	Resistance Ohms
200	40
210	31
215	18
225	16
230	15.5
240	14
270	12.5
290	17
310	12
330	9

Unfortunately no further readings were taken but since the working wave length of the station was 230 meters a fair idea of the antenna efficiency can be obtained from the figures at hand. The sudden rise in

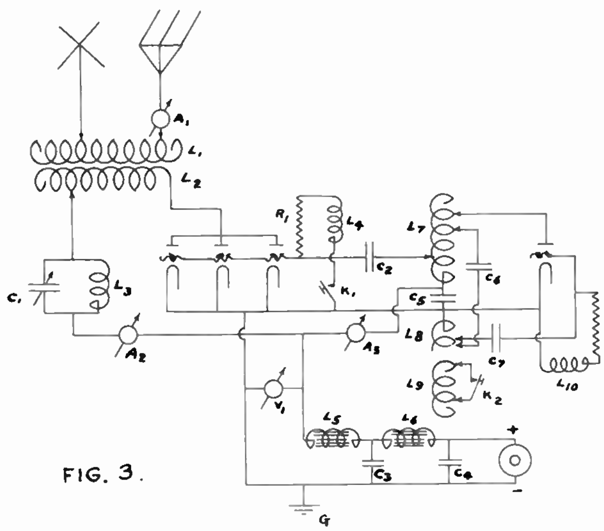


FIG. 3.

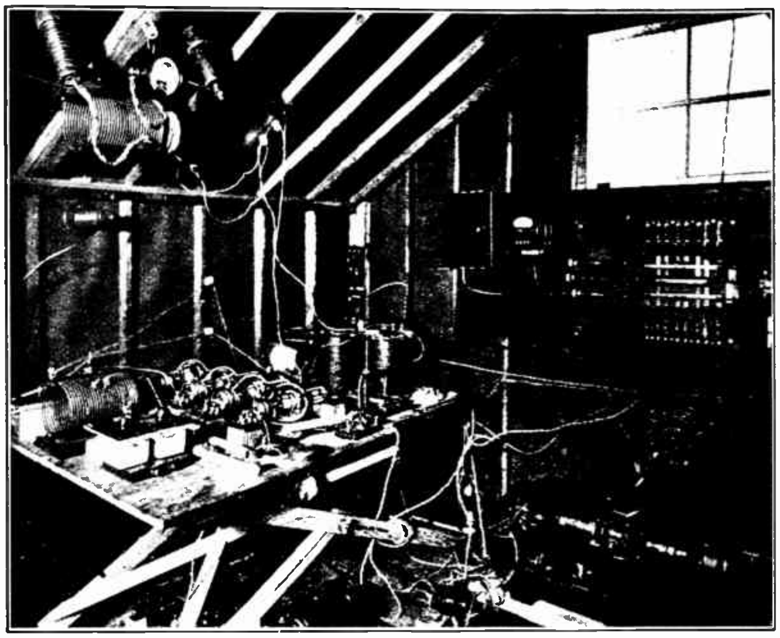
Constants for Fig. 3

A_1 .... 0-15 thermo-couple ammeter
A_2 .... 0-3 ammeter
A_3 .... 0-500 milliammeter
C_1 .... variable
C_2 .... 0.002 mfd.
C_3 .... 0.250 "
C_4 .... 0.0017 "
C_5 .... 0.250 "
C_6 .... 0.001 "
C_7 .... 0.002 "
L_1 .... 5⅓ turns, UL-1008
L_2 .... 36 turns, 5" diam.
L_3 .... 3 millihenry choke
L_4 .... 3 millihenry choke
L_5 .... 9 henries
L_6 .... 9 henries
L_7 .... 16 turns, UL-1008
L_8 .... 3 turns, UL-1008
L_9 .... 3 turns, UL-1008
L_{10} .... 3 millihenry choke
R_1 .... 2500 ohms
R_2 .... 1000 ohms
V_1 .... 3000 volt meter
K_1 K_2 .... relay signalling keys

resistance at 290 meters was later found to be due to the receiving antenna which had a fundamental wave length of approximately 290 meters.

No real earth ground was used in the station except to ground the filaments of the transmitting tubes, and for receiving; this consisted of several four-foot ground stakes driven into the ground.

The design of the transmitter centered about one main idea, the production of that type of 200 meter wave which would be most effectively handled by the superheterodyne method of amplification and that type of audible signal which would be within the narrow limits permitted by the resonance curve of the diaphragm and the physiological characteristics of the ear. There must be no variation in this frequency which will disturb the mechanical resonance of the diaphragm, nor flutter in note which will disturb what may be called the physiological resonance of the ear. The permissible limits of variation in frequency for a 1000 cycle note are well under 100 cycles. Hence for heterodyne reception at 200 meters or 1,500,000 cycles, a variation of frequency of less than 1/100 of one percent would be extremely disturbing to the operator and a variation of 1/20 of one



Interior view of the station

most effective on the combination of the telephone and the human ear.

percent would be sufficient to carry the note into an inaudible frequency.

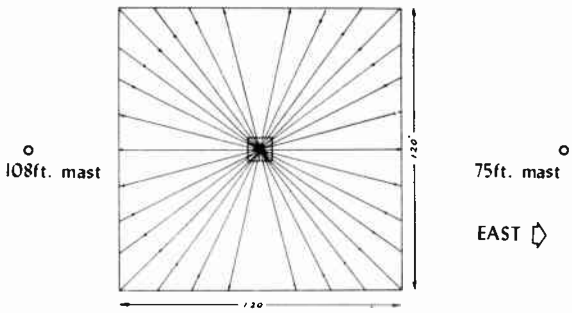
To meet the first condition, that is, the electrical requirements of the superheterodyne, a pure undamped wave must be used. It is obvious that the superheterodyne with its great selectivity and highly resonant system cannot give its maximum response when there is any discontinuity or variation in amplitude in the transmitted wave. Undamped waves must be used, waves of a type which can be obtained only from a vacuum tube oscillator with a continuous current plate supply.

To meet the second condition (the combined electrical characteristics of the telephones and the physiological characteristics of the human ear) a current must be produced in the telephones which corresponds with the natural period of the diaphragms and which remains constant

The whole proposition therefore comes down to the construction of a vacuum tube transmitter producing undamped waves of an absolutely constant frequency which stays constant with an instantaneous application of a load of 1 K.W. There is but one type of transmitter which can possibly meet this condition—the master-oscillator-amplifier type with a motor-generator for the plate supply.

The general layout of the transmitter is illustrated by Figure 3. Four type U.V.-204 Radiotrons were used, one as the master oscillator, three in parallel as amplifiers. The filaments of these tubes were connected in pairs of two in parallel and each pair was lighted by A.C. obtained from the ordinary type of filament-lighting transformers. The plate supply was obtained from a double-commutator 2200 volt 1.5 K.W. continuous current generator with A.C. drive.

The master-oscillator circuit employed was of the standard split inductance type with a fixed tuning condenser of the rather large value, for 200 meter work, of .001 mfds. The inductance consisted of a helix of 25 turns of copper strip wound edgewise, having a diameter of about 6" and a length of 9". This choice of constants was arrived at largely on account of an accident to several condensers of smaller



Counterpoise at I B C G

capacity in the master oscillator circuit on the first night of the tests. The only available condensers capable of standing the required voltage were two .002 mfd. mica condensers which were connected in series to give .001 mfds. The other constants of the circuit were then adjusted to fit this capacity. The usual grid condenser, with a high resistance leak and choke coil connected between grid and filament, was used.

The amplifier consisted of three tubes with their respective grids and plates connected in parallel. The grids were connected thru a series condenser to a tap on the plate side of the master-oscillator inductance. The usual grid leak and choke coil were connected between grid and filament. The plate circuit was coupled to the antenna thru a two-coil oscillation transformer. The primary or plate side of this transformer consisted of a coil of 36 turns of litz, having a diameter of 5" and a length of 3½". The secondary or antenna coil consisted of about 6 turns of edgewise-wound strip 6" in diameter. The plate circuit of the amplifier was tuned by means of a capacity consisting of three .005 mfd. variable air condensers connected in series to withstand the voltage. The path for the continuous current in the plate circuit was completed by a choke coil connected across the three condensers.

The filter circuit consisted of a two stage series inductance, shunt capacity filter, both inductances being placed in the positive generator lead. These inductances were of the open-core type, wound with No. 22 B. & S. wire, each having an inductance of 9 henrys and a direct current resistance of 85 ohms. The capacity of the two shunt condensers was .25 mfds. each.

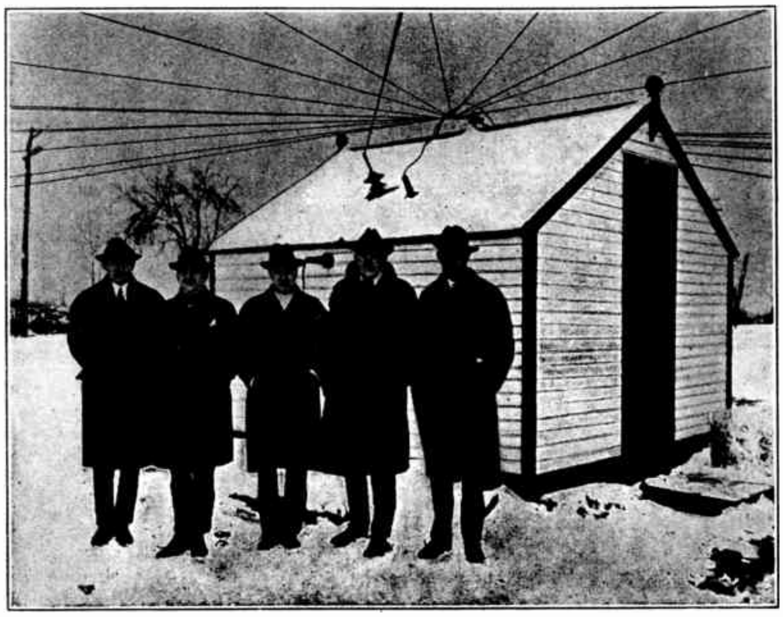
The method of signalling used was as follows: The master-oscillator was connected permanently to the generator and ran continuously whenever the motor-generator was running. Its circuit was never broken. Signalling was accomplished by means of two magnetically-controlled keys. The first opened the grid leak circuit of the amplifiers. The second simultaneously shortened the wave length of the master-oscillator about 5 meters by short-circuiting a couple of turns of a coil in inductive relation with the master-oscillator circuit. Under steady operating conditions this transmitter maintains 6 amperes in the antenna with an input of 990 watts into the plate circuits of all four tubes. The power in the antenna for this current is 558 watts, corresponding to an antenna resistance of 15.5 ohms. This gives a plate efficiency of about 56% with 2200 volts on the plates. On account of various breakdowns in different parts of the apparatus this output was not obtained and the set was not in condition for steady operation until 1:10 A.M. of December 9th.

There are some points of interest about the set which are novel. Probably the most important is the stability of the master-oscillator. This is due to the type of oscillating circuit and the relatively large power of the master-oscillator, and to the tuning of the plate circuit of the amplifier which permits the neutralization of the reaction of the amplifier on the master-oscillator system. This is accomplished by adjusting the tuning of the amplifier plate circuit and the coupling with the antenna until the plate current of the master-oscillator tube remains unchanged when the key is closed.

In addition to this effect the series tuning system in the amplifier plate circuit has the very important advantage of increasing the transfer of energy to the antenna circuit when the antenna coil has but a few turns. It therefore assists in operating the antenna system close to its fundamental wave length.

It is interesting to note here that great difficulty was experienced in the first few days of operation in obtaining reliable information regarding the steadiness of the note. This was due to the fact that signals from 1BCG were sufficiently strong to affect and alter to a considerable degree the frequency at which receiving sets within a radius of fifty miles were oscillating. This resulted in a bad note. The solution to this difficulty was found by setting up a self-heterodyne detector in the station with 150 volts on the plate, without a stopping condenser, and with a tuning circuit of small inductance and large capacity. By adjusting the frequency of this circuit to one third of the frequency of the station, beats were obtained between the fundamental of the station and the third harmonic of the receiver. This enabled the frequency of the station to be observed perfectly. Observation on a windy night, when the notes of all C.W. stations heard were varying so badly as to be almost unreadable, showed the frequency to be absolutely unaffected by the motion of the antenna. The reports on this set from all parts of the country show beyond question that radiation of this kind is superior to very many times the energy radiated from the ordinary types of C.W. transmitters.

In connection with the actual operation of the station it will be interesting to quote from the engineering log in order to give an idea of the difficulties encountered: "Dec. 6th—During the evening the master oscillator is connected up. Two amplifiers in use. Tubes running very hot. A CQ was sent out at 3:30 A.M. and condensers boil over." "Dec. 7—One tube is found to be defective leaving only one amplifier. While we are adjusting the master-oscillator for cooler operation many stations are heard sending in Transatlantics. Finally sent CQ to Godley with 3 amps. in antenna. More tubes arrive—set is in operation until condensers in the master-oscillator circuit heat up so that it is advisable to shut down." "Dec. 8—Much trouble is experienced with condensers in master-oscillator circuit. Tested for adjustment all nite. 1:12 A.M. finally got condensers fixed with 6 amps. radiation and worked until 6:35 A.M. All OK now". From this it can be seen that the station was actually not in operation until the 9th of December and in the short period of three weeks to date has accomplished some amazing long-distance feats.



The station building at 1BCG and five of its owners. Left to right, Messrs. Amy, Grinan, Burghard, Armstrong, Cronkhite. Mr. Inman is missing in this photo. Note the counterpoise radiating from the top of the station, and the lead-in from it and the antenna.

1BCG's signals have been heard in practically every state in the Union; in Scotland on Dec. 9, 10 and 11; England, Holland, Porto Rico; Vancouver, B. C.; California and Washington. The greatest distance covered is to Amsterdam, Holland, approximately 3800 miles, mostly over water, and 2600 miles over land to Smith River, Calif. Last but not least 1BCG has established new records by sending three complete messages to 6XAD in Avalon, Catalina Island, Calif., and one 12-word message to Ardrossan, Scotland, at 9:45-10:00 P.M. Dec. 11, 1921; all with an input of 990 watts and wave length of 230 meters.

Photographs of 1BCG, thru the courtesy of Mr. J. Edw. Brown, of 1BKA, Glenbrook, Conn.

By this time the number of amateur stations had increased to a tremendous extent, and with broadcasting just about beginning, communication was becoming almost impossible. The Radio Club investigated the situation and found that most of the interference was caused by spark and interrupted continuous wave transmitters. It therefore undertook a vigorous campaign of advice and suggestion, through papers presented before the membership, to educate the amateur in the whys and wherefores of pure continuous-wave transmission and its many advantages over the older forms. The campaign proved successful and is still in progress.

It was at one of these meetings in 1922 that E. H. Armstrong startled the radio fraternity by producing a sufficient volume of music to fill the large lecture hall, using his newly invented super-regenerative circuit, a loop aerial and only one Western Electric J Tube. This performance, of course, had never been equalled, and when it is considered that the signals were coming from station WJZ, at Newark, N. J., and that the receiving set was located in a steel building with a copper roof at Columbia University, it was certainly an epoch-making event.

Radio Club receiving booth at Radio Show in Grand Central Palace, 1922.

In December 1922, The Radio Exposition Company held a large Radio Show at the Grand Central Palace, New York. As everyone knows, if all the exhibitors at a Radio Show are permitted to receive broadcast programs at the same time, chaos would result due to heterodyning between the receivers themselves. In order to avoid this difficulty, the exposition directors decided to permit only one concern to do all the receiving. This, of course, was an unhappy thought since there was no way of deciding which company this should be, without causing vigorous protest from the other exhibitors. Finally it was decided to choose a non-commercial organization. The lot fell to the Radio Club of America. A special committee was appointed and the work begun. Tests were made a week prior to the opening of the show with various types of antennas and finally it was found that even a loop would pick up too much of the noises resulting from commutator sparking, circuit breakers, and electric locomotive shoes, from the power houses in the vicinity and the New York Central tracks directly beneath, so that a single wire about fifteen feet in length had to be used. The problem proved to be twofold and a great deal more ponderous than was at first anticipated. First there was the matter of doing away with extraneous noises so as to deliver pure radio signals to the power amplifiers and secondly a physical problem of placing the loud-speaking horns so that there would be no re-echoes or dead spots. The first was solved after much experimentation by the small antenna, a 600-meter frequency trap, and a super-heterodyne receiver. The acoustic problem, however, offered stubborn resistance. Six loud speaker units with four-foot straight horns were obtained, and the question was how to place them so that the sound would fill the entire Grand Central Palace exhibition hall. At first, they were hung radially in a cluster from the ceiling in the centre of the floor space. This proved unsuccessful since many re-echoes were produced from the side walls and dead spots resulted from large columns. Finally, after trying several other positions, it was decided to place the horns on the balcony directly in front of the specially constructed booth which housed the receiving and amplifying apparatus. It is interesting to note that all the horns had be placed together because any separation by placing horns at various points about the hall produced out of phase relationship and distortion. As it was, only five horns could be used, since the sixth faced a wall and produced a decided re-echo which interfered with the speech to a marked degree.

This system proved very successful and in spite of many sceptical opinions at the outset, sufficient volume was produced to fill the hall amply, and on the last night, the signals from WEAF were reproduced with such intensity that several of the audience on the main floor were seen to hold their hats in humorous indication of their approval.

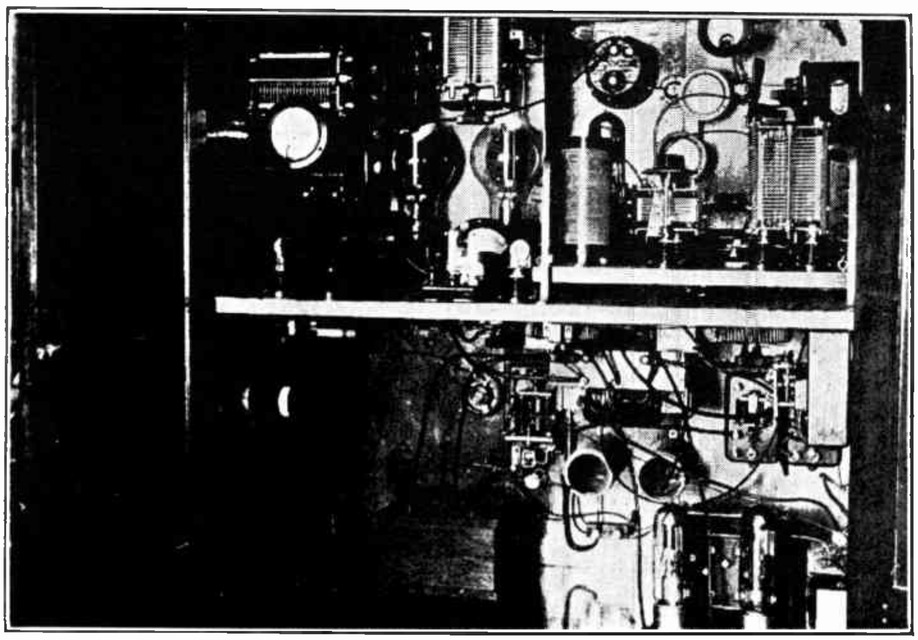
In 1922, when Secretary Hoover found it necessary to call a meeting of the radio interests before a special committee of his choosing, the Radio Club was represented on the Committee by E. H. Armstrong. Thus the Club again as of old took an active part in the regulation of radio by Congress. This special committee reported direct to Congress on its findings, and did much to help frame the present regulations.

With the advent of Radio Broadcasting a new problem now faced the amateur, namely, that of interfering with broadcast reception. The Radio Club realizing the seriousness of the situation at once started a campaign of education and its policies can best be summed up in the following article written by its president at that time:

"The Radio Club of America was organized to propagate the art of radio telegraphy and telephony in all its branches, and true to this ideal it has always lent its aid to the best of its ability to all phases of the art. It originated as an amateur organization with a scientific purpose. It fought for the continued existence of the amateur and helped to educate him. It lent a helping hand to commercial radio, by research and cooperation wherever it could. It gave all it had to the Government when it was in dire need of radio personnel, and, finally, when that new element in radio cropped up—the broadcast listener—it gave him much needed assistance. This organization belongs to no one branch of the radio art but to all branches and therefore its duty at present must necessarily be one of education. Through the medium of its papers and discussions as well as the individual efforts of its members, it must endeavor to terminate the disastrous conflict which has sprung up between the original radio amateur or traffic amateur and the broadcast listener. Both classes must be trained and assisted to become mutually beneficial to one another. The traffic man must be shown how to construct his transmitter so as to create minimum interference and the broadcast listener how to operate his receiver at the point of maximum selectivity. Neither one nor the other can or should be permitted to die out, for each has his own particular value. The broadcast listener class is composed of the general public whose pleasure and comfort must not be interfered with at any cost, while the splendid services of the traffic amateurs in the World War will never be forgotten and surely entitle them to an everlasting right of existence. But, unless these two warring factions, can be educated to cooperate and aid one another, one of the two is doomed; and this task of education for the good of the radio art must now be the important work of the Radio Club of America as well as all other radio clubs throughout the United States."

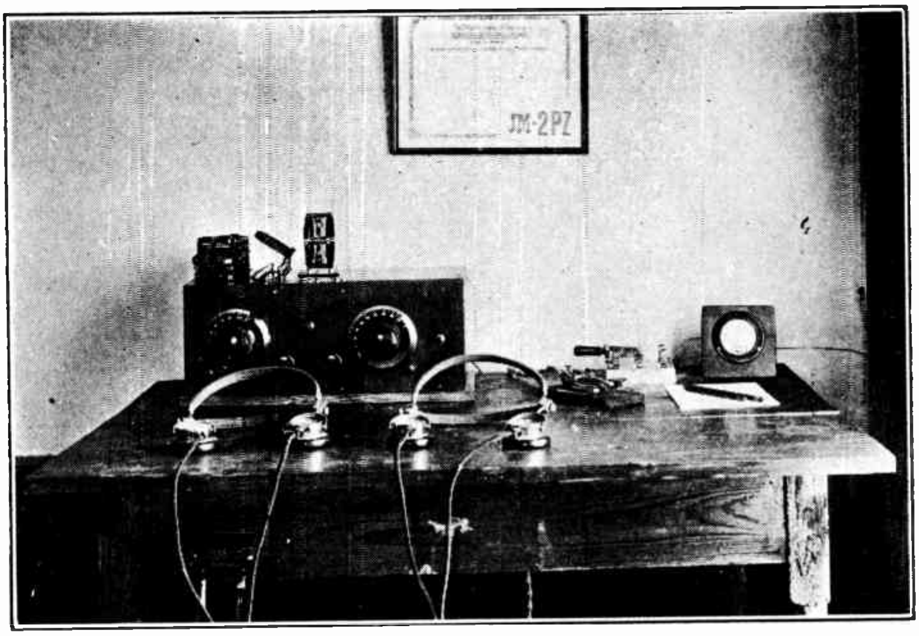
Radio experts at the White House in 1923. Left to right: Howey, Burghard, Hogan, Sheppard, Godley.

But the club did not confine its activities along these lines, entirely to the amateur. In 1923 the Boston American organized a committee of radio experts to present the problem of interference by Naval stations, which were causing great annoyance to broadcast listeners, to President Coolidge. Messrs. Paul Godley, J. V. L. Hogan and George E. Burghard, were asked to serve on this committee and



Transmitter, station "2AG", C. R. Runyon, Jr., Yonkers, N. Y., 1927. This is a typical layout of the C. W. tube transmitter short wave. period.

visited the President in Washington on Dec. 10th, 1923. Jack Hogan, acting as spokesman for the committee, so ably stated the case that even the laconic Mr. Coolidge uttered an exclamation when he heard that his own radio speech had



Receiver, station "NJ2PZ", John Grinan, Kingston, Jamaica, B. W. I., 1926.

been rendered unintelligible in his home town, through the interference of the transmitting station at the Boston Navy Yard. The matter was at once referred to Secretary Hoover.

Now, the short wave era of amateur radio was at hand. To be sure the original small boys had grown to be full fledged men of affairs. Most of them

Amateur Casts Vote 1,700 Miles Away by Radio

John Grinan in Jamaica on Business Listens In on the Discussions at Meeting in Yonkers

Sends Meeting Proceedings 1,700 Miles

C. R. Runyon jr. operating his amateur station at Yonkers.

Casting his vote at a recent board of directors' meeting at the Radio Club of America, although 1,700 miles away, John Grinan, old wireless amateur, in business in Jamaica, West Indies, "sat in" on the balance of the discussion, getting the entire proceedings from his friend, C. R. Runyon jr., 544 North Broadway, Yonkers, where the meeting was taking place.

This is believed to be the first authentic time that a vote was asked for, and received, all by radio, while the meeting was in progress.

Hears Proceedings of Meeting

Following the receipt of the vote Grinan followed the proceedings of the meeting, being kept constantly informed about the developments by Runyon, who stayed at the key of his transmitter. The conversation, started some time after 5 p. m., continued on until a quarter of 7, when the distant operator and director signed off to keep were sent down, and assembled quickly, with the friendly help of Runyon, who checked by wireless the various adjustments made by the experimenter in Jamaica. Some changes in the apparatus layout were advised by radio, and latee made, which improved signals to a great extent.

Although the authorized wave-band for American amateurs communicating on short waves is from 35.7 to 42.8 meters, Grinan has been using 33 meters. This is the official wave alloted him by the British Postoffice authorities. His power is but fifty watts, and the sending has been mostly done in the late afternoon, during daylight.

In New York Runyon has a crystal controlled push-pull 250-watt set, which is tuned to 80 meters. His call letters are 2AG. Grinan has been assigned NJ-2 PZ.

New York Tribune, February 6, 1927.

held prominent radio positions in that rapidly growing industry. Naturally the character of the membership of the club as well as that of the papers, underwent a similar change. The club had now all the earmarks of a genuine scientific body. The spirit of the organization, however, never changed. These men, now engineers, executives or scientists were still amatuers at heart. Many of them still had their own stations, and using the very latest equipment were nightly communicating with the whole world on 80 meters and below. Notable among these experimenters we find Randy Runyon and John Grinan who attained great prominence with their activities. Runyon's station 2AG was located in Yonkers, N. Y., and from there he worked practically every country in the world.

In 1925 when the Hamilton Rice expedition went to the Amazon River in Brazil, John Swanson, an old member of the club, went along as chief radio operator. They were equipped with long and short wave apparatus, but most of the traffic was handled through Runyon at Yonkers, who was in nightly contact with Swanson on Short waves. In fact, on one occasion when the branch expedition was lost up the river, 2AG succeeded in working them on their portable set, when they could neither raise nor hear the base station, and relayed their position to the main camp thus ultimately bringing about their rescue.

AMATEURS RELAY PRIZE FIGHT STORY

Radio Club Station and Jamaica "Ham" Reach Tom Heaney's Friends in Antipodes.

Through the various steps of breadcasting, short-wave transmission by dot-dash, and relaying from a distant point where conditions happened to be more favorable at the time, a blow-by-blow description of the boxing bout between Tom Heany and Paulino Uscundum was placed in New Zealand and published in the afternoon papers just a few hours after the fight, when New Yorkers had tuned in for the night.

The fight, blow by blow, was broadcast by Jack Philbin, through Station WMSG in Manhattan. This broadcast was picked up with a superheterodyne at Station 2 AG in Yonkers and transmitted an instant late on a 40.9 meters to NJ 2 PZ at Jamaica, British West Indies, some 1,500 mile away. An effort was made to work New Zealand, the home of Tom Heany, direct, but the fading on the 40.9 meter wave length was too severe for direct operation.

At the end of the fight, however, NJ 2 PZ transmitted the blow-by-blow description to OZ 2 AC at New Zealand, on 21 meters. The latter amateur station was the scene of excitement, as newspaper representatives received the dot-dash reports just as rapidly as they were transcribed, and then rushed off to get their stories into type for the afternoon edition.

In order to keep up with the blow-by-blow description of the rapid-fire announcer, it was necessary to telegraph letters for whole words, and combinations such as "Heany lands right on jaw" became simply "H R J" in this ham shorthand.

Station 2 AG is the official station of the Radio Club of America, and is owned and operated by C. R. Runyon, jr. At the Jamaica end was John Grinan, also an active member of the Radio Club of America and an old hand at amateur radio.

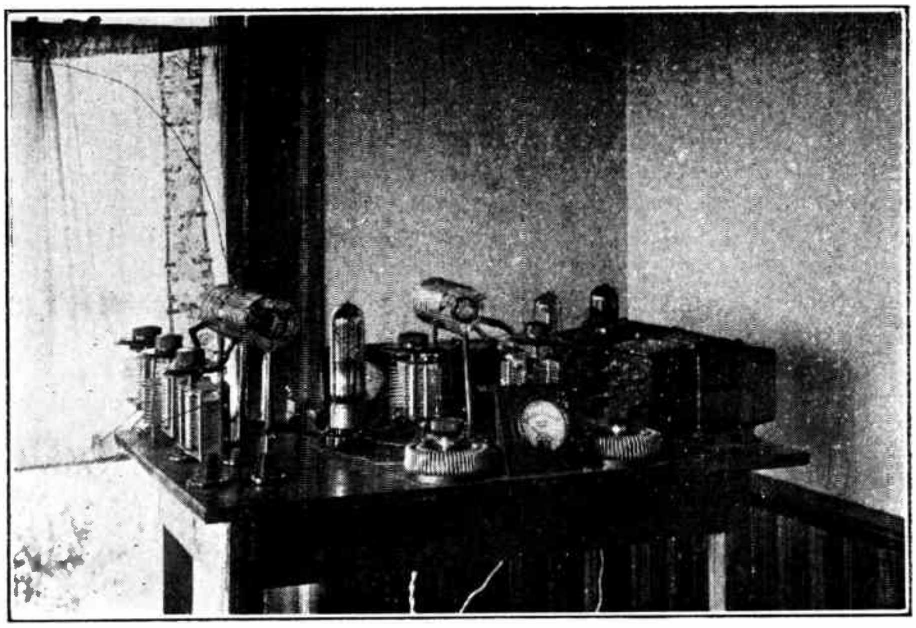
Brooklyn Times, April 17th, 1927.

Johnny Grinan, who has the distinction of being the first amateur to send transcontinental signals and messages, as well as trans-Atlantic messages, built his station NJ 2 PZ in Kingston, Jamaica B.W.I. This station later known as VP 5 PZ grew to be one of the most famous amateur stations in the world. He worked every country, and on several occasions worked distant stations the long way around the globe. At the time of the Tom Heaney fight in the U. S. he succeeded in receiving the returns from a U. S. station and relaying them direct to Tom's home town in New Zealand, blow for blow, for which he was roundly thanked by Heaney's admirers some 7000 miles away.

One night in 1927 the Radio club directors were holding a meeting at Runyon's home in Yonkers. A very important matter was up before the board and a single vote became necessary to decide the question. Randy simply turned on the juice, called John in Jamaica, explained the situation to him, and John cast the deciding vote by radio, thus creating a somewhat novel precedent.

These are of course only a very few of the interesting incidents of radio progress. Space will not permit the telling of the activities of the many other, now middle-aged, small boys, but we know that they too, are still true to their old love, Radio.

On May 13th, 1926, the Radio Club held its first regular annual banquet at the Hotel McAlpin in New York City. It was indeed a gala affair, over 150 prominent radio men attended, among whom were, Professor M. I. Pupin, David Sarnoff, Gano Dunn, E. H. Armstrong and J. V. L. Hogan. Professor Pupin was the guest of honor and made a stirring speech which was broadcast through the facilities of station WMCA. In his speech the Professor denounced the White-Dill



Transmitter, station "NJ2PZ"

bill, which was pending at that time, and purported to take the control of radio out of the hands of the department of commerce and empower a special Federal Radio Commission to deal with the difficult problems of regulation. He closed his address with this parthian shot of advice to the Senate: " 'Noli me tangere,' which in plain Anglo Saxon means, 'hands off.' "

Radio Club 17th anniversary banquet, Hotel McAlpin, N. Y. C., 1926.
Prof. M. I. Pupin guest of honor.

Several other speeches were made during the course of the evening, and as a crowning event Professor Pupin and David Sarnoff were made Honorary members of the club. A good time was had by all.

THE WORLD:

LEAVE RADIO 'AS IS,' URGES PROF. PUPIN

"Government Hands Off" Is General Tenor of Speakers at Annual Dinner

SENATE'S PLAN DENOUNCED

Hoover Praised for His Policy of Co-operation

"The Government must keep its hands off radio," was the tenor of speeches at the annual dinner of the Radio Club of America, in the Hotel McAlpin last night. Among those who stressed this necessity before the 140 diners were Michael Pupin, professor of electro-mechanics, Columbia University; David Sarnoff, Vice President and General Manager of the Radio Corporation of America; Gano Dunn, consulting engineer, Past President of the American Institute of Electrical Engineers Major Edwin H. Armstrong, inventor of the regenerative and super-regenerative radio circuits used throughout the world, and John V. L. Hogan, consulting radio engineer. E. V. Amy, President of the Radio Club of America, presided.

Prof. Pupin and David Sarnoff were elected honorary members of the club.

Prof. Pupin told how the club was started by radio amateurs. Although some of these have become great experts, he said, they are still amateurs in the highest sense of the world. Commercial considerations were not allowed to bias the scientific opinions of either himself or his audience. Continuing, he said:

"It is not so much the occasional inventor who nurses a great technical art as it is the intelligence of a well organized and liberally supported research laboratory. When I think of that I am perfectly convinced that very few of the great advances in the telephone art would have happened under Government ownership.

"Some six or seven years ago I opposed a bill which proposed to place the radio art under Government ownership. The Congressional Committee believed me. If it had not we would have no radio broadcasting art to-day. This art was developed in this country first, because you and I and our industrial research laboratories were free from all interference on the part of bureaucracy.

"The Department of Commerce has consulted us, because it has found that nothing can be done without us, the parents. It has a democratic and not a bureaucratic method of procedure. To replace it by another instrumentality of the Federal Government would mean to eliminate from the present critical condition of the young radio art an intelligent and experienced co-operator without any assurance that the new instrumentality will ever be equal to its task.

"If it is proposed that this new instrumentality shall be a commission, resembling in its authority and mode of operation an Interstate Commerce Commission, then it will certainly be a failure. Who can tell to-day whether a year or two, or several years hence, the best wave lengths for broadcasting will be ten, fifty, 100 or several hundred metres? Who can tell what will be in the very near future the best method of establishing selectivity? Who can tell what additional means must be employed to diminish the annoyances of static?

"President Coolidge is right when he favors the Department of Commerce to co-operate, just as heretofore, with the creators of the radio art in the solution of the outstanding problems.

"The Senate is wrong when it proposes to solve a complicated scientific problem in its own way without a thorough knowledge of the science which the solution demands."

New York World, May 14, 1926.

Later in the same year when the broadcast situation was becoming dangerously involved due to the pending legislation, the club went on record by issuing the following resolution, passed at a special meeting of the board of directors:

"RESOLVED that until the present limitations of the powers of the Department of Commerce shall have been removed or other provisions made by legislation, no broadcaster should change his wave length or hours on the air or increase his power without first receiving the approval of a committee representative of the art organized for the purpose, and be it further

"RESOLVED that the Radio Club of America, organized for the object, among others, of developing the radio art, hereby declares that the present condition in the radio field, caused by the temporary removal of legal restrains, is a new occasion for the exercise of that capacity of self-government and respect for the interest of the public, in which the radio art has led, and it further declares that it will hold its members responsible in the opinion of the club for their conduct in the observance of the principles underlying these Resolutions."

R. C. of America for Continuance of Old System

Radio Club Thinks That Hoover Regulations Worked Well.

AT a special meeting of its board of directors the Radio Club of America—the oldest radio organization extant—drew up a resolution backing the regulations heretofore rigidly observed in broadcast practice. While the club has no authority other than over the activities of its extensive membership, the action at this time is significant in the sense that this club has always stood for the rights of radio amateurs and broadcast listeners, thereby safeguarding the best interests of the radio art.

The resolutions drawn up by the board of directors of the Radio Club of America, with regard to the present broadcast situation, read as follows:—

"Resolved, That until the present limitations on the powers of the Department of Commerce shall have been removed or other provisions made by legislation, no broadcaster should change his wave length or hours on the air or increase his power without first receiving the approval of a committee representative of the art, organized for the purpose; and be it further

"Resolved, That the Radio Club of America, organized for the object, among others, of developing the radio art, hereby declares that the present condition in the radio field, caused by the temporary removal of legal restraints, is a new occasion for the exercise of that capacity of self-government and respect for the interest of the public, in which the radio art has led; and it further declares that it will hold its members responsible, in the opinion of the club, for their conduct in the observance of the principles underlying these resolutions."

The club has always taken an active interest in all legislation outlined to affect the rights of radio amateurs and broadcast listeners. In 1910 a delegation was sent to Washington to protest against the Depew bill, and this measure was largely responsible for the defeat of that bill. In 1912 action was taken to defeat the Alexander bill. These bills aimed to stifle the activities of the radio amateur. In 1910 one of the first amateur radio telephone stations in the world was constructed and operated by members of the club. Music broadcast from it was received by many of the U. S. battleships anchored in the Hudson River. In 1921 the first amateur message ever sent across the Atlantic was transmitted from a club station erected for that purpose, the message being received in Scotland by a club member who went abroad for the test. For these and other reasons the Radio Club of America can be expected to follow the present broadcast developments with more than ordinary interest.

New York Telegram, August 7th, 1926.

In March, 1927, when the smoke of battle had cleared and the White-Dill bill had become a law, the Radio Club once more arose to the occasion, and strongly recommended the appointment of Robert H. Marriott, one of its most prominent and honorary members, to the newly formed Federal Radio Commission. Ernest V. Amy, president of the club at the time, sent a telegram to President Coolidge, urging the appointment.

Boosts Marriott as Commissioner

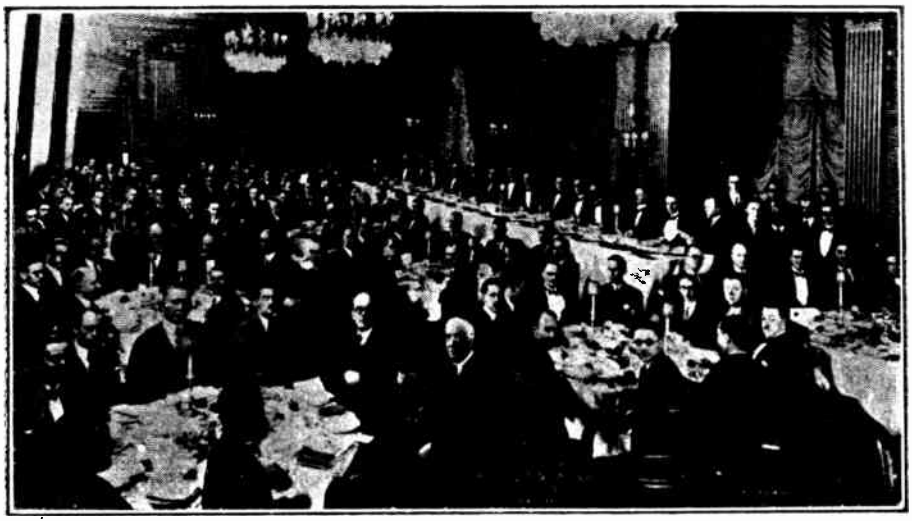
The appointment of R. H. Marriott, first president of the Institute of Radio Engineers, is being sponsored by various radio organizations. The Radio Club of America, when informed of the passage of the Dill-White bill Friday evening, sent the following telegram to President Coolidge:—

"Oldest radio club in the world begs you to consider R. H. Marriott, of New York, for member of the Radio Commission. Mr. Marriott is an old and experienced radio man—knows art and practice thoroughly. He is not connected with any company or interests, has wide acquaintance and support in the radio field and is universally liked. Mr. Marriott would make an ideal and popular choice as one of the five Radio Commission members."

New York Telegram, February 26th, 1927.

In the past few years there had, to be sure, been much discussion about incorporating the club, but no definite action had been taken. Towards the latter part of 1928 the board of directors finally took the necessary steps by appointing a special committee to have the papers drawn up. The result was, that on February 4th, 1929, the club was duly incorporated under the Membership Corporations Law of the State of New York, and became the Radio Club of America, Inc.

After the huge success of the seventeenth anniversary banquet in 1926, at which Prof. Pupin was the guest of honor, it was decided to hold regular annual affairs of this sort in the spring of each year. This rule was rigidly adhered to for several years, much to the enjoyment of all concerned, but in later years, due no doubt to the well known depression, a decided deviation occurred. The last annual dinner was held in 1931, and as a matter of record a full list of all club banquets is given below.



18th anniversary banquet of the Radio Club of America, Inc., Hotel McAlpin, N. Y. C., 1927.

Oldest Radio Club Holds Banquet

The nineteenth anniversary of the Radio Club of America was celebrated with a banquet at the Hotel McAlpin last night at 7:30, to mark the founding of what is probably the oldest radio club in the world.

Robert H. Marriott, honorary member of the club and past president of the Institute of Radio Engineers was the honorary guest. The toastmaster's duties were managed by Harry Sadenwater, radio operator on the NC1 in the first transatlantic flight, who is now broadcast engineer of the General Electric Co. at Schenectady.

New York Telegram, June 2nd, 1928.

1926 May 12th, Hotel McAlpin, 17th anniversary. Guest of honor Prof. M. I. Pupin.

1927 May 12th, Hotel McAlpin, 18th anniversary. Guest of honor George F. McClellan N.B.C.

1928 June 1st, Hotel McAlpin, 19th anniversary. Guest of honor R. H. Marriott.

1929 May 15th, Hotel McAlpin, 20th anniversary.

1929 Oct. 4th, Hotel McAlpin, special testimonial dinner to Captain Henry J. Round of England.

1931 April 21st, 22nd anniversary Beefsteak Dinner at the Elks Club in Brooklyn.

This brings our story up to modern times, and before closing let us once more scan the activities of the grown-up small boys who were responsible for the club's beginning. The accompanying photographs of typical amateur experimental stations of the period 1932-1934, certainly give an idea of the tremendous progress which has been made over the span of twenty-five years. The small boy now has become a veritable scientist. New developments have come thick and fast and he has embraced them with the same zest and thirst for knowledge with which he welcomed the advent of the electrolytic detector and the rotary gap.

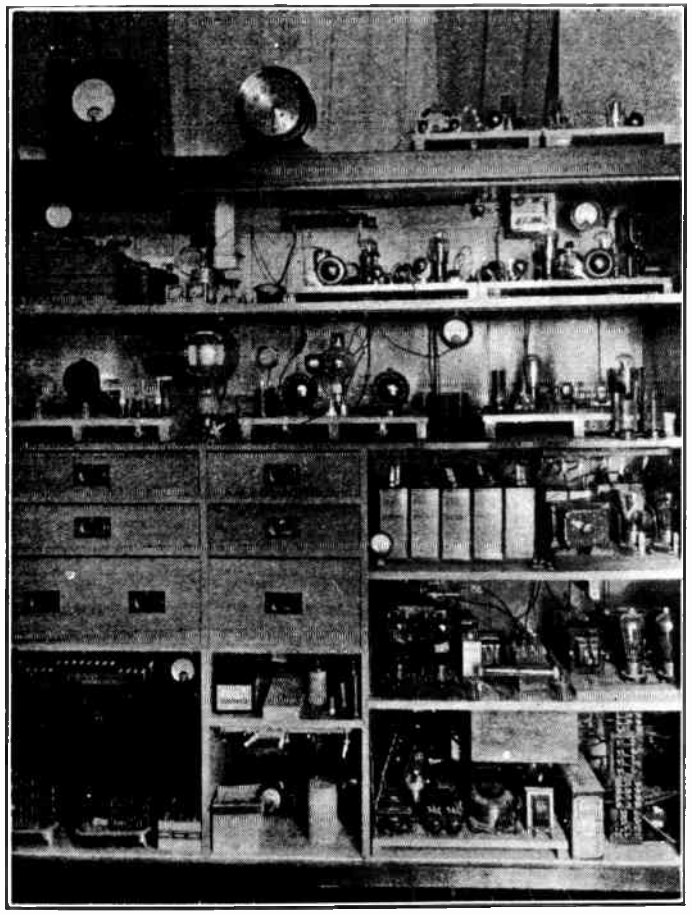
Of course the frequencies in use today are vastly different from the early hit or miss days, the allotted amateur bands now being: 160, 80, 40, 20, 10, and 5 meters. The equipment now consists of, crystal controlled master oscillator power amplifier transmitters, producing the steadiest of C. W. signals, and short wave superheterodyne receivers with crystal filters. The antenna systems are also carefully designed from formulas, of the matched impedance type, for the exact operating frequency. Naturally the achievements of such stations, which are in fact practically the equal of any commercial station in design, are astounding, particularly in reliability and annihilation of space, but unfortunately space will not permit their recording on these pages.

Both the stations illustrated, are equipped with the very latest systems of modulation, and radio telephony, on all frequencies permitted by law, is used most of the time. Of special interest is the 5 meter or 60 megacycle telephone. This new field of endeavor took the amateur by storm, and nightly, numerous duplex conversations can be heard over distances of 30 miles or more. The apparatus shown is of the master oscillator power amplifier type, and the receivers employ the Armstrong super-regenerative circuit. The fascination of duplex telephony is obvious, and particularly on these ultra short waves, because of the absence of static interference and fading. The greatest distance covered so far has been about 100 miles, at which duplex contacts have been maintained quite successfully. This would seem to be rather a meager performance, as compared with the

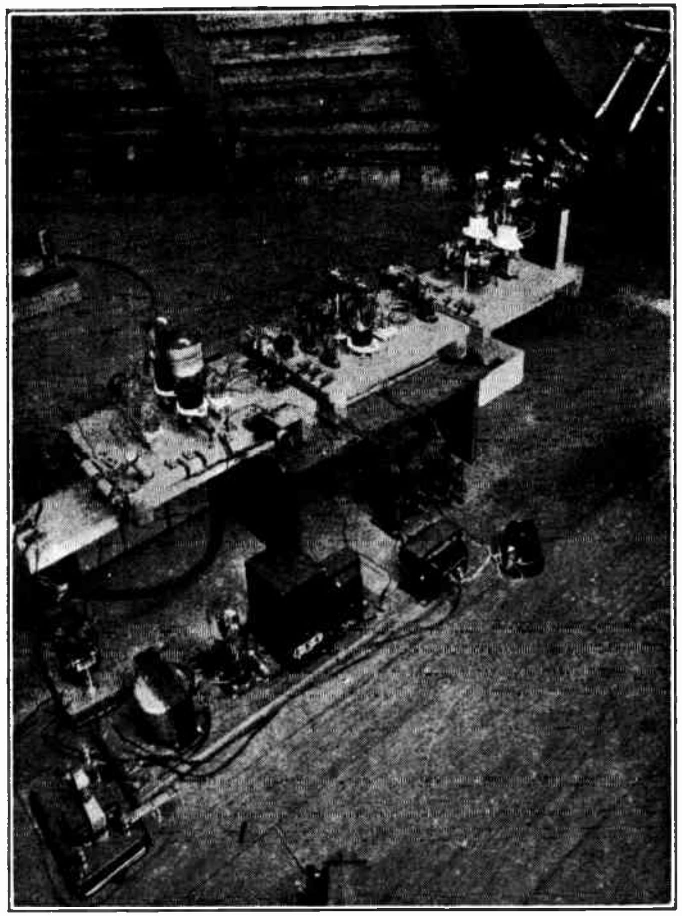
Receiver, station "W2AG," C. R. Runyon, Yonkers, N. Y., 1933. Note—single signal short wave superheterodyne center, and super-regenerative 5 meter receiver on the right. Randy Runyon was the first amateur to develop and use the single signal superheterodyne receiver, which is now the last word in C. W. reception.

distances covered on other frequencies, but when we consider the inauspicious beginning of 20, and 40 meter transmission and the tremendous progress made in a short time, the future for 60 megacycles looks very bright indeed. In fact new developments are coming at such a rate of speed that, if one remains idle for a month or two, one becomes a horrible greenhorn all over again. Even at the present writing, several amateurs, notably our old friend Randy Runyon, are maintaining successful telephone communication over some thirty miles, on two and one-half meters with beam transmitters.

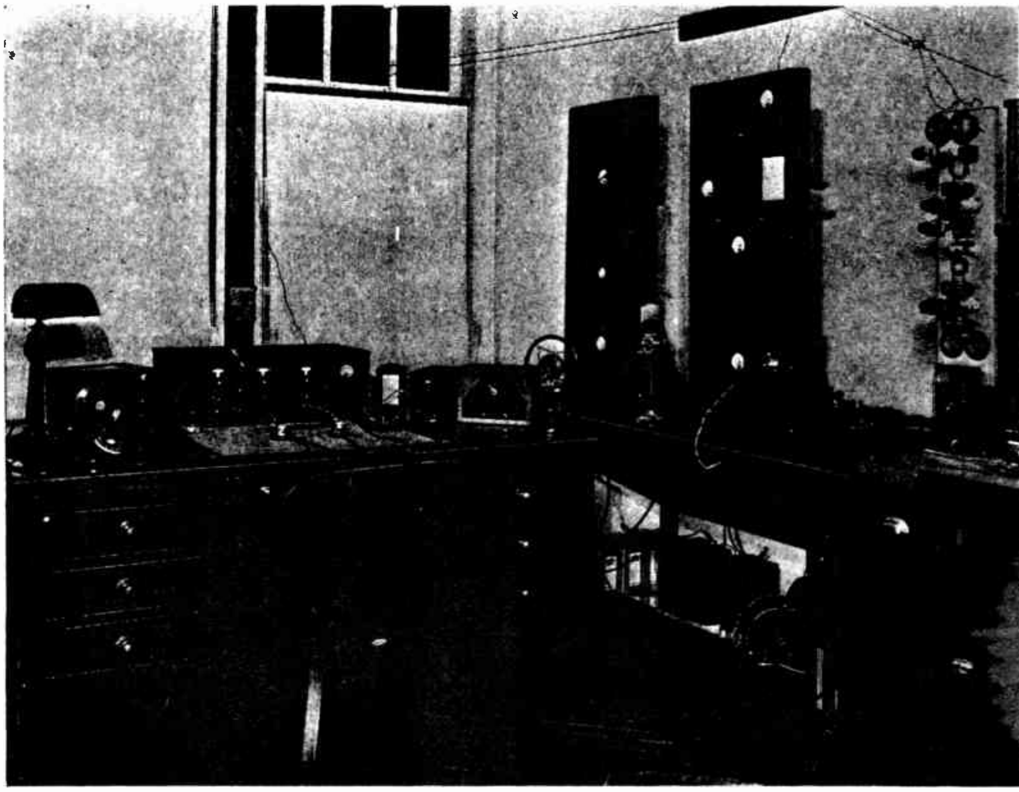
This most certainly shows the results of that undying zeal and love for radio, which has imbued these once small boys since the beginning. It is our one hope that this ardor may never be dampened, and that by example and sharing of knowledge this same spirit may be passed on to those who come afterwards.



Transmitter of "W2AG". C. W. crystal controlled M.O.P.A. 900 watts.



5 meter master oscillator power amplifier transmitter at "W2AG", 1933.



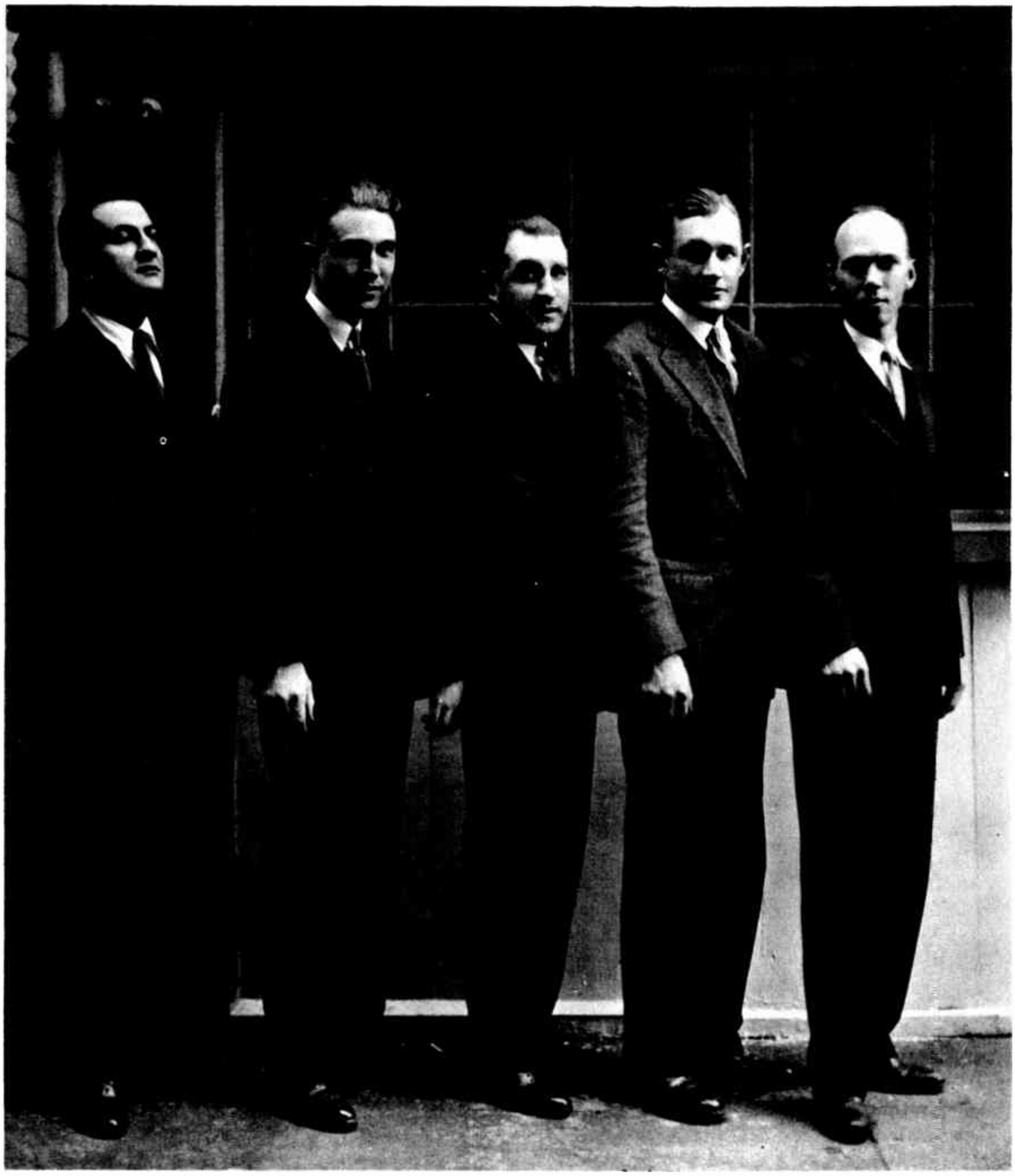
Station "W2GEC". G. E. Burghard, 520 East 86th St., N. Y. C., 1934. Left to right: Frequency meter, single signal superhet, 5 meter super-regenerative receivers, Modulator panel, C. W. transmitting panel, 20 to 180 meters, and 5 meter M.O.P.A. transmitter.

In conclusion, let us say, that this History was written with a twofold purpose. First, to chronicle as accurately as possible the most interesting club events of the past twenty-five years, and secondly to try and give a general idea of the development of the small boy who was responsible for its beginning. We have purposely omitted, with but a few exceptions, the recording of the many truly great scientific, literary, and engineering achievements of the members, because of their unweildly nature. Some idea of their magnitude can be gained, however, by browsing through other sections of this volume i.e. "Proceedings" and "Who's Who".

We fully realize, that the apparent character of the club has, quite naturally, changed with the years. The Radio Club has become a respected scientific body, but the spirit of friendliness and cooperation which lies deep within, has never changed, and our old friend, Professor Pupin, very beautifully complimented us on this rare quality, at the Seventeenth Anniversary Banquet, when he said:

> *"You love this art for its own sake and not for what profit it brings you. If I thought otherwise I would not be with you this evening."*

Therefore, permit us to say, that, if these pages have succeeded in arousing in the older members and instilling in the newer ones, that spirit of friendliness, cooperation and unselfish desire for radio knowledge, which was the prime factor of our beginning, and is the sole reason for our continued existence; then, this story has more than accomplished its purpose.



Charter members of the Radio Club of America lined up before the radio shack in Frank King's back yard at 326 West 107th. Street, New York. It was here that the special meeting of the Junior Wireless Club was held on October 21, 1911, when the name was changed to The Radio Club of America. Left to right: John Grinan, Frank King, George Burghard, Ernest Amy, Faitoute Munn. The picture was taken in 1929.

FIFTIETH ANNIVERSARY GOLDEN YEARBOOK

1909

1959

RADIO CLUB OF AMERICA INC.

11 WEST 42ND ST., NEW YORK 36, N. Y.

FIFTIETH ANNIVERSARY COMMITTEE

George E. Burghard, *Chairman*
Ernest V. Amy
Pierre Boucheron
Ralph N. Batcher
George J. Eltz Jr.
Frank A. Gunther
Harry W. Houck
Frank King
Walter A. Knoop
Carman R. Runyon Jr.
Harry Sadenwater
Francis H. Shepard
William E. D. Stokes Jr.
George Washington Jr.

FIFTIETH ANNIVERSARY GOLDEN YEAR BOOK COMMITTEE

George Washington, Jr., *Chairman*
George E. Burghard
Pierre Boucheron
Craig Walsh
Harry Sadenwater
Perce B. Collison
Perry H. Osborn

THE HERITAGE OF THE RADIO CLUB OF AMERICA

By Lloyd Jacquet

Perhaps we were misunderstood by our friends and contemporaries of a half century ago. The term "egghead" was not yet invented; or at least its full connotation had not taken on the meaning that represented our position in those early days. We were young, and with a certain lightness of heart peppered with a purpose, with a straight unalloyed sincerity in our dedication to all things that had to do with "electricity," "wireless," and "science" generally.

None of our pals or classmates thought us book-wormish or abnormal. On the contrary, we were the "bright boys" of the usually misunderstood physics teachers, who would somehow look to us kindly as we pushed the lab class along with our own inhibited enthusiasm, raising the over-all marks of the students at exam times. Maybe there was a certain amount of satisfaction in being able to explain authoritatively to the spell-bound classroom what a Voltaic pile was; and to quickly draw on the blackboard an electric bell dry-cell circuit diagram; or gleefully hook up a telegraph key and sounder in a demonstration of fast code work that the girls marvelled at.

We reserved our more profound and esoteric knowledge of "wireless" however for our fellow-conspirators. And if perchance there were enough self-raised, self-started neophytes in a particular area or borough, we might draw the circle closer by forming a "Wireless Club" with constitution, by-laws, and the inevitable "sergeant-at-arms." For there was an attractive force as with the poles of a permanent magnet that drew together only those of a same mind, of a same interest, and to a large degree, of a same feeling of fellowship.

In our own private excursions into the mysteries of what was to evolve in a half century as one of the most important branches of science, we spent many lone hours at our hand-made instruments, in the quiet of our attic room, or cellar corner, and so developed a certain way of thinking. Even the most insignificant result of our experimental blundering was eagerly reported to our fellow-conspirators for verification and sharing. This eagerness and frankness in distributing the results of our findings undoubtedly molded the form of fellowship which is such a striking quality of the Radio Club's membership.

We were undoubtedly romantic about ourselves, possessors of strange new secrets that enabled us to send and receive messages without wires. We were in love with "wireless," and so dedicated our every spare moment to this goddess. The man-hours of loving efforts thus lavishly spent alone and together have of course left their mark on any and all under the influence of this magic. The habit once formed was impossible to lose, come war, or further schooling, marriage, family, and many other enticing hobbies.

Exalted and inspired as we were in belonging to a relatively small and unique group initiated into the very few mysteries of the art, we were free and open with our ideas. Our knowledge and secrets were shared with all neophytes that besought the scant information. They were brought into our homes and shown our highly individualistic "labs" and "research projects," as well as working equipment. Advice and help was freely given. And soon the beginner would want to join "the gang"—belong to the Club.

Politics? We had no time or patience with them, and our Radio Club was run by the best men we thought as we voted them into office. And with this confidence, they performed unselfishly and bravely. This developed leadership, and still retained the individual stamp of democracy. And it has continued thus for a half century.

Vigilant and jealous of our position, and not quite sure of our legal "rights," we kept an eager watch over our own actions as they might hurt others; but also quickly stopped others who would curtail our sincere efforts. And thus it was that we went to bat with the full support of the Radio Club's membership when unfavorable legislation, or rules and regulations that would adversely affect all amateurs had to be faced and fought out. Yet we never would attempt to dictate to others our own ideas or concepts of laws to rule all. How much of this upright, sincere, and selfless spirit eventually permeated the Radio Laws that were written into our national bills we may never know. But certainly the influence of Radio Club men here and there, quietly and rightly, trickled through to the law-makers, and the matter was kept in the proper perspective, that all radio men, as individuals, might enjoy their full rights.

Many have been the guests at Radio Club meetings who have commented upon one of the most obvious characteristics of the members: their strong friendship among each other, their sincere fellowship, their open goodwill. These are qualities that have grown with the founding members, and is one of the prized appeals that the Radio Club retains for those affiliated with it through these many years.

For this is a Radio Club with a distinctive personality. It is and has stayed the *individual's* Radio Club: the pioneer, the lone researcher, the staunch amateur, the independent inventor. It is the place—in a conformist-ridden industry overshadowed by "big business" aspects—for the independent amateur, the theoretical physicist, the practical engineer, the famed inventor, the beginning experimenter, the business man and marketer, the independent scientist, to mingle and to fraternize on the one, common level of good fellowship.

There seems to be a shrinking of places where the essential pioneer spirit can survive: the spirit of independent investigation and scientific research so essential to the progress of the whole electronic art. The value of the *individual* person, his character and his achievements, can best flourish in the proper environment. There are few oases as inviting today as the forum and fellowship of the Radio Club.

Though a half century old, it is a strange thing that it is so young in spirit. The continued policy of recognizing primarily the value of the individual and his personal worth; the giving of full recognition to individual achievement in fields of pioneer investigation; the encouragement to individuals to expand the opportunities for individual achievement in the fields of electronics...these are all powerful factors at work at the Radio Club, all lineal descendants of the pioneer qualities built into it by those who went before, the unique heritage that insures continuity of existence, into the second half of the century mark, and beyond...

At this Fiftieth Year milestone, we may well stop and make a quick moral assessment of our being. Did we, to use a modern phrase, leave *any messes behind?* Were we a luxury, and was our hobby a worthy one? Looking at the pile of old electrical, wireless and science magazines in our old rooms, the tangle of useless wires, the dented coils, broken VT tubes, battered earphones, useless home-made tuning and detecting devices, our parents had to straighten out when we left the roost to go out into the world and prove our worth in the new field of communications, we might have misgivings.

But as for our ideals, and our thinking, and our philosophies—those, we like to believe, were lofty, and noble, worthy of permanence...and without confusion.

All through these five decades, we could, and did, look at ourselves face to face, and be not ashamed. Even though our scientific iconoclasm caused some to raise eyebrows among the uninitiated, the secret something that drew us together originally and kept us together ever since has proved to be real and substantial. As ethereal as this substance is, it was the base upon which we erected this clan of kindred minds that we call the Radio Club of America.

A HISTORY OF THE RADIO CLUB OF AMERICA, INC.

By GEORGE E. BURGHARD

Part II

The year 1934 was indeed one of great importance to the Radio Club for it marked the twenty-fifth year of its existence. Just twenty-five years ago that small group of young boys met in the Ansonia Hotel and founded what is now the oldest Radio Club in continued existence on record. This of course called for a celebration and the President appointed a special 25th. Anniversary Committee to make suitable arrangements. As a result the Silver Anniversary Year Book was published. It contained a complete history of the Club from 1909 to 1934, a list of all papers read before its members during that time, autobiographies of all the members, photographs of all the past presidents, articles by prominent members and a Preface written by one of the founding members George Eltz Jr which will bear repetition here. Some fifteen

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PREFACE

In preparing this, our twenty-fifth anniversary number, the Committee have a keen appreciation of the responsibility imposed upon them by the membership.

Twenty-five years represent practically the entire life span of that most fascinating of the communication arts,—Radio. Our membership has contributed more than its share to the perfection of the science as it is known today. Statistics are therefore available in vast array ready for sorting, sifting, and compilation into neat paragraphs,—that no one will read.

The committee had to decide whether we should prepare a statistical type of anniversary number or whether we should attempt, to the limit of our poor powers, to incorporate in the book some of that spirit which led to the foundation of the club and to which can largely be attributed its continued existence.

To the members of the committee the answer seemed more than obvious, statistics could not be ignored, they were important, yes, but only as the limbs of a tree are important. Statistics are the result of growth just as are the limbs of a tree, it is the spirit, the upward urge that is responsible for both.

In no engineering association is the spirit of growth, the urge to seek new pastures as strongly emphasized as in the Radio Club of America, Inc. Founded in 1909 by a group of school boys whose sole bond, when the club was formed, rested in their interest in "Wireless", the club has continued ever since with that bond as its strongest and greatest asset.

The school boys have grown up, they are now middle-aged men, but when they meet, as they do very frequently, the same spirit, the identical urge to find something new in "Wireless" is always present. If the founders of this club and its early membership bequeathed anything to the club it was this spirit of unrestrained curiosity and willingness to reveal to others without hesitation the results of personal experiments in the beloved art.

There is something big, something cosmic, about radio that washes away the petty things that so trammel other arts and sciences. The rich and the poor, the wise man and the student, meet through the medium of the ether and are comrades. This is the spirit of your club, treasure it, foster it, for when it dies the club dies with it.

When the club was founded radio was an unknown quantity, almost a plaything. How it has developed, the part it played in the World War and the position it holds in the world today is known to all of us. It has been exploited by big business, fortunes have been made and lost in it but the bond that founded the Radio Club is still good. Radio, to those who truly understand its spirit, is above exploitation.

There is no other radio association quite like the Radio Club, no other group quite so free of the commercial taint, old and young, we are amateurs when we meet in the Radio Club, let us remain so.

The statistics on our membership have been cut to the barest possible outline. A glance through the membership list will reveal the reason for this. To do full justice to the achievements of some of our members would require a volume many times thicker than we could afford. It is our desire to slight no one, rather are we actuated by that amateur bond which attributes to each in equal measure, the same spirit, the same desire for development, regardless of past achievements.

It is in this spirit that your committee present to you your twenty-fifth anniversary year book.

GEORGE ELTZ, JR.

Preface to Silver Year Book by George J. Eltz, Jr.

hundred copies of the Silver book were printed and it was well received by the radio press as is evidenced by the clippings shown herewith. It was sent to libraries and institutions all over the world and is at the present time a collector's item. The cover design which was drawn in black on a solid silver background made a striking combination.

For some time members of the Club had been carefully considering the proper way to honor Major Armstrong for his many great achievements in the Radio Art, as well as his interest and faithfulness to the Radio Club of America. In December of 1935 Larry Horle conceived the idea of creating a medal to be awarded from time to time to a member who had done outstanding work in the radio field, and to be known as The Armstrong Medal. He discussed his idea with Harry Sadenwater and George Burghard. They heartily agreed with him and proposed bringing the matter to the attention of Ralph Langley, the President of the club. At his suggestion a resolution was drawn up dedicating the medal to Edwin H. Armstrong and providing for the presentation of an engrossed scroll evidencing this fact, to the Major at the reading of his paper on Frequency Modulation before the club on December 19th. 1935. This of course needed the approval of the Board of Directors and as time was very short all the directors were contacted by phone and their approval received. The scroll was duly prepared and presented to Major Armstrong at a special meeting held in Pupin Hall, Columbia University on Thursday December 19th. 1935. The paper was titled "A New Method of Reducing the Effect of Disturbances in Radio Signalling by Frequency Modulation" and attended by an overflow crowd. The Major was taken completely by surprise and thanked the club profusely for the honor bestowed upon him. The scroll which was beautifully engrossed in colors unfortunately was not ready on the night of the meeting so the President presented Armstrong with a copy of the text and the real scroll duly signed by all the officers and Directors was delivered to him informally later in the year. A facsimile of scroll is shown on page 68.

It now became necessary to produce the actual medals and President Langley appointed Harry Sadenwater and George Burghard a committee of two to take immediate action. To make a long story short; the medal was designed in Camden N. J. by Messers. Vassos, Stevenson and J. P. Barnes and the sculptor was Harry Straubel. First a master was made in bronze and then a mould was made from it and the medals cast in solid silver from the mould. Thirteen medals were made in all, at a cost of $336.00. One finished medal was given to each of the designers as per agreement, for their services. The remaining ten were retained by the

"A History of the Radio Club of America, Inc.," by George E. Burghard, traces in a very interesting and vivid manner the story of the Radio Club from its beginning in 1909. Mr. Burghard has condensed his material into some 38 well-illustrated pages.

Immediately following is a foreword by Lawrence C. F. Horle. This foreword precedes the complete listing of the Proceedings of the Ra Club. To appreciate the value of this . .ting of the Proceedings, even if only for reference purposes, one needs but glance at names of the engineers who have presented papers.

An enrollment of past officers, condensed history of each member, and the Constitution of the organization completes this year book.

The members of the Twenty-Fifth Anniversary Year Book Committee, namely, George E. Burghard, Ernest V. Amy, Edwin H. Armstrong, George J. Eltz, Jr., John F. Grinan, Lawrence C. F. Horle, Frank King, Robert H. Marriott, Fred Muller, Joseph J. Stantley, and W. E. D. Stokes, Jr., deserve a vote of thanks from the Radio Club.

25 Years of Radio

Radio Club of America, 25th Anniversary Year Book, 1934. Available at the Club headquarters, 11 West 42nd St. (Price $1.00 to members, $1.50 to non-members.)

JANUARY 2, 1909 the Junior Aero Club of U. S. met at the Hotel Ansonia at the instance of W. E. D. Stokes, Jr. to consider a new hobby, radio. The members of this group, now the Radio Club of America, were of gentle age—Mr. Stokes was then 12. Today these boys are grown but their interest in wireless survives. The history of their club is the history of radio in America.

In the Year Book will be found photos of Louis Pacent and Harry Sadenwater listening for signals from Europe, Armstrong's regenerative apparatus, radio stations of E. V. Amy and others, Harry Houck's home-made loose coupler, station 1BCG which pumped 200 meter signals to Europe and caused M. I. Pupin and David Sarnoff to go to Greenwich, Connecticut, to see what "the boys are doing."

The entire book brings back memories of the old and glamorous days. Evidently the committee, under George Burghard, is still amateur at heart. In the Book is a history of each of the several hundred members.

Electrical Engineering, April 1935 (top, opposite page); New York Sun, March 2, 1935 (bottom left, opposite page); Radio Engineering, March 1935 (bottom right, opposite page); Electronics April 1935 (top right).

club together with the master. The mould was then destroyed. To date ten medals have been awarded and for the sake of the record the presentation dates and the names of the recipients are listed below:

ARMSTRONG MEDALISTS

1937—Professor Alan Hazeltine
1938—Dr. Harold H. Beverage
1940—Greenleaf Whittier Pickard
1941—Harry W. Houck
1945—Carman Randolph Runyon Jr.
1946—Charles Stuart Ballantine
1947—John V. L. Hogan
1950—Ernest V. Amy
Edwin H. Armstrong
George E. Burghard
Monton Cronkhite
Paul F. Godley
John F. Grinan
Walker P. Inman
1952—Captain Henry J. Round
1953—Raymond A. Heising
1956—Melville Eastham

In view of the fact that the last of the ten Medals was presented in 1956, the Medal Committee was instructed by the Board of Directors to proceed with making a new mould from the Master, and casting a new supply of Armstrong Medals for future use.

The Board of Directors of
of
The Radio Club of America
to
Edwin Howard Armstrong
and to all others to whom these presents may come
Greeting

Be it known that at a special meeting of the Board of Directors of The Radio Club of America held December 19, 1935, in New York City, the following Resolution was adopted by unanimous consent:

Whereas - Edwin Howard Armstrong for many years has diligently, earnestly and effectively given council and encouragement in the guidance of The Radio Club of America, and

Whereas - We look back with pride and honor to the presentations before our meetings of his basic inventions: The Regenerative Circuit, The Superheterodyne and Super-Regenerative Systems and tonight The New System for Eliminating Noise by Frequency Modulation, each of outstanding importance in the Radio Art. Therefore be it

Resolved That a properly engrossed parchment copy of this Resolution be presented to Edwin Howard Armstrong at the conclusion of the presentation of his Paper on Noise Suppression by Frequency Modulation this evening as an expression of our deep appreciation of his keen technical knowledge and untiring willingness to work, and his outstanding contributions to Radio Art and Science. And be it further

Resolved That, in further token of appreciation, The Radio Club this day hereby establishes an award to be known as the "Armstrong Medal", to be bestowed by the Board of Directors of The Radio Club of America upon any person within its membership who shall have made, in the opinion of the Board of Directors, and within the spirit of the Club, an important contribution to Radio Art and Science.

Done at New York this 19th day of December, one thousand nine hundred and thirty-five.

Ralph H. Langley
President

Corresponding Secretary

Board of Directors

Scroll presented to Armstrong dedicating the Medal.

The Armstrong Medal. Front (left) and reverse sides.

It will be noted from the above that an Armstrong Medal was not awarded every year. This is because it is given in accordance with the conditions and requirements formulated in the establishment of this honor by the Board of Directors of the Club. Quoting from the Scroll: "The Radio Club this day hereby establishes an award to be known as the "Armstrong Medal," to be bestowed by the Board of Directors of The Radio Club of America upon any person within its membership who shall have made, in the opinion of the Board of Directors, and within the spirit of the Club, an important contribution to Radio Art and Science."

Although it was the original intention of the Directors to hold banquets annually as anniversary celebrations, nevertheless the depression of 1929 somewhat upset the schedule. There were no banquets held until the 27th Anniversary in 1936.

Professor Alan Hazeltine receiving the first Armstrong Medal from John Miller President of the Radio Club on Oct. 29 1937. Left to right; Edwin H. Armstrong, Prof. Hazeltine, John Miller, Harry Sadenwater, George Burghard.

In 1937, the Board of Directors decided to present the first Armstrong Medal to Professor Hazeltine for his great contributions to the Radio Art.

This was indeed a special occasion and the presentation was made at the twenty-eighth anniversary Banquet held at the Engineers Club New York City on October 29th. 1937. About two hundred members and their guests enjoyed the proceedings and Professor Hazeltine's most gracious acceptance, in the true Radio Club spirit.

CITATION *on the occasion of the* AWARD *of the* ARMSTRONG MEDAL *to* LOUIS ALAN HAZELTINE

The award of the Armstrong medal for 1937 by the Radio Club of America to Professor Louis Alan Hazeltine is in recognition of his outstanding contributions to the art and science of radio communication.

To the public his name will always be associated with the neutralized frequency amplifying systems which he developed to a complete solution from the mathematical point of view and which resulted in the first commercial high gain radio frequency amplifier with stable characteristics.

To radio engineers his contributions are of a much wider scope, embracing among others, the first and most useful of vacuum tube parameters "mutual conductance". The theory behind this contribution led largely to taking the vacuum tube amplifier out of the realm of experimentation and into the field of calculable engineering.

Professor Hazeltine's contributions to the art have been made with the constant thought of their usefulness to his brothers in the science and the profession and most clearly typify the spirit of the Armstrong award, that of individual research and delving unafraid into the then unknown, to the end that a further advance in the science might be made possible for future engineers to build upon.

From this day on the Banquets were held quite regularly in the Fall or Winter of each year. A complete list of the Anniversary Dinners follows:

Radio Club Banquets.

1936—27th. Anniversary Banquet held at the Engineers Club N. Y. C. October 29th. Toastmaster, Thomas Styles.

1937—28th. Anniversary Banquet held at the Engineers Club N. Y. C. October 29th. First Armstrong Medal to Alan Hazeltine.

1938—29th. Anniversary Banquet held at the Engineers Club N. Y. C. November 4th. Guest of Honor Egbert Von Lepel. Armstrong Medal to Dr. Harold H. Beverage.

1939—30th. Anniversary Banquet held at the Engineers Club N. Y. C. November 29th. Guest Speaker Lenox R. Lohr.

Hazeltine Given Medal By Radio Club of America

Awarded Armstrong Medal for Contributions to Radio Communication

Dinner Last Friday

He Is Cited for Design of Neutrodyne Circuit

Louis Alan Hazeltine, Professor of Physical Mathematics at Stevens and eminent mathematician and radio engineer, was awarded the Armstrong Medal for "his outstanding contributions to the art and science of radio communication" at a dinner at the Engineers' Club in New York City last Friday evening. The award was made by the Radio Club of America, of which Professor Hazeltine is a member. He is the first to receive the award.

Miller Reads Citation

John H. Miller, the President of the Radio Club of America, presented the Medal to Professor Hazeltine and read the following citation:

"The award of the Armstrong medal for 1937 by the Radio Club of America to Professor Louis Alan Hazeltine is in recognition of his outstanding contributions to the art and science of radio communication.

Extensive Contributions

"To the public his name will always be associated with the neutralized radio frequency amplifying systems which he developed to a complete solution from the mathematical point of view and which resulted in the first commercial high gain radio frequency amplifier with stable characteristics.

"To radio engineers his contributions are of a much wider scope embracing among others, the first and most useful of vacuum tube parameters — mutual conductance. The theory behind this contribution led largely to taking the vacuum tube amplifier out of the realm of experimentation and into the field of calculable engineering.

"Professor Hazeltine's contributions to the art have been made with the constant thought of their usefulness to his brothers in the science and the profession and most clearly typify the spirit of the Armstrong award, that of individual research and delving unafraid into the then unknown, to the end that a further advance in the science might be made possible for future engineers to build upon."

Among those attending dinner Friday evening were several Stevens men: Lawrence C. Horle, '14, formerly an Instructor in the Physics Department and a close friend of Professor Hazeltine; Lincoln G. Walsh, '26, and William F. Bailey, '33, formerly an Instructor in the Electrical Engineering Department.

Professor Hazeltine is a graduate of Stevens of the class of '06. He did not become engaged in radio work, however, until 1915. Since that year he has devoted himself quite completely to this branch of study, with particular stress on the mathematical point of view. As a result he has made some of the fundamental developments in the science of radio. His most outstanding development was of the neutrodyne principle, which is the neutralization of capacity coupling in vacuum tubes, preventing oscillation. Professor Hazeltine is now President of the Institute of Radio Engineers.

The Stute, Stevens Institute
November 3 1937.

Professor Hazeltine

THE Radio Club of America, a group of the country's outstanding radio engineers, has awarded to Professor Hazeltine its first Armstrong Medal. Though candidates for the award are restricted to Club members, this actually lessens the prestige of the award very little or not at all, for every one who is any one in radio is a member of the Club. The awarding of the Medal to Professor Hazeltine, then, places him in the radio research field second only to Mr. E. H. Armstrong, in whose honor the Medal was founded, and who is, in Professor Hazeltine's own words, the "patron saint" of the Club.

To speak thus definitely of Professor Hazeltine's eminence is only to put into words what radio men have known and Stevens men have surmised for some time. It has not before been an "accepted fact" for the records because Professor Hazeltine is to a rare degree disinclined to advertise himself; zealous champions of our name and fame have not yet called him "Steven's own" because it is unnatural for any Stevens man to think of him as anything but "Hazy," and "Hazy" is a teacher and friend before he is an eminent radio engineer. As Professor Stockwell said when the award was mentioned to him, "I hadn't heard about it, but I'm not surprised."

The incident which led Professor Hazeltine into radio work was interesting. On an evening in 1915 E. H. Armstrong was to present a paper on his recent research in radio. Professor Hazeltine was then a member of the Stevens faculty, and Lawrence Horle, a graduate of '14, was an instructor in the Physics Department. Mr. Horle mentioned the forthcoming Armstrong paper to his colleagues, and they agreed to go together to hear it. Armstrong told of his development of the regeneration principle, a paper which is recognized now as one of the most far-reaching and fundamental in the history of the science. It aroused Professor Hazeltine's enthusiasm and started him on his career.

In 1938 the second Armstrong Medal was awarded to Dr. Harold H. Beverage, for his outstanding work on Wave Antennae. The presentation was made at the 29th. Anniversary Banquet held at the Engineers Club on November 4th.

Harold H. Beverage

CITATION

In recognition of his pioneer work on wave antennae and his continued work in this and other phases of the radio art, the award of the Armstrong Medal by The Radio Club of America is made to Harold Henry Beverage.

Almost from boyhood he has been actively interested in all phases of radio, his first amateur station having been built in 1910. As a radio engineer and under the tutelage of Alexanderson, he rapidly made a name for himself in the development of radio transmission.

To both the amateur and professional worker his name has been immortalized in the Beverage antenna, the precursor of wave antennae of all types. His later work in the development of spaced diversity antenna systems is of outstanding importance in present day radio communication. His knowledge of the phenomena involved in the operation of antennae of all types is profound.

The successful use of long distance short wave signals through all types of interference is basically due to his work in the optimum utilization of space power.

Since Armstrong's disclosure of his new system of Frequency Modulation in 1935 before the Institute of Radio Engineers and the Radio Club of America great interest was aroused in the Radio world and the public hailed the invention as a means of eliminating static in broadcast reception. He read a paper titled "Frequency Modulation in Radio Broadcasting" on March 23rd. 1939 before the Radio Club during which he gave some very revealing demonstrations. He showed that the power at the transmitting station could be reduced to an absolute minimum without affecting the quality of the received program or increasing the extraneous noises or static. A very comprehensive article appeared in the New York Times the next morning, commenting on the paper and the importance of the various tests made with the 20 kilowatt station erected by Major Armstrong at Alpine New Jersey and the 600 watt station of C. R. Runyon located at Yonkers New York.

January 23rd. 1939 saw the thirtieth anniversary of the sending of the first radio distress call at sea. It was sent by one of our distinguished members Jack Binns who was the wireless operator on the illfated liner Republic. He sent the now famous signal "CQD" which was the distress call of that time, and brought immediate aid thus avoiding a great disaster and making himself the hero of the hour.

Greenleaf Whittier Pickard was the recipient of the Armstrong Medal award in 1940 at the annual Banquet on November 1st. The event was very ably reported in the October Proceedings under the heading "Club News," and we quote:

"The Annual Banquet of the Club took place on November 1st at the Engineers Club in New York. The usual spirit of gaiety and reminiscence prevailed, and there were numerous amusing anecdotes and personal references.

Following the dinner, President Henney presented the Armstrong Medal to Greenleaf

NEW RADIO MARVEL REVEALED IN TEST

Transmitter Power Cut From 20,000 to 5 Watts Without Affecting Reception

STATIC AT A MINIMUM

System Developed by Major E. H. Armstrong Explained to Radio Club

Some of the hitherto unrevealed wonders of the new "frequency modulation" radio broadcast system developed by Major Edwin H. Armstrong Columbia University electrical engineering professor, were demonstrated last night at the university at a meeting of the Radio Club of America.

Assisted by three engineers of the General Electric Company, Major Armstrong was able to show in a series of tests that the transmitting power of his 20,000-watt station at Alpine, N. J., twelve miles up the Hudson, and a similar 600-watt station in Yonkers, could be reduced almost to the vanishing point without appreciably affecting the quality of the program. At the same time this huge reduction in power, about 4,000 times in one case and 600 in the other, respectively, did not seem to cause an increase in static noises.

In other words he purported to show, and seemed to succeed in showing, that with his unique system high-power stations are not necessary for perfect, noise-free reception.

Directing the tests by telephoning to his operators at Alpine and Yonkers, Major Armstrong first showed the several hundred assembled engineers of the club what music and sound effects "sound like" with his system blotting out the noise generally considered inherent with all types of reception. Each sound was crystal clear and life-like, and murmers of approval were heard from the audience.

Music Is Not Affected

He then asked Yonkers to reduce power from 600 to one watt. Music sent over the wave thus created by scarcely as much as is required to light the bulb of a pocket flash lamp, seemed to suffer not a bit by the reduction. Next he instructed Alpine to reduce its 20,000 watts to a minimum, which he said would be five or six watts of power. The result was about the same as with Yonkers.

Major Armstrong then explained to the assemblage that "I believe this demonstration speaks for itself; certainly it tells us the system actually does step outside the realm of static. We have reduced our sending power almost to the irreducible minimum and still have transmitted music of the same quality without appreciably adding noise."

The Alpine station, erected by Major Armstrong to prove his theories that "frequency modulation will work," utilizes a wavelength of about six meters. The Yonkers station, owned and operated by C. R. Runyon, an amateur, utilizes a wave of three meters.

Next, programs were routed over both channels; Yonkers to Alpine to the Pupin Laboratory at Columbia, where the music was reproduced by a battery of loudspeakers. Results were quite as favorable as when only one channel was employed.

To Appease the Skeptical

A number of sound effects also were tried, to appease those among the gathering who still were skeptical. Extremely faithful reproduction of the original sounds were apparent in all cases. The faintest tinkle of water poured into a glass at the sending station could be heard.

The technical side of "frequency modulation," and the results of tests carried out in the past few months with similar stations at Schenectady and Albany were discussed by I. R. Weir, C. W. Fyler and J. A. Worcester, engineers of the General Electric Company. The gist of all the field results, it was said, has been highly in favor of the Armstrong system, compared with other methods.

The two up-State stations were arranged to operate on both the Armstrong method and the usual type of broadcasting, known as "amplitude modulation," to compare each system. Identical powers were used in each case, and the same wave length was employed. Then, with a receiver arranged to intercept either type of broadcasting, the engineers motored along the fifteen-mile Schenectady-Albany road looking for trouble.

When the transmitters were on "amplitude" broadcasting plenty of trouble was found, Mr. Fyler said. The trouble area began a mile out of Schenectady and ended only a mile or so from Albany, he asserted. The waves interacted and caused noise and whistles.

"With the Armstrong frequency method, however, it was a different story," related Mr. Fyler. "Only in an area a mile wide, midway between the two cities, did we encounter trouble, and even in that area we made the new method work perfectly. All we had to do was move the set's antenna rod a half-inch one way or the other and Schenectady came in and Albany was excluded, or vice versa."

New York Times, March 24, 1939.

PROGRESS SINCE THE REPUBLIC'S CQD

Anniversary of Disaster Finds Wireless World Revolutionized

THE steamship Republic is thirty years out from the port of Time.

The once proud Queen of the Sea has long since settled in her watery grave; the frantic CQD that flashed from her masthead is lost in the emptiness of space. Marconi, who gave the big ship a tongue with which to summon help, is gone. Endless waves of music now roll out across the waters where the Republic plunged from sight. The Lusitania, the Baltic, Olympic, Titanic, Leviathan, Mauretania and Berengaria have passed from the Atlantic lanes, but not without leaving in their wakes tales of the sea in which wireless added a touch of romance, safety and heroism.

From 1909 to 1939, the Marconi spark has been revolutionized. The wireless of that day, now known as radio, has become a world-wide medium of communication; it has become a social force undreamed of on this January day three decades ago. Up to that time the importance of Marconi's contraptions was not generally realized, but the marine searchlights that played across the murky waters off Nantucket to spot the badly crippled Republic were also spotlights on wireless.

Binns Called for Help

It will be thirty years ago tomorrow that the luxurious liner Republic, bound on a vacation cruise to the warm waters of the Mediterranean, curved out of New York harbor. Caught in a heavy fog off Nantucket, 175 miles east of Ambrose Lightship, at 5:30 o'clock in the morning with her 461 passengers asleep, the big ship was rammed by the steamer Florida.

Quickly Jack Binns tapped from his key the historic CQD, the distress call of that era, and a cordon of ships rushed to the scene, 250 miles from New York. The Baltic was one of the first to arrive for heroic work, and when she came into New York with the rescued on board, Binns was the hero of the hour. Only four lives had been lost. To wireless went the laurels for the invisible life lines it had uncoiled through the fog and darkness. The Republic sank; the Florida with its badly mangled bow slowly limped to port.

The Trio Never Met

The papers of that day which tell the story are now crumbling, yellow and brittle with age. The ever-modest Jack Binns is an official of a radio company in New York, and is frequently seen in Times Square. Always keeping abreast of progress in radio, 1939 finds him deeply interested in television. Commenting on the many magic developments since he called for help from the Republic's lurching and smashed deck, Binns said the other day, "We now have another 'lollapolooza' on our hands—television!" He foresees new wonders, but first, before this branch of radio comes into its own, the program and showmanship problems must be solved.

Captain William I. Sealby of the Republic lives at Vineland, N. J., but generally spends some time abroad each year.

Captain Angelo Ruspini of the Florida, whose masterly seamanship was credited with saving hundreds of lives, by keeping the bow of his ship in the Republic's wound to avert the inrush of water, lives at Great Neck, N. Y. He is now a commuter subject to the whims of the elements that tease the Long Island Railroad. Binns has never met Captain Ruspini, but he remarked the other day, "He did a great piece of work; he was one of the youngest skippers at that time."

How Wireless Has Changed

Wireless has changed some since that CQD. "You bet it has!" chuckled Binns. In 1909, after the wreck, there was no doubt that wireless was something ocean liners should never sail without. But few, if any, expected its waves would wash music across the rooftops and into homes; that a President would be heard in "fireside chats" and reading his message to Congress; that all the world would eavesdrop on a British King abdicating the throne!

No one dreamed that this thing called wireless could be used so effectively by an actor such as Orson Welles to scare the populace through a "Martian invasion." True, Enrico Caruso, according to a dispatch on the day that the Republic shoved off on her last voyage, had signed a contract to sing for $10,000 a week on a tour of English provincial towns, but there is no record that any prophets around the Metropolitan Opera House expected 30 years later a tenor would be paid $4,000 weekly for three or four short songs on a half-hour radio program!

Radio at sea is no longer a dot-and-dash affair secluded in a shack on the upper deck or in a cramped cabin. It has found its voice; it talks from artistically decorated walnut or oak paneled rooms. Transatlantic passengers pick up a telephone in their staterooms. They chat with friends ashore, in cities on the other side of the globe. From mid-ocean one may be talking with Johannesburg in South Africa, another with Shanghai, yet without the slightest interference. And their conversations are unintelligible to curious eavesdroppers, because by a snap of a tiny toggle switch the speech is "scrambled" at the transmitter, to be unscrambled again when the jumbled words strike the telephone station ashore, new magic since the Republic's day.

Jack Binns at the key of a reconstructed transmitter similar to the one with which he sent the first radio distress call (CQD) in history, from the sinking S.S. Republic in 1909.

New York Times, January 22, 1919

President Keith Henney (left) presenting the Armstrong Medal to Greenleaf Whittier Pickard. Dr. Pickard's record in radio research, from the earliest days to the present, justifies the title "Radio's Most Active Pioneer."

Whittier Pickard of Seabrook Beach, New Hampshire. Mr. Henney, and also other speakers later, referred to Pickard's long professional career starting with work on the Perikon detector, signal generators, field-strength measurements, and other subjects; also mentioned was his distinguished family connection as great nephew of the poet, John Greenleaf Whittier. In his acceptance remarks Pickard included a tribute to the Armstrong name, adding humorously that the Armstrong coin has heads on both sides, so that you can't lose.

President Henney then introduced Major Armstrong, who acted as toastmaster. The Major said a few words including the mention of a publication on the use of the wave meter, which was written in the early days—he had found this very interesting at the time. He then introduced the author, our speaker of the evening, now Major General J. O. Mauborgne, Chief Signal Officer of the Army.

In his address, General Mauborgne described conditions in the Signal Corps at our entry into the last war, and compared them with the much better situation prevailing at the present time. At that period, we had practically no apparatus, practically no designs, and practically no knowledge of desired types of equipment; about all we could do was to rush into production of Chinese copies of French and British apparatus. In all these respects of equipment, manufacture, design, and plans, our situation at the present time is far better.

General Mauborgne pointed out particularly that the Signal Corps is ready to consider operable apparatus which is in shape for further development to adapt it to the needs of the service. In distinction to this classification, persons with ideas requiring research, should contact a research group, the National Defense Research Committee, which has been formed under the leadership of Vannever Bush. An additional group under the head of C. F. Kettering, the National Inventors Council, has been formed to consider inventions submitted from any source. These research and invention groups are ready to consider all ideas submitted, and in addition will endeavor to have research projects undertaken, and inventions made, in compliance with specific requests from the military services.

In connection with developments made in the Signal Corps, General Mauborgne mentioned the necessity of terminating the work at possibly 80 or 85 percent of the desired extent, in order to get manufacture of apparatus started. Even under these circumstances, development work generally takes a year, and the inauguration of manufacture an additional nine months, so that it is almost two years before equipment is received in volume. The situation is more difficult on account of the fact that during quiescent times, little money is available for development work, and during critical periods, there is insufficient time. Sufficient money is available now for considerable development and purchase of signal apparatus, the total appropriation amounting to almost $200,000,000.

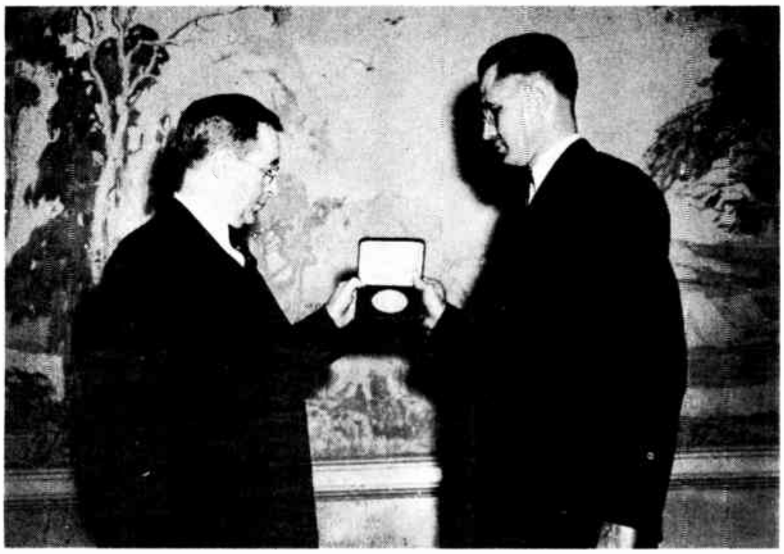
In discussing facsimile, General Mauborgne reported that encouraging results are being obtained. With regard to television, he stated that the requirements are severe, it being desired to see an object the size of an automobile on a dull day by means of a television camera in an airplane at a height of 12,000 feet or more."

Major General J. O. Mauborgne, Chief Signal Officer of U. S. Army, Major E. H. Armstrong, and Brigadier General Dawson Olmstead, Head of the Fort Monmouth Signal Corps Laboratories, at the annual banquet.

Now World war II was well under way in Europe and it was obvious that we ourselves would soon be involved. Accordingly the Board of Directors at its September 16th. 1940 meeting unanimously adopted a provision that the dues of all members who join any branch of the defense services will be waived throughout their term of duty provided they notify the Treasurer of their service connection.

On October 31st 1941 one of our oldest and most prominent members Harry W. Houck received the Armstrong Medal at the 32nd. Anniversary Banquet for his achievements in radio.

More than 130 members and guests attended the banquet and presentation. Major Edwin H. Armstrong, in whose honor the medal was established, gave a brief address following the award. He referred to the wartime days in his laboratory in Paris where Houck assisted him in the development of the first superheterodyne receiver. This was embodied in a large box, very different from the typical small superheterodyne of today. In reminiscing the Major reminded the audience of the difficulties which had to be overcome in making developments in those days. Speaking personally of Harry Houck, he related the true story, already known to various Club members, of how, also in France during the last War, Harry suffered a heavy attack of spinal meningitis, and was being carried out for dead, when he came to sufficiently to say "Where are you taking me?". That question resulted in his being taken back to bed instead of somewhere else, and soon an auspicious recovery began. The guest speaker was



Harry W. Houck (Left) Receiving the Armstrong Medal from President John Callahan

RADIO CLUB MEDAL GOES TO H. W. HOUCK, PIONEER INVENTOR

IS HONORED AT BANQUET

Assisted in Birth of Superheterodyne and Designed Second Harmonic Superhet.

Harry William Houck, consulting engineer, was awarded the annual medal of the Radio Club of America at the organization's thirty-second anniversary celebration banquet held recently at the Engineers Club, New York. Toastmaster at the affair was George C. Conner, with Rear-Admiral S. C. Hooper as the guest speaker. J. L. Callahan, president of the Radio Club, delivered the opening remarks.

Mr. Houck was awarded the medal "for his outstanding contributions to the radio art." Mr. Houck assisted in the development of the superheterodyne and designed the second harmonic superhet, the first type to be placed in large-scale commercial production. His researches on capacitors—paper, mica and electrolytic—made possible the filter systems used in all modern radio receivers.

Radio and Television Weekly, November 12, 1941.

RADIO AWARD BESTOWED

Armstrong Medal Is Presented to H. W. Houck, Industry Pioneer

The fourth award of the Armstrong Medal for "outstanding contributions to the radio art" was made last night to Harry William Houck, New York engineer and radio pioneer, at the thirty-second annual dinner of the Radio Club of America. The dinner was attended by 150 radio men, many of world-wide reputation, at the Engineers Club, 32 West Fortieth Street. The guest speaker was Rear Admiral S. C. Hooper, director of the radio liaison division, Office of the Chief of Naval Operations, Washington.

In presenting the award J. L. Callahan, the club's president, read the attached citation as follows:

"After assisting at the birth of the superheterodyne in Armstrong's (Major Edwin H. Armstrong of Columbia University, inventor of the superheterodyne receiver and father of the current FM system) wartime laboratory in Paris he designed the second-harmonic superheterodyne, first type to be placed in large commercial production. Radio receivers operating from alternating current power lines leaned heavily on the technique, designs and inventions of the medalist."

New York Times, November 1, 1941.

CITATION ON THE OCCASION
OF THE
AWARD OF THE ARMSTRONG MEDAL
TO
HARRY WILLIAM HOUCK
October 31, 1941

The Armstrong Medal of the Radio Club of America is awarded to Harry William Houck for his outstanding contributions to the radio art.

After assisting at the birth of the Superhetrodyne in Armstrong's wartime laboratory in Paris, he designed the second harmonic superhetrodyne, the first type to be placed in large commercial production.

Radio receivers operating from alternating current power lines, from their very inception, leaned heavily on the technique, the designs and the inventions of the medalist. His researches on capacitors—paper, mica and electrolytic—made practicable the filter systems used in all modern radio receivers.

His studious, detailed, careful experimental attack on any radio problem, with results always worthwhile, should be an inspiration to younger men.

Old-Timers and Speakers at the Banquet. Left to right seated are: Larry C. F. Horle, Director; Rear Admiral S. C. Hooper, Guest Speaker; Harry W. Houck, Armstrong Medalist and Director; and Paul Ware, Vice-President. Standing left to right are: William A. MacDonald, Director; George H. Clark, representing the Veteran Wireless Operators Association; George C. Connor, Tostmaster; John L. Callahan, President; and Edwin H. Armstrong, Director.

Rear-Admiral S. C. Hooper, Director of the Radio Liaison Division, Office of Chief of Naval Operations, Washington, D. C. In his address he pointed out the vast differences in the supply of radio apparatus at the present time in comparison with the wartime days of 1917–18. At that time there were only 12 companies engaged in the manufacture of radio apparatus, prominent among whom were Wireless Improvement, Lowenstein, Simon, and Federal Telegraph. It was then necessary for the Navy to lend considerable financial assistance to its radio suppliers in order to initiate rapid manufacture on a substantial scale. In the matter of apparatus, the changes are even more striking. At that time all transmitters for ships were of the spark type, and all were for single-frequency operation. He mentioned, however, the intense interest in the improvement of the art in those days, and the rapid evolution of inventions, these aspects comparing favorably with present times.

The Black Gang, which had come into notoriety at Club banquets of recent years, was especially noticeable this time, its magnitude having increased to the size of four tables. Here Larry Horle, Ernie Amy, Carl Goudy, Frank King, Dave Brown, and others held forth. They initiated George Burghard as a new member of the Gang. Another member present was Fred Muller, now a Lieutenant-Commander ("2 1/2") in the Navy. However, there was one defection in the ranks of the Black Gang; Paul Ware went high-hat, and sat at the speakers table deserting his fellows.

On December 7th. 1941 the nation was once again plunged into a World conflict. This time as in World War I the entire membership of the Radio Club either joined the armed forces or acted in prominent positions in the war effort. The Club, however, did not suspend operations but maintained its schedule of meetings, papers, proceedings and banquets, under a somewhat curtailed program. At least seven proceedings were published during the duration of the war from 1941 to 1945. To include here the many and varied activities of the members in the war years would be impossible. It suffices to say that many of them reached high rank in the army, navy and airforce and won acclaim and decorations for their services both in the armed forces and in the industrial war effort. Several also patriotically offered the free use of all their patents to the U. S. Government to help win the war.

To Carman Randolph Runyon, Jr. has gone the Radio Club of America's Armstrong Medal. Here, Runyon (right) receives the award from Fred. A. Klingenschmitt (Amy, Aceves and King)

After the war was over and things began to get back to normal, the Board of Directors awarded the Armstrong Medal to Carman R. Runyon Jr. for his contributions to the perfection of the Frequency Modulation system. The award was made at the 36th. Anniversary Banquet held at the Engineers Club on December 7th. 1945.

CITATION

on the occasion of the award of the

ARMSTRONG MEDAL

to

CARMAN RANDOLPH RUNYON, JR.

on December 7th, 1945

* * * *

The ARMSTRONG MEDAL of the Radio Club of America is awarded to Carman Randolph Runyon, Jr., for outstanding contributions to the art.

One of radio's pioneer amateurs, entering that art nearly forty years ago, he contributed to it the multi-spark synchronous gap transmitter, the crystal-controlled frequency-modulated telegraph system, and the single signal radio telegraph receiver.

Starting in 1935 at amateur station W2AG, he built the 100 megacycle frequency modulated broadcast transmitter from which he conducted hundreds of demonstrations whose flawless perfection initiated the renaissance in broadcasting which has now reached the ends of the earth.

The patient, persevering effort required to develop the power for transmission over useful broadcast ranges, the untiring search for the troubles inherent in a new system operated under the most difficult technical conditions, and the imaginative approach to the demonstrations now a part of classic radio history, is an inspiring example of what one man, devoted to his art and skilled in the handling of its apparatus, can contribute to the welfare of all.

As mentioned earlier, the Radio Club was now a full fledged scientific body and its meetings and papers assumed a mature engineering aspect as well. The meetings and social functions attracted not only the public but also the scientific and popular press, as is evidenced by a few selected clippings shown here.

Electronic Application To the Piano Subject Of Radio Club Lecture

On December 14, at 8:30 p. m., there will be presented before a joint meeting of the Radio Club of America and the Music Department of Teachers College, at Millbank Memorial Chapel, Columbia University, New York, a lecture-recital on the Miessner Electronic piano.

The lecture, the title of which is "The Application of Electronics to the Piano," is the first of a technical nature on this versatile new instrument, and will be given by its inventor, Benjamin F. Miessner, of Millburn, N. J. The operating principles, circuits, etc., will be disclosed by Mr. Miessner and illustrated by numerous lantern slides. The musical recital on the Electronic piano will be given by Anton Rovinsky, well known concert pianist, whose recitals on this instrument in concert work and in radio broadcast recitals have created such a wide-spread interest in this new instrument.

This new form of piano, in which electrical pick-up, amplifying and reproducing apparatus, takes the place of the usual soundboard, gives to the keyboard artist a degree of control claimed to be unsurpassed in any other instrument. He can produce, in addition to a dynmic range of fine piano tones, tones characteristic of many orchestral instruments, such as horns, wood winds, plucked and percussed strings.

Talking Machine and Radio Weekly

The Armstrong Medal was awarded to Charles Stuart Ballantine in 1946 but unfortunately due to his untimely death the presentation had to be postponed until 1947 when the Medal was accepted posthumously by his close friend Larry Horle, at the 38th. Anniversary Banquet on December 5th. at the Advertising Club in New York City.

CITATION

on the occasion of the award of the

ARMSTRONG MEDAL

to

CHARLES STUART BALLANTINE

on December 5th, 1947

* * * *

The ARMSTRONG MEDAL of the Radio Club of America is awarded to Charles Stuart Ballantine, for outstanding contributions to the art.

In the period of 1908 to 1916 he pioneered in radio in the Philadelphia area just as the members of the newly born Radio Club similarly pioneered in the New York area.

Out of that early experience came his book, "Radio Telephony for Amateurs" which was, in effect, the first ham bible and from which the long line of similar publications has since descended.

During World War No. 1 and building on the discovery of others of the Club, he developed the loop compass and radio direction finder as the primary and major defensive tool against the otherwise utterly successful submarine warfare of the German Navy.

Shortly after his entrance into the field of broadcast receivers in 1923, he developed the principle of negative feed back as well as of automatic volume control.

Later came his epoch making work in developing on purely mathematical basis the theory of the vertical antenna and its low angle radiation: the soundness of which continues to be attested to by the radiating system of substantially every broadcasting station in the world today.

Later came his work in acoustics: ranging widely from new microphone calibration techniques: the invention of the throat microphone as standardized by the U. S. Army Air Corps, the development of especially high fidelity reproduction and so forth.

His many, many inventions and developments which together comprise far too long a catalog to be here detailed, mark accomplishments made primarily as an individual and all too often unsupported experimenter: who persisting always against odds that would, themselves and alone, have defeated someone of less stamina and enthusiasm won out to the ends that contributed so mightily to making radio communication and radio broadcasting the important instrumentality it is today.

A special delegation consisting of Major E. H. Armstrong, Professor Alan Hazeltine, Lawrence Horle, and Harry Houck visited Mrs. Ballantine at her home in Boonton, New Jersey on Saturday, June 26th. 1948 and presented her with the Armstrong Medal. Major Armstrong in making the posthumous presentation described Stuart Ballantine as "One of the world's most versatile engineers."

The 38th. Anniversary Banquet which was a real bang up affair with Major General William (Wild Bill) Donovan as guest Speaker, also saw the presentation of another Armstrong Medal to one of our Honorary members John V. L. Hogan for his outstanding contributions to the Art.

Charles Stuart Ballantine
Armstrong Medalist — 1947

CITATION
on the occasion of the award of the
ARMSTRONG MEDAL
to
JOHN V. L. HOGAN
on December 5th, 1947

* * * *

The ARMSTRONG MEDAL of the Radio Club of America is awarded to John V. L. Hogan, for outstanding contributions to the art.

As a youthful laboratory assistant he painstakingly charted the characteristic curves of the first grid audion that was later to herald a new era in the world of communications.

Fired with the spark of inventive genius, he diligently pursued his studies and experimentation at Sheffield Scientific School, Yale University, where he discovered the ferro-silicon crystal detector. His quest for new ideas and new apparatus motivated his tireless and skillful work resulting in the development of the basic theories for his later invention of the heterodyne receiver.

In 1912, taking time from his research on ink recording of Trans-Atlantic Morse signals, he joined with others in the founding of the Institute of Radio Engineers, an organization that was to become world-wide in bonding together technical men of kindred interests.

A true pioneer, but keenly abreast of every advance of his art, he enthusiastically applied his skill to television and facsimile research inventing the continuous sheet electrolytic recorder. A few years later he established W2XR, the first high fidelity broadcasting station.

His vast experience and technical knowledge proved invaluable to our nation in war, and he gave unstintingly of time and effort to promote the development of electronic marvels that were to hasten peace to a war-weary world.

President Alan Hazeltine presenting Armstrong Medal to John V. L. Hogan at the Banquet held on December 5, 1947.

Lawrence C. F. Horle (right) accepting Armstrong Medal from President Alan Hazeltine on behalf of the late Charles Stuart Ballantine who was posthumously honored for his many inventions and developments in the radio industry. December 5, 1947.

Armstrong Medals Awarded by Radio Club

JOHN V. L. HOGAN, president of radio station WQXR and one of the founders of the Institute of Radio Engineers, was presented on Dec. 5, 1947 with the Armstrong Medal of the Radio Club of America, for his outstanding contributions to the arts of radio, television, and facsimile.

A similar medal was given posthumously to Charles S. Ballantine for his development of radio direction finders in World War I, negative feedback and automatic volume control circuits, mathematical theories of antenna radiation, new microphone calibration techniques, his invention of the throat microphone

John V. L. Hogan (right) receives Armstrong Medal from Alan Hazeltine, president of the Radio Club of America

February, 1948 — ELECTRONICS

Engineers Take Notice: John V. L. Hogan, introducing Prof. Louis Alan Hazeltine, said: "An engineer is a man who takes the word Science and puts two vertical lines through the first letter."

Prof. Hazeltine: Recalling radio activities during the last war, in an address to the members of the Radio Club of America, described radio amateurs as "those who tried anything, hoping that something wonderful would happen — and it frequently did." Referring to his own experiences and those of some of the other oldtimers, he said: "A pioneer is a man who gets shot by the Indians."

Radio-Electronic Engineering & Design, November 1942.

CITATION

on the occasion of the award of the

ARMSTRONG MEDALLION

to

ERNEST V. AMY

* * * *

The ARMSTRONG MEDALLION of the Radio Club of America is awarded to you ERNEST V. AMY, a member of the enterprising group of amateurs who, through the construction and operation of 1BCG, opened a new era in the field of radio communications.

The possibility of transmitting amateur signals to Europe had often been considered by the Club, but no action was taken until November 18, 1921, when you and your fellow amateurs decided to finally meet the challenge.

Within less than one memorable month the station was designed, equipment built, antennas erected and 1BCG put on the air to be heard across the Atlantic, in every state in the Union, and other far distant points.

Each member of the 1BCG staff was skilled in the technique of radio, as far as the art had advanced, but this skill alone was only in a small measure responsible for the success of the venture.

It was your boundless enthusiasm and amateur spirit of adventure which spurred you on to look beyond the horizon of things already accomplished into that vast field of the untried and unconquered.

Today as an impressive granite memorial is being dedicated at Greenwich, Connecticut, with the inscription: NEAR THIS SPOT, ON DECEMBER 11, 1921, RADIO STATION 1BCG, SENT TO ADROSSAN, SCOTLAND, THE FIRST MESSAGE EVER TO SPAN THE ATLANTIC ON SHORT WAVES. 1BCG, AN AMATEUR STATION, WAS BUILT AND OPERATED BY MEMBERS OF THE RADIO CLUB OF AMERICA, an historic event is fittingly recognized and you may look upon the memorial with the just pride of one to whom the occasion has been dedicated.

FOUNDED 1909

The Radio Club of America, Inc.

11 WEST 42ND STREET
NEW YORK 18

SPECIAL NOTICE

The 1BCG Monument dedication ceremonies, commemorating the first radio message ever to span the Atlantic on short waves, and the awards of the Armstrong medals are scheduled for eleven o'clock Saturday morning, October 21, 1950.

This is an outstanding event in the history of the Club. Don't miss it. Plan to be there and bring your friends. Dr. Orestes H. Caldwell will be the principal speaker.

Automobile: Take Hutchinson River Parkway to North Street turnoff. Site is one mile toward Greenwich, Conn.

Trains: Leave Grand Central at 8:25 A.M. and 9:25 A.M., arriving at Greenwich at 9:37 A.M. and 10:24 A.M. respectively. Taxis available for three mile drive out North Street to site at intersection with Clapboard Ridge Road.

No regular meeting is scheduled for October.

Very truly yours,

O. JAMES MORELOCK,
President

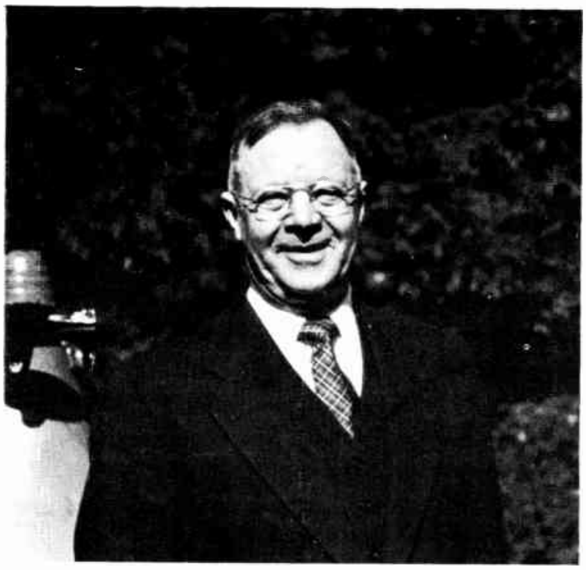
RALPH R. BATCHER,
Corresponding Secretary

"Hands Across the Sea" Paul Godley who received the message in Scotland shaking hands with George Burghard one of the operators who sent it from 1BCG in Greenwich. Left to right: Edwin H. Armstrong, George Burghard, Paul Godley, Ernest Amy with citation scrolls which they received with the Armstrong Medallions.

General view of speakers platform at 1BCG ceremonies Greenwich October 21 1950. President of the Radio Club James Morelock presenting Medallion and scroll to E. H. Armstrong.

On platform left to right standing: Harry Houck, Major Armstrong, James Morelock, Seated (with program in hand) Dr. Orestes H. Caldwell, Larry Horle, Mrs. G. E. Burghard, Mrs. Hawley T. Chester, Daughter of Minton Cronkhite who received Medal in his absence, Ernest Amy, George Burghard.

Ernest V. Amy receiving the Armstrong Medallion and scroll from President James Morelock. Seated on platform left to right: (front row) Major Armstrong and the Honorable Wilbur A. Peck, First Selectman of Greenwich.




NEAR THIS SPOT ON DECEMBER 11
1921 RADIO STATION 1BCG SENT
TO ARDROSSAN SCOTLAND THE FIRST
MESSAGE EVER TO SPAN THE ATLANTIC
ON SHORT WAVES. 1BCG AN AMATEUR
STATION WAS BUILT AND OPERATED
BY MEMBERS OF THE RADIO CLUB OF
AMERICA.
DEDICATED
GREENWICH, CONNECTICUT
1950
1BCG

ELECTRONICS — *December, 1950*

1BCG Memorial

DEDICATION ceremonies by the Radio Club of America for a monument commemorating the first short-wave radio message across the Atlantic were held in Greenwich, Conn. a few yards from the site of the shack that housed the original transmitter.

The historic message was transmitted from amateur station 1BCG on the night of Dec. 11, 1921 using power of less than a kilowatt on a wavelength of approximately 230 meters. It was received by Paul F. Godley, who had been sent to Scotland by the American Radio Relay League for the express purpose of listening for U. S. amateur signals. The success of this test was also a turning point in commercial utilization of short waves, heretofore neglected.

Monument commemorating first shortwave transatlantic radio message was recently dedicated at Greenwich, Conn., by Radio Club of America

AN EPOCH in radio communications history—Dec. 11, 1921—was commemorated at Greenwich, Conn., where the Radio Club of America Inc. dedicated a memorial to amateur station IBCG, first to shortwave a message across the Atlantic. Special medallions and citations were presented to IBCG pioneers by President O. James Morelock on behalf of the club. Four of the original seven operators attending ceremonies are (l to r): Maj. Edwin H. Armstrong, inventor of FM; George E. Burghard, chairman of Memorial Committee; Paul F. Godley, who operated receiving equipment in Ardrossan, Scotland, on the historic day, and Ernest V. Amy. Special occasion, held Oct. 21, was attended by number of engineers and inventors, as well as radio amateurs and experimenters.

BROADCASTING • Telecasting

November 6, 1950

Replicas of the Radio Club of America Armstrong Medals were presented to the original participants at the ceremony. Present to accept the awards were E. H. Armstrong, E. V. Amy, G. E. Burghard and P. F. Godley. Receiving awards in absentia were Minton Cronkhite, J. F. Grinan and Walker Inman.

Opposite page.

Dr. Caldwell (left) and Major Armstrong standing on Clapboard Ridge Road which was closed to traffic during the ceremonies.

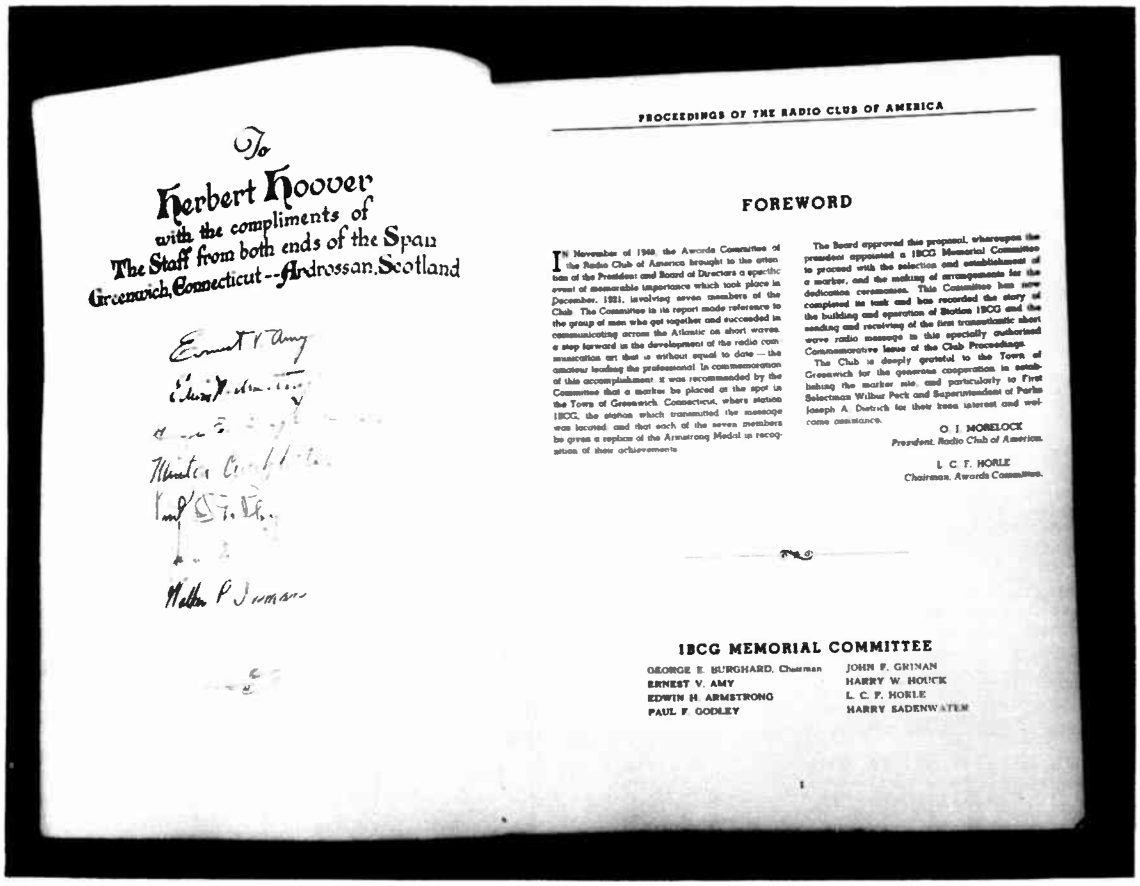
The ever smiling Harry Houck after the unveiling of the 1BCG monument.

Harry Sadenwater, the mainstay of the Memorial Committee, who was responsible for all the arrangements and did most of the hard work.

Former President of the Radio Club Fred Klingenschmitt at the conclusion of the Ceremonies, seems well satisfied.

Admiring the 1BCG monument after the ceremonies. Left to right: Paul Godley, Major Armstrong, George Burghard, W. A. Peck, First Selectman of Greenwich, D. O. H. Caldwell, and Ernest V. Amy.

The Committee had invited Ex-President Herbert Hoover to speak at the dedication but he expressed his sincere regrets at not being able to attend due to a previous commitment. In view of this a specially engrossed page was inserted into a copy of the Commemorative Issue and signed by all the members of the staff of 1BCG and Paul Godley, and sent to Mr. Hoover with a covering letter, for his famous scientific library. He was very grateful and sent us the following letter of thanks and appreciation:



To
Herbert Hoover
with the compliments of
The Staff from both ends of the Span
Greenwich, Connecticut--Ardrossan, Scotland

PROCEEDINGS OF THE RADIO CLUB OF AMERICA

FOREWORD

IN November of 1948, the Awards Committee of the Radio Club of America brought to the atten tion of the President and Board of Directors a specific event of memorable importance which took place in December, 1921, involving seven members of the Club. The Committee in its report made reference to the group of men who got together and succeeded in communicating across the Atlantic on short waves, a step forward in the development of the radio com munication art that is without equal to date — the amateur leading the professional. In commemoration of this accomplishment, it was recommended by the Committee that a marker be placed at the spot in the Town of Greenwich, Connecticut, where station 1BCG, the station which transmitted the message was located, and that each of the seven members be given a replica of the Armstrong Medal in recognition of their achievements.

The Board approved this proposal, whereupon the president appointed a 1BCG Memorial Committee to proceed with the selection and establishment of a marker, and the making of arrangements for the dedication ceremonies. This Committee has now completed its task and has recorded the story of the building and operation of Station 1BCG and the sending and receiving of the first transatlantic short wave radio message in this specially authorized Commemorative Issue of the Club Proceedings.

The Club is deeply grateful to the Town of Greenwich for the generous cooperation in establishing the marker site, and particularly to First Selectman Wilbur Peck and Superintendent of Parks Joseph A. Dietrich for their keen interest and welcome assistance.

O. J. MORELOCK
President, Radio Club of America.

L. C. F. HORLE
Chairman, Awards Committee.

1BCG MEMORIAL COMMITTEE

GEORGE E. BURGHARD, Chairman
ERNEST V. AMY
EDWIN H. ARMSTRONG
PAUL F. GODLEY
JOHN F. GRINAN
HARRY W. HOUCK
L. C. F. HORLE
HARRY SADENWATER

This is the specially engrossed leaf inserted in the copy of the 1BCG Commemorative Issue, signed by all the members of the staff and Paul Godley, and presented to Mr. Herbert Hoover for his Library.

HERBERT HOOVER

Stanford University
California
July 30, 1951

Dear Mr. Burghard:

I am very much honored by the thoughtfulness of yourself and the staffs connected with the sending of the first shortwave message across the Atlantic. Those autographs on the account of that historic event make it a firsthand document I prize. I have not only looked it over with interest - I have added it to other accounts of those days of discovery and achievement, to "keep the record straight".

My thanks go to you, and will you transmit them also to the signers, and members of the Radio Club concerned. I am glad to have that picture.

Yours faithfully,

Herbert Hoover

Mr. George E. Burghard
Chairman, IBCG Memorial Committee
The Radio Club of America
11 West 42nd Street
New York 18, N.Y.

Former President Hoover's much prized letter of thanks and appreciation sent to the Radio Club, on July 30, 1951.

RCA FOUNDED 1909

The Radio Club of America, Inc.

DEDICATION CEREMONIES OF 1BCG MONUMENT
Clapboard Ridge Road and North Street
Greenwich, Connecticut
OCTOBER 21, 1950
Eleven A.M.

Commemorating the first radio message ever to span the Atlantic on short waves from Greenwich, Connecticut, to Ardrossan, Scotland, on December 11, 1921

PROGRAM

MUSICAL SELECTIONS
Greenwich High School Band

INTRODUCTION OF O. JAMES MORELOCK
President of The Radio Club of America
by
GEORGE E. BURGHARD, Chairman Memorial Committee

GREETINGS BY THE PRESIDENT
Brief History of the Radio Club
Outline of the story of Station 1BCG

Presentation of the Armstrong Medal Awards
Medalists

ERNEST V. AMY
EDWIN H. ARMSTRONG
GEORGE E. BURGHARD
MINTON CRONKHITE
PAUL F. GODLEY
JOHN F. GRINAN
WALKER INMAN

Address
HONORABLE WILBUR M. PECK
First Selectman, Greenwich

Dedication Address
DR. ORESTES H. CALDWELL

NATIONAL ANTHEM

Program of the 1BCG dedication ceremonies.

November 8, 1950 RADIO and TELEVISION WEEKLY

RADIO CLUB UNVEILS MONUMENT MARKING THE SENDING OF FIRST TRANS-ATLANTIC MESSAGE

GREENWICH, CONN., Friday—An epoch in the history of radio communications was fittingly commemorated in this city recently when the Radio Club of America dedicated a granite memorial to 1BCG, the first radio station to transmit a message across the Atlantic on short waves.

Located only a few hundred feet from the monument site on Clapboard Ridge road and North street, construction of 1BCG was begun in late November, 1921. It was completed, less than one month later, in time to participate in the tests that were climaxed by the historic message transmitted to Ardrossan, Scotland, on December 11. It was this accomplishment by a group of radio amateurs which opened the way for the many commercial communications facilities in service today.

To personally honor the original operators of 1BCG, special medallions and citations were presented on behalf of the Radio Club by its president, O. James Morelock. Of the recfpients, Major Edwin H. Armstrong, George E. Burghard, Ernest V. Amy and Paul F. Godley were present; Minton Cronkhite, John F. Grinan and Walker Inman were unable to attend. With the exception of Mr. Godley, who operated the receiving equipment in Scotland, the others were responsible for the design, construction and successful operation of 1BCG.

The affair was attended by men in all phases of electronics; famous engineers and inventors joined with the youthful experimetners and radio amateurs in dedicating a monument that will be a shrine to radio men over the entire world.

NEW YORK TIMES, SUNDAY, OCTOBER 22, 1950.

1ST SHORT-WAVE CALL TO EUROPE IS MARKED

Special to THE NEW YORK TIMES.

GREENWICH, Conn., Oct. 21—A granite monument commemorating the first short-wave message to span the Atlantic Ocean was unveiled here today. Officials of the Radio Club of America, which made the tests on Dec. 11, 1921, and town officials participated in a short ceremony viewed by 100 persons.

The monument is in a small park at North Street and Clapboard Ridge Road, a few yards from the field in which short-wave station 1BCG was set up in 1921 with a 108-foot tower. The call letters were held by Minton Cronkhite, early Greenwich "ham" operator.

Four of the seven men who participated in the 1921 test attended the ceremonies today. Bronze medals were presented by O. James Morelock, president of the Radio Club of America, to Ernest V. Amy, Edwin H. Armstrong, George E. Burghard and Paul F. Godley and accepted by representatives for Mr. Cronkhite, John F. Grinan and Walker Inman.

Mr. Godley received the historic message at Ardrossan, Scotland, after having identified the 1BCG Morse code signals for two previous nights.

Dr. Orestes H. Caldwell of Greenwich, radio controls pioneer, who gave the dedication address, said that before the 1921 test trans-oceanic broadcasting had been only by long-wave broadcasting stations, which needed huge amounts of power in towers hundreds of feet high.

On December 12th. 1952 The Radio Club awarded the Armstrong Medal to Captain Henry J. Round for his important work in the early days of Radio and in World War I. The presentation was made by President John Bose at the 43rd. Anniversary Banquet at the Advertising Club New York City.

CITATION ON THE OCCASION
OF THE
AWARD OF THE ARMSTRONG MEDAL
TO
HENRY JOSEPH ROUND
December 12, 1952

The award of the Armstrong Medal by The Radio Club of America to Henry Joseph Round is in recognition of his contributions during half a century to the radio art, and especially of his revolutionary developments during World War I in the fields of direction and position finding and the high amplification of short wave signals.

In 1902, upon completion of his engineering studies, he joined Marconi's Wireless Telegraph Co., Ltd. and after a short course of instruction came to America where he operated "BA"—the Babylon, Long Island, station of the American Marconi Co., the first commercial wireless station in this country. Returning to the British Company in 1907, his research career began as assistant to Marconi in the innumerable long distance experiments on the Clifden, Ireland—Glace Bay, Nova Scotia circuit, the first, and until 1912, the only transoceanic circuit in existence. His invention of the balanced crystal receiver contributed much to the success of the circuit and was the most effective means of combating static known for many years.

His discovery of the regenerative self-heterodyne circuit, independently of its invention in the United States, led him into the vacuum tube field in all its ramifications. He pioneered far in advance of all others in the amplification of signals of short wave lengths; likewise he led the world in the exploration of the 100-meter wave region when he demonstrated in 1921 its long night time range by transmission from England and from the Netherlands to Norway.

Captain Round's greatest achievement came during World War I, when commissioned in the Royal Engineers and assigned to the Intelligence Corps, he developed position finding equipment of extraordinary accuracy, together with means for amplifying weak high frequency currents to a degree then undreamed of. The result of this work had an immediate and profound effect upon the outcome of World War I. It marked also the advent of the direction finder as a practical and useful entity for the service of humanity as we know it today.

CAPTAIN ROUND RECEIVES ARMSTRONG MEDAL

Capt. Henry J. Round of England (right) received the prized Armstrong Medal from John Bose, president of the Radio Club of America, at the Club's 43rd annual banquet. The Medal was awarded to Capt. Round in recognition of his pioneering work in radio, especially in the fields of radio direction and position finding and the amplification of short-wave signals. During World War I the direction-finding apparatus he designed and operated made it possible to trace the movements of the German Fleet, making possible interception by the British Fleet in the Battle of Jutland

Electronics, February 1953.

Rodio Club Group Honors Briton

Capt. Henry J. Round, of England, was awarded the prized Armstrong Medal, at the 43rd anniversary banquet of the Radio Club of America, in New York, Dec. 12, before an appreciative audience of 175 members and guests. Capt. Round received the medal in recognition of his pioneering work in radio direction and position finding. During World War I the apparatus he designed and operated made it possible to trace the movements of the German Fleet at the Battle of Jutland. John V. L. Hogan served as toastmaster of the Club proceedings.

Telegraph and Telephone Age, January 1953.

In 1953 the Armstrong Medal was awarded to Dr. Raymond A. Heising for his invention of the system of modulation which bears his name and his many contributions to long range Radio Telephony. The presentation was made at the 44th. Anniversary Banquet on December 11th. at the Columbia University Club.

CITATION ON THE OCCASION
OF THE
AWARD OF THE ARMSTRONG MEDAL
TO
RAYMOND A. HEISING
December 11, 1953

The ARMSTRONG MEDAL of The Radio Club of America (1953) is awarded Dr. Raymond A. Heising in recognition of his outstanding contributions to Radio Communication.

A pioneer in the art of vacuum tube radio telephony, he invented the system that solved an early modulation problem in a most simple and practical manner. The system today bears his name.

Beginning work on high frequency wire and radio telephone transmitters in 1914 in the laboratory of the Bell System, he specialized in the development and construction of transmitters of progressively increasing power, this work culminating in the construction and the placing in successful operation of the experimental transmitter installed at the Arlington, Virginia station of the U. S. Navy, from which the human voice was first projected via radio across continental and oceanic distances.

His direction of research and development in the field of long-distance radio telephony continued, culminating again with the design and construction of the first transmitter utilized in the establishment of the overseas telephone service now known to all of us. His engineering contributions in this field are unexcelled.

John Bose, President of the Radio Club of America, presenting the Armstrong Medal to Dr. Raymond A. Heising.

FM Inventor Improves His System, Putting 3 Programs on Single Wave

By JACK GOULD

A frequency modulation radio station can transmit simultaneously two or three different programs on a single channel under a new transmission system announced yesterday by Dr. Edwin H. Armstrong, Professor of Electrical Engineering at Columbia University and inventor of FM radio.

Under the system, a set owner would tune his FM set once as at present and receive the first program. Then he could flip a switch and receive a second program. Flip the switch again and he would receive a third program.

Under the new system, the existing thirteen FM stations in New York City could offer a total of thirty-nine programs at the same time.

Present FM transmitters could be modified for the new system at a cost of "a few thousand dollars," according to Dr. Armstrong, but listeners at home would have to buy new FM receivers. The system, the inventor said, does not work with AM, or amplitude modulation, radio. AM stations broadcast in the so-called standard band between 550 and 1,600 kilocycles.

Dr. Armstrong, whose inventions have played a major role in shaping the technical course of modern broadcasting, said one station could offer simultaneously a classical music program, a popular music program and a news program.

"Economically the broadcaster could sell twice or three times as much advertising," he observed.

The availability of two channels on which to transmit from the same station, Dr. Armstrong said, would make practical "three-dimensional sound" on radio, also known as binaural transmission.

Announcement of the system promised to pose a new problem for the Federal Communications Commission, which prohibits own-

Continued on Page 18, Column 3

New York Times, March 17, 1953.

Electronics, February, 1954.

Heising Awarded Armstrong Medal

RAYMOND A. HEISING was presented the Armstrong Medal by the Radio Club of America at its 44th annual banquet, in recognition of his many notable contributions. He was an early worker with electron tubes and invented the system of modulation which solved a radio telephone problem simply and practically. The system today bears his name.

In 1914 Dr. Heising entered the laboratories of the Western Electric Co., specializing in the development and construction of radio transmitters of increasing power.

His other activities include carrier currents, piezo-electrics and fundamental research. He retired recently from the Bell Laboratories after 39 years of service.

In past years Armstrong had made it a practice to make first disclosures of his inventions before the Radio Club of America. This he did for two reasons: First because he always took a great interest in the Club and secondly because commercialism was reduced to an absolute minimum at all the Club meetings and he felt he could speak more freely. Thus on October 13th. 1953 the Club was blessed with another first when Dr. Armstrong and John Bose read a paper titled "Some Recent Developments in the Multiplexed Transmission of Frequency Modulated Broadcast Signals" and demonstrated their system, at a meeting in Pupin Hall Columbia University. The tests were expertly carried out and proved a discovery of major and far reaching proportions.

DISCUSS FM SYSTEM: J. H. Bose and Dr. E. H. Armstrong

FM Inventor Improves His System,

Continued From Page 1

ership of more than one radio station in the same city.

Dr. Armstrong said that credit for the engineering behind the system belonged to John H. Bose, of the Marcellus Hartley Research Laboratories at Columbia, who worked with Perry Osborn, chief engineer of Dr. Armstrong's FM station, KE2XCC, at Alpine, N. J.

The heart of the system is known as multiplex radio transmission, which involves the use of a single carrier wave to transmit more than one signal. Multiplex transmission has been widely used for years in communications.

Dr. Armstrong noted, however, that multiplex had not been used for regular broadcasting because of the problem of one channel intruding on another. The system, he said, overcomes this problem.

Technically, the system can be described as "frequency modulation within frequency modulation." At the broadcasting station an FM signal is sent out with one program. This signal contains a second FM signal.

At the receiver the initial FM signal is first "demodulated"—or converted back into sound. At this point the second signal is beyond the range of human hearing and a listener cannot even tell that it is there. Then the second signal is fed into a second "demodulation" system, where, in turn, it is converted into sound independently of the first.

A third signal could be contained within either the first or second signals, Dr. Armstrong explained. He said that technically it was feasible to carry even more than three programs, but that noise became a factor as the number of programs was multiplied on the same carrier wave.

Dr. Armstrong reported that last summer during a thunderstorm signals were received fifty miles away from Alpine with equal clarity on both a first and second channel.

Neither Dr. Armstrong nor Mr. Bose would predict when the new system would be put into service, but the inventor expressed the opinion that it would materially improve the financial lot of FM broadcasters, now caught in competition with both television and standard radio, and would increase the popularity of FM.

Use of two channels to broadcast a concert, Dr. Armstrong said, would permit placement of microphones at different points in a studio or hall and transmission of the sound from a number of points. With the use of two loudspeakers in a home the concert would have a toned quality similar to what one hears through both ears if actually attending a recital. Such binaural transmission up to now, he said, has required use of either two FM stations or a combination of FM and AM.

Dr. Armstrong announced the development of FM radio in 1935. Previously he developed the regenerative, super-regenerative and superheterodyne circuits. A technical paper on his multiplex broadcasting system is scheduled for delivery before the Institute of Radio Engineers.

ON October 13, Major Armstrong, assisted by John Bose, delivered a highly significant paper on multiplex FM transmission before a joint meeting of the Radio Club of America and the Audio Engineering Society at Columbia University. This was accompanied by a striking demonstration of reception from station KE2XCC at Alpine, N. J., and tape recordings made under test conditions.

While the paper was concerned mainly with FM broadcasting of two different programs, or two channels for binaural reception, this development furnishes the means to provide new communication services.

Stated simply, it is now possible for an FM broadcast station to handle one or two voice communication channels without interfering with its regular 15,000-cycle broadcast program. Since FM transmitters are of substantially higher power than those used for communication, and have high-gain antennas of substantial height, most of them can provide solid coverage over a radius of 50 miles or more over rough terrain, and upwards of 75 miles in flat country.

[1]See the extensive discussion of this matter in *Communication Review*, last issue of COMMUNICATION ENGINEERING.

EQUIPMENT FOR 2-CHANNEL TRANSMISSION ON BROADCAST FM CARRIER

This added facility is too new for the FCC to have given it any formal consideration yet. However, since it opens up the possibility of adding two communication channels at each of some 650 FM transmitters without the slightest interference with broadcast service, it is certain that the Commission will welcome this development as a means of relieving congestion in the safety and special services. Moreover, it opens up possibilities for new types of systems or services because of the enormous coverage obtainable. Such a station as WMIT, for example, can deliver solid coverage over an area of nearly 100,000 square miles.

Consider how advantageously two long-range channels could serve a manufacturing company that had plants and offices in outlying sections of a city where there is an FM station. One channel could be used for communication with company cars and trucks, while the other could be free to serve for special messages and paging.

Probably Major Armstrong used two broadcast programs for demonstration purposes because they provided the most severe test of his method of multiplexing. It is a relatively simple matter to substitute two narrow-band voice channels for the second 8,000-cycle program channel.

Under 15,000-cycle modulation on the first channel, and 8,000 cycles on the second, the signal-to-noise ratio was better than 70 db with 1 millivolt at the input of the receiver. Cross modulation in the second channel from the first was better than 60 db below the program on the second channel. The effect of the second on the first was insignificant.

FM broadcasters will surely welcome proposals to add such communication services, as a means of obtaining additional revenue. It is reasonable to expect, therefore, that Major Armstrong's latest contribution to the radio art will soon materialize in various commercial, profit-making forms.

Communication Engineering,
November-December, 1953.

On February 1st. 1954 the Radio world and the Radio Club in particular was profoundly shocked by the death of one of its most distinguished members. Edwin Howard Armstrong. The Club and its associations were a very important part of his life and by the same token he had become an integral part of the Radio Club's very existence. It seemed impossible that we were no longer to feel his presence at meetings and other functions and listen to his sage remarks and profit by his strong conviction of sincerity and meticulous attention to detail and truth. The example that he set will never be forgotten by those who heard him and will always be cherished by those who had the good fortune to know him well. The Club had lost a great man and a good friend.

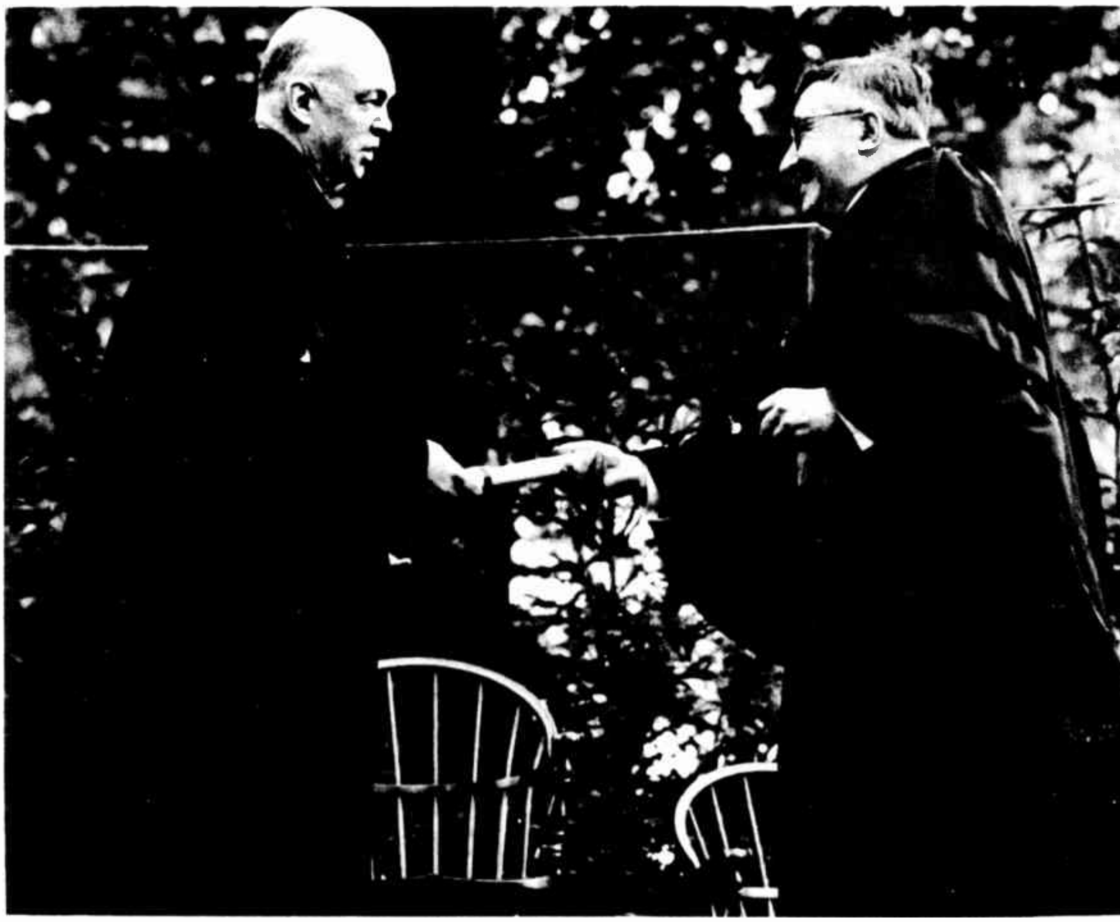
President Shepard appointed a special Armstrong Memorial Committee to see that proper recognition was forth coming. A special folio was prepared for insertion in the next issue of the Club Proceedings. It showed a picture of the Major on the front page and contained a list of all the awards and honors he had attained during his career as well as a copy of the engrossed scroll setting forth the resolution of the Board of Directors. The original scroll was signed by all the officers and Directors and presented to Mrs. Armstrong.

1890 - EDWIN HOWARD ARMSTRONG - 1954

EDWIN HOWARD ARMSTRONG

Honors and Awards

Degree of Doctor of Science — Columbia	1929
— Muhlenberg	1941
— L'Université Laval (Quebec)	1948
Medal of Honor, Institute of Radio Engineers	1917
Chevalier de la Legion d'Honneur	1919
"Armstrong Medal" established by The Radio Club of America	1935
Egleston Medal, Columbia University	1939
Holley Medal, American Society of Mechanical Engineers	1940
National "Modern Pioneer Award", National Association of Manufacturers, on the occasion of the 150th Anniversary of the American Patent System	1940
Medal of Class of 1889 — School of Mines, Columbia University	1941
Franklin Medal, The Franklin Institute	1941
John Scott Medal, awarded by Board of Directors of City Trusts, City of Philadelphia	1942
Edison Medal, American Institute of Electrical Engineers	1942
Medal for Merit (United States) with Presidential Citation	1947
Radio Club "Amstrong Medal" along with John F. Grinan, Ernest V. Amy, George E. Burghard, Minton Cronkhite, Walker P. Inman, Paul F. Godley for the first shortwave transoceanic signals (1BCG)	1950
Washington Award, founded in 1916 by John Watson Alvord, administered by The Western Society of Engineers	1951
Lion Award, awarded by the Columbia University Alumni Club of New Jersey (Essex County)	1953
Honorary membership — Institution of Radio Engineers, Australia	
Honorary membership — Franklin Institute	
Honorary membership — American Institute of Electrical Engineers	



Armstrong (left) receiving the Honorary Degree of Doctor of Science from President Levering Tyson of Muhlenburg College, June 2, 1941.

Many letters of condolence were received and many articles were written about Armstrong but space will only permit the recording of a few on these pages. The following letter was sent by the Major's very old friend and Honorary member of the Radio Club Captain Henry J. Round of London.

Message to The Radio Club of America from Capt. H. J. Round

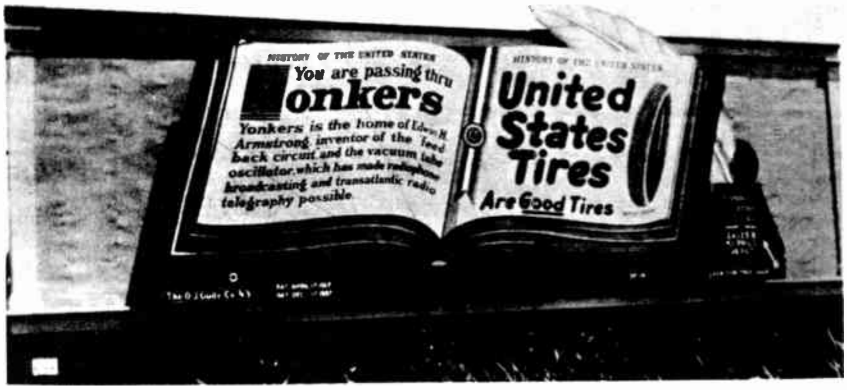
As a member of the Radio Club unable to be present with you, I would like to record my sorrow at the loss of our beloved associate, Major Edwin H. Armstrong.

Only about one year ago I renewed my personal acquaintance with Howard after twenty years interval, and I am honoured to think that he gave the citation when I was presented with your Medal named after him.

I first met Armstrong in late 1917 when he called on me at my laboratory in London, bringing with him the story of the recent U. S. developments in Wireless, and we exchanged information which was very valuable during the latter part of that War.

I met him again on several occasions and had the pleasure of being given a very early demonstration of his Superheterodyne in his Paris laboratory. Mr. Houck was present at that demonstration and has reminded me that I was rather slow at grasping what Armstrong had done.

I met him just after he had invented Superregeneration when he visited us at Marconi's in Chelmsford.



Advertising billboard on the main highway through Yonkers, New York, the birthplace of E. H. Armstrong.

At the Awards Dinner of the American Institute of Electrical Engineers in 1942 when Armstrong (right) received the Edison Medal. With him are (left to right) Gerard Swope, the Hoover Medalist, Dr. Willis Whitney, the John Fritz Medalist.

I remember very clearly his radio message to me from the ship in which he was coming to Europe:

> "*Arriving in England on Saturday with the contents of the Radio Corporation safe.*"

Armstrong on that visit bought in France his Hispano Suiza car which he had for many years.

In 1929 I visited the States, partly on Marconi's business, and stayed with him for a very memorable six weeks, during which we visited Schenectady where I met Harry Sadenwater and saw the radio and scientific progress going on in the General Electric Laboratories.

I remember renewing acquaintanceship with Dr. Alexanderson and the great scientist Langmuir.

We also visited Pittsburgh and I was present at a technical meeting when the next year's models were being tried out. There I had long talks with Conrad and other well known personalities.

Riverhead and my old friend Beverage were visited, and then the great exploration to look for old relics took place.

As I have recorded elsewhere, the site of the Babylon station was discovered and we found the old operating hut which now lies at Riverhead.

The dinner your Club gave me during my visit stands out in my memory because of the large number of well known Radio men I met there.

Since those days until December 1952 when I was present at your banquet, Armstrong and I corresponded very frequently.

He particularly kept me well supplied with the latest American receivers, lately, of course, chiefly FM models, and I am the proud possessor of that very fine R E L super FM instrument which is on my table by the side of me now in full working order.

Unfortunately, there are very few FM stations over here to listen to.

England has been unable, with war and subsequent peace recovery work, to blossom out in that direction on a large scale, but the word has just been given to go full steam ahead and when the planned FM group is finished our small island will have at least six high power FM stations, each radiating three programs at once. This will be our monument to Howard.

Armstrong in his "Spirit of Discovery" lecture said about my old chief Marconi

> "It is seldom that a man makes two basic discoveries.
> When a man makes three his attitude towards problems
> and his method of work merit close analysis and study."

I cannot help feeling that this applies equally to Armstrong himself.

Many men in the past have made discoveries but left it for those autocrats, the scientists, to theorize, the engineers to make a job of things, and the business men to give the world and themselves the benefits.

Howard tried to do it all himself and it was too much even for his great intellect and personality. However, I think that if he had left FM to others in its early stages it would not have gone anywhere near so far, and in fact I think there would have been a tendency to suppress it on the part of vested interests.

It has gone so far now that it cannot be suppressed, and I venture to prophesy that in the not too distant future radio broadcasting in the U. S. will turn largely to FM.

My short acquaintance with your radio last year showed me that you need it even more than we do in England.

Armstrong is now amongst the immortals and is surely in the history of your nation worthy to be classed with Bell, Edison and Westinghouse.

I salute the spirit of my great friend.

H. J. ROUND

WIRELESS ENGINEER

Vol. 31 MARCH 1954 No. 3

Edwin H. Armstrong

By his death on 1st February the United States lost one of the outstanding personalities of the wireless world. Edwin Howard Armstrong was born in New York on 18th December 1890. He graduated in Electrical Engineering at Columbia University in 1913 and was awarded an honorary D.Sc. in 1929. He was an assistant in the electrical engineering department for a year after graduation, and then for 21 years collaborated with Michael Pupin in research at the Marcellus Hartley Research Laboratories in Columbia University. From 1934 until his death he was a Professor of Electrical Engineering in the University. During the first world war he spent two years, first as captain and then as major, in the Signal Corps, and in 1919 was made a Chevalier of the Légion d'Honneur.

The name of Armstrong is most closely associated with four inventions, viz. the regenerative circuit, 1912; the superheterodyne system of reception, 1917-18; the superregenerative circuit, 1920; and frequency modulation, 1935. He was a lad of 16 when in 1906 Lee de Forest patented the 3-electrode valve, which became known as the audion, and it was in 1912, while still a student at Columbia, that he was experimenting with an audion when he discovered the presence of h.f. current in the anode circuit, which led to his invention of regeneration and the valve oscillator, and endless patent litigation. In 1914 he published a correct explanation of the action of a triode and disproved some of the currently-accepted ideas; in 1915 he read a paper on regeneration before the Institute of Radio Engineers, and in 1916 another paper on the heterodyne detector. The impact of these papers may be judged from the fact that in the following year the Institute of Radio Engineers awarded him the first Medal of Honour for his work on regeneration and the production of oscillations. Seventeen years later there was a somewhat tragic sequel to this award for, following the adverse decision of the U.S. Supreme Court on the question of priority of invention of these discoveries, he returned the medal to the Institute in 1934. The Board of Directors, however, unanimously declined to accept it and reaffirmed the original award.

Though naturally not entirely unbiased, some light is thrown on this long drawn-out litigation by the autobiography of Lee de Forest, published in 1950. At the same time as Armstrong was experimenting with the audion in New York, Lee de Forest and two assistants were working on somewhat similar lines at Palo Alto in California, and the fight as to who was the prior inventor went on for 20 years.

In the autumn of 1913 de Forest read a paper on "The Audion Amplifier" before the I.R.E. at Columbia University and he says: "My demonstration of the crashing sounds emitted from my loudspeaker when I dropped a handkerchief on the table before the telephone receiver serving as my 'pick-up' aroused great astonishment and applause. On that occasion young Edwin H. Armstrong, wrapped in deepest mystery, had a small carefully-concealed box in an adjoining room into which neither I nor my assistant Logwood was permitted to peek. But when he led two wires to my amplifier input to demonstrate

This article on Armstrong appeared in the Wireless Engineer of March 1954. It was written by the Technical Editor Prof. G. W. O. Howe.

the squeals and whistles and signals he was receiving from some transmitter down the Bay, we thought we had a pretty fair idea of what the young inventor had concealed in his box of mystery. So we proceeded, meekly and obediently, to amplify whatever signals came over the wires from that room".

That is the first mention of Armstrong in de Forest's autobiography, but early in 1914 de Forest demonstrated his ultra-audion oscillator at the Bureau of Standards in Washington, and he says that Professor Pupin, whom he had long known as a kindly friend, loudly demanded "What right have you to have that here? That thing is not yours. That belongs to Armstrong." He says that he was too flabbergasted to reply, but gazed upon his surprising wrath and "continued the siren sounds." He proceeds, "Then I knew for a certainty what it was that Armstrong had had in his little magic box at Columbia. And that outburst by Professor Pupin was the opening gun of the bitterly contested patent battle to be waged for years in the Patent Office interference proceedings; and thereafter for years more until at long last the U.S. Supreme Court should finally decide the historic contest." Later de Forest says: "On January 15, 1920, I read my paper on the Audion and its evolution before the Franklin Institute at Philadelphia. It was well received, except by one E. H. Armstrong, who sought to show that it was he who had invented the feed-back circuit. 'All de Forest invented was the Audion! We'll concede that', he growled. Whereupon the chairman ordered him to sit down."

The feedback patent, which, after nearly 20 years' litigation, was finally awarded to de Forest, expired in 1941. It had been in turn awarded to Armstrong, then Langmuir, then again to Armstrong, and finally to de Forest. One can appreciate the feelings that prompted Armstrong to return the medal to the Institute.

Another of Armstrong's inventions, with much happier associations, is frequency modulation. This occurred to him as the result of some experiments he and Pupin made with the idea of eliminating static interference; experiments which, he says, were unsuccessful, but which laid the foundations of his system of reducing disturbance by using frequency modulation. In an outline of the history of f.m., which he gave before a section of the I.R.E. in 1946, he said that he started looking for a static eliminator back about 1914, and that he worked a little longer than most people did. He then hit upon the idea of frequency-shift keying and from that went on to frequency modulation. It is pleasing to note that towards the end of his autobiography de Forest says: "Major E. H. Armstrong deserves the greatest credit for the development of his system of frequency-modulation—brought out in spite of the skepticism of the profession, and a reluctant Federal Communications Commission. He has given to radio broadcasting a new arm; for this I salute him."

In 1935 the Radio Club of America founded a medal to be known as the Armstrong Medal. In 1941 Armstrong was awarded the Franklin Medal by the Franklin Institute, and in 1943 the Edison Medal by the American I.E.E.; he was also awarded medals by many other institutions.

In 1947 he received a Medal of Merit and a Presidential Citation for his contributions to military radio communications.

In "Radio: Beam and Broadcast", by A. H. Morse, published in 1925, the patent litigation up to that time is discussed very fully: the author concludes by saying that, "Armstrong's work in radio is such that, had he no patented or patentable inventions—and he has many—he would still rank as one of the foremost exponents of the art". This was before the invention of frequency modulation.

Since 1948 he had been working on what he called the multiplexed transmission of frequency-modulated signals, and as recently as last October he and J. S. Bose, also of Columbia University, read a paper on the subject and gave demonstrations before the Radio Club of America. The multiplex system enables two programmes to be broadcast simultaneously within the standard f.m. band of 200 kc/s. Earlier attempts at multiplexing were not very successful because of cross-modulation between the main and the auxiliary channel and of noise transfer from one to the other, but as the result of five years of work they claimed to have overcome the difficulties, and to be able to obtain results on their second or auxiliary channel superior to those obtained by ordinary amplitude-modulated stations.

One can only regret that so much of his life was overshadowed and embittered by such protracted patent litigation, but during the last 18 years he had the great satisfaction of seeing his frequency modulation becoming more and more highly appreciated, and replacing amplitude modulation on an increasing scale. His name will ever be associated with this outstanding achievement.

G. W. O. H.

Television in Review

A Tribute to Major Armstrong, Who Was Dedicated in the Scientist's Tradition

By JACK GOULD

MAJOR EDWIN H. ARMSTRONG who leaped to his death from a window of his apartment in the River House, will rank with the great inventive geniuses in electrical engineering. With Edison, Hertz, Marconi and Lee De Forest he pioneered the art of broadcasting that today is accepted as a matter of course.

The Major, as he always preferred to be called, was an inventor almost out of a story book. He was a dedicated man in the scientist's tradition; he was often a lonely and somewhat aloof figure; in someways he was stubborn. He also was a disappointed man. Bitterness and disillusion robbed him of many of the pleasures and satisfaction of his engineering triumphs.

Yet over a cocktail the Major could be cordiality itself. In his rare moments of relaxation he could even see the humor to be found in the world of commercial practicality and expediency, a world to which he never fully could reconcile himself. At all times he was the individualist.

The vision of Major Armstrong can be illustrated by an incident of only a few months ago. He was discussing one of his foremost inventions, the modern system of frequency modulation broadcasting that freed radio from static and man-made interference.

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From an old notebook he showed a memorandum that he had written years and years earlier. The memorandum predicted that during a thunderstorm the roar of the thunder itself would be more disturbing to radio reception than would the electrical interference caused by the lightning. He had his own dream come true.

Yet, ironically, FM was to be a personal heartbreak for the Major. He envisioned frequency modulation as supplanting the existing, or amplitude modulation, radio. Just as FM began to take a foothold, the Federal Communications Commission ordered the service moved to a new band. The F. C. C. based its decision on engineering considerations that to this day are disputed. The Major knew that he was "the father" of FM but he had to watch others decide what was best for his child.

By the time FM got settled in its new location on the dial, it was too late. The lusty infant known as television had come along and swept all before it. But in late years the Major was not without hope. He had seen the public become high-fidelity conscious to an extraordinary degree, albeit more through phonograph recordings than FM radio. It may take time, he used to say, but FM still may assume the importance he originally saw for it.

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The Major's fights over patents were legendary in the industry; for himself they were an obsession. He had devoted much of the last four years to pretrial testimony in litigation with his old adversary, the Radio Corporation of America. The rights and wrongs of his position are beyond a layman's comprehension. Suffice that the Major was a controversial figure, with friends who thought he never claimed enough and foes who thought he claimed too much.

In addition to FM, the Major devised the regenerative and superheterodyne circuits that provided the sensitivity and amplification needed for practical long-range radio. The theory of the superheterodyne indeed is basic to the success of present-day communications.

Major Armstrong was one of the last of the active pioneer radio inventors; he read his last engineering paper only a few weeks ago. Though recognizing the accomplishments of corporate research, he never did have too much patience with the use of hordes of specialists to solve a problem. He always preferred to be the master of his own laboratory. That he was.

New York Times, February 4, 1954.

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Creativity in Radio

Contributions of Major Edwin H. Armstrong*

By JOHN R. RAGAZZINI
Professor of Electrical Engineering, Columbia University

I

My purpose here today is to outline the contributions and to analyze some of the factors which have contributed to the creative genius of one of the great inventors of our time, Edwin Howard Armstrong. He would have been here today to speak for himself were it not for his tragic death some months ago. In discussing Major Armstrong, I may betray a certain amount of hero worship to which I freely confess for he was an heroic figure to all who knew him. In some ways, my speaking for him may give you a better picture than he would have been able to do for himself. Possessed of an innate modesty he probably would have minimized his role and personal contributions to the phenomenal series of inventions which have laid the foundations of modern radio communications. In referring to him I shall use the appellation of Major because he preferred it over others to which he was entitled.

To emphasize the importance of the contributions of Major Armstrong, I shall outline his inventions before going into his life, his times, his education and those personal characteristics which contributed to these successes. The four basic discoveries which represent his most important but by no means only creative contributions are the regenerative circuit, the superregenerative circuit, the superheterodyne receiver, and the broad-band frequency modulation system. These will be taken up in turn.

At the time of the invention of the three-element vacuum tube named the "audion" by Lee De Forest in 1906, radio communication, as we know it today, was launched. In those early days tubes were expensive and scarce and their characteristics none too favorable, so that it was imperative to increase the effectiveness of each individual tube. Setting the then accepted theories aside and embarking on an experimental approach, Major Armstrong was able in 1912 to obtain unheard of sensitivities from a single triode. While commonplace today, the concept of reinforcing a week input signal to the tube by feeding back a small portion of the output signal was revolutionary. He not only observed this phenomenon but was perceptive enough to realize its importance as an invention which he disclosed on January 31, 1913, and finally patented in 1914. The regenerative feedback circuit made possible communications across and between continents with a minimum of tubes.

Shortly after the initial disclosure of the regenerative principle for use as a sensitive receiving detector, Major Armstrong discovered that by increasing the amount of feedback it was possible to cause self-oscillations in the circuit. The tremendous importance of this property was quickly evaluated by Armstrong because a technique for producing oscillation by this means would replace the older spark or arc transmitters then in use. He filed a separate patent applica-

* Presented at the Annual Meeting of ASEE, University of Illinois, June 16, 1954.

tion for this circuit, a factor which later cost him heavily in patent litigation. De Forest was able to win an interference suit in 1924 which resulted in the issuance of patents to himself for the oscillating audion and regenerative circuit and the rejection of Armstrong's application for a patent on the oscillator circuit. Ultimately, as late as 1934 and after long and expensive litigation, the Supreme Court upheld the contention that De Forest was the inventor of the regenerative circuit and oscillator although the engineering and scientific societies, including the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Franklin Institute, generally discredited this decision by awarding medals and honors to Armstrong for his inventions including the regenerative circuit.

These brief references to Armstrong's patent litigation are cited not so much for their importance to the purpose at hand but to emphasize early in this talk a facet of his character which led him to fight tenaciously for what he considered to be right. This he did even when it cost him heavily and when he might have benefited financially by accepting an adverse decision. His lifetime will show many other instances of this characteristic.

Superheterodyne Reception

Chronologically, the second of his great discoveries was the system of superheterodyne reception. The first in the sequence of events leading to this invention was, the heterodyne principle which he studied experimentally and presented in his outstanding paper before the Institute of Radio Engineers in 1916. This paper laid the foundations for the future by rationally explaining the phenomenon of beating two high frequency inaudible signals to obtain an audible difference frequency signal. During World War I, the principle of superheterodyne reception was synthesized as a result of speculation on his part that attacking German bombers could be fired upon more accurately if they could be located by picking up the radiation from their ignition systems. The frequency content of this radiation was very high for those days and could not be picked up by then existing methods. The whole concept suddenly occurred to Armstrong that if he could reduce the frequency of the short waves to a value more manageable for amplification, receivers of much higher sensitivity could be designed. In retrospect, this seems to be a natural outgrowth of his early studies in the field of heterodyne detection. In his 1916 paper, Armstrong was dealing with the reduction of the frequency of a received signal from a high inaudible frequency, say 100 kilocycles to an audible frequency of, say 1 kilocycle, by beating with a local signal at 99 kilocycles. The principle was extended to take a very high radio frequency, say 10 megacycles and beat it down to an intermediate but inaudible frequency of say 150 kilocycles, amplifying at this frequency and then detecting the audible signal in this amplified signal. This invention was not used for its original purpose in World War I but it did become the basis for practically all radio reception including radar. It is interesting to note that the circle was completed only in World War II when radar detection of enemy aircraft came into its own using, a reception technique invented by Armstrong for the same purpose more than twenty years earlier. It can truly be said that the invention of the superheterodyne receiver represents a superb exhibition of inventive genius where one step logically led to another and a set of unrelated facts were synthesized into a useful device.

Shortly after his return from World War I, Major Armstrong became involved in the first of a series of court suits in defence of his patents. It was while carrying out an experiment at Columbia University to prove convincingly that statements made by opposing counsel were in denial of fundamental truths that he came upon the principle of superregeneration. While testing a regenerative circuit using a miniature transmitter located across the room without an antenna, he noted strange signals coming in with unbelievable signal strengths. Numerous transmitting stations were identified and their signal strengths were far beyond those observed in previous regenerative receiver tests. Far from ignoring this effect, he tenaciously studied it and finally brought to light a new principle of regeneration. What had happened was that the regenerative detector was being triggered on and off oscillation at an inaudible rate so that on the average, the circuit was being operated at a condition of tremendous gain located near the point of incipient oscillation. It was his ability to recognize that he had found a basic and important new principle that accentuated his genius, for it must have been true that many other experimenters had noted the effect previously. As a matter of fact, Armstrong himself came upon some old notes indicating that he had produced superregeneration in his early experiments many years before but failed to recognize it. This is a lesson that he never forgot and one which made him emphasize his persistence and care in experimentation lest unusual phenomena should go by without being noticed.

Frequency Modulation

Major Armstrong's final important invention was that of static-free frequency modulation reception known as FM. Ever since his early days with Pupin at Columbia, he had dreamed of the day when static, that is natural and man-made electromagnetic disturbances, would be overcome and useful signals could be received clearly and with high fidelity at all times. The basic technique used by Armstrong to solve this problem was to employ a system of modulation in which the intelligence was applied to a carrier signal by varying its frequency. This idea was by no means new, having been considered by numerous authorities in the field and having been discarded as impractical and as having no particular advantage over the current amplitude modulation system (AM).

In particular, expert opinion of the day was that the comparison between FM and AM based on both theory and experiment indicated no particular advantages for FM. This situation would have been enough to discourage any investigator from going much further. However, Major Armstrong had other ideas. He studied some of his concepts developed as far back as 1915 which led him to believe that broad-band, not narrow-band FM was the key to the problem. In view of the fact that the energy of the random noise or disturbances admitted into a circuit is proportional to its bandwidth, his notions seemed completely contrary to accepted concepts. The only trouble was that these concepts, correct as they were, were being applied to only one form of FM and did not reckon with the basic element in the Armstrong system which included the amplitude limiter. This device clipped off all amplitude variations superposed on the signal by unwanted static and permitted only the desired frequency variations containing the intelligence to pass through. The broader the frequency swing of the desired signal, the less significant would be the undesired swings due to noise. It was simply a case of the right theory being applied to the wrong model and again Armstrong proved that he was by far a more precise mathematical thinker even though he did not indulge in the writing of mathematical relationships.

In any case, the broad-band FM system including the all-important amplitude limiter was patented in 1933. This invention made possible the reception of almost completely static-free signals even in the midst of violent thunderstorms in the immediate vicinity, and this was indeed a technological triumph. Accompanying this great advantage was that of high fidelity made possible by the broader bandwidth employed by the system. Also, it was possible to prevent interference between adjacent stations since the Armstrong system caused the weaker station to be completely suppressed. By employing higher carrier frequencies he opened up a new large piece of the frequency spectrum to broadcasting. Finally, the cost of construction and operation of FM stations was less than that of AM stations with the same coverage.

Conflict of Interests

However, it was one thing to achieve this tremendous success and still another to bring about its acceptance by the broadcasting industry and the government. The conflict of interests between established organizations, like the Radio Corporation of America, and Major Armstrong had begun in all seriousness. The fight to bring about adoption of this, his greatest invention, consumed so much of Major Armstrong's time and energy that he was diverted from his primary activity of study and experimentation. FM proved to be the last of his great inventions and most of his activities from the issuance of the FM patent to the time of his tragic death were directed to the fight for adoption of FM. His devotion to this task proved to be so intense that his FM fight has often been referred to as his Cause. He was cast in the role of the lone inventor pitted against the array of great corporations that characterize our economy. In this task he was as dogged, as brilliant and as assured as he had ever been in ferreting out an interesting and peculiar phenomenon in the laboratory.

This recital of the most important technical achievements of Major Armstrong is by no means complete. It has been given to bring into focus the magnitude of his creativity and life-long achievement and to provide the framework into which to attempt to fit the human being that was Major Armstrong. The remainder of this discussion will be devoted to an attempt to explain the factors which contributed to his amazing record.

II

Edwin H. Armstrong was born in 1890 and spent much of his youth in the city of Yonkers, which as you probably know lies adjacent to New York City. While not wealthy, his family lived comfortably, his father being United States representative of the Oxford University Press. In view of his father's position it is not surprising that he was an avid reader of books, a factor that influenced the course of his life. That his preferred reading dealt with the lives of such great inventors as Volta, Hertz and Marconi was significant. One of his favorite idols was Faraday whose accomplishments he rivalled in later life. During his teens Armstrong filled his attic room in the Armstrong house in Yonkers with all the paraphernalia of the typical radio ham, including various wireless contraptions such as coherers, interrupters and spark coils of the day. Most of his spare time was spent listening to the dots and dashes of other radio hams in Yonkers and vicinity and occasionally picking up Naval and commercial stations both near and far. By the age of 19 Armstrong was ready to enter college and the maturing of the amateur into the professiónal had begun. It is important to note than even before entering college he had decided with typical singlemindedness to become an inventor in the field of radio and never to the day of his death did he waver from that objective. This man was no confused uncertain young teenager who had to have someone else make up his mind for him!

In 1909 Armstrong entered Columbia University to study electrical engineering and came under the influence of the great inventor and teacher, Michael Pupin, who was then Professor of Electrical Engineering. It was soon evident that, aided by formal training in electrical engineering, he had developed a knowledge of radio which far exceeded that contained in the textbooks of the day or, for that matter, of many of his instructors. His outstanding performance in this regard led him to study the performance of the then new and revolutionary De Forest audion while still a college junior. His experimentation resulted, as noted before, in the invention of the regenerative detector in the year 1912.

Scientific Turn of Mind

It is important to observe that a major technical contribution made by Armstrong about this time was not just the regenerative circuit itself which was an invention of first rank but also the explanation of the operation of the triode vacuum tube. Until then, it had been regarded as a trigger device, but Armstrong, with typical clarity and logic showed that its performance could be explained by the use of a characteristic curve and laid the groundwork for the vacuum tube circuit theory of today. This illustrates a scientific turn of mind possessed by very few undergraduate students today.

One might be tempted to conclude that Armstrong was a bookworm or possibly a "lab-worm" who paid little or no attention to other aspects of student life. Nothing could be further from the truth. While in college he rode, somewhat recklessly it is said, the hot-rod of his day—a red Indian motorcycle. He entered the usual freshman-sophomore contests and became a tough competitor on the tennis court. The latter sport was one of his favorites and he played well until he sustained an injury to his shoulder in later life. Nevertheless, despite these recreations, Armstrong never wavered from his primary objective, radio. By the time he was a college senior, Armstrong had a basic invention and the benefit of association with Pupin, a foremost inventor in his own right.

Because of his intense interest in his subject and because laboratory facilities would be available to him, Armstrong accepted an assistantship at Columbia University where he continued his work. His salary was quite low, only $50.00 a month, and I have often heard him relate how he used to have his one meal a day at a small restaurant on Broadway near the University because the proprietor was so foolish as to allow him all the bread he could eat with his meal. Not long after his acceptance of this post at the University, his regenerative patent issued and royalties began to pour in at the rate of about $8000 per year.

One might note here that the excellent guidance he received from Pupin and his associates on the management of his affairs as an independent inventor may have laid the seeds of much unhappiness and frustration in later years. Had he renounced all commercial advantage or financial return as his idol Faraday, his creativity might have been even greater because much of the energy he diverted to court actions and litigation would have been available for scientific work. But such was not to be, and much of Major Armstrong's life was spent in the defence of his rights as he saw them. It is interesting to note, however, Armstrong never relinquished his interest in or association with Columbia University and its freedom of thought and investigation, taking over and holding until his death Pupin's chair in electrical engineering. He was always the serious-minded, thorough, experimental scientist.

World War I found Armstrong in uniform as a captain in the Signal Corps. Whoever was responsible for assignment of personnel at that time should be congratulated for having placed Captain Armstrong in a position where he could help solve the problems of communications from ground to aircraft and many other similar problems in which he was a foremost expert. It was in this service that the inspiration for the superheterodyne receiver came to him. Discharged as a Major, he returned to Columbia to resume his life as a scientist and inventor.

Court Clashes

Once back, Armstrong entered into the first of his many court clashes in defence of his patents. The whole question of the regenerative circuit and oscillator against De Forest came up and during the proceedings, Armstrong was made an offer of $335,000 by Westinghouse Company for his regenerative and superheterodyne patent rights. In the meantime, he returned to his work on static elimination with Pupin and accidentally discovered, as described previously, the principle of superregeneration. Concurrently, he participated in the series of tests in 1921 sponsored by the American Radio Relay League which resulted in the successful communication between the United States and England on so called short wave transmissions at a wavelength of about 200 meters. It is significant to note that his colleague, Paul Godley, who picked up the signal in Scotland, used a superheterodyne receiver. Shortly after these tests his superregenerative patent issued, and by 1922 he negotiated with the Radio Corporation of America who wished to buy the rights. Negotiations were completed resulting in the payment to Armstrong of $200,000 in cash and 60,000 shares of RCA stock. This block of stock, combined with 20,000 additional shares for later services, made Armstrong one of the largest stockholders of the growing company. Financially, Armstrong was a multi-millionaire but this made little or no difference to his devotion to radio and his quest for static-free reception.

As a result of many visits to David Sarnoff's office at RCA, he met and courted Sarnoff's secretary, Miss Mac Innes. During this period he lost no opportunity to impress her with feats that were often quite daring and which reflected a bold and boyish personality. The most memorable of these was his hand-over-hand climb of the 400 foot tower of radio station WJZ. When he reached the top he stopped to pose for photographers. Whether or not this had any significant effect on his courtship is hard to say. At any rate, he and Miss Mac Innes were married in 1923.

Shortly after his marriage, Armstrong resumed his series of experiments at Columbia, which culminated in the invention of wide-band FM in 1932 with the patent issuing a year later. It was the fight for adoption of FM which constituted his most bitter series of disappointments. Armstrong tried to interest RCA in his new invention but for reasons which can only be speculative, but which involved the problems of existing investments, the coming of television and possibly personal relationships, he was rebuffed in a manner which offended Armstrong's sense of fair play. At any rate, it may be said that he declared war on RCA to the extent of turning down in 1940 an offer of 1 million dollars for a royalty-free license. The concurrent fight for broadcasting allocations was carried to the Federal Communications Commission where Armstrong finally obtained the allotment of a band in the 40 megacycle range for FM broadcasting. After the war, despite the fact that 500,000 sets were thereby rendered obsolete, the FCC moved the FM band up to its present 100 Megacycle range. This dealt a hard blow to FM, but still it flourished so that by 1949 there were 600 stations on the air. Throughout this latter period, however, RCA was waging war on Armstrong's patent position and most set makers were not paying royalties to Armstrong but were using the so-called ratio detector based on patents held by RCA. Armstrong claimed that this was an infringement and brought suit. The suit was at the stage of pre-trial hearings at the time of his death.

Armstrong fought the battle for FM with the same tenacity he used when attacking his technical problems. Above all, he was outraged at what he considered unfair treatment by RCA, and this may have affected his better judgment so far as personal advantage was concerned. His wife and his colleagues would have wished him to retire and enjoy his remaining years surrounded by loyal friends and revered as elder statesman of radio. The fact that he continued his fight was characteristic of the dogged tenacity which was so essential to his success.

III

Let us try now to review the important characteristics which may have contributed to Major Armstrong's creativeness in research. First, and foremost, he possessed a genius and character which was God-given. Placed in exactly the same circumstances, only a very few human beings would have had the capacity to achieve a fraction of what Armstrong accomplished. He was single-minded in his objective in life. He was thorough, very hard-working and indefatigable. When asked how Armstrong managed to achieve what he did, one of his assistants stated that he was willing to spend 23 out of 24 hours of his day concentrating on radio. If ever there was an example which illustrated the cliche that creative research is only slightly inspiration and mostly perspiration, he was it. He would repeat an experiment over and over again with little or no regard of the hour until every peculiar effect was fully explained.

The second important factor in his life was the professional education which he received. While he no doubt benefited greatly from his amateur radio activities before entering college, it was his formal education which matured him professionally. In addition, he came under the influence of a foremost teacher, inventor, and scientist in Professor Pupin who earned the reverence of young Armstrong. By making laboratory facilities available to Armstrong, Pupin greatly furthered his productivity.

The third important factor was the timing of his career. The time was ripe for the exploitation of the vacuum tube. Great research organizations sponsored both by industry and government were not in existence and the individual inventor had a good chance to do significant work. The type of work done by Armstrong as an individual in the early decades of the twentieth century is done now by whole organizations of engineers and scientists. It is correct to state that Armstrong is probably the last as well as possibly the greatest individual American inventor.

Fantastic Capacity To Think In Physical Terms

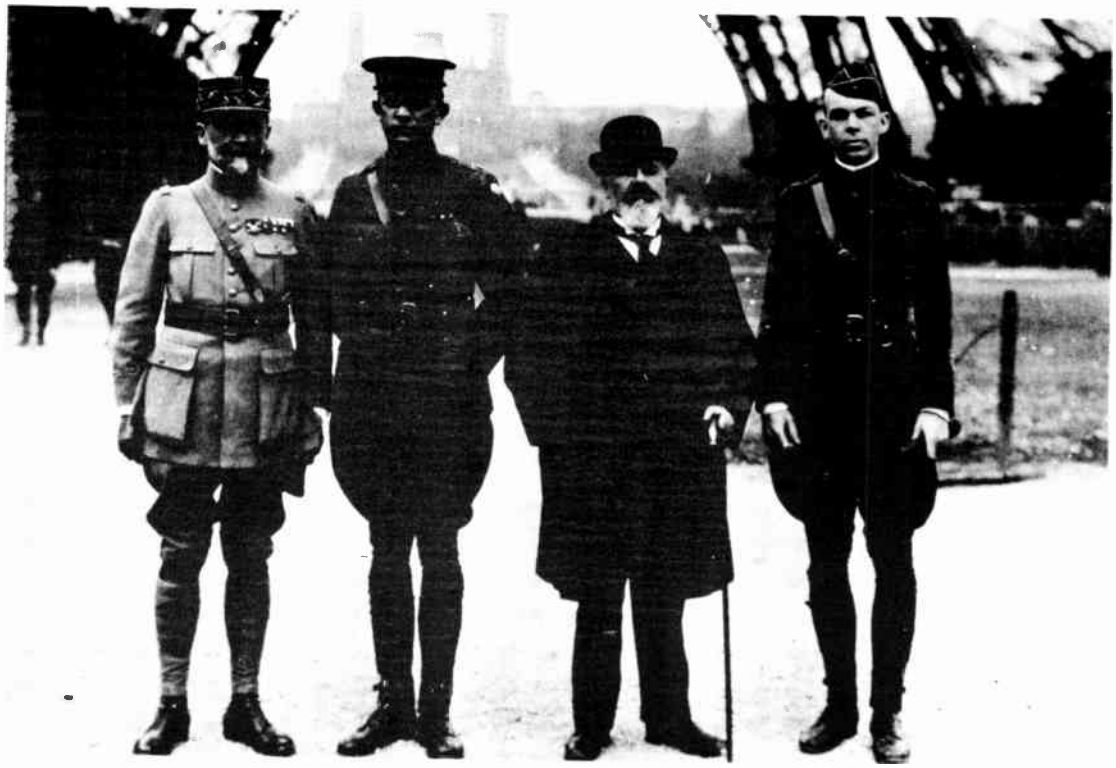
The fourth factor was Armstrong's fantastic capacity to think in physical terms. It is often said that he was a non-mathematical thinker, but such a statement would have been challenged by Pupin. If by mathematics one means simply the formal writing of symbolic mathematical relationships between quantities, he was indeed non-mathematical. A striking characteristic of his papers is that they are generally devoid of any equations. However, if one means by mathematics the exact science of rigorously following one step of logic with another to describe the whole, not necessarily using symbolism, then Armstrong was a foremost applied mathematician. It has been said that he disdained and distrusted the mathematical approach. However, from personal experience I know that he had the highest regard and respect for those who used the mathematical approach. What he objected to was the use of mathematics for its own sake or the application of erudite mathematics to an incorrect physical model resulting in the prediction of an incorrect performance. He demonstrated this devastatingly with his invention of broadband FM. As an experimenter, Armstrong had the uncanny faculty of observing effects and then assembling them into a logical whole thereby producing a clear concise and correct picture of a particular phenomenon. He demonstrated this over and over again starting with his early description of the performance of the triode, explaining the phenomenon of heterodyne and finally pre-

Etching of E. H. Armstrong

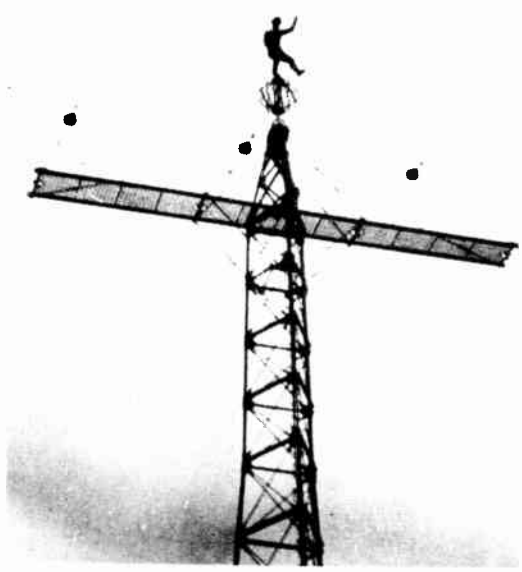
Edwin Howard Armstrong (1890–1954) is portrayed in the latest of the series of etchings published by the International Telecommunications Union. Born in the city of New York, he was educated at Columbia University with which he was closely associated until his death.

Major Armstrong contributed four outstanding inventions. His regenerative circuit of 1913 supplied a much-needed increase in sensitivity and selectivity to the early vacuum-tube detector. In 1918, he produced the superheterodyne that is the basis of practically all modern radio receivers. It allows unlimited increases in selectivity and sensitivity without impracticable multiplicity of controls or instability. It makes the noises developed in the circuits preceding the amplifier the real limitation on over-all gain. Two years later, superregeneration promised to supplant all other methods of reception, particularly at the higher frequences, but some inherent limitations restricted its applications severely. In 1933, his method of wide-band frequency modulation provided the first practical system of eliminating the effects of static; it makes the acoustical output of thunder more damaging to reception of music during a local thunderstorm than the electrical disturbances of the lightning that produces the thunder.

The etching of Armstrong is the twentieth in the series that was started in 1935. On a good grade of paper measuring 9 by $6\frac{5}{8}$ inches (23 by 17 centimeters) including margins, these etchings are available at 3 Swiss francs each from Secrétariat général de l'Union internationale des Télécommunications, Palais Wilson, 52, rue des Pâquis, Genève, Suisse. The entire series is comprised of etchings of Ampere, Armstrong, Baudot, Bell, Erlang, Faraday, Ferrié, Gauss and Weber, Heaviside, Hertz, Hughes, Kelvin, Lorentz, Marconi, Maxwell, Morse, Popov, Pupin, Siemens, and Tesla.



Major Armstrong shown in the attic room of his family residence on Warburton Ave. in Yonkers N. Y. where he made some of his greatest discoveries. The picture was taken about 1950.



Armstrong standing on top of the ball on the antenna tower of RCA Broadcasting Station WJZ, Aeolian Hall, 42nd Street, N. Y. C., 400 feet above the street, in May 1923. WJZ was the first broadcasting station in New York City proper and the pictures were taken just before the opening ceremonies began. As a result of this stunt Gen. Mgr. Sarnoff declared the roof permanently "off limits" for Armstrong.

Opposite page, bottom. Armstrong (right) in Paris during World War I where he invented the Super-heterodyne. Left to right: General Ferrier and Prof. Abraham of the Sorbonne.

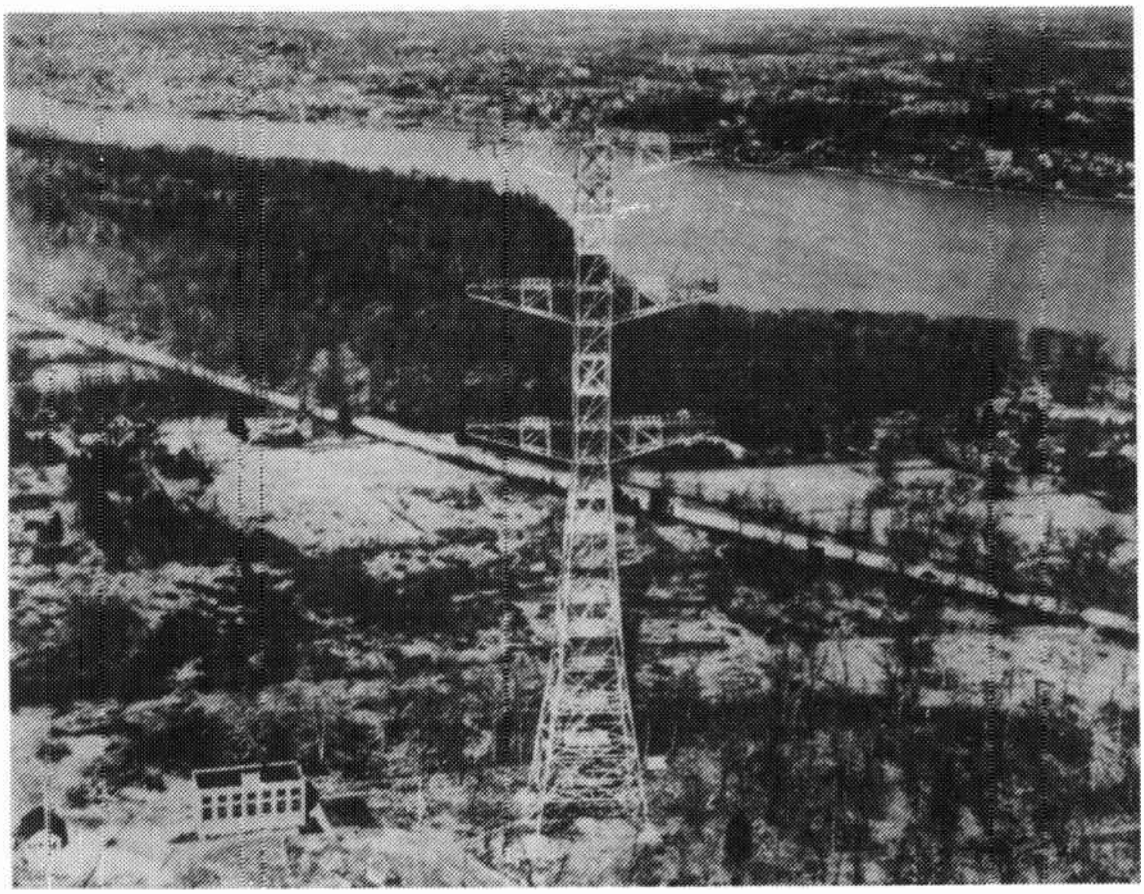
dicting the effect of broadband FM on noise reduction.

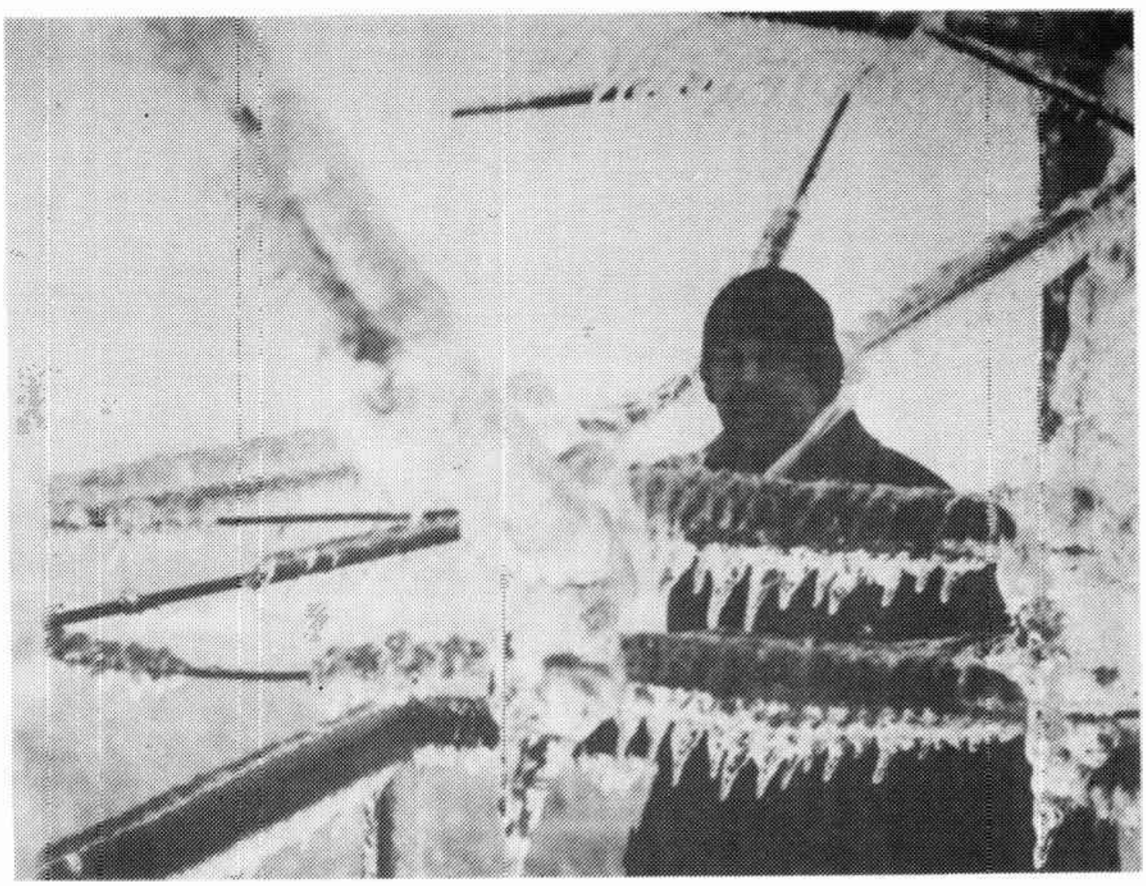
The fifth factor of importance was his ability to inspire loyalty among his colleagues and assistants. Armstrong was recognized by all as an important figure. Yet he retained a modesty and self-effacing character which made all who knew him or worked for him respect and like him. I asked him on at least two occasions to tell me what it was that was responsible for his enormous productivity and success. The question embarrassed him and he evaded a direct answer by reciting certain factual occurrences in his professional life. Never did he play up in any way his personal role. Probably he did not really know exactly what it was that made him the great man he was. His generosity and loyalty towards those whom he felt dealt honestly with him was renowned. At the same time his tenacious opposition to those he felt did not was equally well known.

Youthfulness of Outlook

Lastly, a factor which undoubtedly contributed to Armstrong's productivity was a youthfulness of outlook, a boyish enthusiasm which is hard to define. It was brought out tangibly in a number of his more daring feats such as the memorable climb to the top of the WJZ tower, or his swinging at the top of his Alpine tower in a boatswain's chair to adjust the antenna feed for his FM station. More intangibly, it shone in his eyes when he talked about his work. I shall never forget my last meeting with the Major, some two months before he died. The occasion was dinner at his apartment to which I had been invited to meet a business acquaintance of his who had a research and development proposal which he thought might be of interest to me. The Major was in a good mood. Only occasionally did he show a few flashes of the loneliness which lifelong concentration on his work brought upon him. At the end of a most enjoyable evening, his other guest and I bade him good night in the foyer of his apartment. I clearly remember him as I shook his hand. He was tall, powerfully built, one shoulder drooping slightly, his head bald, smiling his typical crooked smile, and looking a bit tired. But the most striking thing of all was the characteristic twinkle in his eye which belied his age and was like that found in a young man looking forward to another exciting day. Perhaps this was the most important asset of them all.

Major Armstrong died on February 1st of this year. At the time of his death he was in the midst of his greatest battle for FM. Regardless of the rights or wrongs of this or any of his other conflicts, opponents as well as partisans will probably agree that Major Armstrong was the most important creative thinker and inventor of all time in the field of radio and that his passing marks not just the end of the life of a great man but also the end of an era.





RADIO AND TELEVISION

By JOHN CROSBY

The End of KE2XCC

Radio station KE2XCC closed down on Saturday. And that ends an era. KE2XCC at Alpine, N. J. (hereinafter referred to as the Alpine station), was the first frequency modulation station in this country.

John Crosby

When Maj. Edwin H. Armstrong erected it in 1938, it sent cold shivers down a lot of spines. Television was still a gleam in David Sarnoff's eye. Frequency modulation threatened the peace of mind of every broadcaster who was making plenty of money out of amplitude modulation broadcasting (which is ordinary radio broadcasting, as we know it). FM was not only free of static but it reproduced sounds with a fidelity never dreamed of before.

* * *

Of course, these days, when we have Hi-Fi and FM sound transmission on every television set, this is all old hat. But it wasn't old hat in 1938 when this belligerent genius built the Alpine station. I remember a demonstration Ed Armstrong ran at Alpine in those days. He invited a lot of newspaper men out and lined them up face to the wall. Then he poured a tumbler of water from one glass to the other. A second or two later the Alpine station broadcast the sound of a tumbler of water being poured from one glass to the other.

Armstrong defied the newspaper men to tell one sound from the other—the broadcast from the real. Now there is conceivably no more delicate sound on earth than the plash of water passing from one glass to another. But the difference was undetectable. Yet, to my knowledge, not a word appeared in any newspaper about this spectacular demonstration.

* * *

Armstrong was forever scaring people with his magnificent and terrible inventiveness. When he was in the Signal Corps in the first world war, he invented the superheterodyne, without which modern radio wouldn't be possible. He sold this and another invention and bought RCA stock which made him rich.

But he was forever quarreling with RCA over the use of his inventions, and forever suing them, so he sold his stock for several tons of money because he felt that it put him in a funny position. He was one inventor who did not live in a garret. Or, anyway, it was a terribly luxurious garret. He used to live in River House which, before it was remodeled, was one of the citadels of the very, very rich and the only apartment building I know with its own yacht basin.

He took me on a tour once years ago through what seemed like an acre of corridors in this apartment. But where you expected to find libraries or guest rooms, every chamber was piled with electronic equipment that he was forever fiddling with.

* * *

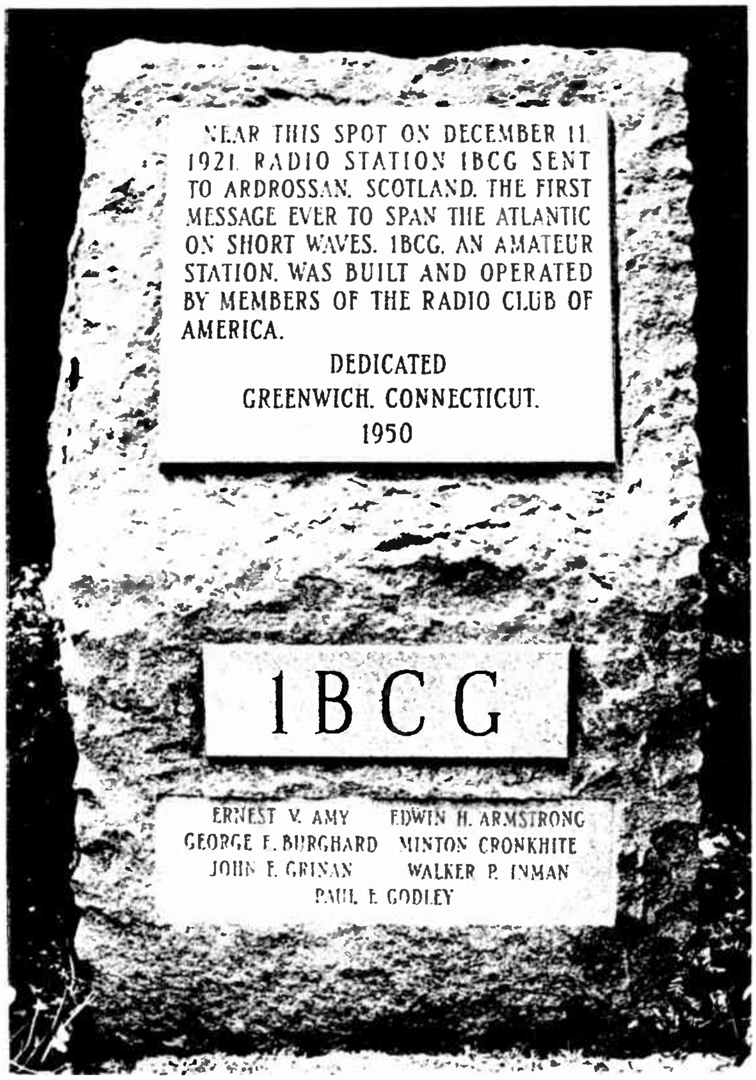
Alpine spent about $1,000,000 broadcasting good music, which was relished by many residents in and around metropolitan New York. But it wasn't the music that interested Ed Armstrong. Alpine started and ended its days as an experimental station. The station and Ed Armstrong endlessly experimented with new transmitters, new uses of FM (it was at Alpine that the Army—and later the Navy and the Marines—decided to adopt FM for mobile communications), for the propagation of ultra-short waves, new ways of relaying radio signals, and, most recently, the transmission of two programs on the same channel.

His was a restless genius, Armstrong's, perennially dissatisfied with things as they are. And when he plunged to his death Feb. 1, the world lost one of the great theoretical minds of our generation.

New York Herald Tribune.

Airview of station KE2XCC at Alpine, New Jersey (opposite page, top). It was originally W2XMN on 43.1 megacycles, built and operated by Major Armstrong in 1938 to demonstrate the merits of his FM system. The 300-foot tower, which is a landmark, the buildings, maintenance, and operation cost him over $1,000,000. From here he maintained high fidelity FM broadcasts for music lovers to show the effectiveness of his new system. The station was closed down on March 6, 1954.

Armstrong on the top of the Alpine tower in mid-winter, trying to clear away the huge amount of ice from the antenna.



The monument as it now looks with the names of the six staff members and that of Paul Godley inscribed below "1BCG."

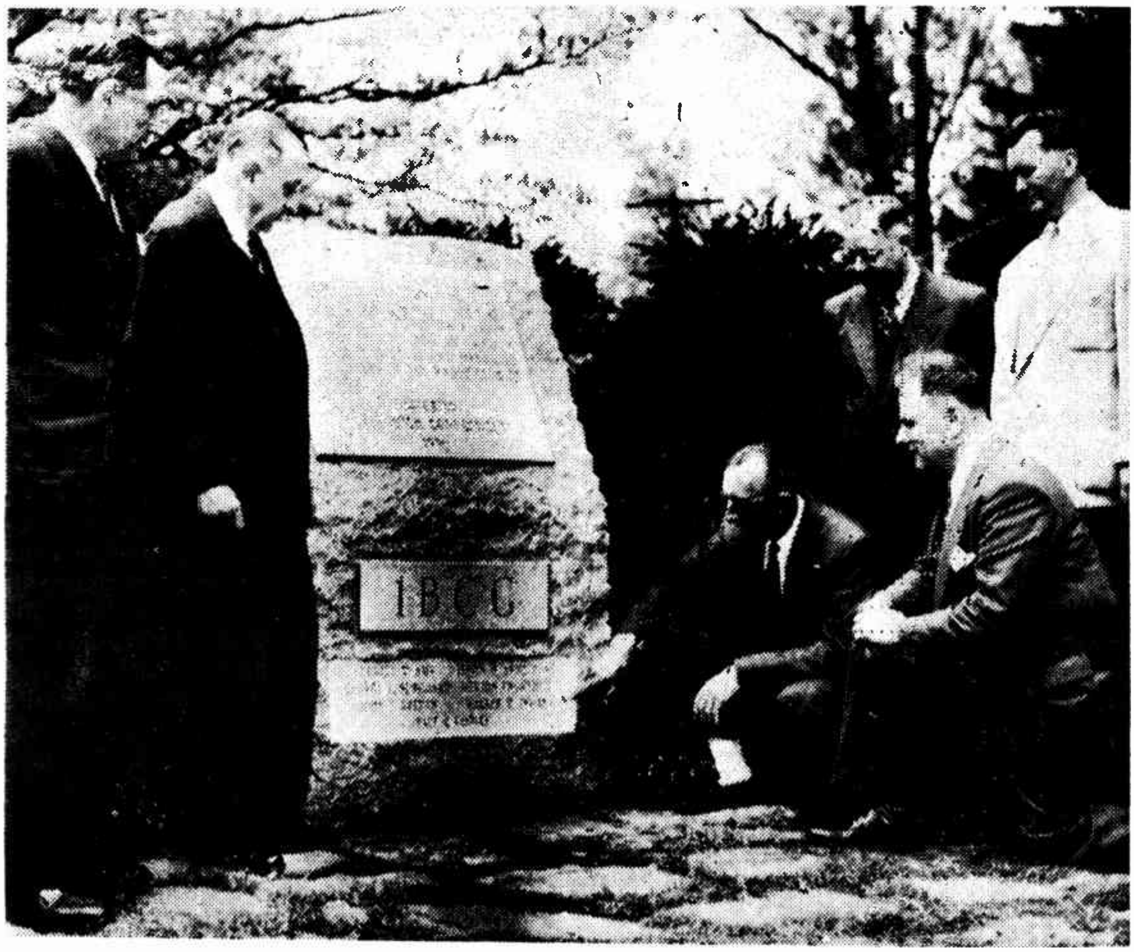
The Board of Directors had originally intended to inscribe the names of the staff of station 1BCG on the monument at Greenwich when it was first erected, but Armstrong had always objected saying that they are all still alive and you just don't put a living man's name on a monument. The Board therefore felt that as an additional tribute to Armstrong the names should now be inscribed. This was done and at a small ceremony at Greenwich on May 11th. 1954 the work was consummated.

As a further tribute to Armstrong a group of his old friends and associates together with the Radio Club and the Engineering Council of Columbia University formed the ARMSTRONG MEMORIAL RESEARCH FOUNDATION Inc. on November 21st. 1955. The original Charter members and Directors were:

Ernest V. Amy, Harold H. Beverage, George E. Burghard, George J. Eltz, John V. L. Hogan, Harry W. Houck, Walter S. Lemmon, Alfred McCormack, Harry Sadenwater, Joseph Stantley, Thomas J. Styles, Dana M. Raymond, Robert W. Byerly, John R. Dunning, C. R. Runyon Jr., James R. Day, Frank A. Gunther, John H. Bose, Raymond A. Heising, Frank H. Shepard Jr., Evan B. Lloyd, Edward L. Bowles.

Officers: George Burghard, President; Harry Houck Vice President, Thomas Styles, Sec-

Historic Event Commemorated At Gathering



Members of the Radio Club of America met yesterday noon at the monument located at the intersection of North St. and Clapboard Ridge Rd., site of Amatur Radio Station 1BCG, which on Dec. 11, 1921 sent the vrst message ever to span the Atlantic on short waves. It was recei ed at Androssan, Scotland. The club members commemorated the event with addition of names of original senders of the message to inscription on the monument. Kneeling above are Francis Fahey. pointing, who inscribed the names, and Frank H. Shepard, president of the Radio Club of America. Standing, left to right: Ernest V. Amy and George E. Burghard two of the original senders; Harry Sadenwater and Greenwich Superintendent of Parks and Trees Joseph A. Dietrich. —Staff photo by Verderosa.

Greenwich Times, Wednesday, May 12, 1954.

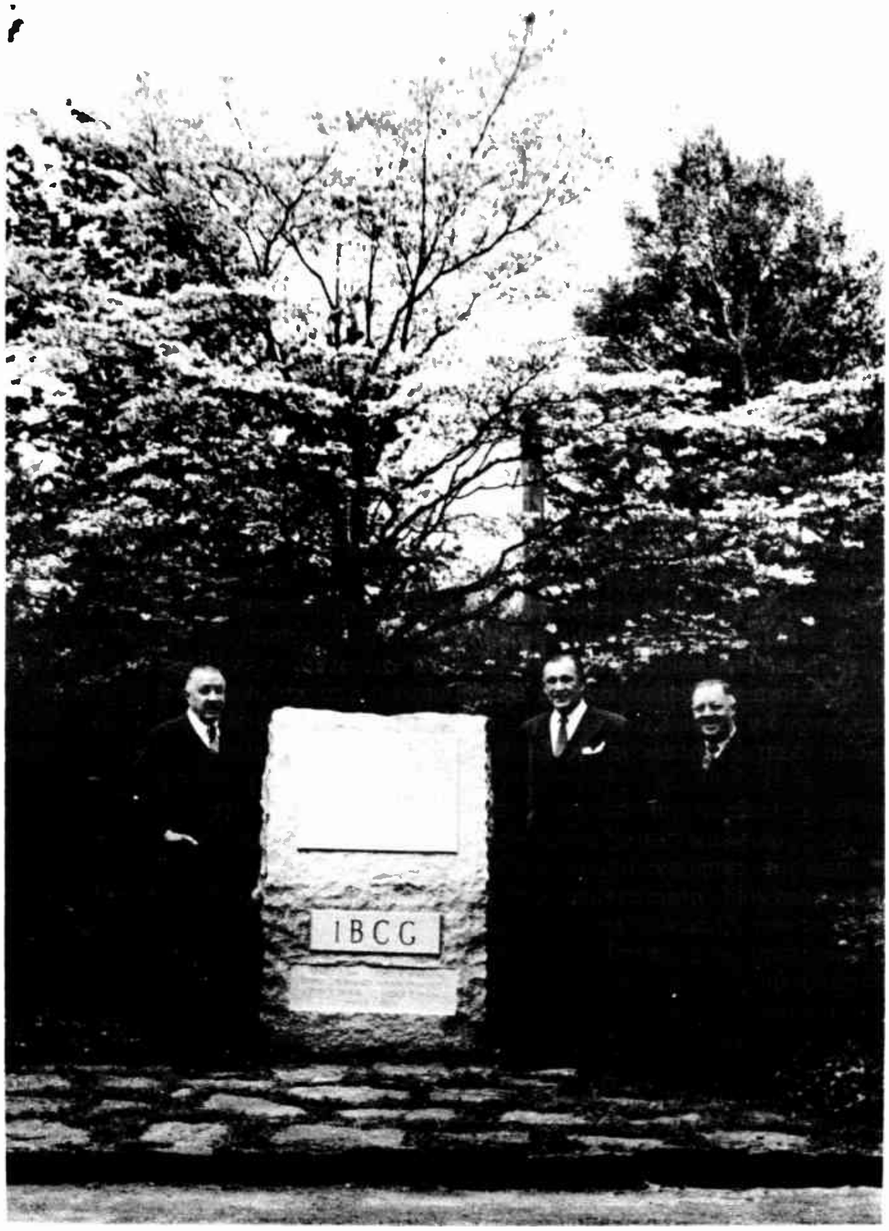
retary and Joseph Stantley, Treasurer. The purposes of the Foundation are set forth in the Charter and We quote:

"(a) to honor the memory of the late Professor Edwin Howard Armstrong by helping to perpetuate the principles that guided him in a life devoted to basic research in electronics;

(b) to aid voluntarily in the continuation of the basic research that was carried on by Armstrong at the Marcellus Hartley Laboratory at Columbia University in the City of New York; and

(c) to contribute voluntarily to the education and training of engineers and scientists capable of doing basic applied research in electronics and related fields of science."

The Foundation now numbers some one hundred members in its four classes of membership ie. Founding, Sustaining, Contributing and Associate, and has succeeded in collecting



Left to right: Burghard, Amy and Sadenwater standing before the monument with tree in full bloom as background, after ceremonies, on May 11th. 1954.

over $60,000.00 from dues and contributions. $40,000.00 of this has been pledged to build and equip the Armstrong Physical Electronics Research Laboratory in the new Engineering Center at Columbia University and with a bright future in view it is hoped that other projects such as scholarships etc. will be forthcoming.

In 1956 the Armstrong Medal was awarded to one of Radio's real old timers, Melville Eastham founder of the Clapp-Eastham Co. one of the pioneer manufacturers of radio measuring apparatus and equipment. The presentation was made at the 47th. Anniversary banquet held at the Columbia University Club.

Fiftieth Anniversary Committee of the Radio Club of America. Left to right, seated: Harry Houck, Pierre Boucheron, Frank King, W. E. D. Stokes Jr., Standing: George Burghard, C. R. Runyon Jr., Ralph Batcher, Harry Sadenwater, Ernest Amy, Walter Knoop. Not present: Frank Gunther, Frank Shepard, and George Washington Jr.

The present administration of the Club is very much aware of the effect of the great change in our way of life on the future of the club. Accordingly President Knoop has recently appointed a special committee to search into every phase of this complex situation and come up with recommendations as to the proper procedure to insure the future welfare of the oldest Radio Club in continuous existence in the World.

President Frank Gunther in 1957 appointed a special 50th. Anniversary Committee to make proper arrangements for the Golden Jubilee celebration in 1959. This Committee has been hard at work ever since. The plans are, to publish a Golden Year Book along the same lines as the 25th. Anniversary Silver Book, and to hold a grand Banquet on December 4th. 1959 to which, for the first time in Radio Club history the ladies will be invited. It should be a very festive affair indeed and well under way by the time these lines are printed and the Golden Year Book is ready for distribution.

This brings our story to an end. Again we must express our regrets that due to lack of space it has been impossible to write about the many excellent contributions of the Radio Club of America members to the Radio Art. If you will take the time, however to carefully read the other sections of this Book we feel sure that their magnitude will become increasingly apparent. Now that our first fifty years have been successfully accomplished we sincerely hope that the Club will live for many years to come in the same spirit and with the same high ideals upon which it was founded.

It All Began With Radio

David Sarnoff
Honorary Member 1926

The adventurous men who founded the Radio Club of America were, in a very real sense, pioneers in a new age—the Electronic Age.

It all began with radio—with spark coils and slide wire tuners. Over the years, the principles of radio were applied to an ever widening area until, today, electronics permeates virtually every aspect of our daily lives..

It has profoundly transformed our concepts of defense, communications, transportation, entertainment, business and industrial operations, and has had a significant impact on our living.

During the past half-century, the Radio Club of America and its members have contributed importantly to the vast evolution from radio to electronics. This evolution has manifested itself in five broad phases.

The *first phase* involved the application of radio principles to communications. This began with wireless telegraphy, and in later years grew into radio-telephone and telegraph communications by long wave, short wave and microwave.

The *second phase* of electronic development brought radio broadcasting as a service to the public. Over the years, this medium grew from an exciting novelty to a durable force possessing immense cultural and economic impact.

The *third phase* saw electronics turned with remarkable effect to military uses in World War II. Radar, sonar, loran, shoran and the infrared "sniperscope" were but a few of the devices that figured prominently in the Allied victory.

The *fourth phase* of electronic development brought television—first in black-and-white and now in brilliant color—to broaden and brighten the human horizon.

The *fifth phase* of electronics is only just beginning, yet it seems likely to exercise the most profound influence upon our lives. This phase is perhaps most dramatically symbolized by the computer which monitors space explorations, guides missiles, operates automated factories and speeds up accounting and office work.

The crude attic radio devices have long since given way to highly complex and sophisticated instrumentation. But one thing has not changed over the past fifty years. The thrill of experimentation and the excitement of discovery that motivated the founders of the Radio Club of America are as fresh and vibrant today as ever.

It is this perennially youthful spirit of high adventure, and the new knowledge and the new tools with which we can work, which convince me that radio, television and electronics will make vastly greater progress in the next fifty years than they have in the last fifty.

AFTER 50 YEARS OF HISTORY—WHAT ABOUT THE FUTURE?

The Club from its beginning has shown itself capable of coping with changing times. It has had few certainties for guidance. In its early years, it had little more than hopes and limited opportunities, but these it has met nobly and with distinction.

History may be defined as the past revealing itself to the present. In a subtle way, it tells about the future too, for the inevitable changes that lie ahead always grow out of the things that were accomplished and the motivating spirit of the years gone by. If we do not clearly understand its past, we cannot wisely guide its future.

The past is an accomplished span of history to be looked at and studied, while the future remains a task to be solved, which will call for continued undismayed wisdom to pilot its course in the uncharted future that lies ahead.

Let us understand the Club's history and be guided by the voice and spirit of our past. At times some of us may have a tendency to become chronically undecided about how to view the future.

The voice of our past is simply the record of what our wise officers and members did for the Club, and who they were and still are, down through the past 50 years of its history. Its future can be assured by carrying on that undaunted spirit and wise leadership that is so basic to our heritage.

Let the Club continue to distinguish itself from the purely scientific and technical societies by its freedom of speech and less commercial atmosphere in the interchange of ideas, with a sustained effort to provide social rallying opportunities for its members with suitable recognition or awards from time to time to those whose achievements entitle them to special distinction in the ever expanding science of radio and its allied fields.

ERNEST V. AMY

A HISTORY OF THE RADIO CLUB OF AMERICA, INC.

Part III

By JOHN W. MORRISEY

The final pages of Part I of this History states: "This History was written with a two-fold purpose. First, to chronicle as accurately as possible the most interesting Club events of the past twenty-five years, and secondly to try and give a general idea of the development of the small boy who was responsible for its beginning. We have purposely omitted, with but few exceptions, the recording of the many truly great scientific, literary, and engineering achievements of the members, because of their unweildly nature.

"We fully realize that the apparent character of the Club has, quite naturally, changed with the years. The Radio Club has became a respected scientific body, but the spirit of friendliness and cooperation which lies deep within, has never changed . . ."

This history of the Club during its third quarter-century is one of an institution in transition. The period saw the financial crisis of the late 1960's and its solution by the personal contributions of the Officers, Directors and members, and then the determined efforts to increase the size of membership to assure sufficient funds. From a membership of 376 listed in the **50th Anniversary Diamond Yearbook**, there now are 1033 names in the current membership directory.

With the successful recruiting of leaders in the telecommunications industry, the caliber of the membership is such that approximately 30 awards to the grade of Fellow are made annually. Recognizing that there still remains a large group of members who are highly qualified for professional recognition, the Club instituted the grade of Senior Member in the Spring of 1984, and amended the Club's By-Laws to permit that grade.

During the last forty years or so, the electronics industry has diversified or fragmented into many sub-groups, some allied in no way with radio communications; yet, it was the consensus of the membership that the Club should recognize the achievements in those allied fields and invite outstanding personages into membership. This has been done, and reference to the club now often identifies it as being the oldest electronic society in the world.

The activities of the Club also have changed considerably during these last twenty-five years. Perhaps symbolic of the changes are the revisions of the Club's Constitution made necessary by the attaining of a tax-exempt status. Prior to 1915, the Club continued to use the original constitution of the Junior Wireless Club Ltd. which was drawn in 1909. With the adoption of a new Constitution in 1915, the purpose of the Club was stated to be: ". . . the promotion of cooperation among those interested in scientific investigation and amateur operation in the art of radio communication."

The 1915 Constitution remained unchanged until 1969 when the following was added to the purpose: "To support educational and scientific research studies to advance radio communication art and its related electronic techniques." This partially resulted from a Club project begun in 1962 to financiallly assist secondary school science students through the Science Honors Program sponsored by the Columbia University School of Engineering & Applied Science.

The success of that program led in 1977 to a proposal to grant scholarships on a wider basis, and a fund to support the grants was started with a contribution from Capt. William G.H. Finch, then a Director of the Club and Chairman of the Finance Committee. To encourage such contributions, the Club had amended its Constitution again in 1975 to conform to the requirements of the U.S. Internal Revenue Service. The revisions in the stated purpose of the Club became: "To operate exclusively for charitable, educational and scientific purposes . . . and more specifically to study and contribute to the development of radio communication programs and provide a scholarship fund for needy and worthy students for the study of radio communication."

The approval of the IRS led to the founding of the Club's Research Projects Committee, and the Scholarship Committee. Shortly thereafter, these were combined into a single Scholarship & Research Committee whose name was changed to the Grants-In-Aid Committee in November 1979, and that committee undertook the solicitation of contributions from members, and the awarding of scholarships to college-level students.

The Club's activities have changed partly due to the wide geographical dispersion of the membership. Whereas the founders met at least once a month to discuss technical subjects, such an activity now is limited to the annual technical session held during the afternoon of the Annual Meeting, prior to the Awards Dinner. The formation of Sections has been encouraged to compensate somewhat for the lack of a location convenient to all members; such Sections were formed in Washington, D.C., Southern California, Chicago and Florida. Each has fifteen or more members as required by the By-Laws, and meets to discuss Club activities and technical subjects. Numerous luncheon meetings were held jointly with IEEE groups, QCWA, ARRL, and AFCEA. Technical speakers were featured.

During these last twenty-five years, the Club welcomed its first lady member, Mrs. Vivian A. Carr, who joined in 1973, became a Director and Chairperson of the Membership Committee in 1974, and was awarded the grade of Fellow in 1975. Since then, many other ladies have joined, and the Club has at least five husband and wife memberships.

During 1983, a proposal was made for the joining of the de Forest Pioneers with The Radio Club of America, and the action was unanimously approved by the surviving members of the de Forest Pioneers, and by the Board of Directors of The Radio Club. Coincidentally with this, the Club established the Lee de Forest Award and a de Forest scholarship grant.

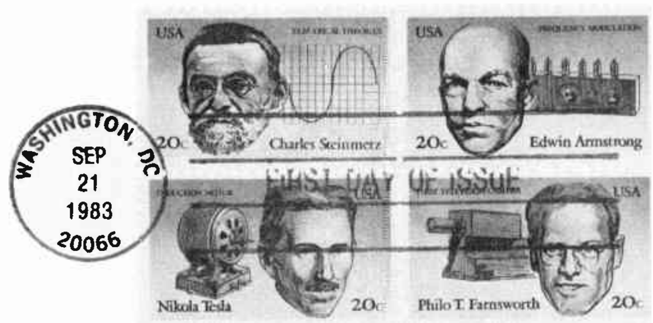
The Lee de Forest Award was the latest of seven honors established by the Club during these last twenty-five years. Prior to 1973, the Club awarded only the Armstrong Medal which was founded in 1935 and first awarded in 1937. In 1973, the Sarnoff Citation was first granted with the Hon. Barry M. Goldwater, United States Senator from the State of Arizona, being the recipient. The President's Award was first granted in 1974 and was followed in 1975 by the Pioneer Citation, and in 1976 by the Ralph Batcher Memorial Award. In 1979, the Allen B. DuMont Citation was established and first granted, and the Henry Busignies Memorial Award followed in 1981. A listing of all recipients is included in the Who's Who section of this book.

The history of these last twenty-five years is being continued in the writings of 36 members whose 38 articles are being included in this section of the **Yearbook**. As our Preface explained, a year book no longer is needed to tell the stories of the achievements of our members, or of the annual Award Dinners and the honors granted because the **Proceedings** now records that information. This **Yearbook**, then, brings somewhat different viewpoints as to what should be included in the history of the Club, and each article tells of some event wherein The Radio Club and its members have influenced history.

This is a history of and by the people who are The Radio Club of America: those who have a special reverence for facts . . . an endless and respectful curiosity . . . and a sense of wonder and fascination in the presence of our legacy from the past.

Edwin H. Armstrong — An Independent Inventor In A Corporate Age

by James E. Brittain, Ph.D. (M 1983)



The Postmaster General
invites you to a ceremony dedicating the
Inventors Stamps
The National Inventors Hall of Fame
Patent and Trademark Office
Crystal Plaza Building 3
2021 Jefferson Davis Highway
Arlington, Virginia
11:00 a.m., Wednesday, September 21, 1983

On September 21, 1983, the U.S. Postal Service commemorated the 100th anniversary of the founding of the IEEE with the issuance of postage stamps honoring American inventors who were electrical engineers. The four so honored were Edwin H. Armstrong, Philo T. Farnsworth, Charles Steinmetz, and Nikola Tesla.

Also in commemoration of the event, The Smithsonian Institution presented a symposium at the National Museum of American History at which papers were presented on E. H. Armstrong and Charles Steimetz.

James E. Brittain, Ph.D., (M 1983), who is Associate Professor of History of Science & Technology at the Georgia Institute of Technology, presented the following paper on Dr. Edwin H. Armstrong.

* * * * *

Edwin Howard Armstrong is widely regarded as America's foremost inventor in the field of radio technology. His four principal inventions were regenerative feedback circuits, the superheterodyne receiver, the superregenerative receiver, and frequency-modulation broadcast systems. He received approximately fifty U.S. patents and he achieved celebrity status especially within the amateur radio fraternity and the Institute of Radio Engineers. As an independent inventor whose patents became pawns in the arena of corporate conflicts, Armstrong devoted much of his time and energy to efforts to establish his priority in a legal sense as well as in the eyes of his peers. The increasing frustrations that he experienced in these efforts caused his final years to unfold like a Shakespearean tragedy.

Armstrong exhibited an unusual style for a 20th century inventor in the high technology of radio electronics. He showed almost a phobic distrust of mathematical analysis and his well-crafted technical papers rarely contained an equation. Instead he relied on circuit diagrams, oscillograms, and the characteristic curves of vacuum tubes in his explanations. He was like an artist except that his medium was the vacuum tube, the inductor, and the capacitor linked in intricate combinations. He was able to grasp intuitively the effect of altering circuit parameters and to track down the cause of unexpected phenomena that baffled less perceptive experimenters. He followed a pattern that he admired in Marconi by undertaking experiments that challenged the dogma of established theory. Armstrong's career that led from his home attic to the top of the Empire State Building with frequent litigious detours well illuminates the changing environment of the inventor during the first half of the 20th century.

ARMSTRONG'S EARLY YEARS AND THE REGENERATIVE FEEDBACK INVENTION

Armstrong was born in New York City on December 18, 1890 at a time when the electrical age was already well underway. Edison's historic Pearl St. power plant had begun operating in 1882. Nikola Tesla's classic paper on the polyphase power system had been presented before the American Institute of Electrical Engineers in 1888, a year also notable for the culmination of the remarkable electromagnetic wave experiments of the German physicist, Heinrich Hertz. The application of the Hertzian waves in wireless communication was destined to become the principal focus of Armstrong's inventive talents. One of the inventors who also is being recognized during this symposium, Charles Proteus Steinmetz, published his proposed law of magnetic hysteresis in a short paper in the **Electrical Engineer** in the issue dated December 17, 1890, the day before Armstrong was born.

The cultural environment in which Armstrong spent his formative years was ideal for a future inventor of radio circuits and systems. His father was an executive with the Oxford University Press and his mother had been a school teacher. New York City was the center of the emerging electrical engineering profession in the United States as the headquarters of the AIEE since its formation in 1884. The Wireless Institute formed in 1909 and its successor, the Institute of Radio Engineers, were centered in N.Y. City. In fact the first meeting of the IRE was held at Columbia University in 1912 when Armstrong was in his junior year at Columbia.

The New York area also was the center of amateur wireless enthusiasts who enjoyed a kind of golden age during the period when Armstrong was attending Yonkers High School and, later, Columbia. Amateur wireless was a cultural phenomenon not unlike that occuring among young computer enthuiasts today. Prior to the first World War, amateur wireless was a populist phenomena fed by "fantasies of friendship, fame and conquest" and dominated by teenage boys who constructed their own apparatus, and eagerly shared information about the latest advances or achievements with others in the fraternity. Their enthusiasm was encouraged by such writers as Victor Appleton who wrote **Tom Swift and His Wireless Message** and Allen Chapman who wrote a series of adventure stories about the "Radio Boys."

Blessed with indulgent parents, Armstrong was permitted to engage in wireless experiments from his home from the age of fourteen. Later he joined The Radio Club of America and remained an active member for the rest of his life. This club had been formed as the Junior Aero Club in 1907 by a New York schoolboy, W.E.D. Stokes, Jr. The club's initial interest was in flying model airplanes but the focus changed to wireless by 1909 when the club became the Junior Wireless Club Limited and finally was called The Radio Club of America in 1911.

In addition to being the home of the IRE and The Radio Club, the New York City area spawned college programs that were exceptionally strong in radio-electronics engineering. Columbia University, where Armstrong enrolled in 1909, served as a virtual incubator for radio engineers and inventors. If offered not only formal engineering courses and access to good laboratory facilities but also enabled motivated students to acquire information about the latest developments through the meetings of the IRE and The Radio Club that were held frequently at the University. Alfred N. Goldsmith, who received his Ph.D. from Columbia in 1911, taught at City College of New York, and was the editor of the **Proceedings of the IRE.** His laboratory was used for radio research sponsored by GE and later by RCA.

Nearby was the Stevens Institute of Technology where Armstrong's friend Alan Hazeltine graduated in 1906 and began teaching the following year. Hazeltine became a successful radio inventor and later founded the Hazeltine Corporation that employed several engineers with an Armstrong connection.

At Columbia, Armstrong came under the influence of the legendary Professor-inventor, Michael I. Pupin, who had sold his loading coil patents to the Bell Telephone Company in 1900 for almost a half-million dollars. Pupin became a role model for Armstrong as well as an effective promoter of the younger inventor. As independent inventors, the two men shared a low regard for the contributions of in-house corporate inventors. The Columbia faculty that included also Henry Mason and J.H. Morecroft encouraged Armstrong to patent his first invention and even referred him to a local patent attorney. Mason loaned him instruments and Morecroft assisted him in oscillogram tests of regenerative amplifiers and oscillators.

Armstrong discovered the regenerative feedback effects while he was still a Columbia undergraduate. He acquired his first audion tubes in 1911, devices that he later described as having been "clouded in the mystery" of the gas ionization theory of de Forest. Armstrong carried out a careful study of the audion with the aid of instruments at the University. While experimenting with tuned-plate and tuned-grid circuits in the Fall of 1912, he observed the phenomenon of regenerative amplification that enhanced greatly the strength of received wireless signals. He also identified self-excited oscillations in the output of an amplifier with feed-back which meant that the vacuum-tube oscillator could serve as a source of high-frequency waves.

He received his B.S. degree in electrical engineering in June 1913 and remained at Columbia to teach a class in wireless for the Navy and to continue his research.

He filed a patent application on the regenerative receiver in October 1913 and it issued almost a year later. Professor Pupin arranged for the regenerative circuits to be demonstrated for representatives of the American Marconi Wireless Company in December 1913, and for engineers of A.T.&.T. early the following year. Neither firm chose to purchase rights to the invention. However the receiver was licensed to the German Telefunken Co. and used by its station at Sayville, Long Island to pick up signals transmitted from Germany.

Armstrong's technical papers on the audion and regenerative circuits made a strong impression on the first generation of radio-electronics engineers. His paper on the "operating features of the audion" in the **Electrical World** of December 1914 employed characteristic volt-ampere curves and oscillograms to show graphically how the tubes functioned. Early in 1915, he presented a paper entitled "Some Recent Developments in the Audion Receiver" at an IRE meeting. In this paper, Armstrong gave a comprehensive explanation of regenerative amplifiers and oscillators, and practical results achieved with receivers at Columbia. This paper precipitated a dispute between Armstrong and Lee de Forest who challenged not only Armstrong's "results and conclusions" but also his priority in the discovery of the feedback oscillator. These first publications by Armstrong later were credited by Alan Hazeltine for having opened his eyes to the engineering possibilities of the vacuum tube and to have exerted a profound influence on his professional career as well as that of many others.

Armstrong remained at Columbia until 1917, as Trowbridge Fellow at the Hartley Research Laboratory. He and Professor Pupin filed five joint patent applications during the period 1915-1917 although none of these were issued prior to the War. In 1916, Armstrong was elected President of The Radio Club of America and, in the same year, he began to receive royalties from the American Marconi Company that finally had decided to acquire a license to use his regenerative receiver.

THE FIRST WORLD WAR AND THE SUPERHETERODYNE RECEIVER

In 1917, Armstrong's talents were diverted to military needs for radio communication and it was during his service in Europe with the U.S. Army Signal Corps that he conceived his second major invention, the superheterodyne receiver. He was given a commission as a Captain and, after a brief period of training, was ordered to Paris, France to establish a Signal Corps laboratory. During a brief stop in England, he learned from Henry J. Round, a Marconi radio engineer, that a critical problem had developed that involved a need to detect very-high-frequency radio signals that the Germans were believed to be using.

Arriving in Paris late in 1917, Armstrong became the leader of a group of talented radio engineers and technicians. Unfortunately the full story has yet to be told of the sociology of the group, their contributions during the war, and their interaction with French and British experts. Among the group's members were Harry W. Houck, Harold M. Lewis, Willis R. Taylor, William A. MacDonald and Jackson H. Pressley. Houck was an amateur radio veteran and an outstanding electronic-circuit craftsman who remained a close associate of Armstrong after the war. Lewis had an engineering degree from Union College and constructed the first working model of the superheterodyne receiver following Armstrong's circuit diagram. After the war, Lewis worked as an engineer-inventor for the Hazeltine Co. Taylor held an engineering degree from Stevens where he studied under Professor Hazeltine, and he later was patent attorney both for Armstrong and Hazeltine. MacDonald had worked for the American Marconi Co. and, after the war, worked for RCA before serving as chief engineer with Hazeltine. Pressley also worked for Hazeltine before becoming chief engineer of the U.S. Radio and Television Co.

The inspiration for the superheterodyne receiver apparently came to Armstrong early in 1918 when he was speculating on whether short-wave radiation from airplane engines might be detected and used to direct the fire of anti-aircraft guns. He was acutely aware of the deficiencies of existing vacuum tubes at higher frequencies, and the superheterodyne principle provided an ingenious solution since it would enable a high-gain tuned amplifier to function at lower frequencies during reception. The first model employed eight tubes, and tests of sensitivity and selectivy were encouraging although the invention was not perfected in time to be used during the war. Armstrong's application for a U.S. patent on the invention was filed in February 1919 and the patent issued in June 1920. Interestingly there is evidence that a German engineer, Walter Schottky, independently conceived the superheterodyne principle early in 1918 during an investigation at the Siemens Labs. Schottky filed for a German patent in June 1918 but he later gave credit to Armstrong and associates for having introduced the new receiveer into practice. A third claimant, Lucien Levy, was a French inventor whom Armstrong met during his service in France and whose patent later was involved in litigation with the Armstrong patent.

Armstrong was awarded the first Medal of Honor of the IRE in 1918 for his feedback discovery, and was promoted to the rank of Major in the Signal Corps early in 1919. He returned to New York in September 1919 to resume his work at Columbia while defending his patents agains litigation. In December 1919, he presented papers on the superheterodyne receiver for both The Radio Club and the IRE.

The environment to which Armstrong the inventor returned after the war had changed in such a way that it provided him with a golden opportunity and quickly made him a millionaire. His position was analogous to that of a small, unaligned nation when two superpowers are seeking a competitive advantage, and his radio inventions suddenly were perceived to have strategic value in corporate radio wars. The major institutional change in the radio environment in the U.S. was the formation of the Radio Corporation of America, in 1919, with a broad mandate to develop international point-to-point radio communication. The Westinghouse Electric Co. had made an entry into the radio-electronics field through the manufacture of military apparatus during the war but saw itself in danger of being excluded from the radio field by RCA and GE, firms with close corporate ties. Westinghouse decided to purchase rights to the Armstrong patents in order to use them for leverage in negotiations with RCA and GE. From this sale, Armstrong realized the sum of $335,000 with a contingency clause that would add another $200,000 if a feedback oscillator patent, that was involved in an interference proceedings, issued. The patents were probably worth the cost to Westinghouse as its principal bargaining chip in a cross-licensing agreement reached with RCA and GE in June 1921.

Armstrong attracted further acclaim in December 1921 when he and six fellow radio enthusiasts successfully carried out an experiment in which a message sent from a 1000 watt transmitter operated at a wave length of 230 meters at a site in Connecticut, was picked up in Scotland by one of the group, Paul F. Godley, on a superheterodyne receiver. The experiment demonstrated that it was not necessary to employ the expensive long-wave 200kw radio alternators of RCA, to communicate across the Atlantic. Armstrong later called the experiment "a turning point in radio history" where "something contrary to what was in the books" had been discovered.

The advent of radio broadcasting and its phenomenal growth during the early 1920s further enhanced Armstrong's reputation and his fortune. The pioneering Westinghouse station KDKA began operation in October 1920 and the number of broadcast stations in the U.S. reached 580 by the end of 1922. A seller's market for household receivers developed and several hundred firms manufactured receivers during the 1920s. Armstrong and Harry Houck helped to develop a commercial RCA version of the superheterodyne known as the "Radiola" that used fewer tubes and simpler controls than earlier versions. Engineers at GE, RCA, and Westinghouse also contributed design improvements before the six-tube sets were introduced to the national market in 1924. The RCA superheterodyne receiver was commonly regarded as the "Rolls-Royce of Radio" during the 1920s and alternative receivers such as Alan Hazeltine's "neutrodyne" were highly regarded competitors until RCA licensed other firms to manufacture the superheterodyne after 1930.

THE SUPERREGENERATIVE RECEIVER

In 1921, while preparing a regenerative circuit as an exhibit for patent litigation, Armstrong invented a sensational new radio receiver that required only two tubes to produce remarkable sensitivity. His lecture on superregeneration presented at a Radio Club meeting at Columbia, in 1922, attracted at overflow crowd who reportedly "simply ate up every word Mr. Armstrong uttered and watched in rapt admiration as he demonstrated his latest development." He attracted what was said to be the largest audience ever to attend an IRE meeting when he spoke on the newest receiver, in June 1922.

In his IRE paper, Armstrong followed his usual pattern of avoiding mathematical analysis. Instead he gave a qualitative explanation that involved variations in negative and positive resistances in a tuned circuit. He pointed out that great amplification could be obtained if the negative resistance exceeded the positive resistance at periodic intervals so long as the average resistance remained positive. He credited his friend Alan Hazeltine for theoretical assistance.

Perceived as a solution to the problem of manufacturing low-cost but sensitive radio receivers, the superregenerative receiver soon attracted the attention of executives at RCA who saw it as a way to gain entry into the lower-price range of a rapidly expanding mass market. Armstrong received $200,000 in cash and 60,000 shares of RCA stock for rights to his superregeneration patents, thus becoming the corporation's largest individual stockholder. He was given an additional 20,000 shares for his assistance with the commercial superheterodyne-receiver design. His holdings of RCA stock eventually became worth approximately $9,000,000 so that he might have chosen to retire to a life of affluence by the time he was 35.

The superregenerative patents did not prove to be a wise investment for RCA since it did not provide adequate selectivity for closely spaced stations in the broadcast band although it did achieve some success in specialized high-frequency applications.

FREQUENCY MODULATION

The decade of the 1920s had been an age of super-power network proposals, superheterodyne, and superregeneration when Armstrong had skillfully exploited his opportunities. In contrast, the 1930s brought a severe economic depression, corporate retrenchment, and the birth of electronic television systems. It was an environment that still could provide opportunities for the independent inventor as demonstrated by the case of Philo T. Farnsworth. For Armstrong, the 1930s were filled with frustration in the courts and in the negative response of RCA to his efforts to promote the frequency-modulation broadcasting system that became his great obsession.

Late in 1933, Armstrong was issued a cluster of FM patents and conducted a demonstration of his system for David Sarnoff, of RCA. The following year, he was permitted to install an FM transmitter in the Empire State Building for tests that continued until April 1935. When it became clear that RCA intended to devote its resources to the development of electronic television rather than FM, Armstrong decided to use his own considerable resources to introduce the system that he was convinced would be far superior in quality to AM. For the first time, his activities would have to go beyong the stage of invention and even development to include marketing and lobbying. In brief, he would have to function as an inventor-entrepreneur rather than as an independent inventor relying on large corporations to convert his inventions to commercial products. To add further to the complexity of the challenge, he was trying to develop a complete system of transmitters and receivers for an uncertain market rather than components for an existing system as his earlier inventions had been. On the positive side, he still had access to laboratory facilities at Columbia and could afford to hire a staff of young engineering graduates to assist in development of the hardware. Filled with optimism after the first successful tests, he wrote in a log book that "after ten years of eclipse, my star is again rising."

Once again, Armstrong followed his earlier pattern by giving an IRE paper on FM in November 1935. He took obvious delight in pointing out that mathematical theorists had erred in dismissing FM as offering no advantages. He stated that he was introducing a "new principle" that conflicted "with one which has been a guide in the art for many years." Again he used no equations but relied on block, circuit, and phasor diagrams in his explanation. Nevertheless, the system he described was based on relatively unfamiliar concepts and the response of the profession was more subdued than it had been to his earlier professional papers. By 1936, he was realistic enough to acknowledge that the introduction of FM might be delayed by "intangible forces" originating in "vested interests, habits, customs and legislation."

As an integral part of his campaign, Armstrong installed an expensive FM transmitter in Alpine, NJ and began regular broadcasts in 1939. The same year, the so-called "Yankee Network" was formed to begin FM broadcasts from several sites in New England. Armstrong's system attracted the support of a large corporation when GE acquired a license to manufacture FM equipment and constructed an experimental station. E.F.W. Alexanderson, of GE, had visited the Alpine facility early in 1938 and had recommended that GE seize the opportunity that had been missed by RCA, and identify itself with a new system of high quality. In a 1940 paper, Armstrong compared the FM-AM situation to the battle between AC and DC power systems of the late 19th century. He predicted that an FM revolution would take place over the next five years and would largely supplant AM broadcasting. His aggressive crusade for FM was gaining considerable momentum when the second World War intervened.

Armstrong continued to receive professional recognition for his technical contributions including the Franklin Medal of the Franklin Institute in 1941, and the prestigious Edison Medal of the AIEE in 1943. During the Edison award ceremonies, he referred to patent litigation as the "bane of the inventor's existence" and likened it to "the serpent in the Garden of Eden." During the war years, he helped in the development of FM communication systems for military applications including two-way systems for Army tanks.

The post-war years brought increasing frustration to Armstrong as FM radio broadcasting suffered at least temporary setbacks. FCC decisions that were unsuccessfully opposed by Armstrong, forced FM to move to a higher frequency band and to operate at lower transmitter power than in the prewar period. In 1948, he brought suit against RCA for infringement of his FM patents but "pre-trial hearings" dragged on for five years placing severe strains on his financial resources. He refused overtures for an out-of-court settlement. The Armstrong tragedy ended in a climatic act on the night of January 31, 1954 in a fall from the 13th floor of his River House dwelling. Armstrong's inventive talents had flourished in the age of vacuum tubes, radio mania, and corporate competition but ultimately his personal characteristics made it difficult to adapt to an environment of regulation and litigation. He fell victim to the serpent that invaded his Garden of Eden.

As I Remember It . . .
The de Forest Pioneers

by J.R. Poppele (M 1941, F 1942, L 1970)

Front row (L. to R.) Marie de Forest, Dr. de Forest and Charles Rice. Standing (L. to R.) Joel Michaels, Dick Egolf and Ed Raser. November 3, 1954, Fraunces Tavern, New York City.

Any story of the de Forest Pioneers would be an unusual one. It wasn't exactly a club but its prerequisites were unusual — perhaps almost those of a cult.

But, by definition, a cult is a system of religious worship whereas the motif of the Pioneers was a veneration of the memory of a great man by a body of admirers.

Those admirers could be counted in legions — classmates at Yale's Sheffield Scientific School, fellow employees at the Hawthorn plant of Western Electric Company, and those of the Publishers Press Association — and even his competition, Marconi, who worked for the Associated Press.

But of all, only 163 came to be known as a de Forest Pioneer for they where the ones who worked with Lee de Forest. Their membership certificates state that the organization was "formed to bring together the men who worked with Dr. Lee de Forest, to perpetuate the memories of those days, to pay tribute to Dr. de Forest's transcendent genius and to acknowledge the affection and esteem in which we hold him."

The goal of the de Forest Pioneers was: (1) to perpetuate the memory and authenticity of Dr. de Forest's work in the minds of the public, the professionals, the student, and in written history; (2) to advocate scientific and rational interpretations of life and environment; and (3) to provide expert advice and efforts toward securing the benefits of science and industry for the peoples of the world.

A further purpose was to revive and perpetuate in the minds of the public, that the source of new knowledge came from inventors rather than from later improvements by industry which, too often, were given credit by an uninformed public due to carelessly-written history.

Organized on January 24, 1952 at the Yale Club, New York City, and incorporated in the State of New York on June 6, 1952 as a non-profit society of the pioneer associates of Dr. Lee de Forest, the Pioneers established dues of $5.00 per year for any classification of membership. There were no initiation fees nor were there age or other eligibility requirements.

The By-Laws called for three classes of membership:

* **Members:** Those who were directly associated with Dr. de Forest or with any of his organizations in the fields of radio telegraph/radio telephone, talking motion pictures, or other activities.
* **Associates:** Those not directly associated but who may have been indirectly connected through organizations pursuing the work of Dr. de Forest. This also included descendents of Members.
* **Affiliates:** Those interested in forwarding the objectives of the de Forest Pioneers but who never were associated with Dr. de Forest or indirectly connected with his work. This included individuals, commercial organizations, and institutions such as schools, historical societies, etc.

Membership was largely comprised of Members, those who were actual associates of Dr. de Forest during the era of his great works, ending about 1938.

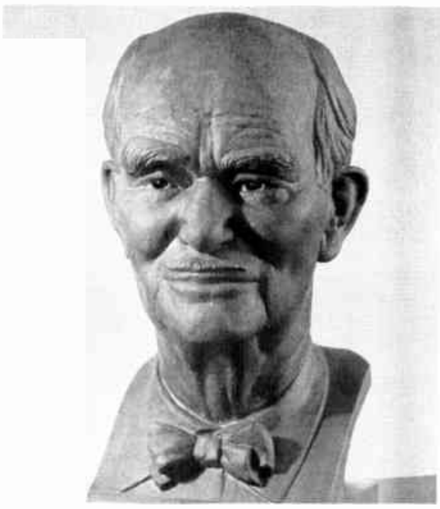
The activities of the Pioneers included annual meetings and award dinners commencing in 1952 whereat recognition was given to achievements of individuals, the publishing of a NEWSLETTER, and the holding of joint functions with similar organizations such as the Veteran Wireless Operators Association (VWOA).

On Tuesday, April 8, 1952, two and a half months after the organization of the de Forest Pioneers, a testimonial dinner was held to honor Dr. de Forest at the Starlight Roof of The Waldorf Astoria hotel in New York City. Other organizations who joined in sponsoring the dinner were:

American Institute of Electrical Engineers,
The American Radio Relay League,
The Institute of Radio Engineers,
National Association of Radio and Television Broadcasters,
Radio-Television Manufacturers Association,

Society of Motion Picture and Television Engineers,
Veteran Wireless Operators Association.

Presiding was Rear Admiral Ellery W. Stone, USN(Ret.), and the speakers were Dr. Lee de Forest, the Hon. Herbert Hoover, former President of the United States, and the Hon. Charles Edison, former Governor of the State of New Jersey. Hoover, the principal speaker, described de Forest as a scientist whose inventions "have shaken civilization into new channels."



Elmo N. Pickerill, then president of the de Forest Pioneers, presented to Yale University a bronze bust of Dr. de Forest, sculptured by Frederic Allen Williams. The bust was received by Irving S. Olds, a fellow of the Yale Corporation and chairman of the United States Steel Corporation.

There were 738 in attendance including 34 Charter Members of the de Forest Pioneers. Later, 21 of those present became members.

On November 12, 1956, the fiftieth anniversary of the invention of the three-element vacuum tube was recognized with the unveiling of a bronze commemorative plaque at 229 Fourth Avenue, New York City, by the de Forest Pioneers. This was the site of the old Parker Building where Dr. de Forest had a small laboratory in 1906, whereat the audion was invented.

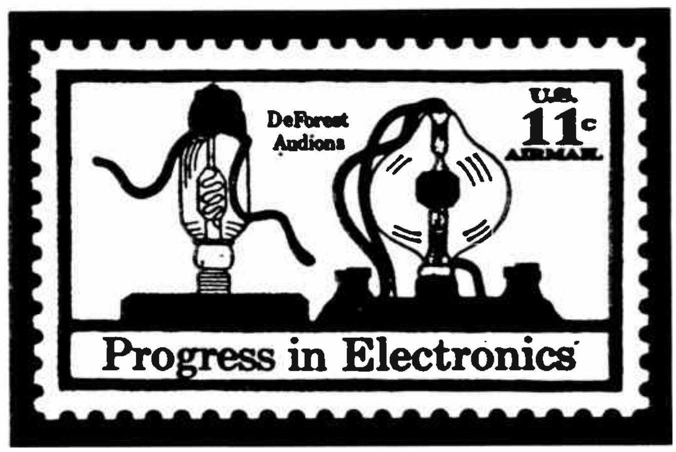
Rear Admiral Ellery W. Stone, USN(Ret.), then president of the de Forest Pioneers, presided. David Sarnoff addressed the group. The plaque was unveiled by Mrs. de Forest who was present for the occasion, with Dr. de Forest. A letter of recognition of the anniversary of de Forest's great invention was sent by Dwight D. Eisenhower, President of the United States.

On November 6, 1959, at the Eighth Annual Meeting held at Fraunces Tavern, New York City, a resolution was passed unanimously which authorized a Lee de Forest Scholarship at Yale University. A sum of $4,000 was contributed to the university "for the establishment of the de Forest Pioneers Prize Fund, to provide an annual award for distinguished creative achievement in Physics, in honor of Dr. Lee de Forest, Ph.B. 1896; Ph.D. 1899; Sc.D. (honorary) 1926."

The objectives of the de Forest Pioneers were carried out conscientiously by its members. A few of their efforts should be told.

Individual members such as Mr. Kenneth Richardson, long-time secretary of the Pioneers, were responsible for the background effort which resulted in the issuing of a postage stamp by the United States government. The idea of a commemorate stamp was first suggested by Richardson in 1955. However, the Post Office policy of honoring persons or their achievements only after their deaths caused the Post Office Department to dismiss Richardson's recommendations. Dr. de Forest died on June 30, 1961 and shortly thereafter, Richardson again submitted a presentation supported by Arthur Trauffer, a Member living in Council Bluffs, IA (birthplace of Lee de Forest), and others including the Veteran Wireless Operators Association, the Society of Wireless Operators, the Antique Wireless Association, and CQ Magazine. The stamp finally was issued in 1973.

The stamp, an eleven-cent airmail issue, was one in a series of four of the series *Progress in Electronics* and commemorated the de Forest audion. The first day of sale was June 5, 1973 at Hemet, CA.



On February 6, 1977, the Pioneers participated in the induction of Dr. de Forest into the Inventors Hall of Fame held at the fifth annual program of the U.S. Patent Office at the Crystal Palace, in Arlington, VA. Also honored at the occasion were George Eastman of photographic fame, Charles P. Steinmetz of electrical fame, Edwin H. Land of Polaroid fame, and Vladimir K. Zworykin of modern television fame. These world-famous inventors were selected from over 150 outstanding inventors by representatives of thirty-three scientific socities.

The 75th anniversary of Marconi's first wireless telegraph service between the United States and Great Britain was celebrated on January 19, 1978 at South Wellfleet, MA, with members of the Pioneers present.

Another member of the Pioneers who has done much to support the works of de Forest is Maurice H. Zouary.

By 1920, the de Forest "Phonofilm" was the miracle discovery of the motion picture industry, and de Forest's success of adding synchronized sound to film was the contributing factor to a run-away idea in movie making.

Zouary, a film historian and archivist, has dedicated much of his life to the researching of de Forest's achievements in the field of sound motion pictures. As a recognized authority on early talking pictures, Zouary is basing his new history of motion picture sound on the original de Forest invention of optical sound, in 1919, and the commercial release of optical sound pictures to theaters by 1923. More than 100 of the de Forest pre-1928 synchronous optical sound Phonofilms from the Zouary Collection were donated to the National Film Collection of The Library of Congress and represents the "earliest examples of synchronous sound-on-film covering the years 1919 — 1927" as stated by The Library of Congress.

The Phonofilms, as they were named by Dr. de Forest, are comprised of technical test reels, interviews with President Coolidge, Charles A. Lindberg and other celebrities, operatic excerpts, short dramatic subjects, and vaudeville headliners.

Twelve of those films were exhibited by Mr. Zouary at the Eighteenth Annual Dinner of the de Forest Pioneers held on February 13, 1970 at Fraunces Tavern, New York City. These films also had been featured at the New York Film Festival held at Lincoln Center during September 1969.

On May 2, 1976, Zouary received the de Forest Pioneers Certificate of Merit for outstanding research work on de Forest's basic inventions and pioneering commercial motion picture optical sound processes.

A Charter Member of the Pioneers, Gilson "Rex" Willets, was a lifelong friend of the de Forests and they frequently shared the hospitality of Willets' home "Quiet Haven" on the Russian River, near Villa Grande, CA. The home was a rustic retreat amongst the redwood trees fronting the river, and was a favorite haven of the de Forests when they wanted to get away from it all.

Willets first came to know de Forest when he sought employment in de Forest's Highbridge, NY experimental laboratory. "I wanted to be close to this great man" said Willets, "And I hoped that some of his genius would rub off on me." "He seemed never to run out of ideas. They came to him in an endless stream, and he passed them along to his numerous co-workers, assigning to them one task after another."

Lee and Marie de Forest spent his 80th birthday at "Quiet Haven". Willets reported that, for the first time, Dr. de Forest refused to discuss the transistor and its applications — "just wanted to hear nothing at all about it."

The de Forest Pioneers continued their annual dinners until 1976 when the 24th and final was held on Friday, May 7th. Thereafter, the dinners were held jointly with the Veteran Wireless Operators Association. The announcement of the 25th Anniversary Dinner, and the first held jointly with the VWOA, listed an active membership of 56. The program of that Silver Anniversary Dinner held May 26, 1977 at the Officers Club on Governor's Island, in upper New York Harbor, listed the 35 recipients of the de Forest Pioneers Merit Awards, the first of which was awarded in 1969. Joint meetings with the VWOA continued through an annual dinner held on May 20, 1978 at the Sheraton Hotel, NYC.

Due to the attrition of age, the membership rapidly diminished during the late 1970's and efforts to recruit new members were ineffective. This led to the proposal in 1983 to combine the activities of the de Forest Pioneers into those of The Radio Club of America during the 75th anniversary of The Radio Club.

On June 10, 1983, as the last president of the de Forest Pioneers, my final act was to transfer the remaining funds in their account in the amount of $3,139.92 to the Treasury of The Radio Club. Those funds then were transferred by action of the Board of Directors of The Radio Club into its Grants-in-Aid Fund and a scholarship in the amount of $500 was granted to Yale University in honor of Dr. de Forest.

Approval of the merger of the de Forest Pioneers into the Radio Club of America was requested by mail on May 19, 1983 from the twenty surviving members of the de Forest Pioneers whose addresses were known. Their opinions were asked regarding the proposed consolidation. Only twelve replies were received — all affirmative.

Only two: Maurice Zouary and Louis Rabinowitz had not been members of The Radio Club, and they were automatically granted Life Membership upon the consolidation. The remaining ten who already were Radio Club members were awarded Life Membership if they were not already at that grade.

Lee de Forest was the last of the great independent inventors who worked on their own rather than in a research organization of a large corporation. In that way, he fit the pattern of the early leaders of The Radio Club.

MEMBERSHIP OF DE FOREST PIONEERS

PAST PRESIDENTS

E.N. PICKERILL
ELLERY W. STONE
CHARLES A. RICE
JOHN V.L. HOGAN
J.R. POPPELE
RAYMOND F. GUY
ALLEN B. DU MONT
SIDNEY A. WOOD
GEORGE F. DUVALL

1. Joel J. Michaels
2. Elmo N. Pickerill
3. J. Albert Stobbe
4. Frank A.D. Andrea
5. Samuel F. Barager
6. Allen B. DuMont
7. Frank A. Hinners
8. John V.L. Hogan
9. Charles A. Rice
10. Emil J. Simon
11. Adm. Ellery W. Stone
12. Eugene M. Thurston
13. Antonio Castilla
Dr. Lee de Forest
14. Ralph R. Batcher
15. Charles B. Cooper
16. Dr. James L. Bradford
17. Lloyd Dopkins
18. Richard S. Egolf
19. Hugo Gernsback
20. E.J. Quinby
21. Robert C. Reinhardt
22. Kenneth Richardson
23. Archie M. Stevens
24. Henry J. Wilkins
25. Benjamin Beckerman
26. Henry F. Bollendonk
27. Leroy Bremmer
28. Frank F. Neuner
29. Victor O. Allen
30. Verne T. Bramen
31. Dr. Charles J. Breitwieser
32. A.W. Dorchester
33. Edward K. Foster
34. Miss Edith Friedman
35. William E. Garity
36. Henry C. Gawler
37. Paul F. Godley
38. Stanford L. Hooper
39. Roscoe Kent
40. Frank S. LeRoy
41. I.R. Lounsberry
42. Mrs. Betty Marino
43. Russell P. May
44. William J. McGonigle
45. William Hodgson Medd
46. Edward G. Raser
47. D.E. Replogle
48. Harrison Reynolds
49. L. Louis Reynolds
50. Frederick C. Ross
51. William Royle
52. Samuel Schneider
53. Frank M. Squire
54. Tom M. Stevens
55. Joseph M. Vananzi
56. A.F. Wallis
57. Raleigh W. Whiston
58. Gilson V. Willets
59. Frank W. Ballard
60. Charles D. Guthrie
61. Robert H. Wendeborn
62. O.W. Hungerford
63. Paul Gristock Watson
64. George V. Wiltse
65. Howard S. Pyle
66. Robert B. Woolverton
67. Peter W. Welch
68. Alfred Ferland
69. Stephan J. Powers
70. John T. Schilling
71. Jerry T. Hill
72. Harold F. Tideman
73. J. Alex Wallace
74. George C. Crom
75. George F. Duvall
76. Frank H. Merriam
77. Edgar K. James
78. George H. Clark
79. C. Thomas Spring Rice
80. Michael Rozjabek
81. Oliver Adams Wyckoff, Sr.
82. Fred Sintes, Sr.
83. Fred M. Link
84. Fred A. Klingenschmitt
85. Paul C. Staake
86. Allan R. Ellsworth
87. Elmer E. Bucher
88. Walter R. Schare
89. Henry L. Crowley
90. Francis L. Tolley
91. Kenneth G. Bucklin
92. Charles P. Marsden
93. Ephraim Frank Duskis
94. George E. Jones, Jr.
95. William J. Barkley
96. Mrs. Samuel E. Darby, Jr.
97. William C. Simon
98. Dexter S. Bartlett
99. Louis Wasmer
100. John S. Gaydosh
101. Harold Floyd Beck
102. Richard G. Raymond
103. Charles E. Maps
104. Peter Kailus
105. Edwin F. Nickl
106. Dr. Charles Eisler
107. Floyd H. Crews
108. Sidney A. Wood
109. Gerhard R. Fisher
Mme. Eugenia H. Farrar
110. Austin G. Cooley
111. C. Frederick Wolcott
112. Arthur H. Lynch
113. Thomas H. Letts
114. Thomas H. Cowan
115. Edward E. Freeman
116. John J. Buckler
117. Anita R. Martine
118. John J. Wheeler
119. Lloyd Espenshied
120. John Goujon
121. Louise Ramsey Moreau
122. J. McWilliams Stone
123. Joseph E. Tringali
124. Bernard Freericks
125. Raymond F. Guy
126. Benjamin Gross
127. Harry E. Athearn
128. V. Ford Greaves
129. Douglas M. Perham
130. Louis D. Fletcher
131. Harry Fioretti
132. Robert A. Smith
133. Henry C. Herbert
134. G. Dewey Zimmerman
135. J.R. Poppele
Mrs. Lee De Forest
136. Wallace P. Dunmore
137. Paul H. Krieger
138. Edward Dervishian
139. Ralph H.G. Mathews
140. Jack Kurt
141. William R. MacLeod
142. Frederick Bernard Stock
143. Abram W. Moss
144. Pierre Boucheron
145. Ralph L. Hazleton
146. Ray E. Meyers
147. Mortimer O. Smith
148. Eugene H. Rietzke
149. Oliver Harold Brewster
150. Edward Byron Lubkert
151. John T. Orr
152. Raymond O. Hallberg
153. James F. Woods
154. Robert S. Bell
155. William P. Cox
156. Perce B. Collison
157. Lester R. Reiss
158. Benzamin N. Lazarus
159. Norman A. Swetman
160. Earle M. Caldwall
161.. Leroy M. Glodell
162. Charles W. Horn
163. E.W. Freeman
164. Maurice Zouary

1975 — Tax-Exempt Status Approved

by David Talley, (M 1949, F 1957, L 1970) W2PF

On November 28, 1975, the Internal Revenue Service determined that The Radio Club of America, Inc. was exempt from the Federal Income Tax under Section 501(c)(3) of the Internal Revenue Code. This action by the IRS culminated more than a year's hard work on this project by the Ad Hoc Committee comprising David Talley and Stuart F. Meyer.

Considerable historical research was required in addition to "mountains" of paperwork, financial records, computations, and legwork. Valuable legal assistance was obtained from Herbert H. Chavis, Esq. in the final preparation of the required forms and documents.

The new tax-exempt status meant that any contributions made to the Club by members or anyone are deductible from income taxes. Also, bequests, legacies, devises, transfers, or gifts to the Club for its use are deductible for Federal estate and gift tax purposes. Moreover, the Club is exempt from State and City sales taxes, and can utilize the lower non-profit postage rates for bulk mailing of its **Newsletters** and **Proceedings**.

The story of how this was acomplished begins with the Junior Wireless Club Limited which, since its inception on January 2, 1909, was a non-profit organization. When the organization's name was changed to The Radio Club of America in 1911, and the original Constitution written, the purpose of the Club was stated as "the promotion of cooperation amongst those interested in scientific investigation and amateur operation in the art of radio communications."

Early in 1929, legal papers were filed for incorporating the Club under Section 803 of the Not-For-Profit Corporation Law of the State of New York. The certificate of incorporation received on February 4, 1929 contained the following as the purpose for incorporating: "The promotion of cooperation among those interested in scientific investigation and operation in the art of radio communication. The accomplishment of the aforesaid objects is not for any pecuniary profit."

The not-for-profit status of the Club served to exempt it from paying Federal and State income taxes over the years. However, the Club had not qualified as a tax-exempt organization under the regulations of the U.S. Internal Revenue Service. Thus, contributions made by members or others were not tax-exempt to the donors.

In 1969, the Constitution and By-Laws of the Club were completely revised and the following purpose was added to Article I, Section 2 of the Constitution: "To support educational and scientific research studies to advance the radio communication art, and its related electronic techniques."

It soon became apparent that a tax-exempt status was needed for the Club to properly carry out its new objectives. Consequently, the Board of Directors at its meeting of July 11, 1973 voted to apply for tax-exempt status under the provisions of Section 501(c)(3) of the IRS Regulations, and appropriated $200 for legal expenses. The President directed the Constitution Committee consisting of Stuart F. Meyer and David Talley, to undertake this formidable task.

Initial studies by the committee indicated that the Club's purpose as stated in Article I of the Constitution again needed revision to meet the IRS requirements for tax-exempt organizations. However, it also was necessary that the Club's Certificate of Incorporation issued by the State of New York, be amended so that its stated purpose would comply with the applicable IRS Rules.

Thereupon, the Constitution Committee prepared the text of a suitable Constitutional amendment and proceeded to obtain the required 25 signatures of members to petition the Board of Directors for this amendment. The Board of Directors gave approval at the meeting of July 11, 1974 and the proposed amendment then was printed in the July 1974 **Newsletter** which was mailed to the membership with a ballot. A total of 247 ballots were received from the membership prior to the August 28, 1974 deadline; 246 votes were in favor, and one in opposition.

As a result of this vote, President Fred M. Link and Secretary Francis Shepard submitted the documents for amending the Club's Certificate of Incorporation to the Secretary of State for the State of New York. The documents were returned with a statement that they were deficient in several respects and should be prepared under the advice and counsel of an attorney. Arrangements were made with Herbert Chavis, Esq. to rewrite the Club's purpose into the required legal form as specified.

The revisions as now stated in Article I, Section 2 of the present Constitution were approved by the Board of Directors at a meeting of January 10, 1975. Attorney Chavis then proceeded to obtain the approval of the Attorney General of the State of New York, a State Supreme Court Justice and, finally, of the Secretary of State of the State of New York.

The new Certificate of Incorporation was received on May 6, 1975; thereupon, the Executive Committee authorized the President and Secretary to sign IRS Form 1023 which had been prepared by Treasurer David Talley. The completed documents were filed with the IRS in New York City on July 2, 1975.

In a letter dated October 5, 1975, the IRS asked for a true copy of the Articles of Incorporation, and submitted eleven questions covering the classes of membership, duties of the Executive Secretary, business interests of officers and directors, descriptions of proposed scholarships and research activities, and data on the publication and distribution of the **Proceedings**.

A letter with the required documents and answers to the eleven questions was prepared by David Talley and carried by him to the IRS District Office in New York, on November 18, 1975, where Talley also discussed the answers with the IRS official handling this matter.

In a letter dated November 28, 1975, the IRS stated that The Radio Club of America, Inc. was determined to be exempt from Federal income tax under Section 503(c)(3) of the Internal Revenue code, and that donors might deduct contributions, etc. Finally, the Club had obtained tax-exempt status.

N.B. — The Board of Directors at its meeting of January 10, 1977 unanimously adopted a resolution: "That the BOARD is highly appreciative of the efforts of Treasurer Talley which have put the Club in its present enviable financial position, and made it possible to obtain our present non-profit status."

Chronicle of The Life Membership Fund

**by David Talley (M 1949, F 1957, L 1970)
W2PF**

During the initial sixty years of its existence, the Constitution of The Radio Club of America prescribed that the membership consists of the Member, Fellow, and Honorary classifications. There were no provisions for Life Memberships.

In 1970, the Club was reorganized under the leadership of President Fred M. Link and the Constitution and By-Laws were revised to meet current requirements. The annual dues were raised to $6.00 for Members and to $10.00 for Fellows.

It then was discovered that a substantial number of members were delinquent in the payment of their dues for periods of two or more years; also, many of the delinquents had been members for 20 years or more. In view of this circumstance, the Board of Directors at its meeting of March 5, 1970 amended the By-Laws to provide for a Life Membership, as follows:

ARTICLE II — ENTRANCE FEE AND DUES

Sec. 7. Any Member or Fellow not in arrears; upon payment of one hundred dollars ($100) shall be exempt for life from the payment of annual dues. Effective January 1, 1970, any Member or Fellow not in arrears shall be exempt for life from the payment of annual dues providing that his age plus years of membership equal one hundred (100); or provided he is sixty (60) or more years of age, upon the payment of twenty-five ($25) dollars if he has been a member for twenty (20) or more years, or upon payment of fifty ($50) dollars if he has been a member for ten (10) or more years.

In 1983, the Life Membership fee schedule was increased to $200 for members with less than 10 years tenure and under the age of 60 years, to $100 for members age 60 or older having 10 years of membership, and to $50 for those age 60 or older with 20 years of membership.

At the January 1970 meeting, the Board of Directors also authorized the establishment of a Life Membership Fund, and the sum of $300 was transferred from the Club's checking account to a new savings account on April 13, 1970. The membership was informed of the actions, and applications for Life Membership were actively solicited from all members and especially from the newer members.

As a result, Life Membership grew to over 100 during the period of 1970-1975 while the total Club membership increased over 100%. As of December 1983, there were a total of 980 members of whom 124 were Life Members.

The rapid growth of the Life Membership Fund during the past 13 years to a total of $6,289.04 (as of September 1, 1983) resulted, in large measure, from the interest earned and compounded on the Fund's investments.

David Talley *receives the Henri Busignies Memorial Award "for the Advancement of Electronics for the Benefit of Humanity" from Mrs. Busingies. Mr. Talley was a telephone engineer with NY Telephone Co. 1923/1946 (except for war leave 1940/1945), and with ITT or Federal from 1946 to 1959. He was an amateur in 1915 (W2PF in 1919) and has worked in radio organizations since 1920, when he helped found the Brooklyn Radio Club. In 1926 he helped organize the Army Amateur Reserve System. In 1940 he continued his AARS work as a Major in the Signal Corps Reserve, and was on active duty throughout the war, afterward helping reorganize the AARS nets as MARS (Military Afilliated Radio Systems). In civil organization, Talley has helped found or actually written the constitutions of several radio associations, including the Club, and has taken an active part in them. Dave joined the Club in 1949, was Fellow in 1957, Life Member in 1970 and Director Emeritus in 1977. He served on the Executive Committee 1971-79 (Treasurer 1971-77) and currently serves on the Scholarship Committee.*

LIFE MEMBERS

as of December 31, 1983

Akin, R.M. Jr.
Albertson, Fred W.
Amoscato, Gaetano (Tom)
Arnold, John W.
Atwood, Horace Jr.

Barber, Alfred W.
Bates, Frank III
Beeferman, Steven J.
Behr, Joseph
Beverage, Harold (H)
Bohman, Albert K.
Borst, John M.
Bose, John H.
Brunet, Meade

Canavaciol, Frank E.
Carini, Louis F.B.
Cervantes, Howard T.
Chalfin, Norman L.
Chittick, Kenneth A.
Christaldi, P.S.
Cohn, Hugo
Connor, George C.
Cook, Lawrence
Cooley, Austin G.
Crawford, John D.
Crawford, Robert V.

Darrell, Robert D.
Demerly, Merle
Dickey, E.T.
Durham, E.R.

Edinger, J. Raymond
Eitel, LaNeil
Eitel, William
Engle, Karl D.
Espenschied, Lloyd (H)

Felch, Edwin P.
Finch, Capt. Wm. G.H.
Fink, Donald G.
Finlay, Robert C.S.
Freeman, W. Harrell

Glaser, Marcus
Goldsmith, Thomas T. Jr.
Graham, Charles B.
Gray, Gary David
Grim, W. Manning
Gross, Al
Gunther, Frank A.

Halligan, William J.
Harmatuck, Samuel N.
Hendricks, Col. Arthur D.
Henney, J. Keith
Holm, Leif
Houck, Harry W. (H)

Johnson, J. Kelly
Jubon, Dorothy M.
Jubon, Jan D.

Keel, William P.
Kelley, Leo A.
King, Frank (H)
Kunik, I. Jordan

Lamb, James J.
Langer, Peter L.
Link, Fred M.
Loughren, Arthur V.

McKenzie, Alexander A.
Marx, Frank L.
Meyer, Stuart F.
Meyers, Ray E.
Miller, Kenneth M.
Minter, Jerry
Mitchell, Robert H.
Moreau, Louise Ramsey
Morelock, James
Morrisey, John W.
Morrison, Dearl O.

Natole, Anthony

Offenhauser, Wm. H. Jr. (H)
Osborn, Perry H.
Osterland, Edmund

Page, E.C.
Palmer, C.W.
Papamarcos, George
Poppele, J.R.
Poppele, June (H)

Quist, A.H.

Rabinowitz, Louis
Raser, Edward G.
Replogle, D.E.
Rettenmeyer, F.X.
Richardson, Avery G.
Rider, John F.
Ronald, T.T.
Russell, W. Gordon

Schnoll, Nathan
Schwartz, Michael S.
Shenier, Henry L.
Shepard, F.H., Jr.
Shortt, Hubert L.
Shunaman, Fred
Sieminski, Edward
Skipper, Lionel C.
Smith, Arthur V.
Smith, Myron T.
Stantley, Joseph J. (H)
Steen, Jerome R.
Stodola, E.K.
Stokes, W.E.D., Jr. (H)
Swinyard, W.O.

Talley, David
Talley, Edward S.
Thorpe, Wilbur E.
Treado, Lt. Col. M.J.
Tsao, T.C.

Van Beuren, John M.
Vogel, William H. Jr.
Voorhis, Harold V.B.
Vorporian, Harry

Wallace, Don C.
Warshaw, Marguerite E.
Watson, William P.
Wheeler, Harold A. (H)
Williams, Dorsey

Zayac, Frank R.
Zouary, Maurice

The Annals of the Captain W.G.H. Finch Scholarship Fund

by David Talley,
(M 1949, F 1957, L 1970)
W2PF

Capt. W.G.H. Finch presenting scholarship award

A memorable event occured at the March 17, 1977 meeting of the Club's Executive Committee when Director Bill Finch announced that he desired to make an initial gift of $10,000 to the Club for the establishment of a scholarship fund under his name. This was to be the first fund to be instituted under the Club's tax-exempt status as an educational and scientific organization.

In a letter dated June 30, 1977, Captain Finch set forth the following criteria for making the scholarship awards:

A. Scholarships are to be available to persons studying or working on projects in the field of radio, telecommunications, electronics and, without limitation, in all types of communications: visual; auditory; or otherwise.

B. Recipients of the scholarships shall be persons studying at or associated with accredited educational institutional providing instructions in the foregoing fields.

C. The scholarships shall be awarded by the Board of Directors of The Radio Club of America, Inc. to persons selected by it from a list or lists of recommendations by one or more such educational institutions.

The Board of Directors, at a meeting held on July 12, 1977, approved the concept of a scholarship fund that would be under the guidance and administration of the Club's Research and Scholarship Committee, of which John F. Rider was Chairman. Thereupon, Captain Finch submitted an initial contribution of $500 pending the preparation of the necessary legal documents by his attorney, as required by IRS Regulations.

At the meeting of the Executive Committee on October 11, 1977, Captain Finch announced his resignation as a Director of the Club, and as Chairman of the Finance Committee. These actions, he stated, were necessary in order to comply with legal and IRS requirements in connection with his gift to the Club. He also delivered a check for the balance of his $10,000 contribution. On January 25, 1978, the Board of Directors elected Captain W.G.H. Finch a Director Emeritus for Life.

The establishment of this Fund also was authorized by the Board of Directors at its meeting of January 25, 1978 by the following resolution:

"RESOLVED: That a Fund to be known as the Captain William G.H. Finch Scholarship Fund be and hereby is established by The Radio Club of America, Inc. in accordance with instructions contained in Captain Finch's letter dated June 30, 1977, and acknowledged on July 12, 1977 by Fred M. Link, President of The Radio Club of America, Inc. using the initial contribution of $10,000 received from Captain W.G.H. Finch, to be administered by a Board of Trustees to consist of four Trustees to be appointed by the Club's Board of Directors; each to serve for a two-year term. Trustees may be appointed for additional terms as the Board may direct."

The Board appointed Messrs. Samuel N. Harmatuk, John F. Rider, Nat Schnoll, and David Talley as the four Trustees for the two-year term from January 1, 1978 through December 31, 1979. The Board also ordered that the money on hand for the Fund be invested in a six-year Time Deposit account bearing 8.07% interest, at the Emigrant Savings Bank of New York. The investment was made on May 10, 1978 and matured on May 10, 1984.

On November 15, 1979, Article IV, Section 7, Item f of the By-Laws was amended by the Board of Directors to combine the activities of the Captain W.G.H. Finch Fund, and the Research and Scholarship Committee into a newly-formed Grants-in-Aid Committee.

The first awards of the Finch Scholarship Fund were made on March 21, 1980 to the Florida Institute of Technology, of Jensen Beach, Florida. Two scholarship grants of $500 each were presented personally by Captain Finch to the nominees during the Commencement Exercises. The Radio Club of America also was represented at this ceremony by Director Emeritus David Talley.

History of Grants-In-Aid Funds

by Joseph F. Walker, Sr. (M 1977, F 1978) W5ZPO and **John F. Rider, (M 1932, F 1937, L 1970) W2RID**

The eminently successful Grants-in-Aid Fund was born from two separate committee entities during the meeting of the Executive Committee on January 15, 1976.

Having gained tax-exempt status for The Radio Club of America as an educational and scientific organization on November 28, 1975, President Fred Link presented the idea of a scholarship aid program for the Club, and announced the formation of two standing committees: a Scholarship Committee with Mr. John Bose as Chairman; and a Research Projects Committee with Mr. Jack Poppele as Chairman. The Treasurer was directed to maintain separate financial records of contributions under the headings of general, scholarship, and research funds.

The first assignment given to the Research Projects Committee was to microfilm the essential records of the Club, and the first Research Projects financial grant was $500 to the Armstrong Memorial Foundation. The purpose of the grant was to help index the papers of Major Edwin H. Armstrong which had been presented to the Foundation several years earlier.

The initial activity of the Scholarship Committee was to grant $250 to the Foundation for Amateur Radio (FAR), to be given to a qualified radio amateur studying electronic communications in an institution of higher learning. At its meeting of December 6, 1976, the Executive Committee voted to recommend to the Board of Directors that the two grants in the same amount be given annually. This action was approved at the January 10, 1977 meeting of the Board of Directors.

On January 24, 1977, the Scholarship and the Research Projects Committees were merged into a single committee to known as the Scholarship & Research Committee under the Chairmanship of John Rider.

The Executive Committee meeting of March 17, 1977 proved to be a banner event. Director William G.H. Finch advised the Committee that he desired to establish a scholarship fund in his name with an initial gift of $10,000.

At the meeting of July 12, 1977, Mr. Rider presented a list of suggested procedures applicable to the conferring of scholarship grants, as follows:

1. The grants would be given to qualified, financially-distressed students studying electronic communications in approved four-year colleges and universities, as well as at two-year community colleges.
2. The selection of students would be the responsibility of the schools. The grants would be forwarded to the schools which would process them for the benefit of the students whose names and addresses as would be sent to The Radio Club of America.
3. Officers, Directors, and Members in good standing could suggest the names of institutions of higher learning to be considered for scholarship grants.
4. The value of the scholarship grants would be determined by the contributions received by the Scholarship Fund.
5. The solicitation of scholarship funds would make use of publicity in the **Proceedings**, appeals to be sent with the members' dues notices, and direct-mail requests to individual members and appropriate corporate personnel.

The resignation of Captain Finch as a Director and Chairman of the Finance Committee was announced at the meeting of the Executive Committee on October 11, 1977. This move was dictated by the legal requirements of the IRS in connection with the donation of $10,000 to The Radio Club of America by Captain Finch. On January 25, 1978, the Board of Directors elected Captain Finch to the status of Director Emeritus for Life.

The Board of Directors authorized the establishment of the Captain William G.H. Finch Scholarship Fund at the same meeting. The money in the Fund would be administered by a four-man Board of Trustees to be appointed by the Board of Directors to serve two years commencing January 1, 1978 through December 31, 1979. The Board of Directors appointed Messrs. S.N. Harmatuk, J.F. Rider, N. Schnoll, and D. Talley to comprise this Board of Trustees.

At the April 15, 1978 meeting of the Executive Committee, the President expressed concern that insufficient effort was being made in the solicitation of money for the Scholarship & Research Fund.

On July 19, 1979, Mr. Joseph F. Walker, Sr. was appointed Chairman of the Scholarship & Research Committee.

After an exchange of letters between Messrs. Talley and Walker, a joint meeting between the Finch Scholarship Committee and the Scholarship & Research Committee was set for November 15, 1979. The purpose of the meeting was to review the committees' activities, establish objectives, review grant awards, discuss industry participation, review committee membership, and discuss public relation activities.

Subsequent to the call for the joint meeting, Chairman Walker wrote to 90 Club members soliciting contributions to the Scholarship & Research Fund. The results were gratifying — $700 was received.

At the Board meeting on November 16, 1979, the name of the Scholarship & Research Committee was changed to the Grants-in-Aid Committee. The new committee was to consist of four or more members including the Club's Treasurer. It would be responsible for soliciting contributions to the Grants-in-Aid Fund, the Captain W.G.H. Finch Fund, and any other scholarship or research fund that may be established in the future, and to administer these funds as directed by the Board of Directors. It also would solicit eligible applicants for scholarship and research grants, and recommend to the Board of Directors qualified individuals or organizations for the receipt of grants from the various funds.

On December 11, 1979, Chairman Walker advised the Grants-in-Aid Committee that a letter had been received from the Florida Institute of Technology stating that Captain Finch suggested that an application be submitted to The Radio Club of America for a scholarship grant. The Board of Directors authorized two grants of $500 each from the Captain W.G.H. Finch Fund.

Contributions to the GIA Fund during 1979 amounted to $1,660 and a target of $10,000 was set for contributions to the Fund during the following year. On March 4, 1980, President Link reported the GIA Fund had reached $11,665 resulting from the contributions of 115 members. By March 12, the Fund had a balance exceeding $13,000 with the receipt of 20 additional contributions.

On August 11, 1980, the Executive Committee authorized the GIA Committee to award $1,500 in grants as recommended by that committee, plus $1,000 in grants from the Captain Finch Scholarship Fund. Director Dr. Henri Busignies wrote to Chairman Walker suggesting that the Polytechnic Institute of New York be considered for a GIA Scholarship grant. Recommended grants for 1981 were:

Captain W.G.H. Finch Scholarship Fund	
Two grants each of $500 to the Florida Institute of Technology.	$1,000
Grants-in-Aid Fund	
Foundation for Amateur Radio (FAR)	500
Two grants each of $500 to the Polytechnic Institute of New York	1,000
Armstrong Memorial Foundation	500
Amateur Satellite Corp. (AMSAT)	500
	$3,500

By the time of the Club's 71st Annual Awards Banquet on November 21, 1980, the total contributions had reached more than $21,000.

On July 6, 1981, Chairman Walker reported that the GIA Committee had lost one of its highly-regarded members. Dr. Henri Busignies died on June 20, 1981 while visiting France.

An announcement was made at the November 4, 1981 meeting of the Executive Committee that the GIA Fund had reached a total of $35,855 and the GIA Committee recommended that $4,000 in grants be approved for distribution in 1982 to the following organizations:

Captain W.G.H. Finch Scholarship Fund	
Two grants each of $500 to the Florida Institute of Technology	$1,000
Grants-in-Aid Fund	
Two grants each of $500 to the Polytechnic Institute of New York	1,000
Southern Methodist University	1,000
Foundation for Amateur Radio (FAR)	500
Armstrong Memorial Foundation	500
	$4,000

In December, 1981, a Fellow and Director of the Club made a large donation to the GIA Fund. He requested that his name not be made public. This donation and other contributions raised the GIA Fund balance to a high of $52,642.

The Executive Committee, on February 9 and March 9, 1982 approved additional grants in the amount of $1,000 to the Cooper Union Institute of New York, and $500 to the Stevens Institute of Technology, Hoboken, NJ. Grants for 1982 totaled $5,500.

Treasurer Apfel reported 115 contributions amounting to $4,290 for the first five months of that year, raising the total of the Grants-in-Aid Fund to $56,932.

Throughout the entire period of the GIA Fund activity, numerous letters of appreciation were received from recipient organizations and individuals, with many stating that the people who had received the grants could not have continued their education without this help.

On August 11, 1982 the Executive Committee recommended that the GIA Committee submit a request for grants in the amount of $6,000 to be made in 1983. The nominees were:

Scholarship Grants	
Florida Institute of Technology (Finch Fund)	$1,000
Polytechnic Institute of New York	1,000
Southern Methodist University	1,000
Foundation for Amateur Radio (FAR)	500
Stevens Institute of Technology	500
University of Central Florida	500
Research Grants	
Armstrong Memorial Foundation	500
Amateur Satellite Corp. (AMSAT)	1,000
	$6,000

The request for $6,000 in grants for 1983 was approved unanimously by the Board of Directors at its meeting of November 19, 1982. At year-end (December 31, 1982) the GIA Fund balance reached $57,766.

On March 1, 1983, President Link advised the GIA Committee of a letter received from Fellow Amory H. "Bud" Waite, Jr. asking the Club to accept a memorial contribution to the GIA Fund "in memory of Richard Edward Waite, Ph.D. (1937-1982) and his daughters Alison and Diane who died at the hands of a drunken driver on June 24, 1982 in Salem, Missouri". The contribution was accepted and acknowledged with the Club's expression of sympathy to the Waite family.

On May 17, 1983, the Executive Committee authorized the GIA Fund Committee to allocate $7,500 for Grants-in-Aid awards for the year 1984 in recognition of the Club's 75th anniversary. In his mid-year report, Treasurer Apfel reported that through June 1, 1983, the sum of $6,580 had been received in contributions to the GIA Fund and its balance was $64,924.

Those contributions had increased to $74,600 through May 1, 1984, partly through the funds obtained in the merger of The de Forest Pioneers into The Radio Club of America.

From a humble beginning, the GIA Fund has accomplished great results. In five years, the gifts of both major and lesser contributions have made it possible for The Radio Club of America to award $19,500 in scholarship and research grants.

Editor's Note:

Early in 1984, Joe Walker retired from employment and, because of extensive travel which was planned, resigned as Chairman of the Grants-in-Aid Committee. At its meeting of June 21, 1984, the Board of Directors elected Mr. Ken Miller to head the Committee, to be assisted by Mr. John Dettra who will handle the Grants-in-Aid Fund, and Mr. Arch Doty who will set up operations of a Legacy Fund.

Jack Poppele — A Man For Tomorrow

One definition of a prophet is: "a person regarded as a leader, or a spokesman of some doctrine or cause." Jack Poppele certainly fits that description.

But the old adage: "A prophet often is without honor in his own country" certainly doesn't apply.

The Newark (NJ) **Sunday Star Ledger** of May 23, 1982 featured the story of Jack Poppele in the article "Pioneer Turns U.S. On to Radio". Let's read a bit of what it had to say.

"On the two-and-a-half-inch disc appeared a black and pink image of Felix The Cat. It was the first crude picture transmitted electronically into a receiver. The year was 1926 and Allen B. DuMont was developing television in a Jersey City shop called Jenkins Radiovisor.

"The production of radiovisor receivers began in September 1926. The second set off the production line was a gift from DuMont to his friend Jack Poppele, Jr., a native of Newark and a pioneer in radio broadcasting in New Jersey. Radio's origins in the Garden State go back to February 1922. The station was WOR, now one of the nation's largest and most lucrative outlets.

"Poppele, then 24, was regarded by his electrical engineering peers as a visionary in the broadcasting industry. In those days, television was nonexistent and radio was a novelty with no commercial value."

Now, more than six decades later, Poppele still fits the definition of a pioneer and a prophet. He serves as Chairman of the Board of Tele-Measurements, Inc. and a Director of The Radio Club of America, Inc. amongst his other activities. His services to The Radio Club have long been documented through his serving as Chairman of the annual Awards Banquet, and his generosity in providing a meeting site for the monthly meetings of The Club's Executive Committee.

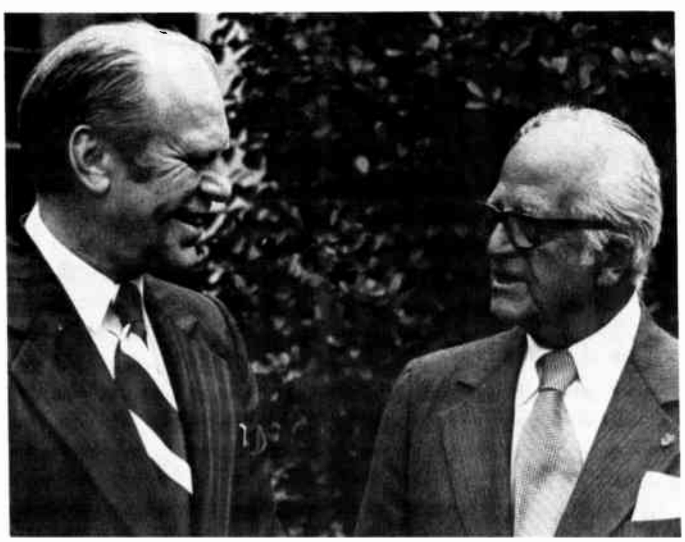
He founded Tele-Measurements in 1961 as an engineering and communications contractor, specializing in radio and television broadcasting. Over its life span, Tele-Measurements has moved into allied video, data and sound fields. Its notable achievements are represented by the recent installation of a Local Area Network at the West Point Military Academy, video surveillance systems at the gambling casinos in Atlantic City, and in the design and installation of Mobile Television Vans for the broadcast and cable markets.

The company, began in a small garage in the home of its President William Endres, has now grown into its own 14,000 square foot building in Clifton, NJ, and is one of the best equipped modern contracting and support facilities in the East, providing complete design, installation and service for RF and Data system communications, Television studios, Production Vans, Teleconferencing, and Graphic Presentation Facilities.

Tele-Measurements provides complete design, implementation, installation, certification, documentation and on-going technical support services for these advanced systems.

Poppele's career spans the entire history of broadcasting and he was an early advocator of AM-radio stereo broadcasting. He has known all of those legendary personages of the emerging electronic era: Thomas A. Edison, Guglielmo Marconi, Edwin H. Armstrong, Lee de Forest, David Sarnoff, Allen B. DuMont, and Samuel F.B. Morse.

His work brought him into the presence of seven successive presidents — from F.D. Roosevelt to Gerald Ford. In 1954, President Eisenhower appointed Poppele to the position of Director of the Voice of America, U.S.I.A. The job's responsibilities were those of directing broadcasts in 43 languages over 83 transmitters located through-out the world.



Poppele's fascination with radio communications began in 1912 when he assembled a wireless set at his home in Newark. Then 14 years old, he quit school to work in a machine shop at wages of five cents a hour. After a ten-hour workday, he studied the theory of electricity at Newark Tech and, later, traveled by trolley-car and ferry to New York City to study code and radio theory at the Marconi Wireless School.

In 1915, he obtained a commercial operator's license and got a job as a wireless operator aboard the S.S. Iroquois. During World War I, he served in the U.S. Army Transport Service.

As radio broadcasting took root in the years immediately following the war, Poppele was amongst the first to recognize its potential. By 1922, the federal government had issued only 13 licenses. Poppele was persuasive and convinced L. Bamberger & Company department store in Newark, NJ to set up a station and WOR became the 14th licensee. Its antenna was a piece of wire strung between two poles on the roof top; the home-made transmitter had a power output of 250 watts. It was enough to broadcast the songs of a local piano player who worked without pay.

A few weeks after turning on the switch, Poppele became the station's chief engineer at a salary of $23 a week. The station operated from 10 to 10:30 in the mornings, from 2-2:30 and 5-5:30 in the afternoons, and from 8 to 9 in the evenings.

"There wasn't much to do so I sold radios in the store between broadcasts," Poppele recalls "I was selling so many radios that they cut my commission from two percent to one percent. To make up the loss, I sold twice as many radios."

Christmas arrived and Bamberger's would be closed on the bigget holiday of the year. That meant that WOR also would be off the air. Poppele went to his boss and told him the customers would have nothing to hear on Christmas Day.

"He wanted to know who would give up their Christmas to operate the station," Poppele related. "I said there'll always be other Christmases." And WOR became the first station to broadcast on Christmas Day. Poppele played phonograph records from 7 in the morning until 10 at night. There were listeners as far away as Asbury Park.

During April 1923, Poppele was summoned to the office of Louis Bamberger. It was a top level meeting on the future of WOR.

"Mr. Bamberger informed us that we had been in the broadcasting business for 14 months and had spent $20,000," Poppele recounted. "He believed Bamberger's had gotten all the promotion out of WOR that it could and he was going to turn in the broadcast license."

Poppele saw his radio future abruptly ending. "I said, 'Mr. Bamberger, you're making a great mistake; radio will be big business.' " Felix Fuld, president of Bamberger's, wanted to know how Poppele knew that radio would be commercially successful.

"I told them that radio can reach all the people on the air; that those people didn't have to buy records when they could listen to music off the air," Poppele remembered. Harry Hattrey, vice president of clothing, sided with Poppele and suggested that WOR stay on the air for at least another two years.

One day, Poppele met Bamberger's china buyer, Pauline Bacmeister. He impressed her that day in 1924 by going on the air and promoting dishes that were not selling in her department. Poppele doubled the price per set from 75 cents to $1.50 and sold two truckloads of china. "I didn't get in trouble because they sold out," Poppele grinned. He married the china buyer the following year.

With WOR assured of a future, Poppele stayed on as Chief Engineer for three decades, eventually heading a staff of 150 engineers and technicians and reaching the positions of Vice President and Director of the Mutual Broadcasting System.

In the early days, many milestones were set by WOR. There was the first trans-Atlantic broadcast between New York and London in 1923, the first play-by-play broadcast of a football game and, in 1927, the transmission of radio pulses toward Mars to help scientists ascertain whether an advanced form of life might respond — a feat that gained national attention more than a quarter century before men began to probe space with satellites. Poppele's job was to arrange and technically supervise those events.

In a sketch published in 1945 by **Broadcasting News**, the WOR engineer was credited with rigging up what was probably the first portable receiver. After buying seats for the Dempsey-Tunney heavyweight championship in Philadelphia in 1926, Poppele discovered his tickets were for the last row in the mammoth stadium. Undeterred, he built a small radio receiver and brought it with him to the stadium. He put a couple of batteries in his pocket, hung an aerial from his seat, and listened to the fight while watching it from a quarter of a mile away.

An early convert to frequency modulation (FM) broadcasting, Poppele was one of the first broadcasters to inaugurate commercial FM programs. These included experiments with transmission of home facsimile programs in association with John V.L. Hogan (HM).

Perhaps Poppele's most important contribution to radio was the directional signal patterns that he developed with two teams of research scientists at Bell Laboratories. Working only with theoretical data, Poppele had to convince his new employer, R.H. Macy & Co., which acquired Bamberger's a few years earlier, that a supertransmitter of 50 kW costing $350,000 plus a directional antenna would give the station exceptional coverage. Winning approval, the world's first super-station was built in 1935. With the new directional antenna beaming a strong signal at population centers and not over the ocean or westerly woodlands, WOR's income rose from $385,000 to $1.2 million, the first year, and to $1.7 million, the second.

Television had its advent long before World War II. In 1926, Jenkins Radiovisors were being built in Jersey City by the de Forest Radio Company. On July 2nd at 8:00 P.M. Eastern Standard Time, the Jenkins Laboratories began broadcasting radiomovies on 46.72 m. (6.42 KHz.) over amateur radio station W3XK and, simultaneously, on 186.92 m. (1.605 KHz.) for Washington, DC viewers. The broadcasts were repeated every Monday, Wednesday and Friday nights.

The programs began with the transmission of simple subjects, then more elaborate subjects, and still later a picture story. Each subject was proceeded by an announcement in the International Morse Code and voice, and each picture story finished with "END" directing the viewer to switch to sound for the next announcement.

The picture standards were 48 lines per picture and 15 pictures per second. The camera consisted of a Nipkow disc having 48 small lenses mounted in holes equally-spaced over a 2½ inch spiral which rotated at 900 rpm in front of a photocell. The lenses transmitted the scanned images of the silhouettes used for the picture subjects. These were relatively easy to pick up and permitted the use of a narrow-picture-frequency band.

The Radiovisor picture receiver units used similar spinning discs, usually of 12 inch diameter, which spaced pulsations of a neon glow tube in synchronization with the pulses generated by the photocell of the camera. While the Radiovisor would produce pictures when attached to any good radio receiver, the manufacturer recommended resistance-coupled amplifiers for better pictures.

The principal problem was in the synchronization of the Radiovisor to the camera. Usually this was accomplished by supporting the disc of the picture receiver unit on a bearing-supported shaft such as that of an idle motor, and using a separate fractional-horsepower motor as a planetary driver. Synchronization was achieved by changing the distance of the driving motor from the center of the scanning disc. An occasional fault occurred when the sides of the disc were reversed; then the picture appeared upside down.

The radio output at about 180 volts was connected through a switch to the neon lamp. The cathode electrode continuously glowed pink in the absence of a pulsed signal, and cutoff or went black when the signal was received to make up black silhouettes on a pink ground.

Jenkins Laboratories' literature forecast:

"This is the beginning of a new industry; a new form of radio entertainment. With these motion picture broadcasts we are hoping to contribute to its rapid development. Ultimately this pantomine story-teller will come to all our firesides as a fascinating teacher and entertainer, without language, literacy, or age limitation; a visitor to the homestead with photoplays, the opera, and a direct vision of world activities, without the hinderance of muddy roads or snow blockades."

This disc scanning system was introduced to the general public at the Bell Telephone exhibit during the 1933-34 World's Fair in Chicago. The picture transmission plus two-way telephone conversation took place between adjacent telephone booths, via telephone lines.

At the New York World's Fair in 1939-40, RCA introduced the all-electronic TV system but the shadows of World War II prevented its exploitation. The advent of electronic television found Poppele amongst the vanguard advancing the art of visual broadcasting. He was responsible for the establishment of WOR-TV in New York City and WOIC-TV (now WTOP-TV) in Washington, DC.

Again anticipating the potential of television, Poppele helped found the Television Broadcasters Association and served as its president for six terms from 1944 through 1950. As the association's chief executive officer, he participated in drafting the engineering rules and channel allocations that serve as the basis of today's TV broadcasting.

Poppele has been honored for his pioneering by being elected a Fellow of both The Radio Club of America and the IRE (now IEEE); he has received the gold medal of the Veteran Wireless Association, and an award from the American Television Society.

A busy man, he finds time to have served four terms on the Grand Jury; as an officer of the county Red Cross; as president of the local Republican Club; as a member of the Board of Directors of Upsala College; and as an active member of his church.

Jack Poppele has been a member of The Radio Club of America since 1942; he served with distinction as Vice President in 1967 and 1968 and as a Director in 1965-67 and 1969-83; he was elected to Director Emeritus for Life in 1983. He was awarded the Club's Sarnoff Citation in 1974 "for Significant Contributions to the advancement of Electronic Communications."

With an active lifetime devoted to the growth of America and with the vision and foresight to help its young people to become the best, all that Poppele has asked in return is — "Just a few kind words."

Tele-Measurements, Inc., 145 Main Avenue, Clifton, New Jersey.

Hallicrafters — A Name You Will Remember

by William J. Halligan
(M 1960, F 1964, L 1980)
W9AC/W4AK

It all began when I received my amateur and commercial radio operators licenses in 1916 after graduating from high school. I went to sea; my first ship was the SS Dorothy Bradford sailing between Boston and Provincetown. Then, I served aboard vessels sailing from Boston to Portland, Maine and Savannah, Georgia.

At that time, wireless operators awaiting assignments usually congregated at Radio Station WBF located in Boston's Filene Building. There, I first learned about the Naval Reserve. I knew both the American Morse Code and the Continental International Morse used for wireless transmissions so, when I applied for enlistment in the Naval Reserve, I was immediately accepted.

The time spent in the Naval Reserve prior to World War I and then on active duty during the War stand out in my memory as the most important and, perhaps, most influential period of my life. My initial duty assignment was at the Navy radio station NAE on Cape Cod; it was rumored that German submarines were communicating with people on the Cape, and the Navy was trying to intercept such signals.

Then, I was assigned to a small ship that had been converted to a mine layer. We joined a convoy and sailed for Scotland from whence we made almost daily mine-laying trips on the North Sea. Those mines were anchored to the bottom of the sea and floated at various depths so as to be hit by different types of enemy ships. Towards the end of the War in 1918, our mine layer, the SS Canonicus, joined other ships to witness the surrender of the German fleet at Scapa Flow.

Back home in Boston, I enrolled in Tufts College. Later, I believed that West Point offered the type of engineering that I wanted; so I applied, took the examination, and won an appointment. During the third year, I had to leave West Point because of a rule which prohibited a cadet from "owning a horse, having a wife, or raising a mustache"; never a conformist, I had married Miss Kate Fletcher, of New Rochelle, N.Y.

Out of West Point, I first worked on a newspaper — The Boston Telegram — doing rewrites, but they were having financial problems. About then, Tobe Deutschmann wanted me to join his company. He had an office on Cornhill in Boston, where he displayed things that he imported from Germany. He knew that I was an active radio amateur and thought that I might be of help in his business. Eventually, I took control of the company while Mr. Deutschmann concentrated his activities in expediting material from Germany.

The interest in imports grew and we wondered if they should be better displayed. Together, we selected a place on Brattle Street, in Boston, near other radio dealers. Our place did not have a name so, as a radio operator, I suggested that we call it RADIO SHACK. Soon, we were doing an active business in parts that Hams and radio experimenters needed.

At that time, most radio sets were battery operated but demands were beginning to be made for AC/DC power supplies and these used condensers, transformers and rectifiers. Amongst the things that Tobe imported from Germany were filter condensers.

I knew Larry Cockaday and several others who were editors of various radio hobby magazines. Authors wrote articles for those magazines on how to build power supplies, and Cockaday and other editors tested the circuits using Tobe condensers. These were attractive and well built; as a result most editors promoted their use.

As a result of this activity and the prominence of Tobe condensers, McMurdo Silver and Larry Chambers invited me to join their separate companies, both in Chicago. Chambers offered half of his business if I would join him, and I did. The company named Chambers-Halligan did very well with another condenser line in selling to Zenith, Wells-Gardner and other radio manufacturers.

At this time, The Radio Corporation of America owned a large pool of patents on radio equipment and, at their discretion, would license other radio manufacturers to use the circuits. Such a license was needed in order to enter into radio manufacturing, but this was denied me. Therefore, I devised another means of developing the business. I would design receivers, draw the schematics, sell the receivers to radio stores and, after selling 50 to 100 units, would commission the manufacturing of the sets to a company holding an RCA license.

Among such manufactures was the Echo-Phone Company which was in financial difficulties. This made it possible for me to buy control of the company and to gain use of its RCA license. Now, we were able to manufacture the radio equipment under the "Hallicrafter" label at much lower costs.

Why did we call it "Hallicrafters"? Well, we were manufacturing and supplying a few other manufacturers with equipment which they sold under their own names. At the same time, I was doing some advertising in Ham magazines and had a good advertising man, Lloyd Back, who asked me: "Why don't you develop a name for your activities?" He mentioned several things that had been done with a name and the suffix "-crafters" meaning craftsmen, and that suggested "Hallicrafters". We started using it in our Ham ads and eventually it became very well known.

With the advent of World War II, Hallicrafters developed a powerful radio transmitter in a small, rugged and transportable package for military communication systems — the world-famous BC-610. Soon afterwards, this unit was incorporated into the SCR-299 and SCR-399 trunk-mounted radio stations of the U.S. Army Signal Corps, which were used throughout World War II.

The period after the War probably was the most difficult in the company's history. The nation as a whole was in considerable flux. Hallicrafters managed to stay in business by reverting to its pre-war philosophy concerning the amateur radio operator. We designed and built the best receivers and transmitters available on the belief that amateur radio operators soon would begin to increase in large numbers. Time has proven that this estimate of the situation was correct.

During this period, Hallicrafters had successfully established the standards of the electronic industry in the fields of radio communication. In view of this, the company began producing radio equipment for the Department of Defense and other governmental agencies, manufactured broadcast and short-wave receivers, and then initiated the design and production of television receivers.

I always insisted that the Hallicrafter's high standards be maintained in producing the consumer line of radios and TVs, but the rapid expansion of the industry and resultant intensive competition made it extremely hard to compete on an economic basis. This resulted in Hallicrafter's decision to leave the consumer market in 1959, and to increase its operations in the military and radio amateur fields.

N.B. — The Radio Club of America at its 75th Anniversary Awards Dinner recognized the achievements of William J. Halligan with the awarding of the Sarnoff Citation. The Sarnoff Citation was instituted in 1973 and established by the Club's Board of Directors to be given to a Club member for significant contributions to the advancement of electronic communications.

Also in 1983, Tufts University awarded the honorary degree of Doctor of Science to William J. Halligan for his contributions to the advancement of electronic communications.

The REL Story

by Paul Gruber (M 1956, F 1961)

This story is about REL — in times past, called RADIO ENGINEERING LABORATORIES. This is a story about REL's early history, its pioneering people, some of their startling accomplishments, and their effects on today's technology.

Read on — it is an interesting tale. It encompasses the story of the greatest inventor in telecommunications, a real science fiction exploration of the Moon, and some of the greatest communication achievements covering commercial broadcasting, long-range multi-channel radio transmission, and military appliations. It is a story about people — people who participated in and followed the doctrine of The Radio Club of America. So please read on.

IN THE BEGINNING

The year was 1922. Two amateurs, one by the name of Charles Srebroff (M 1927), formed REL to build radio equipment in a small loft on Thames Street in New York City, with a precision and quality that was not commercially available. Now, an Amateur could purchase professional 75-watt ham transmitters operating in the 4-30 MHz band using the modern four-pin type 852 triode as a power amplifier.

In the '20s, a young amateur named Frank Gunther (F 1951, President 1956-1957) (W2ALS) joined REL where he participated in the design of broadcast transmitters. Such amateurs raised quite a few eyebrows when their radios found their way into the planes of Clarence Chamberlain and Amelia Earhart, and into the Graf Zeppelin.

"What will you do to top that?", Srebroff asked jokingly. "You'll see," answered Gunther, who was Chief Engineer by this time, and he set to work. By 1931, the promise was kept when Gunther gave working demonstrations of a two-way radio system designed for vehicular installations. A year later, the granting of FCC type approval culminated in the installation of the World's first two-way mobile radio system by the Bayonne, NJ police department — and opened the horizon for all of the two-way mobile radios that were to follow.

Later, Glen Musselman (F 1936) developed the first sim ple, one-tube phase-shift FM modulator that became the standard for two-way FM mobile radio systems.

THE BIRTH OF FM

REL's emphasis on problem solving and precision engineering had attracted the attention of the late Major E.H. Armstrong (F — President 1916-1920). The father of the regenerative, superhetrodyne, and superregenerative circuits needed an organization to build a transmitter and receiver for his greatest invention: frequency modulation (FM). The result was the first public demonstration of Armstrong's revolutionary FM transmission from the home of his friend, .R. Runyon, Jr., in Yonkers. The transmission was to the Institute of Radio Engineers meeting, November 6, 1935, in New York City. Previously unheard clear transmission shook the professional community. It catapulted REL into the forefront of FM.

C.R. Runyon, Jr. (F — Vice President 1927) (W2AG), a member of The Radio Club since 1912, and who later was to buy REL, helped build the FM transmitter. Runyon had been a railroad telegrapher as a boy and, in 1908, his interest in electronics caused him to switch to wireless and set up his own station. Sometime in 1909, the noisy spark signals from the Runyon home attracted the attention of Howard Armstrong, also a Yonkers resident, to see what was making the commotion. This started a lifelong friendship.

Salvatore Barone (F 1926) was a young, superb REL engineer, and he understood the future importance of FM. In the late '30s, he developed the first 10 kW broadcast transmitter to operate in the 42-50 MHz band. The unit was installed on top of Mt. Washington, NH where it broadcasted 24 hours a day. All through the Second World War, it served as a civil defense station.

His name was James R. Day (F 1938). He was lean, energetic, vibrant, a mathematician by education, and he worked for Armstrong. He built Armstrong's 1935 IRE demonstration receiver and, later, many more advanced versions. In 1939, Jim Day designed the type 517 FM receiver; it was mass-produced and became the standard of the broadcast industry. After World War II, J.R. Day became REL's Vice President of Engineering. In 1947, he invented the "Serrasoid" FM modulator — a simple crystal-controlled, high-deviation modulator. The Serrasoid modulator found its way into most commercial broadcast transmitters and became the standard of the industry.

Jim Daly was only one of the "Armstrong Boys" who were to work for REL and develop FM applications further. There also were Perry Osborn (F 1944), Malbon H. Jennings (F 1948), Robert Hull, and Marvin Stevens — each carving his own bit of history at REL.

The year was 1945. Jim Day calls to his office Mal Jennings, George Papamarcos (F 1940), and Benji Hara (F 1983), and outlines what was to become the first true high-fidelity FM receiver. "The noise figure is to be better than 10 dB, the IFs must be 150 kHz wide, linear phase and — oh yes — three limiters with a Foster Seeley detector." This is how the type 646 FM receiver was born. The unit was mass produced in 1946, and was used by WQXR for relay transmission to upstate New York. The FCC used it for monitoring purposes.

In 1951, the FM revolution then penetrating the commercial broadcast industry actually paused at REL when Paul Gruber (F 1961) and Perry Osborn built a 50 kW, CW, 150 MHz, pulse-modulated radar system (code name "Diana"). It was used by the U.S. Army to bounce signals off the Moon to permit its accurate plotting.

THE DAWN OF TROPOSCATTER COMMUNICATIONS

The Bell Telephone Company of Canada, in 1951, decided to install telephone service between Newfoundland and Baffin Island. This frozen and inaccessible 1300 mile path was not practical for line-of-sight (LOS) communications. The solution was forward-scatter communication; that is, bouncing signals off the troposphere over hundreds of kilometers using large antennas. Since FM was the preferred modulation mode and high-powered amplifiers were required, REL was the obvious choice for designing and manufacturing the equipment.

The program, code named "Polevault", was implemented with nine 10 kW klystron-amplifier UHF links. It was the start of an era as exciting and challenging as the dawn of FM. In addition to high-power klystron amplifiers, the diversity-receiver combining was developed by Jim Day and Paul Gruber using a transient-free baseband combining technique. The tension mounted until the system became operational in 1954. The quietness of the FM noise channels amazed even the Bell Telephone Laboratory consultants from the U.S. The successful completion of Polevault proved that tropo was a viable communication technique. It was the start of a new communication technique which took on explosive proportions.

This led, in 1955, to the construction of the 24 link, 132 channel White Alice tropo network which covered the mountainous and storm-ridden terrain of Alaska. Between 1956 and 1957, five additional major military and commercial networks, including the famous Texas Towers, were implemented. ACE HIGH, the NATO Backbone Tropo Communication System was successfully bid in 1957. Then, two years later, Bell Telephone Labs and Western Electric decided to use REL's equipment for the greatest tropo-communication network ever conceived.

The Aleutian Islands were to be interconnected to Turkey via 154 fixed tropo terminals; in addition, 48 transportable 10 kW terminals were employed — destination unknown. Great as that project had been, it was followed in 1962 by a requirement of the Bell Telephone Laboratories for solid-state tropo terminals handling 132/300 channels. The specifications were startling, the challenge fascinating, but the job was won and REL produced 174 terminals for military and commercial use.

EPILOGUE

REL went on to develop an advanced FM feed-back threshold extension technique that increased receiver sensitivity and led to the use of REL equipment in the NASA Space Program and by the U.S. Navy. Then came the introduction to radar through the merger with Reeves and the entry into electronic warfare business.

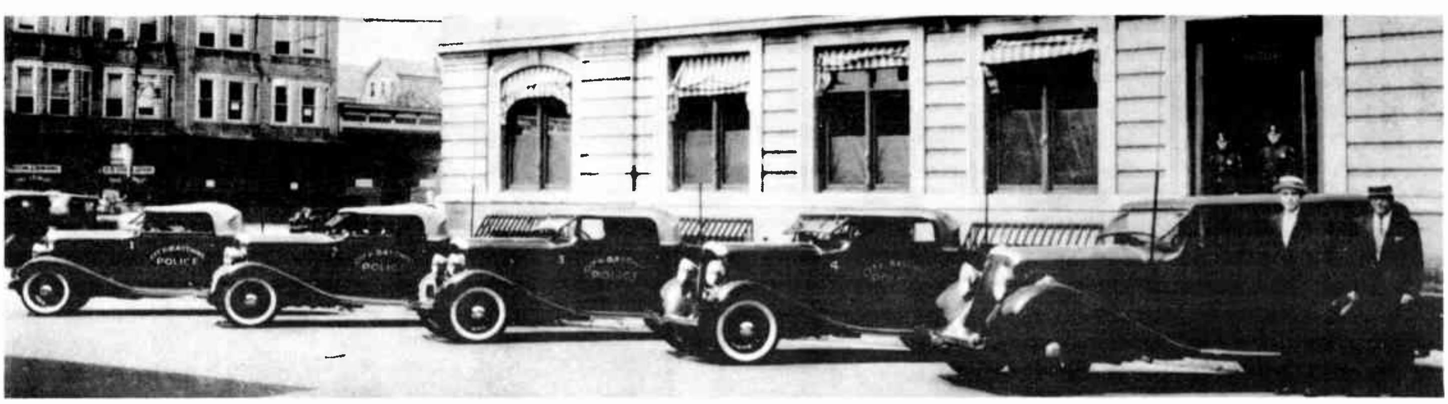
But the tropo communication techniques and, for that matter, REL's survival of 61 years, could never have been accomplished without the genius of E.H. Armstrong and spirit of The Radio Club of America. Twenty-five REL engineers were members of the Club. E.H. Armstrong, C.R. Runyon, Jr., Mal Jennings, and James Day — all members of the early Armstrong group — have passed away.

Harry Sadenwater (F), radio pioneer, the 1931 President of The Radio Club, and winner of the Navy Cross for his participation in the first Trans-Atlantic NC-1 flight., was associated with REL from 1948 until his death in 1961. Frank Gunther, President of REL for over ten years, is still active in the industry. Perry Osborn has retired. George Papamarcos, Benji Hara, and Paul Gruber are still working for REL and participating in the company's dynamic growth.

Sixty-one years have passed in REL's life. It is certain to celebrate its 86th birthday with The Radio Club of Ameria's 100th anniversary, with the same enthusiasm and even greater successes.

The World's First Public Demonstration of Two Way Mobile Radio, Bayonne, New Jersey Police Department — 1932.

MAJOR INVENTOR: Major E.H. Armstrong (right), chats with lifelong friend, REL President Runyon.



FIRST MOBILE SYSTEM: Bayonne, New Jersey, became in 1932 the World's First City with Two-Way Police Radio, developed and manufactured by REL.

How The Students Spoke

by John D. Ryder, Ph.D.
(M 1983, F 1984)
K4IHX, ex-W8DQZ
Chairman — IEEE Centennial Task Force

For fifty years, the AIEE and the IRE went their respective ways in the field of electrical engineering. The AIEE stressed the power aspects of the field and the IRE covered the radio-electronics area.

The coincidental presence of two strong and capable engineer/executives: Clarence Linder of the AIEE and Patrick Haggerty of the IRE, provided the leadership which showed the desirability of combination to the two organizations. In their views, this combination could provide for service to members over the whole field of electrical engineering by one strong organization. The efforts of these men and others culminated in 1963 in the merger of the AIEE and the IRE, resulting in today's Institute of Electrical and Electronics Engineers.

However, it was the student members in the colleges and institutes which made the merger necessary and inevitable. To them and to many of their teachers, electrical engineering was one field, using one frequency spectrum and covered by one set of electromagnetic laws. With electronics and solid-state devices permeating the field, any arbitrary division into strong current and weak current, or into low and high frequencies divided at 60, 1000, or 100,000 Hz made no sense, especially when the separation into two societies called for payment of two sets of annual professional dues to cover the field.

In 1903, President C.F. Scott of the AIEE had listened to requests from the campuses and the AIEE authorized groups of electrical engineering students to organize and conduct campus meetings as AIEE Student Branches. This was a major step in geographical dispersion of Institute efforts and followed by only a few years the recognition by the controlling New York group that members in major cities deserved the advantages of paper presentation and discussion which had been reserved to only the New York members. This was the first split: into Sections in remote cities. To forestall this, the opinion was expressed in New York that these remote cities would soon run out of topics to discuss!

The feeling of unity in a profession that engendered the Student Branches also led to formation of the electrical engineering professional honor society, Eta Kappa Nu, at the University of Illinois in 1904. Today, this organization has over 160 chapters.

There were 13 AIEE Student Branches authorized in 1903 and this figure reached 130 by the time of the merger. AIEE Student Membership and Branches were restricted to schools holding accreditation from the Engineers Council for Professional Development, and reached 5000 students by 1938, with a peak of 20,000 in 1950 during the post World War II student surge.

The IRE did not recognize students in a special grade of membership until 1941 but, after that date, permitted Student Members to be enrolled from engineering colleges and from strong physics departments in liberal arts colleges, noting that physics and electronics education often flowed together. Recognition of a Student Member grade was not so necessary in the IRE, where the non-professional grade of Associate had permitted affiliation of anyone with an interest in radio: this covering physics and mathematics students, "ham" radio operators, and basement experimenters.

With the post-war surge in interest in radio and electronics, the IRE organized Student Branches in 1947 with the first being at CCNY and NYU. Subsequently many schools, where interested and interesting professors were available to serve as Branch Counselors, established separate AIEE and IRE Branches, often competing for members and in campus activities. Students in those schools were confronted with the necessity of joining two Branches and paying two membership dues if they wished to partake of the full range of campus activities.

To the faculty Counselors and to many student leaders this was an illogical arrangement and they petitioned for the establishment of joint activities, with only one dues payment to the parent Institute of the student's choice. The two Institutes were to contributed equal financial subsidies for the Joint Branch operations. This solution was an immediate success after the procedure was established in February of 1950, with 30 Joint Branches operated by April. The Student Member received the IRE **Proceedings** (much of which he could not read), or the AIEE **Electrical Engineering** (much of which was not of campus interest) in accordance with his choice of parent Institute.

The Joint Branch did much more than resolve a difficult campus situation; when combined with the post-war surge in electronics interest, it reduced the dominant position of the AIEE on the campus. This had been represented by 20,000 Student Members in the AIEE in 1950, compared to 7000 for the IRE; this AIEE total was rapidly eroded and essential equality between the Institutes reached in 1955, at 7000 each. The reduced total of Student Members was due to the reduction in number of post-war GI students.

The establishment of the Joint Branch can possibly be taken as a precursor of the Institute-merger ahead. Students who had seen unity work on their campuses were not likely to pose objections to unity operations in the professional field after graduation. Yet such objections had been raised as recently as 1949 when a joint Summer convention operation was attempted in San Francisco.

In 1951, the AIEE noted that it received 4168 applications for Member grade from Students, and 2082 applications from all other sources. Yet neither Institute gave much attention to Student Members as the source of future professional Members. The two Executive Secretaries apparently regarded the flow from Student to Member as a natural process of osmosis not needing encouragement.

But this was soon to change in the IRE when a young man, Theodore A. (Ted) Hunter, W0NTI, an engineer with the Collins Radio Company, Cedar Rapids, IA, was elected to the IRE Board of Directors to represent the Midwest Region in 1951. This writer, then at Ames, IA., joined him on the Board as a Director-At-Large in 1952, and observed and somewhat abetted Hunter's efforts to recognize the students for what they were: the future professional members of the Institute. By many, his efforts for the Student Members are believed the primary cause of the IRE Student Member surge, which carried that enrollment from equality with the AIEE in 1955 to 21,000 in 1962, while the AIEE could achieve only 10,000. During this interval, the overall IRE membership climbed from 47,000 to 103,000 while the AIEE climbed only from 56,000 to 68,000. These figures were not overlooked by the architects of the merger in 1962.

Hunter's first project was to be a magazine of, by, and for the students. His concept first was broached at a Cedar Rapids Communications Conference in the Spring, 1953, where it was suggested to Hunter and his group that a good way to "sell" the IRE Board of Directors on the idea was to present them individually with a sample issue of his magazine. This was done, with the help of the Collins Radio Company in bearing the printing costs, and the 32 page, Volume 1, Number 1, September 1953 issue of the **IRE Student Quarterly** is a classic, printed in a limited edition of only 80 copies.

Some articles were career oriented, covering the work and experiences of young engineers, but the issue also included technical papers on the Collins pi-network for antenna coupling, the analogue computer, and the germanium transistors.

A page of Student Branch activities at the University of Iowa was included as an example of student news possible.

In his Preface, Hunter stated that "the content of this sample publication was suggested by students, young practicing engineers, and faculty members..." This was to be Hunter's guiding principle: when in doubt "Ask the students."

Ted Hunter was an innovator, among a group of young innovators in the war years at Collins. He designed the Collins permeability-tuned oscillator, an awesome engineering job and, after the war, he was responsible for the design of the 75A-4 amateur radio receiver. He was a leader in presenting the petition for an IRE Section at Cedar Rapids in 1946.

Needless to say, the IRE Board of Directors agreed to finance the **Student Quarterly** when the project was presented. Later it became recognized that there must be headquarters support to aid Hunter's student advisors in the publication process, and a Student Secretary was added in New York. This was the first recognition by either Institute of the value placed on Student membership.

The **Student Quarterly** later became the **IRE Student Journal** and achieved a circulation second in size only to that of the **IRE Proceedings**, with many practicing engineers paying a subscription fee to be added to the **Journal's** recipients because of the fresh viewpoints given by Hunter and his student authors, and even by the cartoons. At that time Hunter was busy visiting Student Branches, carrying the torch for electronics and the IRE.

His interests also went to the professional members, and he was instrumental in achieving Board approval of IRE Professional Group subsidies to permit these bodies to publish and thus the birth of the IRE, now the IEEE, **Transactions**.

In the meantime, the AIEE had introduced a student magazine, the **EE Digest**, but it was edited at New York headquarters, lacked a Ted Hunter, and never achieved the impact of the IRE publication.

Came the merger, and the accumulated evidence of the success of the IRE student program readily persuaded the 14-man Merger Committee to carry over the IRE student policies and staffing, including Ted Hunter. After the emergence of the **IEEE Spectrum** as a readable member publication, a Board decision was made to substitute **Spectrum** for the **Student Journal.** Today, however, the student field is covered by **IEEE Potentials**, but there seems to have been only one Ted Hunter.

The students of the fifties left no doubt of their views on professional unity when, in 1962, the member vote for the merger was 87 per cent favorable in both Institutes. The students had been heard.

Man Of The Renaissance

by Donald K. deNeuf
(M 1972, F 1974)
WA1SPM

Webster's Dictionary: "Renaissance — a French word meaning rebirth; a name made popular by a group of writers in referring to the revival in Italy during the 14th and 15th Centuries of a study of ancient civilization, which marked the end of ignorance and superstition. The Renaissance marked a shifting of emphasis rather than a rebirth of culture; this attitude may now be defined as humanism."

The men of the Renaissance found the society they sought in the classical culture of ancient Greece and Rome, in the teachings of an Aristotle or a Gallileo. The more intensive study of the classics was the natural consequence of the humanistic philosophy and this phase of the Renaissance is properly defined as classicism.

The Renaissance partakes of both the old and the new. It was a rebirth only in the sense that it sought in antiquity something on which to base its challenges. It was the early cultural expression of a new age which emphasized the supremacy of civil authority versus the ecclesiastical, and the prime importance of the natural man. The Renaissance developed further into the Age of Enlightenment which preceded and prepared the way for the French Revolution.

Throughout history, groups of scientific intellectuals evolve around men like Aristotle, Gallileo and da Vinci and women like Mme. Curie — and contribute to the advancement of all mankind through their teachings.

Some men of intellect and their contributions remain unrecognized during their lifetime and in their environment. And, in each era, others have appeared wherein that rare gift of scientific perception and humanitarian considerations have been combined. In our age, such a person is William S. Halstead, a Member of the Radio Club since 1972 and a Fellow since 1976. Like other men of the Renaissance who have preceeded him, Halstead is a precursor in analyzing possible reforms.

While such men don't always have correct answers, they none-the-less ask the right questions. Number One Question today is: *"How can we assure peace throughout the World?"* Here is one of Halstead's proposals which was included in the report on "Technology in War and Peace" published in the October 1982 issue of the **IEEE SPECTRUM.** One section was entitled "Beyond Peacekeeping: Systematic Approaches" part of which is quoted:

"In the late 1970's, William Halstead, a telecommunications consultant, Fellow of The Radio Club of America, and longtime member of the IEEE, formed the Unitel International Television Foundation whose purpose is to serve as a catalyst in the developing support for a global satellite system under the aegis of the U.N.

"The current president of the foundation is Donald K. deNeuf, former president of ITT's Press Wireless Division and member of the IEEE since 1933. The major purpose of such a system, termed UNISAT (United Nations International Satellite), would be 'to provide politically unbiased world news and other information including cultural and other programs judged to be of interest to a world audience.' Under the plan, the majority of programs would originate at television and radio facilities at UN headquarters in New York City. The Unitel Foundation is a nonprofit organization."

In September 1979, **TV Guide** magazine published an article *"Whose 'Truth' Can You Believe?"* It stated:

"Monitoring six different countries' news broadcasts for the same week reveals more about nations than events. We looked for consensus and instead found contradictions. Selection and analysis of what is 'news' depends upon a particular nation's inherent structure (democracy or dictatorship), official ideology ('news' in one country may be construed as propaganda in another) and geographical location (proximity to a news event may heighten interest and, at the same time, increase the degree of distortion in coverage)."

Dr. Michael Z. Wysotsky, a Soviet scientist and Deputy Technical Director of Mosfilm Studios of Moscow, the largest producer of motion-picture films in the USSR, in a letter to Halstead under date of 14 November 1980 stated: *"I quite agree with you that there is a great need for means by which peoples of different countries and nations can understand each other and can emphasize the fact that all nations of our planet are interdependent."*

Today, the peoples of many countries view TV and listen to radio broadcasts that are completely controlled and operated by their governments. They decide what the public can see and hear. Attempts by these people to receive information from other sources often is prohibited by their governments. But there is the possibility that programs on world events and other matters of global importance as provided by the United Nations satellite service, with transmissions in the five official UN languages, will bring about a better understanding between nations. It is believed that such a system would greatly assist in minimizing the possibilities of a thermonuclear war with all its consequences.

Under the proposed mode of operation of UNISAT, the majority of the programs would originate in the UN Radio and Television Centre in New York. Transmission of the programs would be via the UN communications satellite system, and reception would be through Earth stations at the television and radio broadcast centers in each country.

With the Soviet Union, its allied countries, and most of the Third World nations being members of the UN, the proposed global satelite broadcasting system would resolve the troubling problem created by UNESCO in support of restrictions on printed or broadcasted information by the "new world information order."

Strong opposition to UNESCO's action has been made by the commercial news gathering organizations and most of the Western nations. The late Stanley Swinton, Vice President of the Associated Press and director of its international operations, stated that the proposed UN information satellite system would counteract the efforts of UNESCO, the Third World Nations, and the USSR in restricting media coverage of those countries. Indeed, if successful, a U.N. sponsored global TV and radio satellite system might turn swords into electronic plowshares.

Halstead has done more than dream. His outline of the scope of work needed to gain the support of the United Nations in developing the proposed UNISAT system is brief:

1) Preparation of descriptive material for review by officials of the UN including information on the technology involved, its service value to the world community, and a comparison with other existing modes of international broadcasting such as those of the Voice of America, BBC, and Radio Moscow.

2) Detail the growing usage of international satellite transmissions by the major TV networks to cover matters of world interest, and the excellent quality of the audio and visual program material delivered to the homes.

3) Direct attention to the wide usage of TV receivers through out the world in comparison to the relatively small number of shortwave receivers. Describe how, in the UNISAT program, the UN originated radio and television programs may be received through satellite receivers at anchor stations of national radio and television networks then transmitted through those networks to local broadcasting stations. This permits translations of sound portions to local dialects and, perhaps, the simultaneous broadcasting via multiplexed audio channels of many such dialects.

4) Report on the use of community viewing practices in rural areas where the cost of television receivers precludes private ownership, or where direct reception from satellites is employed in the absence of network facilities.

5) Present an economic study of the estimated costs for operation of a global satellite system such as UNISAT. One mode of operation could be the use of channels on Intelsat and other existing satellite systems, with the UN paying for the use; another possibility would be to use facilities of a private contractor who already has access to satellites; and a third approach would be the ownership of a satellite system by the United Nations.

Based on the great success of world-wide TV satellite coverage during the 1984 Olympic Games at Sarajevo and Los Angeles in providing superb color pictures and sound — the latter in a number of languages — it appears that the time is at hand for the United Nations to utilize the power of the television medium on a global basis. The result would be greater understanding between the peoples of the world and a major step toward peace on this planet.

In every age, some men see the need and the possibilities of an invention long before most of their fellow men do. They see the benefits that will follow to society and to themselves if they can devise a new machine or apply a old one in some new way. Samuel F.B. Morse was a professional artist but his mind grasped the possibilities of an instrument that would send signal quickly over long distances. The building of such an instrument became the most important interest in his life.

Haverford College is one of the foremost of the nation's small, academically excellent liberal arts colleges located in Haverford, PA and operated by the Society of the Friends (Quakers). In 1979, Halstead — an alumnus of the Haverford Class of 1927 — received the coveted Haverford Award made to outstanding alumni whose lives and work reflect Haverford's stated concern that knowledge be put to socially useful ends.

In the school's quarterly publication *Haverford Horizons*, Miss Paula Singer, Director of College Relations, tells of Halstead's achievements. The article is published in its entirety with the permission of the college.

Halstead has that intellectual discipline which, in another age, was to set apart a Renaissance man like Artistotle. But maybe that recognition won't come until historians in another century rediscover the man.

Haverford Award Winner: William S. Halstead '27

Global Communicator

Walter Holt

". . . the time has come in the evolution of mankind when it has become essential that scientists and engineers cooperate in improving communications between peoples of all nations. . . . These developments will contribute greatly to improved understanding and will aid in preserving peace."

William S. Halstead, on receiving the Popov Medallion in 1959 in Moscow at the International Conference of the Popov Society for his contributions to the electronic communications field.

Bill Halstead's road to Moscow—and to Japan, Uganda, Jordan, Nigeria, India, and many other places—began 57 years ago at Haverford. It was then that Halstead and fellow members of the Radio Club built and operated the College's radio station, WABQ. It received a license in 1923 from the Federal Radio Commission (the forerunner of the Federal Communications Commission) for a 50-watt station, which was later increased to 1000 watts in 1926. WABQ was heard throughout the Delaware Valley and at night could be picked up on much of the East Coast. While under Halstead's direction the station was ranked among the 50 best radio stations in the country.

"Founding the Haverford Radio Club and operating the broadcast station with Gerald Gross '26, Irving Smith '27, and Charles Thompson '27 profoundly influenced my whole life's work," said Halstead as he toured the current Haverford radio station, WHRC, during a visit to campus last year.

In 1924, Halstead and other Radio Club members made national headlines by conducting the first overseas chess match—with Oxford, using a shortwave amateur radio transmitter and receiver operated by Smith. The *New York Times* said that the contest marked a "new step forward in radio communications as well as in intercollegiate competition."

Perhaps then Bill Halstead's dream of global communications was born. Since then he has devoted much of his life to improving communication between people of many countries through radio and television broadcast technology. A great deal of this work was done on a humanitarian basis with no financial return.

Today, at 77, Halstead, who lives in Woodland Hills, California, is still trying to link the world together in peace through a communications network that would carry television programs to all corners of the world. Far from retired, he is chairman pro tem of the Unitel International Television Foundation, a nonprofit organization devoted to developing support for an international communications satellite system called UNISAT, which would be used to broadcast unbiased news, information, and other programs of interest to an international audience.

"For any nation to wage war with another it is first necessary that the leaders of both countries convince their people that the ideals, customs, and methods of the enemy nation are entirely opposed and different from their own," Halstead explained upon receiving the Haverford Award in 1979. "But when people in different countries can exchange thoughts and ideas readily, then the small national prejudice of one people must give way. International exchange of ideas convinces all people that the human race the world over is basically the same."

Bill Halstead's strong humanitarian drive, coupled with a pioneering spirit and technical expertise, has been instrumental in introducing communication throughout the world. In 1951 he planned the first free-enterprise TV network in Japan, known as the Nippon Television Network (NTV), the largest of its kind in the Far East, employing American television system standards. In 1953, as president of Unitel, Inc., a New York-based telecommunications firm, he supervised construction of the Tokyo station of NTV.

By suggesting that American large-screen television receivers be placed at strategic outdoor locations, Halstead helped the new network introduce commercial television to a large audience at a time when few TV receivers were available to the Japanese people for home use. The success of NTV and the rapid growth of public demand for Japanese TV receivers were important factors in the development of the electronics industry that contributed greatly to the economic recovery of Japan after World War II.

In the early 60's Halstead served as a consultant to the Uganda government in establishing the Uganda Television Network (UTV), prior to the time when Idi Amin assumed power. This system, using community receivers in rural areas, was aimed at assisting then Prime Minister Milton Obote in unifying the country and minimizing the disruptive effects of tribalism. In developing the most extensive TV network in Africa, Halstead was able to provide, by FM Multiplex method (sending two or more programs simultaneously without interference), simultaneous transmission of four of Uganda's major languages during a single news broadcast.

During that same decade, Halstead also advised the Jordanian Government on telecommunications. He selected a television station site on a mountaintop near Amman which permitted programs to reach beyond Jordan's borders into Israel and, hopefully, to diffuse antagonism between the two neighbors. In 1968 he presented the United States Agency for International Development (AID) with plans for a national TV network in Nigeria, then involved in civil war and desperately seeking means by which to unify the country.

Halstead's contributions have not been limited to work abroad. After graduation from Haverford in 1927 with a B.S. in physics, he worked during much of the 1930's as a research associate for a New York telecommunications firm on the development of new types of facsimile systems for transmitting photographs and other graphic material by telephone lines or radio. Because of his contributions in this field, including the first color facsimile system, he was made a member of Phi Beta Kappa by Haverford in 1937.

During World War II he was a pioneer in the development of two-way FM radio for use on railroads to aid in safety and service. In the early 1940's he conceived and installed a highway advisory radio system on the George Washington Bridge. This was the first system to employ localized radio signals to assist automobile drivers with standard radio receivers in selecting the proper traffic lanes and exits to use at the New York end of the bridge. Later, he developed similar systems for tunnels, bridges, and approaches to large airports to further enhance the safety and convenience of motorists.

In 1950 Halstead originated and demonstrated the first stereophonic broadcast, using FM multiplex methods to bring unprecedented dimension to music broadcast over the air. Regarded as one of the most creative people in the communications field, he has been granted more than 60 American and foreign patents on his inventions in the area of electronics.

While radio is Halstead's first love, films and photography have also played major roles in his life. In the 1940's he co-founded with Julian Bryan the International Film Foundation, now a major producer of documentary films to further understanding between nations. In 1934, Halstead and Bryan were the first American film makers to travel through much of the Soviet Union, including the remote Lake Baikal area in Siberia. Their films of the people there were used in an early *March of Time* newsreel on life in the USSR.

To help publicize a lecture which Bryan was giving on the Soviet people and the need to understand them better, the men employed the services of a Manhattan advertising agency. The woman who assisted them, Leslie Munro, became Mrs. Halstead in 1935. Since then she has assisted her husband with his projects throughout the world in addition to continuing her work in advertising until 1971.

The younger Halsteads have taken their parents' leads in pursuing careers in the communications field. Son Dirck, Haverford Class of 1958, is a top photographer for *Time* magazine. Anne Halstead York recently opened her own public relations agency in New York City.

These days Bill Halstead is preoccupied with advancing the idea of global broadcasting via the proposed UNISAT system. "The main objective of this satellite system is to enhance understanding of world affairs," Halstead explains. "Television as well as radio programs could be transmitted to and received by nations throughout the world using the five official languages of the United Nations."

Looking back on the explosion of telecommunications since the first all-electronic TV sets for consumer use were demonstrated in America at the New York World's Fair only 40 years ago, Halstead says that he is not surprised by the pervasive influence of television on modern society. "The next big step will be in improving the audio quality of the medium," he predicts, "with stereo or quadraphonic ('surround sound') capabilities."

Right now the energetic technician is working on a project that may have implications for improved relations on the domestic scene: a multilingual and stereo broadcast system. Using some of the techniques he developed earlier for simultaneous transmission of several languages for radio and television, Halstead recently described in a technical journal a television receiver with a button that can change the language of a TV program from English to Spanish.

It has been many years and many miles since Bill Halstead first tinkered with a 50-watt broadcast transmitter in the basement of Sharpless Hall. But he's never faltered in his mission to bring understanding and peaceful relations between the diverse peoples of the world.

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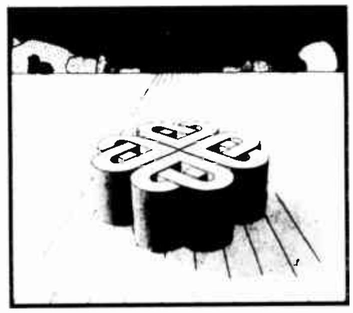
*(*Horizons *is grateful to Bill Halstead's daughter, Anne York, for providing much information about his life and career.)*

1983 — World Communications Year — The Development Of Communications Infrastructures



by Dr. Max C. deHenseler, (F 1982) HB9RS
President, United Nations Amateur Radio Club (4U1UN)

"Everyone has the right... to seek, receive and impart information and ideas... through any media."

(Art. 19 of Universal Declaration of Human Rights adopted by the United Nations General Assembly on December 10, 1948)

The emblem above adopted as the symbol for the year represents a communication network linking North, South, East, and West. The heart shapes formed by the interlinking lines signify that communications serve mankind, and peaceful social and economic development.

COMMUNICATIONS: A RIGHT, NOT A PRIVILEGE

In recent years, governments, decision makers, economists and planners at all levels have become increasingly aware that the greatest obstacle for economic and social progress is inadequate communications. We are, moreover, dependent on communications for the growth and health of our economy, the smooth functioning of our institutions and, even more important, for the quality of our individual lives.

Next only to food, shelter and energy on the list of vital needs for human survival, communications constitute the lifeblood of today's world and serve as a constant reminder of the oneness of mankind. Its history has long been described in terms of Ages whose names reflect the stages of development through which mankind has passed: the Stone Age, the Bronze Age, the Iron Age, down to the Industrial Age. Following the invention of the transistor in the 1950's and the explosive development of electronic communications systems, there is growing agreement today that we have entered a new era. It is being referred to as the Communications Age.

The worldwide telecommunications network is the largest machine in the world. A survey of the telecommunication scene today reveals an enormous variation in systems, equipment and services available from one region to another and even between countries of the same region. In 1982, the global network included 550 million telephones, 560 million television receivers, 1.4 million telex terminals, thousands of data networks, and other special-purpose transmission systems. However, one finds that three-quarters of these installations were concentrated in only eight countries in the case of telephones, and in nine countries in the case of television.

Postal communications also are facing new challenges following the technological revolution of communications systems, and a dynamic attitude has to be adopted in the face of new technologies in the era of telematics and the eletronic mail. At the same time, the traditional services are to be improved and made more reliable, quicker and better suited to the needs of today's users.

Communication is an inexhaustible resource, an ever-growing technology which can greatly enhance the use of all of the Earth's resources: natural; human; and economic. Through a vast array of communication techniques, mankind is able to accumulate, organize and transmit information on a worldwide scale. Therefore, the harmonious and well-balanced development of an ever-closer-knit world-communications network is a major historical event in keeping with the emergence of a collective awareness among mankind as a whole. Following its development, no one should any longer be isolated from the national or international community. Communications should be a right and not a privilege.

The world of today is getting smaller and smaller, thanks to the constant growth of communications networks in many countries. Yet, with the introduction of every new service, man's needs grow even faster and the spiralling demand for more and more communications facilities is a reflection of man's endless search for a better life. However, there exists an imbalance in the development of communications infrastructures in various parts of the globe. Only through the redress of this imbalance by a more even development of communications infrastructures everywhere can the peoples of the world be brought together, thus creating more stable conditions for the maintenance of international peace and security.

A HISTORIC RESOLUTION — CATALYST FOR PROGRESS

The degree of inadequacy varies from place to placc and from project to project, but it affects all sectors of development at local, national, regional and international levels.

This awareness and concern resulted in many informal and formal discussions about a possible "Year" to focus upon and identify the problems and to accelerate their resolution. Consensus on the concepts for such a Year finally was reached and on November 19, 1981, the United Nations General Assembly:

"Recognizing the fundamental importance of communications infrastructures as an essential element in the economic and social development of all countries,

Convinced that the World Communications Year will provide the opportunity for all countries to undertake an indepth review and analysis of their policies on communications development and stimulate the accelerated development of communications infrastructures,

1. Endorses the proposal made by the Economic and Social Council in paragraph 1 of its resolution 1981/60 and proclaims the year 1983 World Communications Year: Development of Communications Infrastructures, with the International Telecommunication Union serving as the lead agency for the Year and having responsibility for coordinating the interorganizational aspects of the programmes and activities of other agencies;

2. Requests all States to participate actively in the attainment of the objectives of the World Communications Year; . . ."

The historic importance of this resolution 36/40 is easily realized, both for the World of Communications and for the ITU. For the first time, the fundamental importance of communications infrastructure for economic and social development of all countries was finally and unanimously recognized by the highest international forum.

The International Telecommunication Union* — ITU — which plans, regulates, coordinates and standardizes international telecommunications, led the worldwide preparation and celebration of WCY '83, assuming responsibility for coordinating the interorganizational aspects of the programmes and activities of other inter-governmental, governmental and non-governmental organizations.

NATIONAL COMMITTEES: BACKBONE OF THE YEAR!

The WCY efforts focus upon communications infrastructure development at the national level. In order to ensure the harmonious development of such infrastructures by effective coordination at the national level, the main-springs of the WCY are the National Committees which have been set up in 57 Member countries, as of May 1983. They represent, at highest level, all the sectors concerned in the development and operation of communications infrastructures: common carrier telecommunications, broadcasting and television, aviation, shipping, transport, meterology, education, agriculture, health, postal services, and industry.

These committees constitute the basic mechanism through which an indepth review and analysis of national policies for communications development can be achieved, and which will ensure that national plans form a cohesive set of activities in support of this objective.

Because WCY committees are largely representative, they might serve, where they do not yet exist, as forerunners to the permanent national coordination committees essential to guide communications development policies, including the financial, material and human resources needed.

Several committees have included in their programmes three major types of activities designed to promote and achieve the objectives of WCY '83: conferences, infrastructural projects ands public information activities. Conferences and seminars aimed at furthering the effort of mature reflection and providing some of the elements required by policy-makers to appreciate the strengths and weaknesses of their communications policies are being organized in various regions of the world.

The aims of the public information activities are to inform the public of the Year's objectives, in particular by means of press campaigns, production and broadcasting of radio and television programmes, and the production and dissemination of relevant documentation.

Such conferences/seminars and public information activities at the national level are too numerous to be enumerated. At the international level, however, the ITU organized at Geneva, Switzerland, the 4th World Telecommunications Exhibition, Telecom '83, within the framework of the World Communications Year. This exhibition aimed at presenting the latest advances in communications technology, and at demonstrating the possibilities of applying communication science and technology for the benefit of developing countries. Telecom '83 constitued, in fact, the World Exhibition of the World Year. Major activities of Telecom '83, in addition to the Exhibition itself, included the World Telecommunication Forum (FORUM '83), the World Book Fair, the Golden Antenna '83 Film Festival, and the World Photo and Drawing Competition.

As discussions about the possibilities of such a Year advanced, so did the planning. An Inter-Agency Committee was established for WCY. It was made up of 17 international organizations and bodies and is led by the International Telecommunication Union*; it meets regularly to coordinate

*** The ITU is the specialized agency of the United Nations for telecommunications, with headquarters in Geneva, and comprising four permanent organs: the General Secretariat, the International Frequency Registration Board (IFRB), the International Radio Consultative Committee (CCIR) and the International Telegraph and Telephone Consultative Committee (CCITT).**

*** In addition to the ITU, it comprises: the UN (United Nations), the ECE (Economic Commission for Europe), ESCAP (Economic and Social Commission for Asis and the Pacific), ECLA (Economic Commission for Latin America), ECA (Economic Commission for Africa), ECWA (Economic Commission for Western Asia), UNIDO (United Nations Industrial Development Organization), UNDP (United Nations Development Programme), FAO (Food and Agriculture Organization of the United Nations), UNESCO (United Nations Educational, Scientific and Cultural Organization), ICAO (International Civil Aviation Organization), WHO (World Health Organization), IBRD (Interntional Bank for Reconstruction and Development), UPU (Universal Postal Union), WMO (World Meteorological Organization) and INTELSAT (International Telecommunications Satellite Organization).**

global concepts and plans. Governments, non-governmental organizations, industry and others discuss their most pressing communications needs and their potential activities.

The Secretary-General of ITU, on behalf of the Inter-Agency Committee, invited Heads of State to become member of a "Committee of Honour" for World Communications Year with a view to stressing the importance of attaining the basic objectives of WCY '83 and to encouraging participation in the Year's activities at the national level. By May 11, 1983, 54 Heads of State had accepted the invitation, including two Radio Amateurs: H.M. King Hussein (JY1); and H.M. Don Juan Carlos (EA0JC).

As a result, when the Year was proclaimed, steps had already been taken on many fronts. Over fifty projects were submitted by ITU, 18 by UNESCO, ten by the Universal Postal Union (UPU), two by the Food and Agriculture Organization (FAO), two by the Economic Commission for Africa (ECA) as well as a further 22 by Telecommunications Administrations of Member States.

The projects which will be implemented include the establishment of radio relay links, the provision of a task force of experts, the preparation of pilot courses on teletraffic engineering practice and management, the awarding of fellowships and the establishment of an advance warning system in the event of natural disaster.

All of the projects proposed were selected for their applicability to a number of countries to that they will have a catalytic effect. Other countries with situations similar to those for which the pilot projects are carried out thus will be able to benefit from the lessons drawn from the experience. In this way, each pilot project will have a specific impact in the recipient country and a didactic value for several other countries.

The execution of these projects will depend on the resources made available by governments, companies, foundations, industrial groups and other interested parties. The entire programme of WCY activities at all levels is being financed by voluntary contributions, and initial resources had been pledged when the proclamation was made. A number of industrialized and developing countries have pledged funds and other resources, including intentions to undertake their own WCY projects. Communications manufacturers have announced contributions in cash or kind, including equipment, seminar speakers, and network development assistance.

Finally, several radio amateur societies have responded with enthusiasm to the appeal made by the ITU Secretary-General, requesting them to publicize WCY on the largest possible scale and to organize, according to their possibilities, events relating to this major event. Commitments have been made by the radio amateur clubs of Argentina, Australia, Chile, Colombia, Ecuador, El Salvador, the Federal Republic of Germany, Honduras, Hong Kong, Iceland, Japan, Nigeria, Portugal, Philippines, the United States and the USSR. In the United States, for example, the setting up of a worldwide network of beacons on 14.100 MHz by the Northern California DX Foundation is an outstanding contribution to the WCY in the field of progagation research, involving amateur radio clubs in 7 countries and at the United Nations (4U1UN).

The World Communications Year, through the activities that it has engendered, or is yet to engender for the establishment of its programme and through its execution which will continue for many years after its launching, is providing an unprecendented occasion for consultations and the starting point for strengthened collaboration between policy-makers, economists, planners, operating agencies, manufacturers and users of communications to harmonize, at the national level, across-the-board needs and requirements with the future development of communications technology and policies. It also provides an ideal framework to identify the obstacles which impede a balanced development of communications infrastructures, to take stock of the achievements in the field of communications, to identify and understand the proven and anticipated benefits of all technological options, to determine how to optimize the use of new technologies, and to explore ways to translate the decisions taken into reality.

ANNEE MONDIALE DES COMMUNICATIONS
WORLD COMMUNICATIONS YEAR
AÑO MUNDIAL DE LAS COMUNICACIONES
1983

A Peaceful Revolution

by W.R. Gary, (M 1982, F 1984)
K8CSG/5

We are in the midst of a revolution, one which is affecting virtually every facet of our lives — our educational systems, the way we work, our entertainment and even our hobbies. This is the revolution of the "computer decade." Wherever we turn, be it the gasoline station or the grocery store, there we find the obiquitous microcomputer. The computer has become a pervasive influence on our lives, but nowhere has it had greater impact than in telecommunications.

Perhaps the earliest substantial use of computers in telecommunications was the stored-program-control (SPC) telephone central office. The #1-ESS of the Bell System is the best example of early systems. Its development and successful implementation heralded the beginning of the end of eletromechanical switching systems, although step-offices and cross-bar machines are still in limited use. The electronic SPC switch revoluntionized central-office technology, and subsequently that of PBX's. It provided hitherto unknown features, and reduced the effective cost to customers. System reliability was increased, accompanied by lower maintenance requirements and costs. However, the sheer size of early computers, even small ones, forced the develoment of electronic telephones to await another major technological accomplishment.

Torn-tape teletype relay was for many years an effective, widely-used means of communications. It was a manually operated store-and-forward message switching system, applicable equally to military and commercial use. Paper tape was the storage medium or memory. Incoming messages were punched into tape on an electromechanical marvel called a "reperforator". The messages were separated by tearing the tape between them, stored on routing boards in queues, and routed in turn to their appropriate destinations. These manual methods later gave way to more automatic systems, i.e. 83B, but which were still more mechanical in nature than electronic.

The development of the computer opened up a whole new telex/TWX world. Disc and tape storage replaced paper tape as buffer media. The software-controlled computer replaced the human operator, reading the routing codes and properly queueing the traffic, selecting the appropriate dedicated or dial-network lines, and delivering messages to distant terminals. Properly formatted traffic switched through the system automatically; operator intervention was rarely required except for garbled or poorly formatted traffic. Systems of this type, in highly sophisticated form, are used today throughout the world. Global message networks with multiple switching nodes (computers) exist to serve the general public, and many large corporations operate their own dedicated networks. The computer has revolutionized this popular, economical communications technique.

Supervisory control and data acquisition (SCADA) systems represent a specialized industrial application of communications technology. Remote collection of measurement information, i.e. pressure, flow, voltage, current, etc. is important in many industries. Transmitted to central locations, these telemetered variables may be displayed or processed to meet various needs. Supervisory control complements this remote data acquisition, enabling distant valves, regulators, switches and other devices to be operated from a central point. These systems are the keys to safe, efficient control of liquid and gas pipelines, as well as gigantic electrical networks.

Intelligent Telex Terminal.

Early SCADA systems were classic examples of electromechanical ingenuity. Clutches, gears, vacuum tubes, slide wires, relays, potentiometers — all were found in early products of instrument and system manufacturers. The results, in addition to generally providing the capabilities desired, inevitably included frequent breakdowns and high maintenance costs.

Enter the computer — with remarkable results. First came the replacment of the electromechanical monstrosities at the central sites. The whirring, clicking gadgets were replaced by silent computers; the tedious mechanical adjustments required to calibrate or adjust ranges were replaced by software and keyboard entries. Reliability went up, repair costs down. Through the use of graphics and color CRTs, for example, the machines were made much more user-friendly. At remote measuring or pump stations, microprocessors invaded instrumentation and device control with similar results. The entire technology of SCADA systems has been changed by the computer.

These examples illustrate how the small mainframes and minicomputers of early generations influenced new directions of communications equipment and systems development. The impact of the computer was clear, but its size and cost imposed early constraints on many potential applications. Once the microprocessor/computer-on-a-chip became reality, the proliferation of micro-based communications products began; it became a flood by the early 1980's. Data-communications equipment, already linked closely to the computer world, was an early leader. Data test instruments, relatively crude and simple devices in their early stages, bloomed in the microprocessor age. Content-monitors enabled data streams to be displayed on CRT monitors, in English cleartext as well as hexadecimal, EBCDIC, or other forms. Computer protocols were emulated in test sets, enabling circuits and remote devices to be analyzed offline. Intelligent data modems permitted sophisticated diagnostics to be performed without assistance at remote sites. An entirely new concept, and its accompanying "tech-control" buzz-word, came into existence. Today, a centrally located computer can manage an entire data network with very modest human assistance. The tech-control system can monitor the health of the network and its components, reporting and defining impairments or failures. Circuit parameters can be measured automatically during idle periods, with results neatly summarized in management reports.

Other computer-spawned adjuncts to the data communications arena include economical forward-error-correction (FEC) capabilities and statistical multiplexers. FEC is not a new technique; the microprocessor has simply improved performance, reduced the size and cost of equipment, and made it more readily available. In FEC, bits of information may be added to the data stream. This not only enables transmission errors to be detected at the distant end, but permits the receiving equipment to automatically correct them without retransmission.

Statistical multiplexers permit multiple data streams to be mixed on a common transmission path to optimize utilization of long, expensive circuits. Priorities may be assigned to prevent delays of important data which might result from "hogging" of circuit capacity by lower priority applications. The microprocessor heart of the stat-mux, programmed through software or firmware instructions, acts as a policeman directing traffic at a busy intersection. However, the electronic copy rarely gets sick, never complains about the weather or working 24-hour days, but silently and efficiently keeps the traffic flowing.

Store and Forward Messages Switch.

The ubiquitous microprocessor has similarly transformed various communications terminal devices. Electromechanical teletype terminals have been replaced by CRT devices equipped with solid state memory and floppy-disc storage. These terminals, which are actually special-purpose microprocessors, have various capabilities of word-processing, text-editing, and merging of "canned" paragraphs from floppy-disc storage with keyboard entered text. Some include error checking and internal dictionaries. Speedy dot-matrix or daisy-wheel printers complement the entry devices. Such tools, along with electronic keyboards, have removed much of the drudgery from the telex operator's work.

Coupling these electronic marvels to a new-technology optical character reader (OCR) brings an entirely new approach to the telex or communications-center world. Early OCRs, like early computers, were large, relatively constrained by inherent limitations on type-font recognition, expensive — and prone to fail. The OCRs of today are small, quiet, relatively cheap, reliable, and can read multiple fonts. They are another triumph of microcomputer technology.

Facsimile (FAX) is not new; it has been around in its various forms for decades. Unfortunately, early products suffered from inherent constraints of available technology, i.e. analog transmission, slow speed, modest resolution, wet paper (some models), and others. Although these limitations failed to deter some users, the growth of facsimile proceeded slowly.

New FAX machines are truly "state-of-the-art" devices. Equipped with the intelligence of their internal microprocessors and sophisticated integral modems, new products are capable of "handshaking" with virtually any FAX machine meeting CCITT Group I, II, or III standards. New machines operate up to 9600 bps, 28-seconds/page transmission rate, and offer resolution of OCR-readable quality. Machines developed in the early 1980's automatically adjust themselves to accommodate the line speed and transmission mode of a remote machine connected to it.

Machines of today can be hopper-fed, or they can accommodate lengthy "roll" messages. They can be remotely polled, automatically answer incoming calls, and hopper-feed traffic left for nighttime transmission at lower cost. Some FAX machines provide discrete ID's, or answerbacks, to calling machines for positive handshaking. Some automatically number messages, time-stamp them, and generate 24-hour logs of traffic in and out. And, several models will accept telex input and deliver output similar to a FAX copy; sort of a dual-purpose FAX/telex terminal. With the advent of the microchip computer, facsimile technology and economy have finally come of age.

Optical Character Reader.

Telephone technology has been revolutionized by the computer. There is an unmistakable trend to digital systems, i.e. switches, transmission, telephones, and accessories. Since this is a subject for a book in itself, only a few highlights can be covered here. The facet of this technology most apparent to everyone is the ordinary telephone — which has suddenly become very *un*ordinary.

The marketplace is flooded with new products. For example, one can now buy an attractive telephone which includes tone-dialing or pulse-dialing capability, memory dialing of up to 100 or more stored numbers, hands-free "speakerphone", automatic re-dialing, display of the date, time, called number, and so on. New "cordless" telephones integrate radio and telephone technology cheaply and effectively. The list of features seems endless.

Business communications systems integrating digital voice and data switching *and* transmission are growing in popularity. These systems permit digital voice, full station features (hold, transfer, add-on, etc.), and 9600 bps data to be accommodated over 3 pairs of unshielded wiring — or less. No more half-inch, 50-pair station cables. New telephone sets for these systems may include a CRT, keyboard, and capabilities such as calendaring, electronic mail, mainframe CPU access — and so on. In these switching and station-set (terminal) configurations, a substantial degree of local area networking is inherent.

Telephone-tag is one of life's never ending frustrations. All too often, we return missed calls only to miss the original caller — and so on. A new computerized system can alleviate, if not eliminate, telephone-tag. Analogous to the store-and-forward telex switch, the voice-mail switch (or exchange) is now a commercial reality. Voice messages are digitized at the voice-mail exchange and stored in disc memory. Routing instructions are entered via a tone-dialing keypad and stored. Users have "voice mailboxes" for messages; each mailbox has a discrete address. Stored messages can be retrieved by users who interrogate the system periodically, regardless of were they may be traveling. Alternately, the voice-mail computer may attempt to deliver messages according to the sender's instructions. Or, users may be alerted by the computer to ask for undelivered messages. Messages may be redirected to other individuals, with or without additional comment; replies to messages may be returned to senders. Voice-mail is very effective in situations where direct dialogue is not required.

Radio, its technology, and its equipment have not been neglected by the computer/microprocessor revolution. Military, commercial and amateur radio operations have all been touched by the magic of the tiny computer. Crystal-switching for frequency selection is needed no more; frequency synthesizers are now found even in hand-held radios. Digital VFO's, complete with several memories for storing frequencies, are common. Autotune systems can continually monitor for transmitter and antenna resonance and VSWR, adjusting circuit parameters automatically for optimum operation. Radio teletype and CW signals can be "read" electronically and displayed on CRT or LED monitors. New TTY keyboards and CW keyers benefit from their micro-brains. Amateur contesters use computers for logging contacts, checking for duplicates, maintaining checklists, and other chores which can steal precious operating time. The computer often generates the QSL card and inserts the appropriate contact information from the log.

No discussion of the impact of computers on communications should ignore the role of computers in cryptology. Readers of *The American Black Chamber* can only imagine what author Herbert Yardley would think today. The acknowledged father of American "black chamber" artistics, Yardley labored at early-1900's code-breaking with only the most rudimentary tools. His natural abilities and skill enhanced by modern computers could have even more widely altered the course of history; the same is true of Freidman, Rochefort, Safford and others of their times. Today, massive computers are the keys to our National Security Agency's forays into the black chambers of the world.

Radio and telecommunications have seen many revolutionary inventions during the past seventy-five years. Those which often seem to have had the greatest impact are the electron tube, the transistor, the integrated-circuit, and now the microcomputer. Assessing which has been the *most* important is best left to others.

It is more appropriate that we recognize individuals as the most important facet in the rapid evolution of communications. Inventors, manufacturers, innovative applications engineers, technicians and businessmen — these have been the keys. Enshrined in the annals of The Radio Club of America are many of those who have quietly revolutionized our lives, our society and our world.

The Early Days of Radio Periodicals

by M. Harvey Gernsback
(M 1970, F 1975)

Hugo Gernsbach, founder
Radio-Craft/Radio-Electronics

The 75-year history of the Radio Club of America is paralleled by that of Gernsback Publications Inc., the publishing company founded by Hugo Gernsback (F). His first magazine, **Modern Electrics**, appeared in April 1908; it was America's first radio magazine. Gernsback followed with **The Electrical Experimenter** in 1912, **Radio News** in 1919, and **Radio-Craft (Radio-Electronics** since 1949) in 1929.

It is interesting to review the early development of wireless as seen through the pages of **Modern Electrics, The Electrical Experimenter**, and **Radio News** published between 1908 and 1923.

Despite **Modern Electrics** name, the lead article in the first issue (April 1908) was titled "Wireless Telegraphy". Another short story by "Our Brussels Correspondent" described a two-way wireless-telegraph station installed in a limousine used by the artillery corps of the Belgian Army.

The issue also included the first article on radio trouble-shooting: "How to Remedy Troubles in Wireless Telegraph Instruments". The unknown author offered two bits of still cogent advice:
"Learn to sharpen your senses and learn to observe"; and *"In hunting trouble it pays to start first working the brain and afterwards the hands. If vice versa, more trouble is sure to arise!"*

The editor announced that, beginning with the next issue, there would be a monthly contest for the best photo and description of an amateur wireless station. The winner would be paid three dollars.

In the August 1908 issue, William Dubilier discussed the new Collins arc wireless telephone. In the same issue, Victor Laughter described the de Forest wireless telephone transmitter and receiver circuits. The transmitter's oscillator consisted of a 220-volt arc lamp burning in the flame of an alcohol lamp!

In the October 1908 issue, John V. L. Hogan, Jr., discussed the structure of the three-element de Forest Audion and showed an Audion detector circuit.

November 1908 was a "Special Wireless Issue", and in the January 1909 issue, Lee de Forest described the results of his radiophone tests for the British Admiralty.

Gernsback's lead editorial in the February 1909 issue commented on a memorable event in the history of wireless:

"At last wireless telegraphy has had its real christening. For the first time in history, due directly to wireless telegraphy, a terrible disaster was averted and close to 500 human beings are now alive instead of resting on the bottom of the ocean, like so many others before the days of wireless.

"Only a few weeks ago there were many people who doubted the practicability and usefulness of wireless. All this has been changed in less than a week. Wireless has at last become a public property.

"Accidents such as the one just witnessed when the steamer Florida collided with the ill-fated S. S. Republic in a fog at sea will soon become a thing of the past, thanks to wireless. Already the U.S. Government has taken steps to make wireless compulsory on ocean ships, and other governments will undoubtedly follow soon.

"However, when talking of the Republic let us not forget its gallant wireless operator, Jack Binns (F) the now famous CQD man. It was due chiefly to his efforts that the passengers of the Republic were saved so promptly without the loss of a single life. He has set an unforgettable example to all wireless ship operators and has shown us what the duties of the operator are when his ship is sinking."

The March 1909 issue featured an article from Paris describing a new Bellini-Tosi radio goniometer.

The June issue featured a paper that Greenleaf W. Pickard (F) had read before the Wireless Institute of America; it dealt with antennas.

The editorial in the October 1909 issue stated that some amateurs were transmitting false CQD calls that endangered lives. The editorial warned that government regulation of amateurs might result from such abuse of the air waves by a few. (Amateurs were still unlicensed at that time.)

In the December 1909 issue, Gernsback published his article, "Television and the Telephot". That was the first use of the word television in the English language. The article said that it was only a matter of time before wireless picture transmission and picture phones became common, and suggested several ways in which it might be accomplished.

The first air-to-ground wireless transmission was reported in the September 1910 issue; it took place on August 27th, at Sheepshead Bay, in Brooklyn, NY.

An advertisement of the Electro Importing Co., in the August 1911 issue, was noteworthy because it was the first to offer the de Forest Audion vacuum tube for sale: price, $4.00.

In the November 1911 issue, E. Jay Quinby (F) described an antenna that he had built and whose directivity could be switched.

In 1910, bills that would have regulated the use of wireless, were introduced in both houses of Congress. Amongst other things, they would have outlawed amateur wireless transmissions.

An editorial in **Modern Electrics** alerted amateurs to protest to their Congressmen and the bills were tabled. However, Gernsback did not oppose regulation. In his February 1912 editorial, he proposed that Congress should pass a bill regulating the maximum power that amateur stations could use, and limiting their transmissions to specified wavelengths. In the same editorial, he pointed out the amateurs' value to the country and to the developing technology. When Congress passed the Wireless Act of 1912, the amateur section was virtually a paraphrase of that editorial.

In the spring of 1912, **Modern Electrics** was sold and Gernsback started a new magazine, **The Electrical Experimenter.**

The August 1915 issue of the **The Electrical Experimenter** described how the French Army was using a Hughes balance to located buried unexploded enemy bombs (World War I had started in Europe in August 1914).

A sign of the times was the change in the name of a monthly department in the October 1915 issue: "The Wireless Department" became "The Radio Department".

The same issue included the article "Telemechanics or Control by Radio Waves". It described the principles of radio control and presented receiving and transmitting circuits.

An article in the January 1916 issue discussed regenerative Audion circuits. Using wireless to locate vessels at sea was the subject of an article in the May 1916 issue.

Milton B. Sleeper (F) described a Practical Portable Wireless Set, in June 1916; that was a construction story on a wireless telegraph transceiver.

Up to this point virtually all receivers used some form of crystal detector; de Forest's Audion was still a curiosity. In the January 1917 issue, an advertisement for the RA-6 Paragon Regenerative Audion Short-Wave Receiver appeared; that was one of the very early tube sets.

The February 1917 issue contained an article describing a remarkable talking clock that H. Hartman had built. A photo illustrated the innards. The voice was recorded by embossing it acoustically on 35mm motion-picture film. It was reproduced on a miniature acoustic phonograph built into the clock!

The May 1917 issue included the article "Receiving the Marconi 300-kw Spark Station with An Oscillating Audion."

The U.S. entry into World War I in April 1917 put an end to civilian wireless activities.

Benjamin F. Miessner (F) described the development of U.S. Naval aircraft radio in the November 1917 issue.

The war ended on November 11, 1918. Ten days later, identical bills were introduced in both houses of Congress to amend the Radio Act of 1912. The new bills made no provision for amateur stations. Gernsback sent telegrams to thousands of prewar amateurs alerting them to this omission which would have killed off the hobby. The resulting deluge of protest to Congressman caused the bill to be tabled. Editorials on the battle appeared in the first three 1919 issues of **The Electrical Experimenter.** The February issue included a memorable cartoon by Frank Paul who was to become famous later as a top science-fiction illustrator. It is reproduced here. The March editorial gleefully headlined: "Amateurs Win, Alexander Wireless Bill Is Killed". Almost as an anticlimax came the announcement in the June issue that all wartime restrictions on amateur stations were ended immediately.

In the February 1919 issue, Nikola Tesla wrote the first of a series of articles titled "My Inventions", and in the March issue, Lee de Forest contributed an article "How I Invented The Audion Vacuum Tube."

"New Regenerative Tube Circuits" was the title of an article in the June issue, and in August Greenleaf W. Pickard told readers "How I Invented the Crystal Detector."

In the winter and spring of 1919, Gernsback decided that the time was right for him to start a new, all-radio magazine and so, in July 1919, **Radio Amateur News** was born. Within a year its name was shortened to **Radio News.**

The first issue's advertisments reflected the war's effect on technology. Vacuum tubes were now common, as were regenerative tube receivers.

The cover picture on the August issue showed a 1919 version of a mobile amateur or CB radio station. A young man was barreling down a road with a huge set on the seat of his roadster. The accompanying article by A.H. Grebe (F) described his mobile radiophone installation; later in the 1920s, Grebe became a successful manufacturer of amateur and broadcast receivers.

In the January 1920 issue, two English engineers, Eccles and Jordan, described a new trigger-relay circuit which they had recently invented; it used two triode Audions — the now familar flip-flop.

During the latter part of 1919, advertisements of the Marconi Wireless Telegraph Company of America appeared in each issue of **Radio News** offering the Marconi V.T. tube for amateur use. The January 1920 advertisement added something new; the Marconi company's name was listed jointly with that of a newcomer, the Radio Corporation of America. That joint advertisement appeared for three or four months and then vanished.

In the February issue, H.W. Houck (F) described the new Armstrong Super-Autodyne Amplifier. It was the superheterodyne receiver that Major Edwin H. Armstrong (F) had developed in a laboratory in Paris during World War I. An experimental circuit was included in the article with enough data for an experimenter to build his own.

In the same issue, it was noted that at the monthly meeting of the Radio Club of America on January 23, 1920, new officers were elected: Edwin H. Armstrong (F), president; Girard Pacent (F), vice president; E.V. Amy (F), treasurer. The Radio Club now had over 130 members, the item said.

In the September issue, Gernsback's editorial was titled "Radio Concerts". Commercial broadcasting had not yet begun and the historic broadcast of presidential election results by station KDKA in Pittsburgh was still two months away. The following is a quotation from the editorial:

"Why cannot someone go after the presidential candidates and invite them to make a speech via radio through a powerful telephone apparatus in the near future? With proper advertising and with the proper enterprise behind such a scheme, it certainly should not cost a great deal to do. The people of the United Staes, through the amateurs, would get a chance to listen to our candidates in a very novel manner."

In the November 1920 issue, the Radio Corporation of America took a full-page advertisement to announce a new line of vacuum tubes call Radiotrons. The Marconi name had vanished. The ad stated that the tubes had been developed by the General Electric Company Laboratories and included two types initially: UV 200 and UV 201. The tubes were licensed only for experimental and amateur use.

In 1921, the Department of Commerce began licensing the first commercial broadcasting stations. In the December 1921 issue, there was an article describing the new Westinghouse broadcasting station WJZ in Newark, New Jersey. It also described the programs that the station was broadcasting. At that time, all broadcasting stations were operating on one wavelength: 360 meters.

In the February 1922 issue, Pierre Boucheron (F) reported on the successful Trans-atlantic amateur radio tests on 200 meters sponsored by the American Radio Relay League between the U.S. and Scotland, which had taken place in December 1921.

In the March 1922 issue, RCA ran a two-page ad announcing its new line of radio broadcast receivers and the August 1922 issue carried a story about the new Armstrong superregenerative receiver, which had been demonstrated recently before the Radio Club of America. In the September issue of "With The Amateurs" department was a description of one New Yorker's amateur station, together with a photograph. Its call sign was 2 PF, assigned to David Talley (F), a name familiar to members of the Radio Club of America.

The November issue contained a report of Marconi's work during the war years on directional antennas for wireless telegraphy at wavelengths below 20 meters. He had used cylindrical parabolic reflectors.

The February 1923 issue chronicled the first broadcast in history of a presidential message to Congress. President Harding spoke to a joint session of the 67th Congress on December 8, 1922.

The February issue also called attention to the need for new radio legislation relating to broadcasting. It pointed out that as of January 1, 1923 there were 565 broadcasting stations in the United States, sharing 3 different wavelengths (360, 400 or 485 meters). The interference was considerable, even though none of the stations used more than 500 watts power.

The April issue contained a description of Jenkins' system of radio transmission of photos. The May issue contained a story by Professor L.A. Hazeltine (F), discussing the theory and operation of his neutrodyne TRF receiver. He told how regeneration and even oscillation in the TRF circuits were eliminated by neutrialization of the grid-plate capacitance of the amplifer tubes.

The June 1923 issue contained the regulations of the National Radio Commission, setting new frequency allocations for commercial, government and amateur stations operating between 95 and 2300 Kc. Radio broadcasting stations were freed from the three-frequency strait jacket that had existed up to that time. Broadcasters were divided into class A and class B stations; Class B could use higher power and were assigned frequencies between 550 and 1040 Kc; Class A stations were assigned frequencies between 1050 and 1350 Kc. Stations were assigned frequencies separated by 10 Kc and that meant that there were 81 channels available for broadcasting.

Amateur stations were assigned frequencies between 1350 and 2000 Kc. Spark-telegraph stations were restricted to frequencies between 1700 and 2000 Kc. From 1350 to 1500 Kc., amateurs could operate high-grade CW stations under special license.

The March 1924 issue reported that broadcast station KDKA in Pittsburgh also was transmitting its programs over an experimental shortwave transmitter operating on 3200 Kc. The shortwave signals were being received by a broadcast station in Hastings, Nebraska and rebroadcast on its regular frequency. Westinghouse, the operator of the Pittsburgh and Nebraska stations, planned to use the shortwave station to relay KDKA programs to its other broadcast stations around the country. It was hoped that the shortwave station would provide sufficiently good reception so that all the stations could use KDKA's programs extensively.

The December 1924 issue reported further changes in frequency assignments. The amateurs lost the 1350-1500 Kc. band. In return, they were given 1500 to 2000 Kc and a series of bands centered near 3500, 8500, 15,000 and 60,000 Kc.

The broadcast band was extended from 1350 to 1500 Kc, providing sixteen additional channels.

The Dream of an Electronic Home Newspaper

Excerpted from the archives of Capt. William G.H. Finch and the files of The Radio Club of America

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title — Patent Laws, U.S. Department of Commerce, Patent and Trademark Office.

**Capt. Wm. G.H. Finch — USN (Ret.)
M-1927, F-1959, L-1971**

Invention is putting materials together so as to make something which did not exist before. When William G. H. Finch (M 1927, F 1959, L 1971) took a crude electro-mechanical telephone relay and built a sensitive radio relay that would operate on minute currents, he invented the key to the wireless typewriter. That was the first of 208 inventions upon which U.S. patents were awarded to Finch. During his lifetime, those inventions have almost completely changed the transmission of information in most parts of the world.

The Finch Radio Relay invented in 1919, was covered by a patent issued on February 20, 1920. An advertisement in **Practical Electrics** issue of August 1920 claims that the relay would automatically receive and record a telegraph-encoded message on a paper tape, simultaneously record and retransmit messages, operate a telegraph sounder, ring a bell, serve as a radio-controlled burglar alarm, control a moving vehicle, and permit remote ignition of explosives via radio.

Soon the U.S. Lighthouse Service and the War Department became prominent users of the Finch Radio Relay. By now, the advertisements spoke of using the system to capture the code transmissions of government and commercial messages.

Such a sensitive relay, designed to operate in place of a pair of headphones, had tremendous potentialities. It made possible the radio typewriter first described in the September 1924 issue of **Popular Radio Magazine:**

"Most of us have heard of the telegraph printer. This is a machine that prints out messages that have been sent over wires by specially-spaced electrical impulses. Both the transmitter and the receiver are somewhat similar to the typewriter; the main difference is that the transmitter operates a selective device that sends out the electrical impulses, and the printer at the other end of the line receives these impulses and converts them back into letters and spaces them into words in the same formation as they were recorded.

"The automatic high-speed radio printer is a combination of the present telegraph-printer equipment with that of a suitable radio installation. At the transmitting end, the manually operated key is replaced with a machine transmitter, while at the receiving end the output of a suitable amplifier is fed into a sensitive relay — which in turn controls the circuit of the receiving printer.

"During the early part of 1920 numerous stations were copied at high speeds both at Buffalo and Detroit by the system here described; the average distance was about 1,500 miles.

"In the early part of 1921, the management of International News Service saw the possibilities of employing the system for the dissemination of news. Accordingly, a test was arranged by them between the Navy Department at Washington and Buffalo, and between the Inner-City radio stations at Detroit and New York. The results were successful and proved beyond doubt that the telegraph printers that were then available could be operated by radio. From that time on the International News Service has been experimenting and investigating the possibilities of establishing a supplemental radio news service.

"A little over two years ago, the work had progressed to such a point that tests were conducted for long continuous periods of operation in which the Kleinschmidt printer was operated at a speed of ninety words a minute, with very few errors.

"Amongst the advantages of using the automatic high-speed radio printer may be included in the following features:

1. It insures secrecy of its messages, thereby preventing use by unauthorized persons.

2. It makes possible high-speed operations, from 65 to 100 words a minute, thus insuring low costs.

3. It supplies all services to remote locations at a nominal figure.

4. It furnishes a local news service to the newspapers in larger cities where it is difficult to obtain wire service facilities.

5. Its quadruple operation makes available four different channels of operation which may be employed for four different kinds of services.

"Other kinds of business enterprises that depend upon communication systems are: shipping companies, brokerage houses, banks and railroads, all of whom may eventually make use of such a system."

In 1932, Finch became Chief Engineer of the Hearst newspaper radio services and had set up key regional stations for radio-typewriter transmission in New York, Chicago and California; Havana was added a year later. In December, 1932, Finch installed one of his radio typewriters aboard the U. S. S. Reuben James and conducted a number of successful tests between the Finch Laboratory in Carlstadt, NJ, and the Reuben James cruising the Atlantic seaboard between Bar Harbour, ME and Norfolk, VA. This led to the equipping of a number of naval ships with radio telegraph printers.

A year later, Finch became Assistant Chief Engineer of the FCC, in charge of the telephone division. From this, he turned his mind to the uses of facsimile transmission of intelligence and conceived the possibility of transmitting a newspaper by radio. For this, he formed the Finch Telecommunications Laboratories, in New York City.

In one instance during August 1939, daily news reports were received via Finch facsimile on the U. S. S. Tuscaloosa for delivery to President Franklin D. Roosevelt, who was aboard. The news reports were prepared and transmitted by radio station WOR, in New Jersey, with the cooperation of Jack Poppele (M 1941, F 1942, L 1970).

In 1935, Austin G. Cooley (M 1971, F 1973, L 1973), a leading inventor of facsimile equipments, made history by transmitting a newsphoto of the survivors of the Navy's dirigible disaster across America through the medium of an ordinary telephone call. This in spite of the opposition of the telephone companies who "proved" that it was technically impossible to transmit a news photo in such a way, and the lawyers who said it would be illegal to connect such a device to a telephone line. Cooley met the challenge by developing a system that would couple into an ordinary telephone.

From the December 1937 issue of **Current History:**

"From the National Resources Committee, the special deputation of President Roosevelt, has come tangible evidence that facsimile transmission is about to break in radio. It is an invention of which there have been few harbingers although facsimile transmission by radio is not new, nor is it a technical problem with future, though vague, possibilities.

"In a recent comprehensive and authoritive report the National Resources Committee singled out facsimile transmission as one of thirteen inventions carrying potentialities for changing the economic, cultural, and social life of the nation. Further than that, President Roosevelt pointed out that soon, by means of facsimile broadcast, the average citizen would be receiving his morning newspaper in his home. In this statement the President assumed the role of pessimist. Soon encompasses a vague future. The facts concerning the availability of facsimile broadcast are of the present. The radio newspaper is here.

"Imagine a family at home preparing for breakfast. From a small cabinet, attractively designed and operating automatically through a time-clock connection with an ordinary radio set, unfolds a wide ribbon of paper. Tearing off a strip the master of the house exclaims: 'Sweetheart, take a gander at this! Last night the Secret Service uncovered the fact that our Secretary of State is really a member of the British royal family. Whew! What a mess!'

"But 'sweetheart' is already occupied with a few radio newspaper columns of her own, getting a peek at an illustrated advertisement decribing the breath-taking bargains in fur coats at the favorite department store.

"How is it done? To answer the question at once — done with the greatest simplicity.

"Comparatively, the facsimile transmitter is little larger than the receiver. The copy to be sent, whether straight news bulletins or photographs or line drawings, involved no printing, since the material is inserted directly into the machine. And the insertion of material requires less skillful fumbling than loading a movie projector. With the material in line an electric bulb throwing a tiny spot of light swings back and forth across the copy to be facsimiled. The mechanical action is similar to the human eye sweeping from left to right along a line of type recording images of black characters upon a white background. From the copy the spot of light is reflected back to a light sensitive photo-electric cell. Thus, when the scanning light strikes the white it returns a full reflection, on the densest black no reflection, while on the gray and varying shades of black it returns only a partial reflection. Through the action of the photo-electric cell these reflections metamorphose into their equivalent of electric energy. On the receiving end such electric impulses are employed to operate a stylus sweeping synchronously across a carbon-backed paper. Thus, a black impulse will press the stylus down, a white impulse will lift it. One hundred lines will build an inch of type, or, at the operating speed of the present machine, a two-column newspaper at the rate of five feet per hour.

The facsimile system can transmit through any circuit, whether shortwaves, micro-waves, telegraph wires, or normal broadcast frequencies. Distance of facsimile transmission depends entirely upon the amount of power employed. At present, broadcast stations will use their regular wavelengths to broadcast facsimile during the early morning hours when normally such facilities would remain idle.

"As an economic venture for the broadcasters the facsimile is promising. Operating expenses will be more than offset by advertising revenue, since the facsimile carries both pictures and text. At present, that is in the future. After six months when actual experiment on the public has been completed then the station owners will be able to calculate their possible profit.

"In brief, that is facsimile transmission. Already, broadcasting stations have applied to the Federal Communications Commission for permission to start at once experimental facsimile transmission of radio newspapers to home in their service areas. In the East, WOR owned by the Bamberger Broadcasting Service, Newark, New Jersey, has announced that they are preparing to inaugurate a service in the New York area. In California, the MacClatchy news-

papers operating four broadcasting stations have applied to the FCC for permission to send facsimile. Stations WHO, 50,000 watts, Des Moines, KSTP, 25,000 watts, St. Paul and Minneapolis, and WGH, 250 watts, Norfolk, Virginia, have already received permission to broadcast facsimile to their service areas using regular broadcast frequencies and full power. These latter stations are awaiting delivery of machines for installation in homes for use during an experimental period."

Historically, the idea of a facsimile was not new. The principals involved were first stated more than a century before, but many years passed before the development of electronics made it possible to put them to practical use.

During the New York World's Fair in 1939-1940, Finch broadcast a tabloid newspaper **"Air Press"** from the Finch Station W2XBF, 1819 Broadway, New York City, to the I.T.T. booth at the fair grounds using news and photos from International News Service. Those demonstrations and the experimental tests of the broadcasters were successful but not economical but many broadcasters continued to offer the services until forced to stop by World War II.

Finch had foreseen the possibilities of such difficulties when, 15 years earlier, he began to build the independent patent structure upon which he based his finished products. Perhaps Finch possessed the most formidable independent communications patent set-up in the country. To quote one of his associate engineers: "That the machine is working is not so amazing as the independent patent structure supporting it." Amazing indeed, for the patent is the pivot of our machine age. In more than one way, the Finch Telecommunications Laboratories symbolized the dozens of independent organizations waging a relentless war against the patent pools and radio monopolies.

Finch was not to be put down by the commercial defeat of his radio newspaper. Rather, he proceeded to develop a technique for transmitting a three-color picture via long-distance wire lines. From the June 5, 1937 issue of **Editor & Publisher:**

"Something brand new in wire picture technique — the transmission of a three color photograph by wire — is here.

"It is the first time to our knowledge that a color picture sent by wire has been reproduced on a printed page by a regularly issued publication.

"The process used is that developed by William G.H. Finch, inventor of the Telepicture system of transmitting black and white photographs by wire over regular long-distance instead of leased wire circuits.

"Called the Finch Telechrome system for transmitting natural color photographs, it depends upon three coordinating factors for its success. First, the color separation negatives at the sending end must be true and distinct. Second, the picture signals sent over the wire in varying intensities according to the lights and shadows of the negatives, must be true and strong to overcome noises present in a long distance wire. Third, the color key sent with the picture must be exact and exactly reproduced to result in a color picture suitable for plate making and printing at the receiving end.

"Mr. Finch described the process as follows: 'If a telephone conversation can be held between two distance points, natural color photographs can be transmitted between the same points. The system is economical in that telephone service is paid for only while the picture is being transmitted.'

" 'The coupling coil of the Telepicture transmitter and the method of getting the picture signal on the telephone line are interesting. By means of a clamp, a coupling coil is held against the bell box of the ordinary telephone in such position that it is near and coaxial with the induction coil of the telephone. While there is no physical connection between the Telepicture transmitter circuit and the telephone circuit, sufficient inductive coupling is obtained to put a good strong picture on the telephone line. This strong signal will override the small noise currents present in the telephone line and give good picture quality.'

" 'The new method of transmitting natural color photographs involves the making of three monochromatic color separation prints, one corresponding to each of the three primary colors of red, yellow, and blue as such colors are present in the original object photographed.'

" 'The three color separation prints are received at the Telechrome picture receiver as negative films. Positive films can be made from these, one being toned to each of the three primary colors of red, yellow and blue. The 3 colored positive films can be superimposed to give a natural color transparency or three colored positive films can be superimposed and backed with a white paper to produce a natural color photograph.'

" 'Some of the advantages of the new Telechrome equipment are the ability to operate whereever a telephone is available, the necessity of using the telephone line only while the picture is being transmitted, the freedom from color distortion given by the simultaneous scanning of the color separation prints and the ease of attaching the equipment to the telephone.' "

A week later, **Editor & Publisher** featured an article titled: "New High Speed Cathode Ray System Sharply Cuts Wire Picture Time." It described an electronic scanning system covered by a patent issued to Finch for the high-speed transmission and recording of pictures on a continuous roll of film. Five-inch by seven-inch pictures could be transmitted in one minute.

The system was designed for the rapid transmission of news photographs over coaxial cables or broad-band UHF radio channels where high speed operation is particularly desirable in order to use such circuits economically and efficiently.

It now is 1940 and Finch uses a two-prong attack toward the use of facsimile in airplanes. Mindful of the technical successes of transmitting newspapers by radio, first Finch invited members of the press to witness a dynamic demonstration. It was reported in December 1940 as follows:

"At Bendix airport, in Jersey, the Finch 'flying laboratory', an eight-place Fokker plane, was used to carry the newspaper men aloft in relays. They took turns in writing messages which were transmitted to the company's field laboratory.

"When the newspaper men were returned to earth, they were shown facsimiles of messages in their own handwriting. When they arrived at the company's plant 15 miles away, they again were shown their chirography as it was transmitted over telephone lines from the trailer to the factory."

But of far greater importance to the country was the introduction of radio facsimile transmission to the U.S. armed forces, whose story was featured in the rotogravure section of the **St. Louis Post-Dispatch** on April 27, 1941. The text accompanying the photographs stated:

"Radio facsimile transmission, by which marks on a piece of paper— photographs, drawings, words— can be promptly reproduced on another piece of paper miles away, has been adapted to the uses of war. It is an important contribution to the speed and co-ordination so greatly desired in modern military operations, for it enables scouting planes, warships, tanks or remote outposts to send to headquarters such vital information as photographs and maps of enemy positions in a few minutes.

"In the World War(I- ed.), when a reconnaissance plane took a photograph of an enemy gun emplacement or concentration of troops, this information was not available to the intelligence staff until the plane had returned to its field and the picture had been developed and printed. With facsimile transmission, the aerial photograph can be developed right in the plane, through the use of special apparatus, be put in the plane's facsimile machine a minute after it was taken, and begin to appear in reproduction immediately in the receiving unit at command headquarters. While transmission is in progress the plane can continue its scouting. Flyers in United States Army planes can carry on conversations by radio telephone with headquarters during transmission since their facsimile units are 'multiplexed', the voice being carried on the same wave band as the photo or map.

"The military radio facsimile unit used by the United States Army and Navy and the Royal Air Force, which have exclusive military rights to it, is a portable machine not much larger than a typewriter and weighing only 35 pounds. It was invented by British-born American, William G.H. Finch, a former assistant chief engineer of the Federal Communications Commission. His patented device involves use of a special 'synchronizing impulse' to achieve proper synchronization between the stylus, the wire needle which burns in the image on the paper of the receiving unit, and the tiny beam of light which travels across the message in a scanning movement."

World War II! Since being commissioned in 1929, Finch had served in the U.S. Naval Reserves. In 1940, he went on active duty with the Navy as a communications officer aboard the U.S.S. Wheeling. In 1941, he transferred as a Lt. Commander to the Office of Buships in charge of electronic warfare projects, and was promoted to the rank of Captain in 1944. He transferred in 1945 to Office of Naval Research as Chief of Patents and Patent Counsel for the Navy. He retired in 1959.

After the war, non-military interest in facsimile was revived. Mindful of the technical success of his radio newspaper, Finch arranged in 1946 with Capital Airlines to offer their passengers the latest news bulletins right off the International News Service wires. The test flights were reported by **Editor & Publisher** on July 13, 1946:

"Passengers in an airliner reading the latest news bulletins, right off the United Press wires... reading them even before many a landlocked news editor sees the same copy!

"We saw how it's done this week in a demonstration staged by PAC Capital Airlines, the International News Service and FM station WGHF, New York City, which is owned and operated by Capt. W. G. H. Finch, president of Finch Telecommunications, Inc.

"Aboard the plane, we received copies of Finch's newspaper-of-the-air, **Air Press,** *which his station broadcasts thrice daily in current operations. It is a 7 x 9-inch page, made up in newspaper style with International News Service news dispatches, the United Press having entered into a long-term contract to furnish its special radio service, both news and pictures, to WGHF for facsimile broadcasts.*

"It was the first public showing of a wartime miracle of comunications which is being translated into civilian use in one of many services. This particular news service, in which International News Service is pioneering, is to be developed by Capital Airlines chiefly because of a growing need for ways to keep passengers from boredom.

"More than being a recreation stunt for passengers, Finch visualized it as a means of keeping travelers informed of news events back home and particularly in places to which they are going. The facsimile machines can also be used for receiving weather maps, flight orders, or business messages.

"Captain Finch is considered the 'first radio editor' in U.S. journalism, having worked in that capacity for the **New York American** *in the 1920's before he became director of radio enterprises of the Hearst organization. In recent years he has been assistant chief engineer of the FCC and during the war, while he served in the Navy, he licensed the government under his patents to permit other manufacturers to turn out facsimile equipment, his own firm being wholly occupied in making radar equipment."*

By 1946, facsimile machines would record pages of about 8½ x 12 inches at the speed of 28 square inches per minute, or four pages every 15 minutes. Since these pages were about one-fourth the size of a standard newspaper page, it meant the equivalent of a newspaper page was being received every 15 minutes.

Facsimile, in its technical sense, involves the conversion of the visual aspects of graphic intelligence, such as written or printed copy, photographs, and other types of illustration, into an electrical signal which may be sent over telephone, telegraph, or radio circuits. At the receiver, the signal is converted back into its visible equivalents, appearing on the recording machine as a replica of the original. The received copy is in record form and may be handled, observed at will, or filed for future reference.

Culminating years of research and development, these rather simple devices constitute a communication system of unparalleled accuracy. Their basic charateristics of exact duplication eliminates all possibility of transmission errors. It makes no difference whether the page to be sent is a hand written letter, a typed document, a sketch or a photograph — the message received cannot contain any errors in substance.

Small, compact receivers have been developed for installation in automobiles, trucks, railroad trains, airplanes and small boats. These units are able to furnish a wide variety of services, supplying permanently recorded facsimile copies of all incoming messages without the attention of the personnel. This means that maps, sketches, pictures and written instructions can be sent to police vehicles, forest rangers, firemen and so on, without interfering in any way with their essential activities.

A future possibility in facsimile broadcasting is in the use of multiplexed signals wherein facsimile and audio programs can be broadcast simultaneously and received by a single home radio. This would result in some interesting and useful program arrangements. Musical programs could be accompanied by printed and illustrated program notes; women's programs could be accompanied by printed recipes, designs and instuctions; news could be broadcast simultaneously with a sporting event; and so on. Facsimile is still an infant giant in the communication industries.

In the 1930's, John V.L. Hogan (H 1915) joined Elliott Sanger in the establishing of a high-fidelity radio station using a 10 KHz bandwidth, to broadcast classical music on AM. The station was granted an experimental license with the call 2XR. This later became WQXR which exists today.

Foreseeing the possibilities of inter-city transmission of broad-band programming, Hogan arranged with Raytheon, Inc. to set up a microwave link with six repeaters between terminals in Boston and New York. On August 16, 1946, this system was used to transmit hand-written messages and maps via facsimile between the cities. The fax equipment could handle 500 words per minute within a 3 KHz channel. The 15 KHz bandwidth of the microwave system could accommodate facsimile transmission with automatic synchronization at 2,000 words per minute.

In the 1950's Hogan arranged with the General Electric Company to build facsimile recorders for radio-received newspapers, into the GE AM/FM console receivers.

The **New York Times** bought WQXR but never tested or used facsimile on the WQXR multiplex channel. Perhaps the **Times** primary interest in acquiring the station was to be first if the electronic home newspaper should develop and become practical.

The dreams of someday transmitting complete newspapers by facsimile culminated on August 20, 1956 when a ten page edition of **The New York Times** was transmitted to San Francisco, during the Republican National Convention. The transmission was on equipment designed by Austin G. Cooley, of Cooley Prototype Service, and built especially for the job. The facsimile edition of the **Times** was transmitted at the rate of a page in two minutes, with scanning at a rate of 250 lines per inch, modulating a 60 KHz carrier on a channel provided by AT&T. Recording was on photographic film from which zinc engravings were made. The zinc plates were wrapped around the printing press cylinders and offset printing proceeded.

But has the dream of home delivery of an electronic newspaper died? There is a revival of interest because of the rapid development of cable television systems which provide easy access to many homes. However, the stumbling blocks seem to be in the cost of equipping subscribers with machines, the costs and difficulties of maintenance, and the supplying of recording paper.

But the promises? Well, the broad spectrum available in a cable channel would permit a far greater speed of transmission and, in turn, demand facsimile systems no longer dependent upon mechanical devices. Perhaps the transmitter would utilize a flying-spot scanner and the receiver would be a video monitor equipped with an "instant" camera. Such a system would supply the public with a newspaper delivered electronically into the home at a rate fast enough to contain all the news, features and advertising that now appear in the daily papers.

And what of Bill Finch? The road of the independent inventor is rough and arduous, and recognition sometimes is slow in coming. Capt. William G.H. Finch, USN Ret., received an honorary degree of Doctor of Science on December 10, 1983 from the Florida Institute of Technology, in recognition of his past achievements and his continuing work on electronic and communications systems. His biography has been included in Who's Who in America since 1924, and in Who's Who in the World since 1976. He was awarded the Armstrong Medal by The Radio Club of America in 1976, and was a recipient of The IEEE Centennial Medal in 1984.

THE FINCH SYSTEM OF HOME FACSIMILE

AS DESCRIBED TO THE CLUB

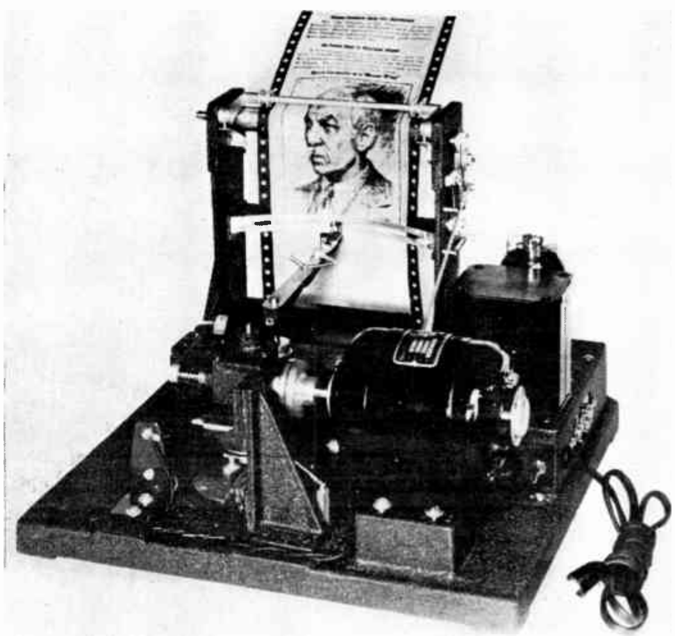
BY

R. H. MARRIOTT, April 14, 1938

Radio facsimile transmission as a communications medium is not new. It has been used commercially for years in sending news pictures and other copy across the Atlantic. Not until recently, however, have systems suitable as adjuncts to radio broadcast service been developed and these are being adopted only because certain basic problems have now been solved satisfactorily. Amongst these is the problem of synchronization, by which facsimile transmitting and receiving machines are maintained in step with each other and the problem presented by the need for simple and reliable automatic methods and equipment by which the radio facsimile newspaper may be printed in the home.

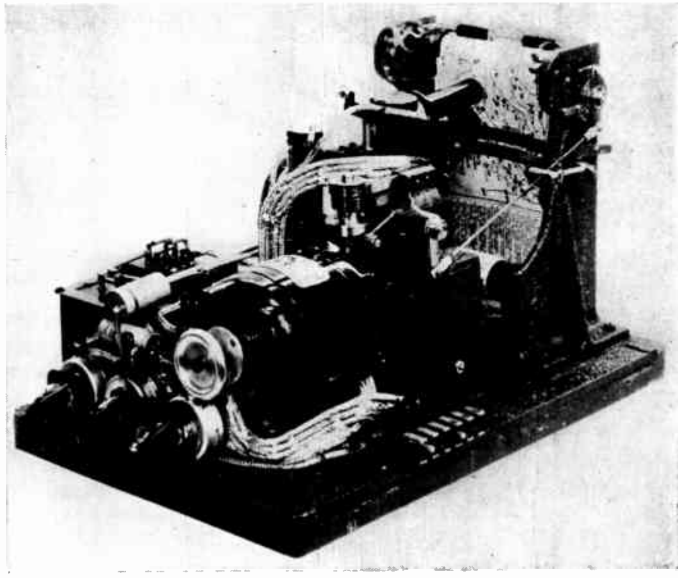
Synchronization

In the Finch radio facsimile system synchronization is effected by two simple means. One is the motor that drives the home recording machine in such a manner that it holds its speed at a substantially constant value. The other is a sensitive electromagnetic clutch operated by what is termed the "selective synchronizing pulse"—a low frequency tone modulation of the radio signal of extremely short duration which not only starts and stops the recording machine at exactly the right time but also keeps the receiving machine in exact step with the transmitter throughout the printing period.



Scaning Unit

The facsimile transmitter employs a scanning machine which comprises the "copy head"—which holds and advances the copy—and the "scanning head." The latter consists of a small electric bulb, a lens system and photocell. The light from the bulb is focused, as a small spot, on the surface of the paper carrying the copy and the reflected light is picked up by the light-sensitive photocell. The scanning head is moved from side to side through a small angle by an electric motor so that the spot of light traces a series of parallel paths across the copy. The copy is moved upwards through a distance equal to the diameter of the light spot at the end of each scanning stroke. In this manner, the entire surface of the copy is scanned horizontally one hundred times for each vertical inch of copy. The variations in light reflected on the photocell effect a change in current flowing through it and thus control the amplitude of the tone available for modulation purposes to the radio transmitter in the same manner as in sound broadcasting.



Recording Unit

The recording machine is in many ways similar to the scanning instrument. A "copy head" holds the electrosensitive recording paper which is fed as a continuous strip, two newspaper columns in width, from a roll carried in the lower part of the machine. A small synchronous motor moves the recording stylus back and forth across the paper in step with the scanning head of the transmitter. The recording stylus, .010 inches in diameter, marks the paper throughout one half of each excursion in accordance with the intensity of the audio tone signal. At the end of each excursion the stylus comes to rest until a low-tone signal impulse sent out by the transmitter starts the next excursion through the action of the magnetic clutch. In this manner the recorded copy is built up line by line to duplicate the original copy.

The home recording machine requires about 300 watts for its operation and may be connected without auxiliary amplifying equipment to the output circuit of any broadcast receiver having a power output of four watts or more.

The broadcasting station from which facsimile signals are sent is tuned in as when regular sound programs are to be received. The facsimile recorder is switched on and the volume control of the receiver is turned to the point where copy has the desired contrast. There are no adjustments on the recorder other than the initial adjustment of framing and of stylus pressure.

A Brief History of the Key

by Louise Ramsey Moreau
(M 1975, F 1980)
W3WRE

Alfred Vail invented the key as a short-cut while testing the Baltimore-Washington wire "only a few weeks before" (according to Morse) the May 24, 1844 demonstration of the telegraph. Six months later, Vail had modified his crude strap instrument into the basic design of every key made since that time, a design that he described as "a lever acting upon a fulcrum."

His straight lever lasted for four years and, when the growing industry had sent the news that gold had been discovered, the lever had curved into the high hump of the "Camelback" style. That, with the straight-lever keys, would be the standard in this country for the next forty years. The 1850's brought the coil spring, the first transceivers mounting the key and sounder on a single base, and communication's earliest miniaturized units — the Pocket Relay of the lineman's test sets.

The Camelbacks, straight levers, and the little test sets as well as many homemade keys, were used by both the Confederate and Union Forces during the Civil War bringing rapid communications directly to the battle field, and then in 1862, from balloons to transmit history's first airborne observations.

With the end of the War, the demands of the industry increased as more and more requests for special types of keys were received to meet the needs of the telegraph. The successful completion of the Atlantic Cable required dual-lever "discharge keys" (for submarine operation); the development of duplex, then quadruplex operation, brought the so-called "pole-changer" instruments to easily switch circuits on the same wire.

The railroads demanded strap keys for signaling and these were a curious return to the earliest Vail instrument; while a growing public interest brought the need for practice sets.

By the time that Mrs. O'Leary's cow had burned Chicago, the Camelback had begun to change into the more familiar, less-exaggerated curve. Then, ten years later in 1881, Jesse H. Bunnell came up with the one-piece steel lever and oval hollow frame that everyone, today, recognizes as the telegraph key. The style was succesful almost instantly with both the companies and the operators and, by the turn of the century, the Camelbacks and straight-lever instruments were no longer offered by the manufacturers.

When wireless telegraphy entered the communications picture, the keys had to change for here was a medium with very high currents that could be, and were, lethal; and the small contacts of the land-line instruments could not handle the high current. In 1896, Spark started using the so-called "Grasshopper Key" that automatically cut out the receiver to prevent its shattering during transmissions, and other changes were added to protect the operators. The contacts got larger and larger for a while in the "brute-force" era and thus required a larger and heavier lever with added safeguards.

The Walter Massie Company produced the largest keys which had 14 inch cast brass levers and cooling surfaces mounted on slate bases, resulting in a key that weighed eighteen pounds. Others had contacts that ran an inch in diameter with large cooling fins to carry amperage required for ten kw, and those of United Wireless used a long, curved lever and employed a bleeder to help dissipate the high current. Others mounted the contacts in an oil bath, and almost all were mounted on slate or marble bases, with a skirted knob (incorrectly called a "Navy knob") to protect the operator's fingers. And the extremely high-powered "rock crusher" transmitters were operated with "Large Capacity" relay keyers between the transformer primaries and the key.

From the beginning of radio, Amateur interest was high and their keys ranged (depending on their pocketbooks) from the homebrew "dime key" through commercial products such as the lovely marble-based "Boston" of Clapp-Eastham, or the RECO; through the brass keys of Signal Electric and Bunnell, or of Sears, Roebuck and Company.

Then, as Spark improved, the keys got smaller until, with the outlawing of the spark gap and the advent of cw, the telegraph instruments were brought into radio operations.

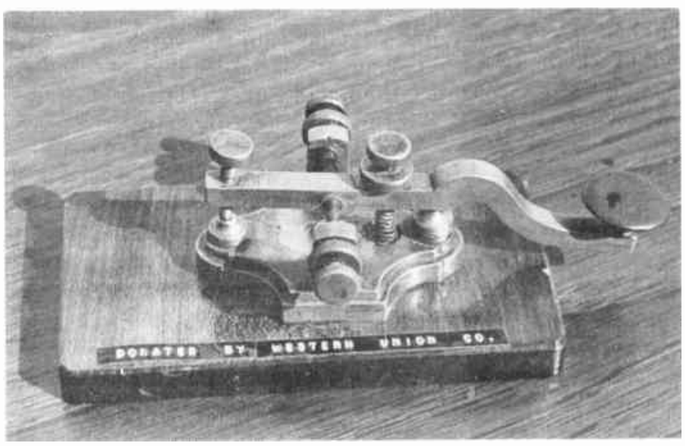
Although wireless and semiautomatic keys came into communications at about the same time, the "bug" was produced for telegraphy only. However, there is evidence that even in the early days of spark, they were used in experiments just to see if they would work and they did, through the big relay keys. But other than that they were strictly a landline key.

As the traffic loads kept increasing until the operators were sending from ten to eighteen thousand words in a single trick, there was an increasing need for an instrument that not only lent itself to the greater speeds required, but also would contribute to operator comfort. In 1902, Horace G. Martin sewed up the field with an eight-page patent that covered every possible form of semiautomatic operation with an instrument that he called the "Autoplex", and the speed key was born. In 1904, Martin produced the first Vibroplex and followed with six versions by 1923, with only brief appearances of the Hulit, and the Mecograph companies as competitors. There were others that bloomed briefly then died under Martin's patent infringement suits, for this was a new market that seemed to promise golden profits. However, Vibroplex held the winning cards. Vibroplex controlled the field until the beginning of the 1920's when the expiration of the Martin patents and relaxation of the manufacturing rights brought a flood of these keys.

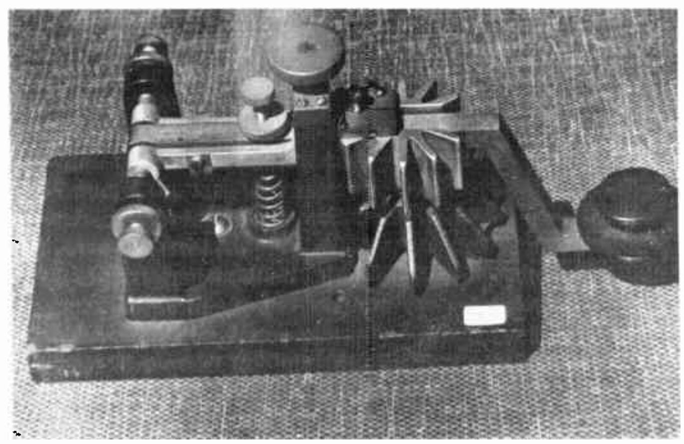
At first, they were designed with intentionally-different appearances from the Martin instruments to appeal to the potential buyers, both Amateur and professional operators; however, all eventually worked into the familiar Vibroplex design. Then, by the mid-1940's, the electronic keys appeared which produced both automatic dashes as well as dots as "lazy-man's cw" and, again, Vibroplex led the field to produce their "Vibrokeyer" to key the electronic instruments.

Three men stand out as milestones in key design: Alfred Vail, who gave communications the first key and then lever action; Jesse H. Bunnell, with his light, efficient, steel-lever key; and Horace G. Martin, for his incomparable semiautomatic style.

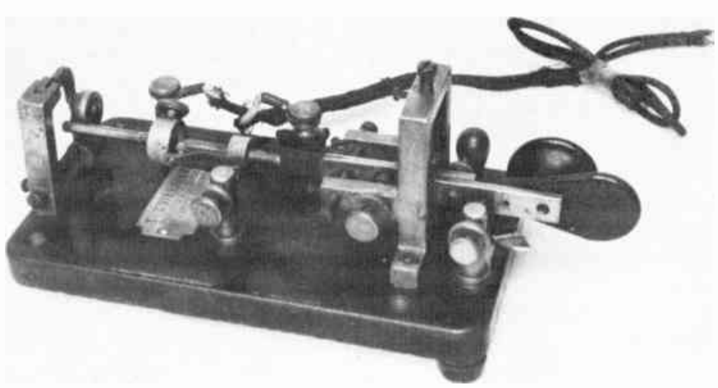
In 1832, Morse said: "If the presence of electricity can be made visible in any part of a circuit, I can see no reason why intelligence cannot be transmitted by this means." But, no matter how great the power of a transmitter, all it can do is transmit a signal. Whether we call it a beam or a carrier or a wire, without an instrument to create intelligence: a microphone, keyboard, camera, or, in this case, a key— there can be no bulletin, voice, music, picture, dry chatter of a sounder, or high-pitched cw. These and other methods of creating intelligence are actually the "tongue" of a communications system, and the key, the earliest of all these instruments, is the only one of all communications equipment that can be marked: "Made in the U.S.A. by an American."



1905 de Forest 10 kw Navy Spark key with 1" silver contracts and brass cooling fins from the Naval station, Pensacola, Florida. (Photo AWA Museum.)



1860-1880 period Camelback key. This one from the Western Union offie, Johnstown, Pa. after the 1889 flood. (Photo W2BWK. Moreau collection.)



1904 Original Martin Vibroplex. This key the prototype made by Martin for his patent. (Photo Moreau collection.)

Cellular Radiotelephone & What Went Before

by Ramsey McDonald (M 1970, F 1972)
W4OHD
and James A. Craig (M 1971, F 1979)

It is 1983 and amongst the year's most significant advances in telecommunications is cellular radio. Chicago has been chosen as the testing ground. It that area alone, the market is estimated to be 100,000 customers.

Little is known about a fully operational cell system set-up in 1951 or of the pioneering work that led to fully-automatic mobile radiotelephone services.

Cellular radio services began as a direct result of the FCC's decision to grant no more than three frequency pairs to the Checker Cab Company of Detroit despite the fact that their dispatching system was to employ almost 900 mobile radio units using the 425 MHz taxi channels.

The basic decision to employ frequency reuse was based upon traffic calculations of 10 calls per minute, with peak loads of double the average hourly rate. That required that the city of Detroit be divided into zones or cells, as designated in Figure 1.

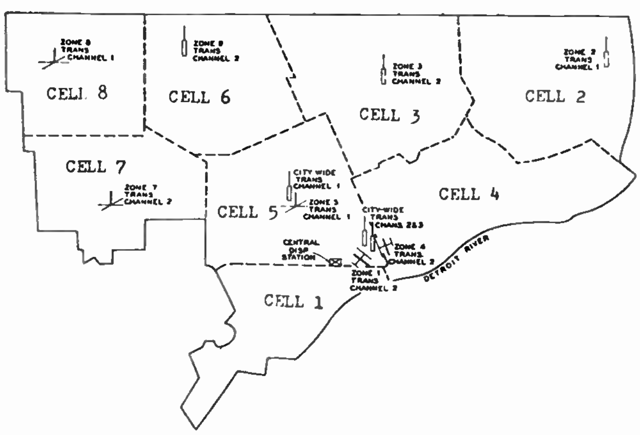


Fig. 1—How the city of Detroit was divided into zones, and how antennas were located to cover the city with three channels in such a way as to provide a maximum of coverage with a minimum of overlapping.

The ultimate number of zones and the area included in each was predicated on the taxicab company's experience. Planning was to distribute the traffic so that currently busy zones would not be overloaded and, at the same time, to provide zones on the outer fringes of the city that could absorb traffic growth to be expected from population shifts and the increased business accruing because of the advantages of taxi dispatching by radio. This was to be the forerunner of cellular radio without the automatic channel switching of the various zones or cells.

To realize the advantages of splitting the dispatching work load amongst many dispatchers, each would have to have simultaneous access to the radio facilities without mutual interference.

Two requirements were given primary importance in the development of the zone system: first, complete coverage of each zone by its transmitter; second, minimum signal overlap between common-channel zones. These requirements were virtually in direct opposition. A certain amount of overlap in one zone from another same-channel zone could be tolerated provided that each transmitter signal would completely capture a receiver within its zone.

Meeting these requirements involved many experimental checks on antenna heights, locations and configurations, and variations in transmitter powers. It soon became evident that transmitter power played a minor role in determining coverage at 450 MHz. If line-of-sight transmission existed on a given circuit path, then 2, 20, and 40 watts produced nearly the same results. Therefore, the zone transmitters all were made standard 20-watt equipments.

The most important factor affecting coverage was antenna height. Indeed, at antenna elevations of 60 to 75 feet, the coverage could be tailored in terms of four or five city blocks by changing antenna elevation by four to five feet.

While this discovery solved a lot of problems, each zone still had to be evaluated on its own merits and peculiarities. Referring to Figure 1, non-directional antennas were used at elevations of 60 to 110 feet in cells 7, 8, 6, 3, and 2. In zones 7 and 8, unity gain ground-plane antennas were used. Stacked co-axial arrays, which produced low-angle radiation at a power gain of 3, were used in zones 1 and 4 since available antenna locations were not centered in those zones.

During the final tailoring of the systems, a downtilt antenna was used at one location to eliminate cell overshoot. At that time, no such antenna was available "off the shelf", but the problem was solved by mounting a ground plane antenna upside down, resulting in an umbrella-shaped radiation pattern.

Zones 1, 4, and 5 intersect in the loop area of Detroit where there are many tall buildings which produce propagation shadows. For that reason, the zone 5 transmitter is located as shown on the map with its antenna at an elevation of 300 feet giving complete coverage of the zone with almost no dead spots. In the absence of comparable heights within zones 1 and 4, the final decision was to locate both antennas atop a 400 foot building located in the center of the loop district, using Yagi antennas trained down the centers of the respective zones. Each Yagi was equipped with a vertical V-shaped metal screen to minimize leakage behind and to the sides.

All of the taxicabs were equipped with 10-watt transmitters manufactured by the Link Radio Corporation. Each mobile unit was equipped with a selector switch on the control head. With this switch, the driver could select any of the three channels, depending upon his zone location. A zone map similar to Figure 1 was mounted on the vehicle's sun visor to inform the driver of the zone boundaries and the corresponding channels. Boundaries were arranged so that a minimum of channel switching was required in cabs traveling most of the main streets.

By employing frequency reuse in the same geographical area, greater spectrum efficiency was achieved when compared to the conventional mode of operation. In this particular system, the short messages employed in taxi dispatching worked relatively well with the sizes of the cells employed. While the manual channel switching would be a limiting factor when considering an expansion of the system by increasing the number of cells for greater frequency reuse, that problem has been resolved in today's cellular systems by electronic processing techniques.

A few years before the installation of the Detroit cellular system, radio common carrier operations were known as Limited Common Carriers or Miscellaneous Common Carriers. They used two-way radios with loudspeakers so all subscribers could monitor incoming calls. The verbal paging, or one-way signalling, required the mobile subscriber to listen in every half hour to hear whether their code number was being broadcast.

In May 1946, the FCC released experimental frequencies in the 152-162 MHz band to telephone companies and Miscellaneous Common Carriers (now RCC) for the installation of mobile radiotelephone services. The Bell Telephone System installed the first mobile radiotelephone system in St. Louis, Missouri, using operators to handle all calls to the mobile units. This was the MTS service offered by the telephone companies.

By late 1946, the common carrier pioneers arrived. Applications for experimental licenses were filed by several business men, generally those already in the telephone answering services. Mr. Frank Quatman, Jr. of the Lima, Ohio Telephone Company was one who wanted to investigate the possible use of mobile radiotelephony for his company.

At that time, the Link Radio Corporation had selective calling equipment for tone signalling, and used Western Electric dial handsets to eliminate the use of loudspeakers. Quatman placed an order for the Link mobile and base stations and installed the mobiles in test vehicles, using only the last digit of a 5-digit number to signal the mobiles. The operation with the Experimental Class 2 license used voice-operated relaying to key the base station while the mobiles used press-to-talk. This was a simplex type of operation even though separate base and mobile frequencies had been issued.

The Lima Telephone Company wanted more mobile units for use in dispatching taxicabs but the dialing was found to be too slow for taxi operations so loudspeakers and hand mikes were installed, and all selective calling equipment removed. The operations then were switched to a taxi channel, and the telephone company reverted to MTS operations using Western Electric 600/1500 Hz. decoders for signalling in order to serve the Bell System subscribers in the Lima area.

On March 1, 1948, the Richmond, Indiana Radio Dispatch Service, a company owned and operated by Ramsey McDonald, started operations. McDonald had purchased the selective calling equipment from the Lima Telephone Company, and had contracted with the Richmond (Indiana) Home Telephone Company to furnish a selector-level interconnection for calls from the telephone company subscribers, permitting them to directly dial a mobile radiotelephone unit — a one-way signalling service. An unlisted connector line number interconnected the base station receiver to the central office to access the land-line telephone system from a dial radiotelephone mobile unit.

This was the first fully-automatic dial radiotelephone system providing full-duplex operation, and the first MCC with legal interconnection.

The company furnished radiotelephone service to doctors, businessmen and the local municipal electric company, as well as to the Richmond Home Telephone Company who operated 12 radiotelephone units.

The proposed *Rules & Regulations Governing Domestic Public Mobile Radiotelephone Services* stated: "Contact with the mobile units shall be initially established only by the licensed operator at the control point." Such a rule precluded a fully automatic radiotelephone system. At hearings on that Docket 9046, McDonald convinced the FCC to allow automatic operations providing that a licensed operator was available at the control point and who would be in a position to disable the transmitter if off-frequency or other unsatisfactory operating conditions occurred. At that time, profane or indecent language was prohibited and violators were subject to heavy fines, imprisonment, or both.

In 1952, an independent telephone company in Foley, Alabama installed a similar dial radiotelephone system after the owner had visited and observed the Richmond operation. Again, Link Radio Corporation mobile and base station equipments were used together with a radiotelephone terminal manufactured by Link Radio and covered by McDonald's first radiotelephone system patent, No. 2,722,-598. This installation encouraged the Rural Electrification Agency, in Washington, to plan other radiotelephone installations, and was instrumental in getting the FCC to issue a waiver on the requirement of an operator on duty at all times for fully automatic radiotelephone systems.

In August 1957, a new dial radiotelephone terminal was installed in the Richmond operation. This terminal was marketed by the Allen B. DuMont Laboratories and manufactured under McDonald's second radiotelephone system patent, No. 3,009,149. This system included mobile-to-mobile direct dialing on the same channel without the use of the telephone exchange facilities. A demonstration of the operations of the company, now known as Richmond Radiotelephone Inc., was given to engineers of A.T.&.T., Western Electric, and the Indiana Bell Telephone Company, starting the Bell System on its changeover from manual operators to IMTS operations.

By this time, the independent Richmond Home Telephone Company had been acquired by General Telephone & Electronics. In February 1965, a disastrous fire at their central exchange knocked out all subscriber service including the fire alarm circuits. The radiotelephone system of Richmond Radiotelephone with its mobile-to-mobile facilities was impressed into service for all emergencies and, since the central office exchange was without dial service for many months, the FCC granted the addition of Dispatch Stations to most of the radiotelephone subscribers.

After the GTE central exchange was rebuilt, the telephone company advised that the selector-level interconnect was to be discontinued and that a connector number line would have to be used for each mobile subscriber. Another terminal then was designed to handle such an operation and a 100 pair cable was installed.

The cellular radiotelephone systems of today did not "just happen"; rather, they grew out of the early radiotelephone systems and their successors, the fully-automatic dial-direct terminals.

CB Radio And Its First Cousins

As told by Al Gross
(M 1977, F 1980, L 1978)
W8PAL

CB radio was born in 1958 just as The Radio Club of America was preparing to commemorate its fiftieth anniversary. It grew through a lusty childhood to become the delight for every trucker and teenager, and then developed to maturity when it became another useful tool of telecommunications.

When W. E. D. Stokes, Jr., the first president of The Junior Wireless Club Ltd., was preparing an address to be given at the 75th Anniversary Awards Dinner of The Radio Club, he wrote:

"In recent years, I've had a two-way radio in my automobile to call for assistance on long trips to remote areas, but found the inconsequential vulgar chatter on all the Citizens' Bands too much to tolerate. More power to our scientists and engineers who are doing a great job of building such equipment — but does much of this concern for excellence trickle down to the general public and truck driving element?"

A harsh indictment? Maybe — but perhaps CB radio only reflects the American way of life of this past quarter century.

Citizens Band Radio was pioneered in 1948 by Al Gross, W8PAL(M 1977, L 1978, F 1980) who was granted the first FCC certificate of approval for a CB radio transceiver of his manufacture and issued the call sign 19W0001. This was several years before the establishment of the present Class D Citizens Band Radio Service.

In 1937, Gross designed and built two 300 MHz., hand-held, battery operated transceivers and, a year later, used them to work a 45 mile QSO.

This led to the first of the CB cousins. Early during World War II, Gross was contacted by the Office of Strategic Services who needed specialized two-way radio equipment for counter-intelligence activities. With the Communications Branch of the OSS, Gross developed the key to the SSTR-6/SSTC-502 combination which was considered as one of the most spectacular radio developments of the war.

This highly-secret "Joan-Eleanor" system allowed an agent on the ground to conceal a tiny transceiver for communications with an equipped plane that copied UHF voice transmissions on a magnetic wire recorder, and then retransmit the messages to U.S. military intelligence units. Both sides of the ground/air conversations were recorded in the plane for purposes of accurary and as a check on the identity of the ground operator. The British-made "Mosquito" plane, built of wood, usually was used because of its speed and high-altitude capability.

The "Joan-Eleanor" sets proved highly-effective. Operating on 260 MHz., the operations did not need scrambling or codes. The danger of enemy monitoring was minimal due to the very high frequency used and the horizontal antenna beam pattern cast upward which made it improbable that ground-based enemies would hear the signals. The aircraft would hover over the OSS agent for only a few minutes in order to avoid disclosure of the agent's position, and to evade enemy ground fire.

The direct two-way voice communications permitted spot advice on priority intelligence, and in some instances, the required information at once. A contact via Joan-Eleanor lasting several minutes could supply a greater volume of intelligence than many hours of war-time coded transmission using cumbersome wireless telegraphy.

The value of this communication system was dramatically shown in this typical example when an OSS operator in a plane 30,000 feet in the air received the following via Joan-Eleanor from an agent speaking from near Munich (unessentials are deleted from this transcript):

"The Weilheim railway junction has from 40 to 50 trains passing through all night. In Weilheim proper there are two airplane factories. Number one is the Dornier works and the second is a factory making spare parts for planes.

"Peissenberg is nearby. It is the last coal mine out of which the Germans are now obtaining coal within the Reich to send to Berchtesgaden. The spare airplane parts and the completed parts from the Dornier plant are shipped by rail to Garmisch in the mountains.

"You must absolutely knock out the railway line Weilheim — Peissenberg, Weilheim — Augsburg as soon as possible. This line must be knocked out.

"I have something else to say to you. You must not bomb Raisting under any circumstances. The people are 90% on our side and so is the entire Volkssturm. Raisting, Raisting, do not bomb it, please."

Upon return of the aircraft to its base, this intelligence was immediately forwarded to the Air Force which decided to bomb the Weilheim target and the nearby Pasing railway station in Munich on the same mission. At the time the raid took place, a rather heavy overcast prevented an immediate estimate of the damage from the air. Another Joan-Eleanor mission was flown to the same agent on the night after the bombing; he reported:

"I want to thank you for almost killing me yesterday. I was in Munich and was 800 meters from the Pasing station when it was attacked.

"Now an eyewitness report. Pasing station was hit directly during the bombing attack yesterday about 1100. Railroad traffic in the direction of the mountains and Garmisch was halted and is paralyzed. All tracks are destroyed.

"In the double bombing attack at Weilheim, the station and tracks were hit. Only the aircraft plant Fahrdorf which we were talking about, was nearly undamaged."

After conversing with the agent, the Joan-Eleanor plane dropped to a low altitude and photographed the Weilheim damage. The photographs and agent's report were delivered to the AAF immediately. The town of Raisting was not bombed.

With the approaching end of the War in 1944, Gross was invited by FCC Chief Engineer George Stirling to a meeting of the Commission to demonstrate the OSS hand-held transceivers and to discuss the possible development of a citizens radio communications service. "It was to be a personal, two-way radio system for the public," said Gross "and even then we realized what a tremendous thing this could be." One criteria was that the applicant had to be 18 years of age and a citizen of the United States to use the band of frequencies set aside for this new service. "Hence the name Citizens' Band Radio."

As a result of the meeting, FCC Commissioner E. K. (Jack) Jett published an article that appeared in the July 1945 issue of the **Saturday Evening Post** entitled "Phone Me — by Air". It described the possibilities of a postwar citizens radio communication service: "From mere listeners or spectators as they are now, people in homes and offices throughout the country will become active participants."

The commissioner said that the potential for a personal citizens band radio service was limitless and would undoubtedly bring American citizens — both in the cities and in the country — closer together. He also predicted the emergency applications of such a system: "When storms, floods, earthquakes or other disasters disrupt wires, families and communities can remain in touch with the outside world." This idea led to the present CB channel 9 set aside for emergency communications and which is monitored by local police, highway patrols and the U.S. Coast Guard.

Now, another cousin of the CB radio arrives: the one-way, radio selective pocket pagers. Again, Gross is involved when during 1950-51, he designed, developed, and manufactured the first FCC type-approved digital-signalling paging transmitters and pocket receivers. These operated in the 460-462 and 467-470 MHz portions of the Class A Citizens Band.

Also in 1950, Gross demonstrated a second-cousin to CB radio: a hand-held transceiver for use as a remote telephone having full duplex operation. It received on 1.7 MHz and transmitted on 465 MHz. Because of telephone interconnect restrictions in effect at the time, the portable telephone could not be marketed for the public as it is today.

Gross continued to invent a number of gadgets through the years, leading to still another cousin. Perhaps the most novel of all, the helmet radio was similar to those now used by military pilots and the astronauts. In 1952, the Cleveland Browns football team asked Gross if he could design a radio helmet which would allow Quarterback Otto Graham to receive plays from the sidelines. Using the induction radio system invented by Nathan Stubblefield in 1892, Gross installed a big loop around the Cleveland stadium and installed a small receiver in Graham's helmet. From the press box, spotters were able to transmit plays to Graham on the playing field. The helmet radio was banned by the National Football League after one season.

CB radio didn't click with the American public in general until 1972 when a truckers' strike hooked the nation on CB's and how it was being used. The average person saw on his TV news how truck drivers tied up the nation's highways by communicating with their CB transceivers. Shortly afterwards, the 55 mile-per-hour speed limit was instituted on the nation's highways and CB sales skyrocked as the average driver hooked into the truckers' game. CB radios got into the hands of 55 million Americans. It is still a growing market and has spread worldwide.

Life has been exciting for Gross with his CB family. In February 1980, Gross received an invitation from the Secretary General of the European Citizens Band Federation, Brussels, Belgium, and from the Secretary General of the World CB Union, Milan, Italy, to be their guest for the ECBF/WCBU Congress sessions in Cologne, West Germany. Representatives from 14 nations were in attendance. The visit included meetings with officials of the Post & Telegraph Departments from these countries, with discussions on promulgation of rules to satisfy the legal use of Citizens Band Radio in their respective countries.

Again, in November 1981, Gross was invited to London for the inauguration of legal CB in the United Kingdom. After buying the first British CB license, Gross sent a CB message from a waiting Rolls-Royce to a British CBer waiting in a nearby Jaguar.

Are there any more cousins to Gross's CB? Well, there's one we might talk about. It's an idea that ended up in the comics. Gross had designed a tiny FM transmitter that fitted into a wrist-watch case. About that time, Chester Gould, creator of "Dick Tracy", paid Gross a visit, presumably to investigate the possibility of outfitting the sharp-faced detective with a hand-held walkie-talkie. Instead, Gould saw the tiny wrist-radio FM transmitter and decided, for comic strip purposes, to make it a two-way transceiver. In October 1948, Tracy was seen for the first time wearing his now-famous two-way "wristradio" transceiver.

The real two-way "wristradio" transceiver may be closer than we think. The introduction of cellular radio systems opens the urban areas to telephone calls between landline subscribers and low-powered miniaturized transceivers. And with slightly improved receivers aboard space satellites and an adaptation of the selective beam pattern of the OSS Joan-Eleanor horizontal antenna, sufficient gain may become available so that the "wristradio" transmitter can speak to the World.

And the future — who knows what the next cousin will be?

ANTRAC

... which is the story of a radio set that went to war and what it accomplished, as told by one of the two civilian radio engineers who, after having helped to build and test it in the U.S., joined forces with Uncle Sam's fighting GIs to teach them how to use it to best advantage in the European invasion.

by Amory H. Waite, Jr.
(M 1974, F 1976)
W2ZK

PROLOGUE

1942 ... The United States was committed to war. At the U.S. Signal Corps Laboratories in Fort Monmouth, NJ, three radio engineers were discussing how wire lines and radio could be linked together to leap rivers, mountains, and swamps where hard-working wire crews could not get, especially under combat fire.

"That new Spiral-Four Cable/Carrier System with relay stations every 25 miles can carry four voice or 16 teleprinter circuits duplex but weighs tons and costs a fortune."

"Yes, but ground-to-air VHF radio is working over 100 miles and should do as well to ground stations on hill sites."

"Why don't we put a radio set every 30 miles to replace 20 tons of wire? The sets would need only small vehicles to carry them, and a generator like a little PE-75 and some gas cans... and they can act as their own repeaters. Forty-foot masts will give almost 40 mile line-of-sight contact on level ground, and better if hills are around, especially with FM."

"Why not? All we have to do is to get Fred Link or someone else who's already building FM Army gear to build us some models so that we can test them. They must be broad-band enough so that the audio channel will span the 200 to 12,000 cycle range of the Spiral-Four Carrier System, and frequency-stable enough so that when bunches of them get close to each other, they won't interfere. Maybe, they'd better be crystal-controlled, single-frequency jobs."

"Yeah. Then we could have a bank of crystals for each field army or division, and a special frequency-allocation officer to keep the mess in order. And the higher the frequency the better 'cause the higher we run this thing, the smaller the antennas will be . . . less visible and so less open to combat damage."

And then they went home: Paul Dove, the aircraft VHF engineer; the carrier-system expert; and "Bud" Waite, the guy who later built the antennas and masts, and liberated 50,000 pounds of nylon from the Air Corps just for guys alone.

They did not know that high-brass in Washington, DC and in other places like North Africa already were working on means of getting duplex radio systems. A Lieutenant and five civilians in North Africa were getting experience with simplex radio-relay circuits over hundreds of miles.

When that team returned to the Signal Corps Labs in late 1942, they found our group getting together the masses of antenna parts, crystals, tubes, and hundreds of items that made up the 182 boxes of gear that formed one three-link relay system identified as the AN/TRC-1/3/4.

Two of the North African team continued with the AN/TRC team: Vic Colaguori (F 1976) W2VC, and Russ Berg. Russ left the group before Colaguori and Waite went to England in the Spring of'44 with a single 100-mile AN/TRC system to convince the Army as to how good it was.

Both Colaguori and Waite had solid amateur radio and military experience; together, they assembled, repaired, and taught the operation of the first FM link radios. Colaguori won everlasting fame when he won the coin toss that let him go to France with the invasion forces of the U.S. First Army.

Waite had been Flag Radio Operator of the Atlantic Battle Fleet, USN, in 1921, and then a Master Sergeant in the famous 26th (Yankee) Division. Then, he had been one of the four radio operators during 19 months of the Second Byrd Antarctic Expedition in 1933 — 1935, and was credited by Byrd's family for his part in rescuing Byrd from death.

Both men were awarded the coveted Bronze Star, as civilians, for their performance under combat in World War II, and were mentioned 47 times in the *Signal Corps History of World War II.*

"Much has been written of planes and trucks and ships and guns, but without communications to keep them coordinated and supplied, their advances would have been chaos, their victories defeat."

Now, let "Bud" Waite tell the story of ANTRAC:

* * * * * *

"We'll be lucky if half of us are alive tomorrow, Lads, but go now; get to your stations and, when darkness comes, hoist your antennas and stand ready! Remember, not a move on the hilltops — not a mast aloft until after dark! Jerry mustn't get a glimpse of us until dawn at the earliest!"

It was twilight, June 5, 1944. We were being given our last minute briefing by the veteran Major of British Signals who commanded all communciation activities on the Isle of Wight, that nearest part of Old England to those beaches of Normandy where, tomorrow, the life's blood of so many American and English men would hallow those already historic sands.

Day after day we had waited, patiently adjusting our hidden radio gear, tensing at the frequent blasting of air-raid sirens and always asking ourselves: "Would they get ashore?" "If they did, could they get their sets working before they were blown into Eternity?" . . . and, "For God's sake, when is D-Day?"

Now we knew! D-Day was tomorrow! In twelve hours, they would be out there dying almost within sight and we, too, would have a job to do. As the Major finished his directive, the hundred-plus of us, gathered in the quiet beauty of the century-old English drawing room, stood silent for a moment as if in prayer, then burst for the nearest exits. Involuntarily, I glanced to where the guns of Cherbourg waited just below the haze on the horizon, wondering about Vic.

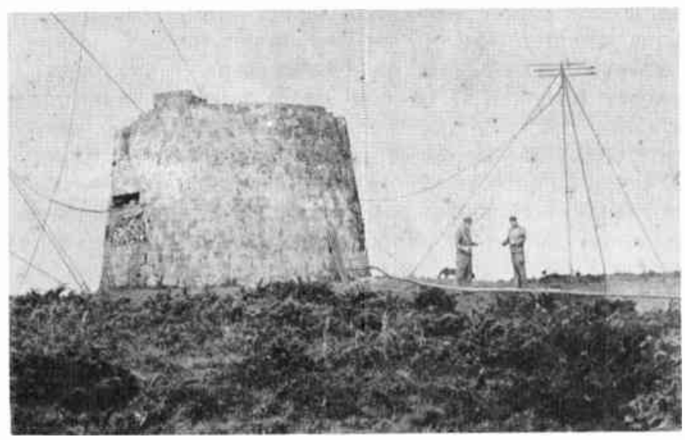
Vic Colaguori was the other end of the American Army VHF/FM circuit which, with luck, would be linking General Bradley's First Army, in France, with General Eisenhower, in England, in a matter of hours. Vic, a civilian radio engineer, together with three GIs, one small and very special radio set, and a three-quarter ton truck, was somewhere aboard an LST headed for France. Tomorrow, they would face the guns, find a hole in which to set up and operate, and then attempt to carry the communications of the American invasion forces back to England across 83 miles of water — using a radio set designed for 30 mile operation and yet untried in combat.

We had chosen the ruins of an old stone watch tower on the very summit of St. Catherine's Hill as the best site to install our station. The weathered but staunch three-foot-thick foundations of the tower which had warned local villagers against invaders since the days of the Armada, seemed safer than trucks or foxholes against machine-gunning and dive-bombing.

Two complete AN/TRC sets had been installed, petrol and food supplies cached, weapons were readied and the entire top of the roofless ruin covered with a carefully camouflaged tarpaulin.

A second station, 40 miles inland at Middle Wallop Airport, also was ready, having been installed simultaneously with ours by Lt. Bob Smith and his crew from the U.S. First Army. Thus, all that was needed to complete the Middle Wallop — Isle of Wight — Normandy circuit was Vic's safe arrival in France, and permission to erect the St. Catherine's antenna.

Shortly after dark on the fifth of June, our antennas went up without a hitch. Two pointed towards Middle Wallop and two others out over the Channel towards where we hoped Vic would be. At the moment that Vic transmitted, his voice would be received at St. Cath's and relayed instantly to Lt. "Smitty" Smith. Then, when the voice circuit was working, both the Normandy and Middle Wallop's terminal sets would be connected directly to the telephone facilities and their operators would carry on from there. St. Cath's, in the control position, could break any communication and redirect it through submarine cables to Central Headquarters, a few miles distant, or to London if occasion demanded.



Radio set AN/TRC-4 on St. Catherine's Hill, Isle of Wight, England.

When contact was completed, four pairs of officers, separated by 120 miles of air, would be able to speak by telephone over a single radio circuit. That is the "ANTRAC" radio relay, but let's look back in time for a few moments . . .

Up to just a few months before D-day when a General commanding an Army wanted to verbally discuss battle plans with a Corps Commander, it was necessary for his signalmen to struggle through miles of swamps and jungles, over mountains, and around enemy positions, dragging reels of wire, setting poles and even building bridges to support the lines over otherwise impassible rivers. Then maintaining the wire was difficult because of its vulnerability to fifth columnists, bombs, shells, and even the activities of the General's own vehicles.

Ordinary radio equipment proved to be of limited value in military communication systems because the transmitted speech could be heard by the enemy as well as by the intended listener. Obviously, no General can win battles if his conversations become after-dinner prattle in camps of the enemy. Therefore, until the radio signals which were to carry confidential conversations could be confined to narrow beams and with low enough power to keep them from going beyond a desired point, it would be impossible for our General to talk freely over his radio-telephone.

Signal Corps engineers working with commercial organizations just prior to the war had developed telephone apparatus capable of transmitting four duplex telephone conversations simultaneously, in a pass band of 200–12,000 cycles. This, called "Carrier Telephone Equipment" had its introduction to the troops in 1942, and was designed to operate over 100 mile lengths of a special cable with signal-strength boosters or repeaters every 25 miles.

At almost the same time, a new teleprinter was developed for Army use over wirelines. A "Carrier Teletype Equipment" followed which could transmit messages from four teleprinters on each of the four channels of the Carrier Telephone Equipment. Thusly, a system could transmit any combination of four voice messages, three voice plus four teleprinter, two voice plus eight teleprinter, etc. These carrier equipments were a great improvement over existing equipments but there still was that cable that had to be dragged, maintained, and repaired . . . so let's look at the radio side of the picture for a moment.

Early in World War II, VHF radio made its debut in military communication systems. The sets were light weight and could be carried easily in tanks, halftracks, and planes . . . and used radio wavelengths which were so short that their signals could not be heard very far. The shortness of their wavelengths dictated small, compact, and easily transportable antenna systems which readily could be made directional when used in semi-fixed positions.

Furthermore, the use of frequency-modulated signals considerably reduced interference from ignition sources and static. Combined with the very-high frequencies, FM provided the ideal radios required, having longer range than AM radios for any given power.

Just before the North African Campaign, the idea developed that if VHF/FM radios were used with carrier telephone/teletype equipment, multiple telephone and teleprinter communications could be relayed from point to point by radio circuits instead of over the conventional wirelines. Research in the laboratory and tests of experimental radio carrier relay circuits over the hills of New Jersey and New England followed. Circuits of existing radio sets were improved with the help of the engineers from F.M. Link Company, New York, to carry many communications simultaneously. A few weeks later, seven communications including voice, teleprinter, and facsimile picture transmissions were being carried through a single radio circuit over a distance of 30 miles with quality so good that traffic routing operators were unaware that wirelines were not being used. As a plus feature, messages carried via the carrier telephone equipment on radio circuits were scrambled in such a way that an enemy interceptor would require exceedingly complicated equipment to decode them.

While the first multi-channel, telephone-to-radio-to-telephone combinations were being tested, single channel systems were being assembled for use in North Africa. Used there and in Sicily and Italy, these experimental sets carried thousands of radio-teletyped words of vitally-important traffic. One circuit operated as a relay link over a 600 mile path, served for weeks when paralleling wirelines were being damaged or stolen by Arabs, every day.

The results obtained in the Mediterranean Theater gave impetus to the development of the four-channel set. Its name was to be Radio Set AN/TRC - 1, 3, & 4 which translated means Army Navy Transmitter Receiver Communications but which soon was shortened by its GI operators to "ANTRAC".

In April, 1944, the first few new F.M. Link Company Antracs were sent to England with two civilian radio engineers, to be used in training GI operators. Personnel and equipment were immediately assigned to General Omar Bradley's First U.S. Army which was preparing for the invasion of France. While ships already were loaded to the bulwarks with the First Army's signal gear, Colonel Grant A. Williams (F 1975) and Lt. Col. Elmer Littell obtained General Bradley's quick authorization for six Antrac sets to be loaded aboard the vessels, and seven more were assembled for use after the D-Day landing. Each 100 mile system consisted of two terminals and three intermediate relay units plus 100 percent backup spares, packed into 188 boxes.

Two trucks loaded with equipment, men and supplies were sent southward to install a terminal station at Middle Wallop Airport. The "control" relay point also was established on the Isle of Wight. Now let's look forward again to D-Day . . .

All through the early hours of June 6th, the radio sets in the tower on St. Cath's were being monitored. With the coming of daylight, a set of vertically and horizontally-polarized high-gain rhombic antennas were pointed at France to insure the chances of hearing Colaguori on Omaha Beach if his normal antennas should be shot away and some "haywire" rig became necessary. Then the ships came by, and more ships, and more until the channel was covered with them as far as one could see in all directions. Squadron after squadron reached out to the horizon like armies drilling on an immense prairie. Wing after wing of planes went overhead, almost dipping in salute as they left our old tower — their last landmark of safety.

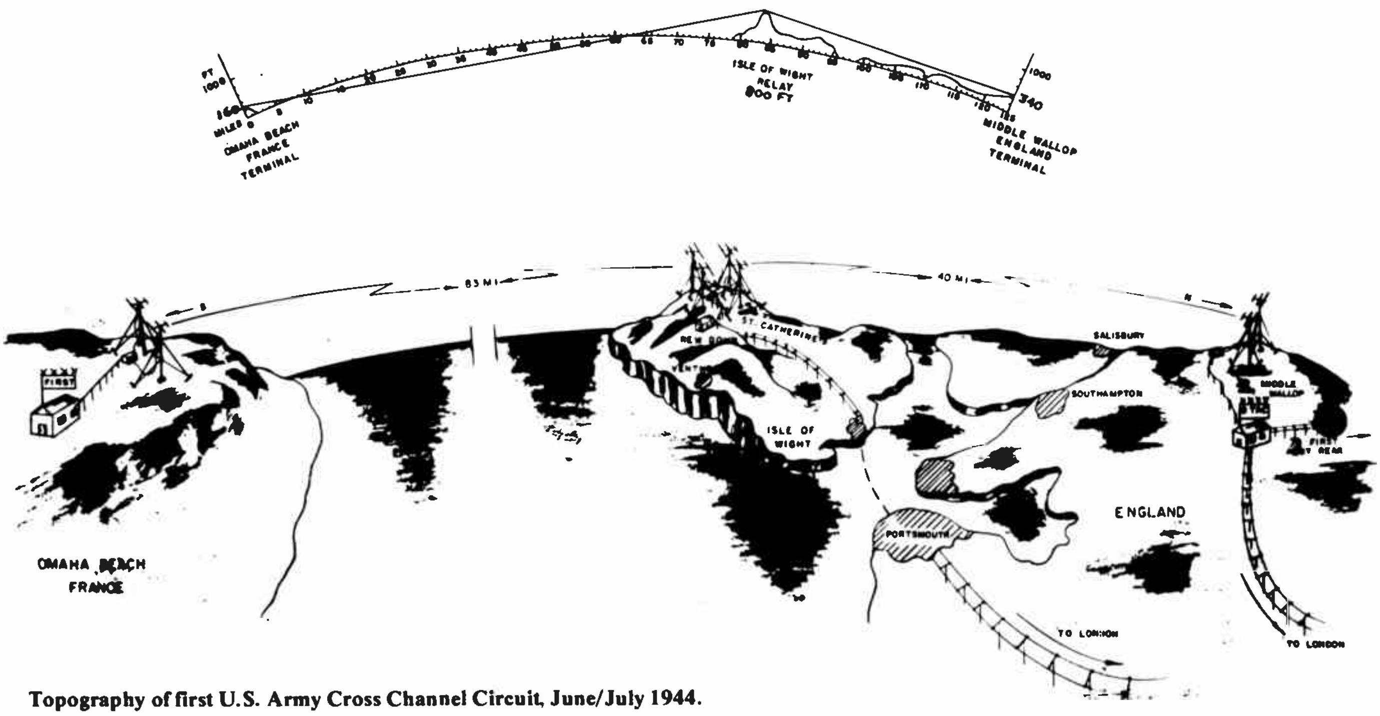
A day passed, then word arrived that the British had landed near Caen "without many casualties", and a little later we learned that the first British communication circuits were operating. Darkness came and with it the distant red flashes that looked like oil tankers going up in puffs of flame; you could hear the bombs explode, too, in the jumbled rumble from across the water, if you listened.

Fighting was heaviest at Omaha Beach. Colaguroi, embarked on an LST, could not get ashore throughout D-Day. That night, he succeeded but it was many hours more before he could advance four hundred yards to the bluffs. That night dragged into the second day and Vic was still unheard until, a little after one o'clock on the afternoon of June 8th, the needle on the meter of our receiver kicked a little and then swung up to normal and stayed there! "Hello, B for Bobby; this is V for Victor" came the pre-arranged coded message with complete clarity.

Vic was safe! As soon as I could answer "Hello, V for Victor, this is B for Buddy" and in my relief: "Where in hell have you been?" "What d'ya mean where have we been; we've been through hell," his reply came back, puctuated by the nearby explosion of a German 88 shell. But they had gotten their complete antenna up and their sets installed, and they were going to stick!

Two hours after that first contact, Vic had not only talked to the Middle Wallop terminal but photos of enemy installations taken by Allied planes over Normandy, were being flashed by the Antrac circuit to the gunners on the French beaches in less than seven minutes per picture. Modern reconnaissance with the aid of Antrac made it possible for half-buried guns on the beach to knock out hidden tank after tank, and one train or gun emplacement after another, with single salvos.

Two days later, the headquarters of the First U.S. Army went ashore with carrier equipment, and the circuit was completed so that General Bradley in France could talk to Montgomery and Eisenhower in London. The entire project more than paid for itself in those ten minutes.



Topography of first U.S. Army Cross Channel Circuit, June/July 1944.

In a report to the Signal Corps Labs, it states: "... cross channel communication was established on the AN/TRC-1 on D plus 2 at 1314 hours ... The circuit has been in continuous operation without fading except for two periods of not more than one minute each. The general opinion seems to be that this is the most reliable cross-Channel circuit yet put into operation."

Our system proved to be the only continually-reliable phone circuit. The cross-Channel cable had been put into operation on D-day plus 2 but it failed so often that our circuit became invaluable. Our Antrac circuits at Army headquarters on Omaha Beach, in operation on D plus 6, kept Bradley in constant touch with all of his Corps commanders when other communications proved inadequate. When VII Corps took the Cherbourg Peninsula in those first few days when the entire beachhead hung in balance, and when the XIX Corps moved on St. Lo, and V and VIII Corps rolled towards Falaise Gap and Brest, Antrac gave immediate contact.

When I reached France in mid-July, Colonel Williams, Vic, and a few GIs had five Antracs set up in a little tree-surrounded field connecting all telephones of First Army Headquarters with the four Corps. Vic had gone to Cherbourg to set up a relay station on the hills to improve the circuit back to England.

When Vic returned, we were rushed with Antrac sets to the newly-operative VIII Corps which had been borrowed from the Third Army. The Fourth and Sixth Armored Divisions had started southward through the gap at St. Lo. Our task was to find the end of a wireline left by one division, tie an Antrac to it and thereby provide contact with VIII Corps Headquarters.

An exceedingly harassed artillery lieutenant led us through a maze of back roads, shellholes, wrecked equipment and the dead to an isolated signal unit, and darkness came. No sooner had we made contact with headquarters than the Germans flew over and dropped their cargoes on columns of tanks less than a mile away. Flares fell and our station loomed-up like a signboard in the middle of a field, but we got the truck and all covered before the next flight came over, and then spent two hours in a ditch.

By midnight, we were again on the road chasing the end of that elusive 4th Armored Division wire. Bomb flashes were visible everywhere as we drove the next few miles without lights, in the everpresent stench of death. In reaching our hilltop only to find that the Division had gone further on, we pulled under an abandoned German lookout tower and set up the station again. Our request for orders was accented by the sound of German "burp" guns in the nearby woods; in ignorance, we got our first real shock at daylight when a very worried Signal Corps major raced up in a jeep and exploded: "Hey! Do you guys know you've been 8 miles ahead of the infantry all night?"

A few days later when General Patton started his famous Third Army on its history-making dash across France, Vic and I moved with him with 8 Antracs which soon became 16 then 24 when there weren't more than 50 in the entire European Theater of Operations. Those few sets kept the Third Army Headquarters in touch with its corps whenever time did not permit the installation of wirelines, or when they failed.

At the time that the 101st Airborne Division was surrounded at Bastogne during the Battle of the Bulge, a War Correspondent reported: "A little truckful of secret communications equipment was raced in to that brave outfit just before the encirclement became complete." With what was in that truck, the General who said "Nuts" to the Nazi's demands for surrender, kept telephone contact with the outside world over the heads of the enemy . . . contacts with air forces, the British troops, and Patton's tanks . . . and the Bulge became history.

The history of this new equipment could be continued indefinitely but our telling must be kept with limits, so we leave Europe and proced to the Orient. Vic Colaguori was raced to Guam when the B-29s were starting their long-range bombing runs over Japan. Contact had to be maintained by voice across 120 miles of water to Saipan . . . Antrac did it.

The Navy put sets on shipboard for telephone contact with invasion forces during landing operations. Now, a ship's Captain could pick up the telephone on his desk at sea, dial a number and talk directly with a tired Infantry Colonel who was 20 or 30 miles away somewhere in a jungle.

The Sixth Army landed at Lingayen Gulf, near Manila, and the Antracs were ashore in the first wave. The attack rolled down the valley with the radio relay keeping MacArthur in contact with his widespread fighters, his ships off-shore, and his air cover.

When the writer arrived in the Philippines, over 50 circuits were in operation. On Leyte, fully 90 percent of field communications were via Antrac. It was used by radio broadcasters and newsmen to transmit their stories to a ship off-shore which served as the relaying terminal to the States. Twenty Antrac units had been installed on seagoing barges with high-powered, long-distance transmitters, and these could be controlled from mobile headquarters through Antrac keying circuits. Thus, the invasion forces could keep communication with the World without the tons of equipment normally needed. MacArthur's famous mesage: "I have returned" was carried over that circuit.

That spectacular use of the Antrac occurred when, early in March and immediately upon entering Manila, General MacArthur spoke from the Crystal Room of the Malacannan Palace. The nearest broadcasting studio was on a ship lying off shore in the Lingayen Gulf, 100 miles away. The speech was picked up by telephone, relayed by Antrac to the ship and, from there, broadcast to the world.

When the Japanese General Yamashita eventually surrendered his Baguio mountain strongholds, a running account of the event started on its way to the outside world over Antrac. One set installed at the meeting place in the hills easily spanned the 25 miles to the communications center at San Fernando La Union. From there, the messages proceeded over a circuit comprised of Antracs and short lengths of wire 190 miles to Manila.

With the arrival of V-J Day the first landings of occupation troops in Japan proceeded as if in combat, with communication systems to be as vital as ever. The landing of our communication unit at Wakayama met no opposition but heavy sand, and an Antrac unit soon was in operation from the command ship to the beachhead. The stations on the beach were then connected through two relay stations in the hills to General Kreuger's headquarters in Kyoto, the least-bombed city in Japan.

Our assignement was to put a second relay on a 2500 foot mountain near the bombed city of Osaka but before the equipment could be transferred, we were recalled to Osaka where the Antrac was set up on the second day. An hour later, messages from the ships at Wakayama were racing through our gear to Kyota, 20 miles northward.

We then were told that a renovated airbase, 140 miles from Kyoto by a narrow, unpaved road that was littered with native dung carts, was to be used as a replacement center from which thousands of high-point Yanks were to be sent home; could Antrac provide communication? The hop of 86 miles worked perfectly even through the tail end of a typhoon that filled the Japanese underground radio stations with ten feet of water.

The fame of Antrac spread rapidly in Japan. One day, shortly after the storm and when taking a tour of one of the largest long-wave radio stations in the world, we were suddenly asked by its chief engineer: "What is in those small green boxes at Osaka that allows them to carry four voice channels so far and so clearly? A friend of mine told me about them, last night." Obviously, bombed out or not, communications in Japan were still good.

A few weeks later, we learned that the Japanese had been working for two years on a 450 mile, ten-jump circuit to operate from Tokyo to Fukuoka and carry six voice channels. In investigating the nearest station at Mt. Rokko, it was found that the typhoon had completely destroyed the massive antenna system because of the Japanese love of symmetry. In constructing masts from 60 foot telephone poles, they had so artistically dove-tailed the poles to fit together that the system was weakened sufficiently that the heavy wind destroyed it. Six months then passed before the system was completed and allowed to operate, due to the lack of attention on the part of the designing engineer.

Later, the Sixth Army installed an Antrac system paralleling the proposed Japanese circuit, and this became the supreme achievement of the principle of multi-station radio relaying. The system jumped 20 miles from Kyoto to Mt. Ikoma, 110 miles onward to Okayama, thence 70 miles to Kure near Hiroshima, 40 miles from there to Beppu, 60 miles to Asoyama, and completed a total hop of 450 miles at the Marine Base at Sasebo. Now, telephone and teleprinter messages originating in Sixth Army Headquarters at Kyoto could be received clearly in an outpost in Fukuoka, 120 miles beyond Sasebo via their switchboard, over a total distance of 550 miles and using seven relay stations.

The dreams of those nights in North Africa and Normandy had become reality. The battle-worn and inspiring motto of the Signal Corps was upheld by Antrac: "The Message DID Go Through!"

"ANTRAC, Son of 1498"

by Jerry S. Stover (M 1972, F 1975)
W5AE

with thanks to
Lt. Col. Sam Dawson, USAF (Ret.) (M 1983)
for his help in preparing this report

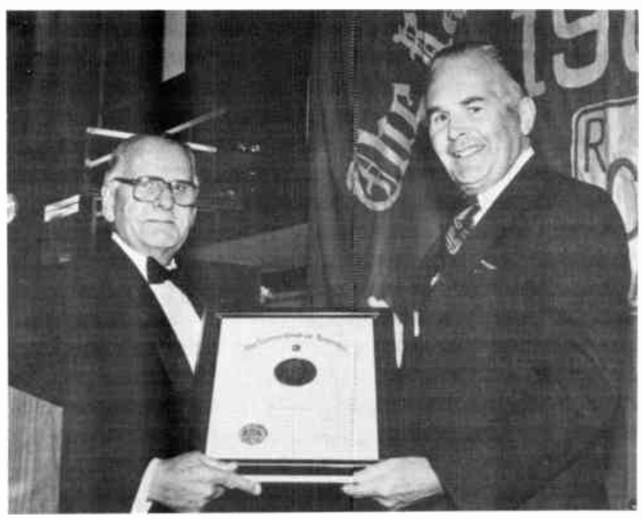
Weapons like ANTRAC are indispensable in war, and it's always better to have more and better weapons than one's opponent. Yet weapons are only tools. Even the best count for little in the hands of ill-trained or demoralized troops, or under the command of officers incapable of grasping battlefield opportunities.

(Editor's Note)

The story of ANTRAC by Amory Waite, Jr. gives an excellent overview of a radio system that was amongst the most widely used and important communication developments of World War II. Because a large number of Radio Club members participated in the designing, manufacturing and combat usage of ANTRAC, some additional background on its development and wide-spread employment by the U.S. Air Forces will contribute to its excellent record.

Before and during World War II, the development and procurement of communications equipment for all arms of the United States Army, including the Army Air Corps, was the responsibility of the U.S. Army Signal Corps headquartered at Fort Monmouth, NJ. Also, radio and radar officers, and the technicians who operated and maintained the equipments were trained by the Signal Corps. This may explain why a communications system so widely used by the Army Air Corps (later the U.S. Air Force) was derived from tests made for the armored forces.

In 1938, the Signal Corps Laboratories and its director, Colonel Roger B. Colton (later Major General), began studying the work of Dr. Edwin H. Armstrong, inventor of frequency modulation (FM). After Colton and his staff observed the operation of FM radios in the cars of the Connecticut State Police, additional tests were run at the Signal Corps Laboratories in 1940. The decision then was made that the new mobile radio sets for the Armored Forces would use frequency modulation — a truly historic and courageous decision. The Connecticut State Police network had been designed by Dr. Daniel E. Noble, Assistant Professor of Electrical Engineering at the University of Connecticut, using equipment manufactured by Fred M. Link (F 1968), current president of The Radio Club of America.



Following the war, in 1950, Jerry Stover looked up Fred Link at an IEEE Meeting to tell him how great the Link 1498 had performed at Omaha Beach. In 1981, 31 years later, it was Fred's turn when, on behalf of The Radio Club of America, he presented Jerry the Club's David Sarnoff Award for Jerry's contributions to the Land Mobile Industry!

Until then, the Army was using an antiquated radio system that relied on the dots and dashes of the telegraph key. In 1936, the Army started to mechanize its cavalry and was using a radio system in its armored cars by which field officers would communicate using secret-coded Morse and hand signals. It often would take several minutes for the radio operator who also served as a gunner, to jot down the message and then decode it. A new problem also was introduced in switching from horse-borne to mechanized units in the ignition noises generated by the vehicles.

The Signal Corps learned of Link's police radios through the Louisville, KY Police Department, and military officials at Fort Knox asked for a demonstration. "Few demonstrations can have brought together the inventor, potential civilian and military users, and manufacturers as the Fort Knox occasion did," reported the authorized encyclopedia of America's wartime history, *The United States in World War II,* "but few were impressed. The audience as a whole was paying scant attention to FM because it was not yet ready to prove its case. A heater to provide an ample supply of boiling water for field kitchens excited much more attention, thanks to an enterprising Quartermaster officer who crashed the Signal Corps demonstration and temporarily stole the show."

While an engineering report said that the Link system "does not appear in its present state to be complete cure-all" for the Army's communications problems, a young officer, Capt. Grant A. Williams (F 1975) (later Colonel), felt differently, "If this equipment is so simple that a cop with limited training can use it, I don't know why trained people in the military couldn't use it." Williams later was to become Chief Signal Officer for the U.S. First Army.

Capt. Williams borrowed some of the mobile radios from Link and began testing them in armored cars. After the tests, Link received a contract to supply radios for war-game maneuvers at Camp Drum, NY, but the radios were to be used by the umpires who judged the war games. The generals came back with the idea that radios should be used in tanks.

With the first order from the Signal Corps, Link put his design teams to work on radios that would be used for training purposes. Amongst many, the design teams included some who were to become members of The Radio Club: Gaetano (Tom) Amoscato (F 1981), William Fingerle (F 1973), and James Craig (F 1979). Because of the highly secretive nature of the ANTRAC system and the fear of sabotage, Link was required by the Army to have three sources of production. He subcontracted work to his friends Bill Lear (F 1969) and Norman Rauland. Between the three, probably $100 million of ANTRAC equipment was made.

Pending the manufacture of the new SCR 500 series of FM radios, the Link police radios were standardized as the Army's SCR 293 in 1941. Although intended for training use only, the SCR 293 was the first FM radio used anywhere in combat. A National Guard tank battalion, hurriedly equipped after Pearl Harbor, was sent to the Philippines and into combat — only to be captured a month or two later. Then, with American troops being sent to North Africa, the SCR 293 was used there.

When the United States declared war on the Axis powers, the First and Second Armored Divisions were sent to Ireland to get ready for the invasion of North Africa; they took the Link FM-test radio equipment with them. During Field Marshal Rommel's panzer divisions attack at Kasserine Pass, the First Armored Division was badly mauled and some of their radio equipment was captured by the German forces. Because of their testing designation, the radios had never been tagged with the usual Army nomenclature and simply carried the imprint "Fred Link Radio Co., New York City." On seeing the name, the Germans theorized that Fred Link must be bigger than General Electric. Years after the war, former German radio officers sought out the mysterious Link and told him that when they first saw the radios, they knew nothing about FM and couldn't figure out how the sets worked.

Meanwhile, the Air Forces were calling for point-to-point communications in their air-defense systems and, pending the "designed-for-combat" ANTRAC, turned to Fred Link's commercial model 1498 — a multi-channel FM radio operating at 80 to 100 MHz. One of the first to use the Link 1498 for Air Force communications was Lt. Sam Dawson (later Lt. Colonel) (M 1983) WA6BQI. As Dawson tells it:

"Was commissioned in June 1942 and assigned to AAF-SAT to test light weight radars then reassigned to the First Air Division as the field communications officer for maneuvers at Beltbuckle, Tennessee. My heart sank when they told me they wanted to use phone and SCR-399's for radar reporting because those radars were scattered in a 50 mile radius!

"Someone mentioned that they had a lot of civilian mobile equipment in a warehouse but no crystals for them. They showed them to me and there must have been fifty 1498's stacked in a corner of the warehouse. They all had crystals except that they were on the same frequency. Since phones really wouldn't work as they would take too long to install, I set up the 1498's in jeeps, trucks or whatever, strung up vertical dipoles at each radar site and at the control center, and then crossed my fingers. Until I could get other crystals, we used the one frequency and made each radar report in sequence. Worked fine."

Sam Dawson and I first met in 1943 when he came to the Army Air Force School of Applied Tactics in Orlando, FL to test and evaluate light-weight radars, and FM reporting systems using Link and Motorola equipment. Little did either of us realize what lay ahead.

Within twelve months D-Day had come, and Dawson was atop a windswept hill on the Isle of Wight, in England, and I was on a hill at Omaha Beach. We were using the Link 1498 to establish a 90 mile voice-and-teleprinter circuit across the English Channel so that the Advance Headquarters of the U.S. Ninth Air Force in France could communicate with the main headquarters at Uxbridge, England.

The Link 1498 was used as a driver for the Link 1505, 200 watt amplifier. After rigging a "vertical rhombic" on high ground just east of Grandcamp-les-Baines, I heard Dawson's Alabama-accented "Calling Gangway, calling Gangway" — the telephone code for the Ninth Air Force. This took place about four days after the OVERLORD invasion.

The "Police Model 1498" was designed for a single voice channel but, with Ham ingenuity, Dawson removed the low-pass filter and jiggled the output to increase the audio frequency response so that the radio could carry simultaneous voice and teleprinter. Dawson had been at Orlando when the vertical rhombic was being tested for VHF so he had rigged one on the Isle of Wight and, for that long haul, vertical polarization was used. The well-designed, horizontally-polarized Yagis furnished with the ANTRAC were used on future links with equal success.

When Lt. General Hoyt S. Vandenberg, Commanding General of the U.S. Ninth Air Force, and his operations staff moved to the Continent, the 9th Air Force Advance Headquarters moved into the vicinity of St. Lo adjacent to the tactical headquarters of General Omar N. Bradley's U.S. Twelfth Army Group. From then until the end of the war, the two commands moved together across France, Luxembourg, Belgium, and Germany. Likewise, the IX, XIX, and XXIX Tactical Air Commands kept their headquarters near those of the Army for which they provided air support; these were, respectively: General Courtney H. Hodges' U.S. First Army, General George S. Patton's U.S. Third Army, and Lt. General William H. Simpson's U.S. Ninth Army.

Fortunately, before setting off on the campaign across Europe, the 9th Air Force received its ANTRAC's and it was these reliable, high-capacity radio-relay links that interconnected the 9th Air Force Advance Headquarters with its three tactical air commands, with field orders and reconnaissance information passed rapidly between the operations officers at both ends. The most common configuration of the ANTRAC was to use the baseband channel for service and maintenance operations, two of the upper channels for voice circuits, and the fourth subdivided into four teleprinter channels using the Western Electric CF-1 and CF-4 carrier equipment. Dawson tells about it:

"After moving across the Channel to the headquarters of the 9th Air Force Advanced, received many AN/TRC-1's (old friends: the Link 1498 in khaki). Was dubbed R/T officer and proceeded to set up all over France, Belgium, Luxembourg and Germany. Only had trouble keeping in touch with XIX TAC which was moving with and supporting General Patton. Every time I set up, he moved. Finally from Wiesbaden, in desperation, we set a relay above Frankfurt am Main, thence 200 miles south to a relay in a warming hut on top of Mt. Zugspitze (12,000 ft.) near Garmisch-Partenkirchen. From then on, whenever XIX TAC came to rest, all they did was point their antennas toward Zugspitze, and in they roared, loud and clear. We even picked them up from Pilsen in Czechoslovakia."

Even early in the campaign, the confidence level in ANTRAC was so high that when my boss, Colonel Tom J. Cody, Chief Signal Officer of the U.S. Ninth Air Force, sent me to accompany Brig. General Richard Nugent as he selected a new headquarters location following the breakout at Avranches, I piled an ANTRAC into a jeep and trailer, and headed south. I was confident that we would get back to St. Lo through a relay point that Sam Dawson was installing on high ground just east of Avranches. Sure enough — when we set up in a field about 20 miles south of Avranches that evening, there was Dawson, loud and clear — he connected us right through to our headquarters.

After giving our location for relay to General Vandenberg, Lt. Colonel Walter E. Lotz, Jr. (later Lt. General) (F 1975), as Executive Officer to Colonel Cody, came on the line and asked whether there were any problems. All was quiet at our end but Dawson reported increasingly heavy bombing at the relay point. Lotz then told us that the Germans were attacking from Mortain toward the coast to cut us off and, if that happened, we should bury our equipment and hide out. Fortunately, on the next day, August 7th, with the help of the rocket-firing RAF Typhoons and our own fighter-bombers, the German counter-attack soon was blunted and the tenuous Avranches lifeline maintained.

A few months later, things did not turn out quite as well. The U.S. Ninth Air Force had headquarters in Luxembourg and had important ANTRAC links from there to IX and XXIX TAC headquarters in Belgium. On December 16, 1944 the German attack, later known as "The Battle of the Bulge", soon threatened our key relay point at St. Hubert. We watched the situation map and, as the red line indicating the position of the German armor moved steadily westward, Dawson set out in a truck for the St. Hubert hilltop with orders to move the ANTRAC relay to a hill further to the southwest. There, below the Bulge, it would be able to contact a relay north of the Bulge with a clear shot right over the German position.

Jerry Stover and his jeep near St. Lo, France in August 1944 just before taking a ninth air force Antrac radio unit through the "Breakout Corridor" at Avranches.

After bucking snow, refugee-clogged roads and our troops moving back, Dawson was able to get to the site only to see German tanks at the foot of the hill. He ordered the equipment destroyed with hammers, and then brought the team out safely. Regarding the communications used during The Battle of the Bulge, Dawson reported:

"The Army set up the ANTRAC relays on half-tracks to make a very mobile set-up. I discussed this idea with our boss, Colonel Cody, but he nixed it saying we would need infantry to protect the stations as our men weren't trained to do it. Ironically, three months later, one relay station took a whole German company prisoners when they smelled coffee and bacon being prepared at the camp. They hadn't eaten in three days and were home-guard types, teen-agers and kids mostly."

It was during this period of The Battle of the Bulge when we temporarily fell back onto HF radio and CW, that everyone realized what a vital communication tool the ANTRAC had become. We had become so used to the flexibility of direct-voice communication and high-speed encrypted teletype that even though we had solid backup communications via our SCR-399 HF units, some of the operations people became rather caustic about "the failure of our communications."

In December 1944, we began to encounter severe problems due to the popularity of the ANTRAC units used by both the Air Force and Army units at the front and in the rear. High elevations including the Eiffel Tower were ideal radio relay locations and it was not uncommon for four or five relay systems to use the same site. Early in those operations, we found it necessary to separate the transmitters and receivers to avoid interference on the limited number of channels available.

Even after having separate sites for transmitting and receiving, the radiation from the receiver's local oscillator often interferred with another receive channel. When this happened and a change of channel frequency was attempted, this often would upset another link or, worse yet, the change might require a change at the next repeater site which would, in turn, upset the equilibrium of that site! Whenever a move was made or another outfit moved in near us, there was a constant game of "musical chairs" in an effort to find a clear channel for all links.

We finally ran out of "chairs" when we reached Wiesbaden, Germany in April 1945. Our ANTRAC link back to the Eiffel Tower in Paris was over 270 miles in length and used seven relay stations. Dawson finally had to use a British Type 10 PPM microwave link from the Eiffel Tower to our rear headquarters at Chantilly, 20 miles north of Paris, to terminate the circuit.

I close this narrative on a personal note. While we were at Omaha Beach, a big storm wrecked many ships and I salvaged a small nautical compass, or binnacle, from a wrecked landing craft. As we moved across Europe, it was to prove invaluable when we set up ANTRAC relays and aimed the beam antennas. This was the one World War II souvenir that I was able to bring home. In 1946, when Tom McMullin (F 1977) and I started a company to install FM radios on oil-drilling rigs, the same binnacle served us well when it was necessary to orient directional antennas to reach an oil company office. Today, it occupies a special place on the mantel of my home.

Television Puts On Its Overalls

by Carl R. Ceragno (M 1983)

HELP WANTED!

WORKER to labor 24 hours a day, 7 days a week. No lunch, coffee breaks, vacations or fringes. Must be tolerant of high heat and extreme cold. Willing to relocate into a dirty, dusty and damp environment. Immunity to radiation and toxic chemicals desired. Please call ###-#### for immediate openings.

Yes, television has put on its overalls and we have made it our *electronic* blue collar worker. This would have been impossible without the many engineers, scientists, practitioners and manufacturers who have dedicated their efforts to its advancement and refinement. For many it was a labor of love; we owe them a great debt, for all of us are touched by television in our lives.

Since development of the first television camera, television technology has been continuously refined and sophisicated uses developed. Of the mass media recognized today, i.e. print, radio, film and television, television has undergone the greatest dynamic change and enjoyed the most diversified usage. Other media have undergone refinement, but have functioned similarly in scope and utilization from their infancy through development and into a mature state.

The technology of television and its diversified use make it increasingly important in maintaining our life style today. Even in the expanding computer age, television continues to develop strength and finds new applications through the advancement of technology. Much of this is fallout of the computer industry.

Television is much more than entertainment and capsulized news. This is just the most visible of its uses. Although some stagnation occurred in broadcast television, the cable television industry opened new vistas. And the F.C.C. recently approved low power television (LPTV) with the intent of providing small stations with limited range to better serve the many small communities of the nation. The impending LPTV explosion will create many new jobs in these stations, and their construction will yield increased sales of television equipment, i.e. tape gear, transmitters, and antennas. This thirst for equipment will again press technology, perhaps sparking creation of a new generation of products. Television broadcasting, though a maturing industry, has room for substantial future growth.

Leaving the glamour and formal dress appearance of broadcast television, we can look beyond and truly see "television in overalls". Television can go where man cannot. We use television to explore outer space from our unmanned probes, and lower cameras into the oceans and great crevasses of the Earth to learn about our inner world. Television cameras become the eyes of technicians looking inside nuclear reactors so that robots can perform their unique tasks. Many cities and industries use television to inspect pipelines which would otherwise require excavation. Bridges, tunnels and highways are now monitored by television. The health and safety of people, including the individuals previously required for patrol, is improved. These observations are important in improving traffic flow. They are invaluable during accidents and disasters.

Public safety has become a national concern. Many communities have installed closed circuit TV at major intersections, shopping centers and public areas to assure the well-being of the public. The camera is always there watching, and somewhere an observer is monitoring many scenes instead of one. Helicopters are being equipped with television to provide another perspective when disasters strike.

Television surveillance is used in banks, shops, stores, institutions and at public gatherings more than ever before. Low costs, high performance and small physical size make it attractive for these applications. The most carefully monitored television systems in the world may be those found in gambling casinos. These systems use many television cameras to monitor the activities on the gaming floors, assuring the integrity of operations involving millions of dollars.

Small portable television cameras and video tape recorders are used to document field reports. These reports may include geological mapping, structural survey, and construction progress. Television recording is used to document belongings or property in a home or business. In the event of robbery or a disaster, the record established can assist in supporting insurance claims.

Television becomes a teacher almost every day, helping to educate children, train employees, and improve the skills of professionals of all types. Much of what we know as "communication" involves television. This will continue to increase as video conferencing becomes more widely used.

Video-conferencing is a rapidly developing potential giant in communications. Now meetings can be conducted with the participants separated by blocks or continents. It is conservatively estimated that executives spend 40% of their time attending or traveling to meetings. With video-conferencing, they can spend less time, have more meetings (perhaps of better quality), and never lose the time required in travel. This can yield greater executive productivity, which may be even more important than the reduced overhead cost of travel.

In transportation, television can improve safety. Cameras on the rear of tractor trailers and buses permit drivers to actually see what is behind them as they back up. Experiments of putting cameras in buses seem to indicate reduced crime rates on those buses. Television is both a deterent and means of security for the transit passenger's benefit.

The list of existing and potential applications of television technology appears endless. The job of the television camera is a difficult one that many people would not be willing to accept. Though overalls may be archaic garb for such a versatile device, surely jeans or levis would seem appropriate.

Tom Carter And The Interconnect

as told by
Thomas F. Carter
(M 1969, F 1969)

On the 75th anniversary of the Radio Club, the American Telephone and Telegraph Company divested itself of its 22 operating companies and the United States came to know a whole new telephone system. It is interesting that this phenomenal action began with the persistence of one man, a Member and Fellow of The Radio Club of America, Tom Carter.

Tom Carter is somewhat of a legend. He began an electronics business in Dallas in 1946, installing and maintaining public address systems, interoffice communications systems and facsimile equipment for the Navy and the U.S. weather service. In 1948, he was selling and installing two-way radios in North Texas, largely to the petroleum industry. Here, his customers had a need for a device to interconnect a two-way radio to the public telephone system.

In his workshop, Carter managed to design and build a tube-type unit that did just what was asked: it acoustically coupled the telephone and the radio. The coupler was set on a shelf and forgotten for a few years. In late 1958, Carter saw a real need for such a product so he searched through the cluttered shelves and found the old tube model, converted it to transistors and applied for a patent which was issued in 1963.

By the Summer of 1959, Carter was manufacturing the device which he called the Carterfone, and placed his first ads in *Petroleum Industry Magazine.* The Carterfone sold well but soon customers reported threats from the telephone companies to cut off service if the interfacing equipments were used. The telephone operating companies referred to the Carterfone as "foreign equipment" that was denied connection through their lines.

Carter continued to manufacture the Carterfone, and would load them on his airplane and take off to cities around the country where he would sell the device, install it personally, and assure the customers that they could legally use it. In a few years, there were 3500 Carterfones installed.

In early 1960, Carter went to New York to meet with management personnel of AT&T and suggested a compromise wherein the telephone companies would bill the user at a rate of $1.00 per month per interconnect. The response was that such "foreign equipment" would cause irreparable harm to the networks.

It was becoming exceedingly difficult for Carter's business to function due to threats of the telephone companies against his customers. Carter took decisive action — in 1964, he filed an antitrust suit in the Federal District Court in Texas against AT&T, the Bell operating companies, and General Telephone & Electronics.

The case eventually ended up before the FCC who requested the Bell System to produce documentation of their claims of possible harm to their networks. The attorneys provided testimony that "if anything electronic is attached to the telephone system by someone other than an operating telephone company . . . if it is not installed and maintained by the operating telephone company . . . it will cause degradation of the network."

Carter and his attorneys set up a test using a megaphone and a speakerfone. With a person standing next to the phone, then across the room and again at the door, the unamplified voice was picked up the speakerfone. "No harm," said Bell technicians. Then from out in the hall, the voice was sent through the electric megaphone. "That's harm," claimed Bell personnel. Later, they were asked: "You can't produce one solid complaint where the Carterfone caused any damage, can you?" "No, sir," was the reply. The Bell attorneys were unable to find a single proof of harm and Carter won the case.

Says Carter: "You know, it's strange; the Carterfone was just a small part of my mobile radio business — it was a service to my customers. We installed a Carterfone at a hospital in St. Louis. Doctors in their cars would talk to the nurses at their patient's bedsides. The phone company district manager cut off the hospital's phone system because they were using a Carterfone. That thing was bigger to me than all of the 3500 units eventually installed at the $248 retail price. The Carterfone device was a matter of life or death for some of my customers. No way was Bell going to stop this."

It took Carter nine years from the day in 1959 when he first started making Carterfones to that day in 1968 when the FCC finally handed down its Carterfone decision. The decision resulted in the birth of competition in one of the world's great industries — telecommunications. But by the time that the FCC had reached its decision, Carter had sold his ranch, had converted other assets to capital to pay expenses, and his business had dwindled from one hundred employees to one.

On June 27, 1968, the world of telephony in the United States changed. The FCC decision ruled that equipment other than that manufactured by telephone companies could be bought by users and connected to the telephone network if it was privately beneficial without being publically detrimental. The FCC also affirmed that the ruling was not limited to the Carterfone — rather it was intended to serve as a broad outline of FCC policy on all forms of interconnection. Interconnect was indeed born when, on January 1, 1969, the order was implemented.

The Carterfone victory was a major one for the future of the telecommunication industry. It led to the formation of the North American Telephone Association in 1971 and that association's highest award, The Tom F. Carter Award, given in recognition of outstanding service in the public interest to the field of telecommunications.

In 1978, Carter predicted: "The industry is destined to go straight up. In ten years, the interconnect industry probably will be providing most of the terminal equipment in this country and the common carriers will merely be the medium of transmission. I've felt that from the start."

He no longer is involved in the interconnect industry having sold his business in 1976. Today, Tom Carter and his wife, Helen, live quietly on a ranch near Gun Barrel, Texas. He has set up a radio communications system there, and leases two-way radio equipment and mobile telephones to business and medical organizations.

And today, the major technologies in the field of interconnects include digital terminal systems, digital microwave equipment, two-way cable, cellular mobile radio and teleports. The industry has come a long way.

THE RADIO PROXIMITY FUSE

by
DR. L. GRANT HECTOR, Ph.D.*

THE NEED FOR A PROXIMITY FUSE

Before the Second World War, anti-aircraft fire was notoriously ineffective due not only to the lack of effectiveness of tracking and aiming systems but, of at least equal importance, to the difficulty of attaining the necessary accuracy in the setting of time fuzes to assure explosion of the shell in the proper position with respect to the plane at which it was directed.

The first of these difficulties was minimized by applying radar and electronic tracking equipment to the automatic control of gun aiming.

The second difficulty pointed to the need for a fuze that would be triggered, quite automatically, by the object to be hit. Such a fuze was called an "influence" fuze and also a "proximity" fuze. The need for such a fuze was given great emphasis in the early part of the war by the sinking of large battleships by land-based planes.

That the attack on these two aspects of the problem of improvement of anti-aircraft fire was successful is indicated by the fact that before the development of the improved aiming devices, fire, in the order of tens of thousands of rounds on the average, was required to bring down a single enemy plane. The use of the new aiming and tracking equipment reduced the number of rounds per plane brought down to the order of thousands. The addition of the radio proximity fuze to the anti-aircraft protection further reduced the necessary fire to the order of hundreds of rounds per plane destroyed.

TYPES OF PROXIMITY FUZES

Many types of influence fuzes have been proposed. The best known is probably the magnetic type used in mines. For explosive devices other than mines, three general classes of proximity fuzes have received major attention. These are the microphonic, photoelectric and radio types. Except in certain mine applications the microphonic type did not prove successful. The British as well as the Americans gave early attention to the photoelectric and radio types for use in bombs, rockets and shells. The photoelectric type was made to operate successfully in bombs and rockets. On the other hand, the radio type was successful in all three fields of application.

RUGGED FUZES

This presentation is concerned primarily with the radio type fuze as used in shells. The important distinction to be noted between a fuze used in a shell — that is, a high speed projectile — and a fuze used in bombs and rockets lies in the fact that in the shell the fuze and all its component elements are subjected to a vastly higher order of magnitude of forces than is a fuze used in a bomb or rocket.

In general, shells are fired at high velocity from rifled cannon. For instance in 5" naval guns the forward acceleration may be of the order of 15,000 times the normal gravitational acceleration. Furthermore, for objects at one inch from the center of rotation, the centrifugal forces due to spin may be of the same order of magnitude in some guns as the forward forces. In addition, forces occur resulting from vibratory motions of the projectile, particularly when fired from worn guns, and additional similar forces occur in flight because a rapidly rotating projectile tends to yaw in its flight.

None of these effects are present to a comparable degree in the cases of bombs and rockets. While electronic problems to be solved in meeting the needs of these two general types of service present similar difficulties, the mechanical requirements to be satisfied in the case of the shell sets the shell-fuze apart as a separate problem, and will justify the characterization of the shell-fuze as a whole, as well as all of its components, as distinctly "rugged."

In the division of responsibility in the early days of the war, the Navy took on the sponsorship of proximity fuzes for shells, and the Army guided the work on proximity fuzes for bombs and rockets. The shell-fuze reached high scale production first, and was at first used exclusively for its original purpose, namely, the protection of the United States Fleet against aircraft attack. The Navy also assumed responsibility for supplying this fuze to the British Navy, the American Army and the British Army in that order of priority. Later in the war, fuzes for use in howitzers were also supplied by the Navy for use by the Army.

When radio proximity fuzes of the rugged type were developed under Navy sponsorship, they were given the name "VT Fuzes" by Captain Shumaker, Head of the Ordnance Bureau of the Navy. That designation — the contraction of "variable time" — had been used previously by the British in their early work on proximity fuzes. When the same fuzes were used by the United States Army they were designated by the code name "POZIT".

THE USE OF THE RUGGED VT FUZE

The VT Fuze was in mass production by the fall of 1942 and was first used in battle action in the Pacific Theater in January of 1943. Since that date no battleships and no light cruisers have been lost by aircraft attack, and only one heavy cruiser and one aircraft carrier were so lost. This remarkable defense record is, of course, due to the combined anti-aircraft techniques available to the Navy, and it stands in strong contrast to the sinkings of large naval units, both of the American and British Fleets, in the earlier days of the war.

The Navy VT fuze was first used only over water in order that the enemy might have no opportunity to recover duds for study. However, its use over land by the Army was contemplated from the start.

The first extensive use of the proximity fuze over land was over England where it prove far more effective than fighter planes in combating the V-1 bombs launched against Southern England. The fuze was used by the British in 3.7" anti-aircraft guns and by the United States Army in 90 mm. batteries.

The use of the fuze was next authorized for the anti-aircraft defense of the artificial harbors along the Normandy Beachhead. As the anticipated enemy air attack over these targets failed to develop, those batteries did not see action.

The fuze was released for general use over land on October 25, 1944, and was used extensively in howitzers against infantry in Italy and in the Battle of the Bulge. The tremendous effectiveness of the fuze against concentrated infantry is indicated in a letter from General Patton in which he reported 702 individuals killed from one German battalion. During this period the Army also used the fuze extensively in anti-aircraft action against German planes on the Continent and in the defense of the Harbor of Antwerp against concerted attacks of V-1 flying bombs. This record indicates the tremendous strategic value of the weapon in the recent war.

OPERATION OF THE FUZE

The radio proximity fuze comprises a combination radio transmitter and receiver housed in a plastic case which forms the nose of the projectile to be shot from a cannon. In shape, it is similar to the housing of other fuzes since, of course, the ballistics of the projectile must not be altered by the fuze housing. Imbedded in the tip of the nose is a small piece of metal which constitutes the antenna both for the transmitter and the receiver. The oscillator circuit supplying the transmitter with radio power is so designed that its operation is strongly affected by receiving radio signals reflected back by any target. This effect is amplified and fed to a thyratron tube which triggers a very sensitive fuze. This fuze is surrounded by a small charge of special powder which, on being set off, in turn sets off a larger charge which, again inturn, sets off a still more powerful charge. This last is called an "auxiliary detonator" and it is this which actually sets off the high explosive of the shell.

To make the fuze thoroughly effective, it is important that the radiation pattern of the radio transmitter have the proper correlation with the fragmentation patterns of the exploding shell. When this relation has been achieved, any projectile passing within lethal distance of a target will explode and shower the target with high speed fragments.

The proximity fuze is, of course, elaborately protected with safety devices to make handling safe and to prevent muzzlebursts. These devices are both electronic and mechanical.

Other features of the proximity fuze provide for self-destruction in the air for such anti-aircraft shells as may not approach or pass the target sufficiently close and, in types used against land targets, for explosion on contact in case the radio fuze fails.

RUGGED TUBES

All the components of the fuze must, of course, be made extremely rugged to withstand the great forces developed in being fired and in flight, as referred to previously. From the point of view of "ruggedizing" to the point of withstanding the forces of being fired from a gun, the most spectacular items are undoubtedly the radio tubes.

Two methods of attack were followed from the outset in the development of these tubes. One was a cut-and-try technique in which the then avilable types of tubes were fired first at low and later at higher accelerations. After being shot, the tubes were recovered and, on the basis of breaks that occurred, changes in the design were made. The other development technique was an attempt to design the necessary rugged structure in the form of a wholly new tube design.

The first method was applied principally to tubes of the hearing aid type, such as those produced in pre-war days by Raytheon and Hytron. The second method was first applied in the Bell Telephone Laboratories and later at the Sylvania Plant.

In view of the fact that it was so commonly believed the task of "ruggedizing" a tube to withstand firing from a gun was impossible, it was desirable to have many independent lines of development proceed at one time. Consequently, RCA was comissioned to develop a metal tube of the desired ruggedness. Later in the program, Ken-Rad was asked to design a metal tube that would incorporate all of the experiences gained by other manufacturers. The General Electric Company was also engaged in the development of a special type of oscillator tube.

Many of these developments resulted in the production of tubes of the required ruggedness. Sylvania and Raytheon tubes were the first to reach large scale production. This fact weighed heavily in the adoption of tubes as manufactured by these two companies. In the later days of the war, Raytheon expanded its efforts along other lines and Sylvania remained as the sole supplier. Some idea of the magnitude of the operation may be gleaned from the fact that by June of 1945 Sylvania was producing tubes at the rate of approximately 400,000 per day, and plans were under way for increasing production to 525,000 per day. It is interesting to compare this with the fact that before the war about 600,000 radio tubes per day of all kinds were made by all companies in the United States.

THE TESTING OF RUGGED TUBES

One of the more interesting techniques that contributed greatly to the development of tubes of the necessary ruggedness was the method of testing and recovery. In this testing, tubes were loaded into cavities in plastic blocks which, in turn, were loaded into hollow shells. The shells then were fired almost vertically from a high speed, rifled cannon. These projectiles were fired at an acceleration of 20,000 G and with a higher spin than that produced in the Navy anti-aircraft guns. In these tests the excessive acceleration and spin provided a margin of safety over the conditions of actual use.

In the matter of recovery, it will be noted that when a projectile is fired nearly vertically into space it returns to the ground without turning over in the air, sinking into the ground for a distance depending on the nature of the soil. Thus, in practice, observers in two or more locations observe and note the small cloud of dust made as each projectile enters the ground. When the firing has been completed a ground crew, equipped with post hole diggers, dig out the shells. These shells are then returned to the laboratory, disassembled, and the tubes are examined for glass breakage, etc. All unbroken tubes are then tested electrically. Any tube whose characteristics differ from its pre-shooting values is cut open and examined for defects with the aid of a microscope.

These techniques of testing contributed greatly to the early development of the tubes of the required ruggedness. They were continued as a production test right up to V-J Day.

MICROPHONICS

The tubes produced for the proximity fuze were not only the most rugged tubes ever to have been manufactured, but were also the least microphonic. In the development of this characteristic, tubes were mounted on the driving mechanism of a large loudspeaker system and the latter was driven by an alternating current supply of widely varying frequencies. In this manner the motion of individual vibrating elements in the tube was greatly accentuated. Visual observation of the offending element was then made by viewing the tube structure through a low power microscope while illuminated by a stroboscopic light source of controllable frequency.

TESTING OF COMPLETE FUZES

In addition to testing tubes by shooting, completed fuzes were also tested in this manner. The standard technique was to shoot projectiles at a medium-high angle over water. The shells would then explode as they approached the water. This method not only permitted a daily check on the percentage of shells that were operable, but also provided quantititative data on the sensitivity of the fuzes as the height above the water at which the explosion occurred could readily be determined and noted.

Testing of completed units was accomplished by shooting against wire netting suspended from a captive balloon. In most of these tests only a small charge of black powder was used, as this provided the necesary visibility of the burst while not damaging the target at more than a moderate rate. It is interesting to point out that in some of the earlier tests high explosive shells equipped with proximity fuzes were fired at radio controlled planes. Happily for the success of the war effort, the effectiveness of the proximity fuze made this type of testing far too expensive.

FUZE DUE TO VAST COOPERATIVE EFFORT

In an account of an achievement of this order of importance, one would like to credit all the individuals that made the more important contributions. Such a task is extremely difficult. In the first place, the number of those employed in the OSRD Laboratory charged with the development of the device and in the collaborating industrial plants is extremely difficult. In the first place, the number of those employed in the OSRD Laboratory charged with the development of the device and in the collaborating industrial plants is extremely large. Secondly, it is difficult, if not indeed impossible, to properly appraise the work of individuals who have all worked together so cooperatively. The news releases have mentioned the name of the Director of the OSRD Laboratory responsible for the development, Dr. Merle A. Tuve. He was a dynamic leader whose combined vision and drive were in a large measure responsible for the sucess of the project as a whole.

With respect to the development of the rugged tubes necesary for the successful development of the proximity fuze, many men in the cooperating companies merit much credit. The greatest individual contribution to the development of the necesary rugged tubes was made by Dr. R.D. Mindlin. He was on leave from Columbia University and was in the Electronics Section of the OSRD Group which developed the fuze. Dr. Mindlin, himself, was responsible for much of the original design work. In addition, his leadership in enlisting the active cooperation of men in the industry placed a large role in the development

*Director of Research and Engineering, Sonotone Corporation, Elmsford, N.Y., Dr. Hector, on leave from the University of Buffalo as Professor of Physics, was in charge of the Electronics Development Section of Section T, Office of Scientific Research and Development, during the development and early production of the minute and especially rugged electron tubes which made possible the Navy Department's successful VT Fuze.

A paper delivered at the October, 1945 meeting of The Radio Club of America, New York City.

PROXIMITY FUZE
Secret Weapon of W. W. II

Much has been written about radar and its effect in winning World War II. Little mention has been made of the proximity fuze, which may have been equally important. In totally paralyzing the enemy air force, it made the Pacific an American instead of a Japanese lake and gave us complete superiority in that theater of war. Its effect in neutralizing the "buzz bombs" as soon as it got into action in the London area, and later at Antwerp, was decisive, and when it was released on the European front it not only wiped out opposing air forces, but destroyed the morale of ground forces to an extent that was a great factor in bringing the war to an end.

Introduction

by Jerry Minter

The Radio Club of America published two papers in the March 1946 issue of the **Proceedings.** The first was "The Radio Proximity Fuze," by Dr. L. Grant Hector; the second, "Radio Countermeasures: the Science of Immobilizing Enemy Radar," by Oswald G. Villard, Jr. These two papers summed up the two major new electronic developments that resulted from World War II. The proximity fuze paper was presented before the Radio Club at its October 1945 meeting — only two months after the end of the war! The radar paper was presented at the January 1946 meeting.

Many papers covering the subject of radar and countermeasures have since been written. Very little has ever been added to our original story about the proximity fuze.

Our former president, William H. Offenhauser, Jr., suggested several years ago that the full story of the proximity fuze (also called VT Fuze) should be told while most of the active participants were still alive to tell it. As a result of Bill's dedication and action, the following group assembled on November 17, 1978, at the Hotel Sheraton, New York City, during a technical conference of The Radio Club of America;

L.R. (Larry) Hafstad, Ralph Baldwin, Vice-Admiral George F. Hussey, Lewis M. Clement, Harold F. Schwede, A.J. Adams, John M. Pearce, Robert Sprague, William H. (Bill) Offenhauser, Dean C. Allard and Jerry Minter.

Additional comments were made available via tape recordings from Herb Trotter, Admiral Arleigh Burke and Curry Ford.

A binaural tape recording of the entire proceedings was made by Jerry Minter and transcribed by his son, Byron Minter. This transcript was reviewed by Harold Schwede, then sent to Dean Allard of the Naval Library for review and retyping for distribution. Copies are on file in the Naval Library in Washington, DC. The original binaural tapes are 4.5 hours in duration. Some comments not directly related to the fuze have been omitted in this abstract.

DR. LAWRENCE R. HAFSTAD

Deputy Director of the John Hopkins Applied Physics Laboratory and in charge of security, production and quality control.

I suggest that we begin with a brief statement of what I call the research phase, which has already been written in the book, *Scientists Against Time*, which is the history of OSRD.*

At the end of the war, we all felt that we had done a good job which ought to be recorded, but I have long been disappointed that we have never been able to tell this story in a consistent account of the whole job.

In the research phase you have great success if you can assemble devices that can be made to work. In the production phase, you have to produce devices which you can prevent from failing. That's an enormous difference which is usually not recognized by the research and scientific people who generally collect their apparatus, tune it up, spend a lot of time working on it, take a set of readings, and get a Nobel prize.

The job is done. That's just the opposite of what you do in the production cycle. So this is the reason we have tried to fill in — in the name of archives — the difficult problems that you face first in quality control, then in volume production and reliability of all the other things that are needed.

Since we are short of time, we go on to the important things, which are the Crosley story and the suppliers' stories.

LEWIS M. CLEMENT

Vice-President of the Crosley Corporation and personally responsible for all Crosley fuze production. Crosley served as a lead company, being the first major producer of proxmity fuzes in quantity.

I think that this is the greatest example of cooperation that I have ever seen; that is, the cooperation between the technical people, manufacturing people, suppliers and users. Without this cooperation, the job could never have been done.

As far as Crosley is concerned, we received a letter in October 1941 telling us that we would be contacted that month on a very important, Top Secret, top priority job, to determine whether or not we were capable of doing it.

On October 28, Dr. Hafstad, Lieutenant Hicks and the local Inspector of Naval Material came to Crosley and told us that we had been selected because we had the necessary mechanical and electrical background to undertake the job. It was very fortunate that they came at this time since Crosley had been completely reorganized to do an excellent, high-quality job.

I think that there were many small things that happened that benefited the job. One story that I recall is that we had difficulty with a certain coil in the oscillator. It was not uniform. So we sent H. L. Brouse to Chicago to find out why. At 2:00 A.M. — he found out — the room in which the coil was being made had open windows near the coil forming stations. They closed the window and we had no more trouble. Something like that is not understood unless one is in the business.

We undertook the job on the basis that we would first copy what they were making at Section T, with the exception that all metal parts would be made from tools and all plastic parts would be made from molds. This was because we anticipated going to mass production. So, we made ten models of that type. We gave one of our research people the job of looking at the fuze, looking at all the information about the fuze, and making a comment about what he felt could be done to do a good job. The only suggestion that he made was that the antenna series capacitor should be solidly mounted. So we made ten like that. Then we made ten more using GFE** brass caps for antennas instead of the aluminum caps that we had used before. We expected that we would make a change, but only if we would do at least as good a job as they did at DTM.†

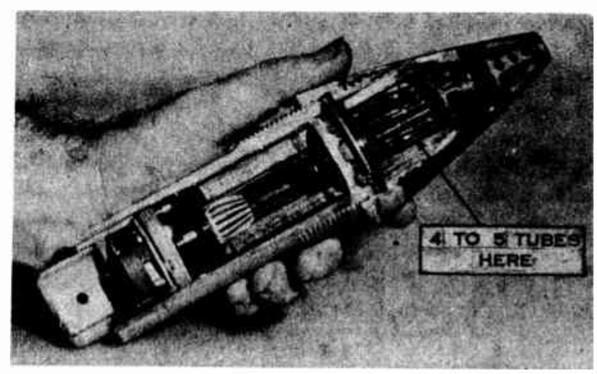
The firing tests were delayed until after the first of January 1942. The first group of ten showed a ten percent score, which was about the same score that they were getting at Section T. The second group, with the solidly mounted antenna, was 40 percent. The third and fourth groups gave zero percent because of tumbling and instability due to a heavier nose cone.

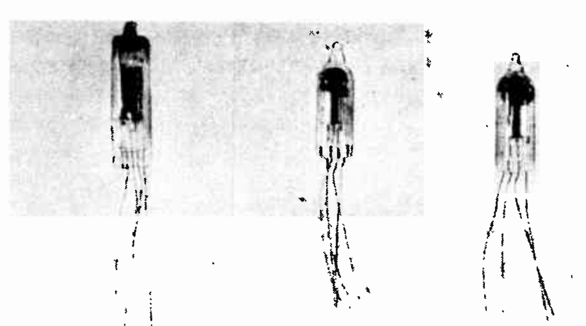
Another thing was to design the stuff for mass production. We had to get cooperation between engineering and manufacturing. We had to devise a system for transferring information from engineering to the factory. We set up a pilot line which was jointly run by the factory and engineering. We made things in the pilot line, and it was set up so that it would have the same operations as in the factory. Thus, the pilot line changed from time to time to keep up to date with the factory situation. As a result, it was very easy to transfer the stuff from the engineering phase to the production end. We used the pilot line to train operators so that, when the time came to go into quantity production, we would have several hundred operators capable of doing the job.

The important thing was that the project required cooperation. To get that cooperation, we issued a weekly report which covered all the work that we were doing, as well as any suggestions that we had in mind. The report was given to the Navy, to Section T, and to Crosley. We also had a resident engineer living at Dr. Hafstad's place who was given no instructions other than to be helpful. In other words, he understood what was going on with us and with manufacturing. We relied upon him to keep us up to date informally. As a result, I think he was valuable not only to us but to Section T as well.

I feel the security was very good because I don't know of a single case of sabotage during the entire period that we worked on the fuze. We suggested a proving ground of our own in the Cincinnati area. We went to the extent of renting farms, building roads, and getting things all set. The day before we were supposed to use it, the Navy took the firing pin away. It took me 30 years to find out why. The reason was security, and I agree completely with the Navy.

Before the end of the war, we had made about five and one-quarter million fuzes. We made forty to fifty thousand fuzes on the pilot line. We made one thousand fuzes before anything went to the production side. We had a closely knit, fully cooperative company on the job — not only among ourselves but with our suppliers, the Navy, and DTM as well.





*OSRD — Office of Scientific Research & Development
**GFE — Government Furnished Equipment
† DTM — Department of Terrestrial Magnetism

VICE ADMIRAL GEORGE F. HUSSEY, JR.

Chief of the Bureau of Ordnance at the beginning of World War II and the officer who made the critical decision to put the proximity fuze into production.

The Admiral began by describing his activity as commander of a squadron of mine sweepers in the South Seas, being called to Pearl Harbor just after the Japanese attack, and later to Washington, where he started to work as Director, Bureau of Ordnance.

Three or four weeks later, the Director of R&D, Sam Shumaker, came in to see me. He sat on the corner of my desk and said, "George, there's something going on around here that you ought to be aware of. It'll take an afternoon to see it. Let's go this afternoon."

We drove out to the Applied Physics Laboratory and ran into the strictest security requirements I had seen since Pearl Harbor. We had to get through two sets of gates and two sets of guards. They finally let us through. I met the most dynamic man I'd ever seen. In a very quiet manner, he welcomed me to the situation and explained in a few well chosen words what it was all about, what they were doing. He brought in several of his assistants, each of whom told me about his particular part in the process.

It began to dawn on me what was going on. Like most of my contemporaries, I had at one time or another knocked a radio set off the corner of my desk. I picked up a pretty sorry mess from the floor and put it in the waste basket. Here were these eminent scientists trying to put a radio set in the nose of a projectile which they claimed would think for itself, go off and get where it should. By the time they turned on the projector, my eyes were fairly sticking out of my head. They showed me the *Cleveland* firing — one drone, one shot, no drone; second drone, one shot, no drone; third drone, one shot, exercises completed; no more drones available. Sam and I went back to the Bureau. A couple of days later, he came down and said we ought to go see where they make those things.

We went to Cincinatti to the Crosley plant. My recollection of it was of a crowded area with a great many buildings, in the middle of which were two or three relatively small buildings. They were quite undistinguished with no special markings on them at all. We were taken into the first one and shown a production line beautifully laid out and running extremely smoothly with no chatter from the operators. The supervisors exercised very close supervision, and only the people at the end of the line knew what the product of that line looked like. That went on to another line, more things were added to it. From there it went to another building where the first product was augmented by more bits and pieces until finally, at the end of the line, there stood a VT fuze.

I didn't know what it was when I first looked at it, but what intrigued me about the whole thing was the massive security — never a reference to the fuze anywhere — and the concentration by the workers and the supervisors such as I had never seen before at any production plant. Then our host at the plant, Mr. Clement, gave us more information on the troubles they had run into, how they got around those problems from a production standpoint, and how they worked together with suppliers to modify components as required to come up with a finished fuze. He gave a clear picture of how much this project meant to the company and to the country. After that, Sam and I went our separate ways.

It was three or four days before we were both back at the Bureau. Then Sam came by once again and said, "George, I think that project's about ready for production," I said I agreed. He said, "Okay, we're out on a limb for 85 million dollars." That's how I got involved in the VT fuze business.

ROBERT SPRAGUE

President of the Sprague Electric Co., who accepted the challenge of producing by the millions the critical high-quality components that were essential to the success of the fuze.

Sometime in the Fall of 1942, I got the most unusual telephone call I have ever received. A lady, who identified herself as Lt. Sally White of the U.S. Navy Bureau of Ordnance, referred to a lot of six samples which she identified by number and which sometime earlier had been sent to the Applied Physics Laboratory of Johns Hopkins University. She requested that I furnish her at the earliest possible date:

1. The cost of facilities for the manufacture of 30 million very slim, unencapsulated paper capacitors per year, which we were to call "Toothpick" capacitors.
2. The time when we could start to manufacture, and the rate at which we could build up production.
3. She also asked for similar information on a much smaller quantity of annular (ring-shaped) capacitors to be used in the same equipment. These were to be furnished at approximately 12 percent of the "Toothpick" requirements.

Imagine my surprise! I had never heard of anybody using 30 million capacitors a year and didn't have the slightest knowledge of the particular samples to which she referred.

I called Dr. Preston Robinson, Director of our Research and Development Department, and asked him to identify the sample lot referred to by Lt. White and then to come to my office to talk about any problems we might incur in furnishing them. It turned out that the capacitors were indeed of unique design and manufacture:

1. Three types of capacitors were to be put into production. Two of these — one of which was by far the largest volume item — used processing materials never to my knowledge previously used in capacitors. The largest volume item, the "Toothpick" capacitor, was to be impregnated with a monomer of vinyl carbazole, and polymerized in situ.
2. The largest volume annular capacitor — and I believe we were the sole source of this particular unit — also used specially treated cellophane film as the dielectric instead of thin capacitor tissue, and was also impregnated with vinyl carbazole.
3. The third unit was another annular. It used paper capacitor tissue impregnated with a chlorinated wax, as the dielectric.

As the capacitors were required to withstand a shock of 20,000 G's, a number of dielectric systems were tried during the development.

Dr. Robinson told me that he became familiar with the German development of the polymer of vinyl carbazole prior to World War II and, for reasons which I do not recall, had purchased a small supply of this material from Bayer just prior to our entrance into the war.

One problem we were faced with was that there was no American manufacturer of vinyl carbazole. It appeared that we would have to set up for its manufacture. And chemical manufacturing was a completely new undertaking for the company!

We go into chemistry

One of our chemists worked with DuPont to develop a process for its manufacture. We contructed, at the Navy's expense, a small manufacturing facility.

We had to design and erect a special building located behind our Brown Street Plant in North Adams, Massachusetts, that was required to withstand an internal explosion because of the fear that a runaway reaction might occur. The acetylene gas to be used in the process was under pressures in the neighborhood of 500 to 600 pounds per square inch! When the plant was finally ready for production, we produced only 300 pounds in the first run, which was a successful one. Then vinyl carbazole became available from the General Analine and Film Corporation. This was the new name for the Agfa-Ansco Corporation which, like the Bayer part of the German I.G. Farben trust, had been seized by the Treasury Department and renamed. This company, which the Government sold after the war, is now known as the GAF Corporation.

The special building, however, was not a complete loss as it and much of the equipment were used to impregnate capacitors with vinyl carbazole until the time when new and special impregnating facilities were designed, developed, and installed in our Marshall Street Plant in North Adams.

Impregnating the capacitors with the monomer of vinyl carbazole posed problems that were new to Sprague Electric and to the capacitor industry. Freezing of the impregnant in our piping was one problem. In the early stages, small impregnators with a basket size of 8" x 10" were used. The impregnating temperature of 85°C. had to be very accurately controlled, and I mean *much* more accurately than other types of impregants required. There were electrical or static spark hazards, and the material was extremely toxic and caused dermatitis.

The new facilities installed in our Marshall Street Plant had more accurate temperature and humidity controls than those mentioned. Also for the first time, we took steps to control the dust particles in the air. Periodic medical tests were required for all operators.

We also had a problem with the cellophane required in one of the annular capacitors. The commercially available cellophane was not a good dielectric. It contained plasticizers which impaired its electrical properties. When we developed a process to remove the plasticizers, the cellophane became brittle and could not be wound satisfactorily. Then we had to develop a supplementary process to soften the de-plasticized cellophane so that it could be wound into capacitors.

A hand-crafters triumph

As our automatic rolling machines could not handle the very small diameters of the "Toothpick" capacitors, it required an enormous number of operators to man all the hand-winding machines needed. At A. G. Spalding in Chicopee, Massachusetts, one of our subcontractors, there were one thousand hand rollers! All rolled units were returned to North Adams for impregnating with the monomer of vinyl carbazole or wax.

Our records indicate that toward the end of World War II about 4,800,000 "Toothpick" capacitors a week were shipped by seven manufacturers. With the Sprague shipment of two million a week, it appears we were supplying about 42 percent of the industry's requirements, and we were the only one using polymerized vinyl carbazole as an impregnant. Our product was shipped to five Navy contractors: Eastman Kodak Co.; The Hoover Co.; Baldwin Piano Co.; McQuay-Norris Corp.; and Crosley Corp.

On September 26, 1945, the company was one of 32 firms selected to receive the Bureau of Ordnance "E" Award out of some 1,000 engaged in what became the Navy's most important secret weapon, the VT fuze. At the height of our production, 2,600 of our employees and employees of our subcontractors were engaged in this program. Prior to this award, the company had received four Army/Navy "E" Awards for excellence in war production.

After the end of World War II, our production of capacitors for the Navy VT Fuze continued for ordnance stockpiles. During this post-war period, there were also some changes in the design of the units, the ultimate being small hermetically-sealed units which were designed for not fewer than 20 years' storage before use.

It is also appropriate for the records to note the names of key Sprague personnel involved in the design and manufacture of the special capacitors. Dr. Preston Robinson, our Director of R&D at that time, made the largest initial contribution. He was assisted by two of our senior engineers: Paul Netherwood and Mark Markarian. Robert Teeple was responsible for the manufacture of both the annular and "Toothpick" capacitors. Edward Goodman and his staff developed much of the special equipment and production processes. Dr. Lester Brooks, with the assistance of DuPont, developed the process for the manufacture of the monomer of vinyl carbazole used as an impregant.

CURRY C. FORD

National Carbon Co. Since Mr. Ford could not attend the meeting, this recorded message was made on November 16 at the home of Bill Offenhauser in New Canaan, CT.

Several weeks ago, Dr. H.G. McPerson, formerly Assistant Director of Research at National Carbon, and retired Associate Director of the Oak Ridge National Laboratory, recalled an initial feasibility test that he conducted on the battery. He said that when National Carbon was asked if a battery could withstand a force of 20 G's, he placed a battery in a steel shell, packed it in sand, and dropped it down a stairwell at the laboratory. He had calculated that the resulting impact would produce the required 20 G's. The battery was not damaged, and I believe this was the origin of the sand-packed concept.

Some time after Dr. Laughlin M. Currie retired, I became the Vice President for Technology of the Carbon Products Division of Union Carbide, the current designation of the old National Carbon Company. Several of the scientists and engineers in my group had worked on the proximity fuze battery and often recall with pride this outstanding technological achievement and exciting experience. Most of them, like me, are now retired.

A.J. ADAMS

Plant manager at National Carbon, and responsible for the production of the millions of high-precision, high-

quality batteries for all the various fuzes.

In November 1940, a man walked in and said, "Gentlemen, I want a battery that I can fire out of a gun." Our President, with two projects behind us that had been completed in a matter of months, said, "Yes, sir, we will give you the battery."

Fortunately the minimax process had been developed and could be miniaturized. We had to cut our minimum size cell in half to get two inches; then we cut it by five-eights to get 1½ inches. That five-eights was a trapezoid. By the middle of 1941, we were delivering batteries to Section T for their experimental work. At once, Mr. French and the rest of us realized that this battery never could function in the field with the logistics that were involved. We knew we were having trouble with it even in radio sets.

The reserve cell breakthrough

Mr. French started thinking, and, by the early part of 1942, he came up with the reserve cell* concept. This was a brilliant development on his part because our Le Clanche experience actually had nothing to do with the development of the reserve cell. It was a completely different animal, plus the fact that the reserve cell depended upon setback and spin to activate it. Not only did we have to develop the battery, but we had to have some means to simulate the action of a gun to test the product in the laboratory. We developed very high speed spinners with methods of breaking the ampule before we could make any progress in the development work. Here we were with two pilot lines running in the development laboratory — one still running on the minimax, the other one running on the reserve cell.

By October 1942, I was sent to the Bennington plant to set up the first half-line production using production equipment. I can remember the day I said to Gene, "We've made 20 units the best we know how." We sent them for testing, and I told Gene to call me as soon as he got the results. He called me. Twenty were tested — 20 failures. That was our start at Bennington.

In the meantime, we had received our major prime contract, and the Winston Salem plant had been procured. Production equipment had been ordered. On April 1, we moved to Winston Salem. We had trained their personnel at Bennington, including the naval inspector, which was a godsend later. We opened the Winston plant on April 1, 1943, and got going. Our battery was known as the NC2. The ABC section of that battery was called XYZ. ABC was never used anywhere in the plant nor by any of our people. The X was the A, the Y was the B, and Z was the C section. The minute the NC2 was in production, we started miniaturizing.

In 1944, Mr. French was ready with the NC6. The Navy decided we had our hands full. They brought in Eastman Kodak who took our battery design, engineered it, and put it into production. They swung into production ahead of us, but there was the most beautiful liaison that you could imagine among National Carbon, Eastman Kodak, Section T, and the Navy. In 1944, we opened the Bingham plant. As soon as the NC6 was in production, Mr. French went back to work on a smaller battery.

*Reserve cell description — A cell in which the electrolyte is contained in an ampule that breaks when the gun is fired; thus the cell remains inactive until used — has an indefinite shelf life.

By early 1945, it was evident that the NC8 was really getting small and I was sent to open the Buffalo plant, which was going to make two lines of NC6's and one line of NC8's. We hired our first production workers on August 3, and we were terminated on August 10, not knowing the end of the war was to be August 15. It was an awful blow to us during those four or five days unaware of the end of the war. It was a story of the adaptability of the whole radio industry.

ADMIRAL ARLEIGH A. BURKE

The famed "Thirty-one-knot-Burke" of the Cape St. George action in the Solomon campaign. He was a user of the fuze in combat throughout the war, and rose through the ranks to become the top Admiral of the Navy and, in due course, head of the Joint Chiefs of Staff.

Dean Allard has told me that all of the people involved conceiving, inventing, designing and producing that wonderful VT fuze during World War II are now gathering together to find out how they did that magnificent job. He also told me that my good friend, Larry Hafstad, is the moderator for this interesting occasion. If Larry does as a good a job on this as he did when he ran the Research and Development Board, you will all have an exhilarating time. Furthermore, it will be worthwhile.

During the Solomon campaign in the South Pacific, I was in command of various units of destroyers. It was a rapidly changing and hectic situation. The ships that were assigned to me frequently were changed because ships were being sunk, ships were being damaged, and the crews were becoming very tired. As a result, there was a drastic shortage of those fine fighting ships in that area.

I cannot now remember which outfit I had when Deke Parsons came out with boxes of VT fuzes and asked if we could use them. Of course, we were delighted, for I knew that anything Deke Parsons recommended had to be good. I think I was on the *Conway* at that time, but I know I was commander of destroyers operating in the slot or, as we called it, COMDESLOT for short.

In any case, Deke came to that outfit because we quite frequently had a lot of night action. We had encounters with enemy aircraft, barges, destroyers, and we were expecting larger ships at any time. We fitted one division of DESLOT with VT fuzes which were to be used on orders as directed by Deke. We went up the slot looking for plenty of action.

As you all know, that is the time that the enemy never cooperates. However, about the second or third night out, enemy aircraft snoopers were picked up. Deke said, "Now is the time. Snoopers are better than nothing."

Those snoopers came into range, and we opened up. We brought down one of them right away, much to our surprise, as the 45-second mechanical time fuzes we had on our regular ammunition brought down a plane at night only by accident. Those mechanical time fuzes were good for harrassing enemy aircraft at night, but that was about all. We were delighted, but Deke was disappointed because he wanted to use those fuzes against a full-scale enemy attack. Well, so did we, but you can't do that unless the enemy obliges, and they didn't. Worse than that, we ran into no barges and no surface ships.

After a few days, Deke said he couldn't hang out on those destroyers for the rest of the war. We fired some test runs against some rocks to simulate surface ships. The fuzes worked beautifully, but it rains in the Solomons. It rains quite often and very heavily. So we fired some VT fuzes into those heavy rain clouds. The fuzes worked on them too.

About nine months later, I became Chief to Staff to Admiral Marc A. Mitscher, the Commander of the Fast Carrier Task Force when it was first forming. At that time, all the five-inch 38's and five-inch 25 ammunition was fitted with VT fuzes and, as you well know, those fuzes knocked down enemy planes by the dozens. Had it not been for those fuzes, our ship losses and casualties in the fast carriers in the last half of that war would have been enormously larger than they were. That fuze was a magnificent help. In the nine month period of January 29, 1944 to October 27, 1944, Task Force 58 destroyed 4.425 enemy planes.

RALPH BALDWIN

At the beginning of World War II, a young Ph. D. instructor in Astronomy at Northwestern University. At APL, he was in charge of the development of fuzes for the Army and for their introduction to the combat forces . . . Author of the book "The Deadly Fuze" available from the Presidio Press, Box 3515, San Rafael, CA 94902. Price $14.95

I came to the Applied Physics Laboratory as one of the junior members of the team. I was assigned to work under one of the finest men I ever knew, E.D. McAllister.

Dr. Merle Tuve had a set of precepts which everyone learned. One of them was: "We don't want the best unit — we want the first." I think McAllister memorized those precepts because he gave his team a free hand to come up with new ideas, new ways of doing things, even to tackle projects that weren't specifically ours.

Dr. Hafstad mentioned that I had done some writing about the fuze. I have now completed the book on the history of the organization, the R&D, the testing and the battle use of the fuze.

Dr. Hafstad asked me if I would relate something of its battle use. There were so many places that I'm going to concentrate by giving excerpts from one chapter, "Battle of the Bulge."

"The purpose of a weapon is to destroy the enemy's ability and will to fight. The radio proximity fuze was exactly such a weapon. It did not win the war alone, but when used with the SCR584 radar and the M9 gun director, both NDRC developments, the VT fuze can lay good claim to having been the real Number One secret weapon of World War II. The U.S. Army used two main varieties of Mark 45 fuzes: anti-aircraft and, particularly, anti-personnel types. Army type AA fuzes were used in British 3.7 and American 90-mm guns with terrific results against the V-1 buzz bombs in their attacks on London and later Antwerp."

But these stories, although fascinating and of tremendous import, will just be mentioned here while the main emphasis today will be on the Battle of the Bulge:

"The first test of proximity fuzes over ground was held on April 29, 1943, using a 90-mm gun. The first test of proximity fuzes in any howitzer was held on June 16, 1943. The first test with high explosives in the shells was held on July 9, 1943. The first fuzes actually designed as Mark 45 howitzer fuzes were produced the next October."

Anti-personnel fuzes

I'd like to digress at this point a little bit because it follows through with some of the freedom that Mac gave us. About April 1, 1943, I went to the Army War College to meet with Colonel Furuholman. I was going to tell him of an idea I had that these fuzes, which were primarily anti-aircraft at that stage, should be used against personnel. The only trouble was he beat me to the punch. He said that the main reason for that meeting was to see if the fuzes could be used in howitzers. I went back to the laboratory, got Phil Rudnick and asked him if he would design fuzes for the 90-mm gun. We were still using the Mark 33 fuze which was for the British AA gun at that time, still an early model fuze. This particular one never went into production, but we didn't have anything that would operate at the low spin of the howitzers. We had to test in the 90-mm gun. We ran the tests at Aberdeen. Then we came back and told McAllister. He didn't sound too surprised. In fact, he said, "We knew eventually we'd have to get into that because anti-personnel fuzes were discussed early in the game, but concentration had to be upon the anti-aircraft fuze first."

The first time we used high explosives was the following July 9th. We drilled out the explosive in ten eight-inch howitzer shells. Colonel Furuholman brought a Colonel Malcolm R. Cox to the Aberdeen Proving Ground. Cox couldn't possibly conceive of anything good coming from a group of kids, the oldest of whom was 31 years old. He was bored stiff, but inadvertently we fixed that. We had the good ship *Ricochet*, a beautiful 52-foot long mahogany twin screw vessel that was owned by the Aberdeen Proving Ground. We went out into the bay, anchored supposedly where we were supposed to be, and told them to open fire with a 40-second flight time.

The first shell landed 200 feet from the *Ricochet*. Fortunately, it was beyond us so we were in the null zone and did not get any fragments. But, gentlemen, I don't ever want to be that close to an eight-inch howitzer shell again. They are 200-pound shells. Colonel Cox came alive. By the time we got back to Washington after watching nine out of ten fuzes operate properly, he was all set to win the war with a new order right then.

Within a very few weeks, an order for one million fuzes came through. If I remember correctly, the cost was $75 per fuze. The authorization for release of VT fuzes for general uses over land, anti-aircraft, and anti-personnel was approved, subject to release by SHAEF, a year later, October 25, 1944.

D-Day had come and gone. The Allies were on the Continent to stay. Industrial plants in the United States had been humming for many months. Literally millions of these fuzes had been carefully stockpiled in guarded depots in the British Isles and in Europe. The supply and indoctrination programs were scheduled for completion in December 1944 so that an all out and intensive use could be made of VT fuzes once the Allied high command set the date for battle use.

The Battle of the Bulge started on December 16, 1944, only nine days before the originally scheduled release date of Christmas. The Allied armies began their use of anti-aircraft fuzes immediately. Two days later, December 18, the release for field artillery use was given. The work of the indoctrination teams had been so effective and thorough that during the initial few months of general employment in Europe, there was no report of serious misuse of the VT fuze ammunition.

Simultaneously with the Ardennes offensive, the *Luftwaffe*, which had been in comparative retirement, suddenly reappeared. With equal suddenness, a large part of it disappeared. The German pilots had never encountered such devastating flak as that produced by the 90-mm anti-aircraft batteries equipped with VT fuze ammunition. During the Ardennes offensive, the 1st Army AA claimed 471 planes. This was from a mixed firing of time and VT fuzes against unseen targets at night. Overall results have not been analyzed, but some VT engagements averaging eleven rounds per kill were reported. From mid-December until the time of the Rhine crossing, United States anti-aircraft artillery men in Europe were busier than they had been at any time since D-Day. The VT fuze ammunition is credited with having shot down over 1,000 German planes during that period.

In a report dated January 17, 1945, from the Chief Ordnance Officer of the European Theater of Operations to the Army Chief of Ordnance in Washington, there are revealing incidents of the effectiveness of the fuze:

"Prior to mid-December, the 9th Army AA had negligible activity, but in the last half claimed 350. Day-by-day records show that the rounds per kill decreased as the percentage of VT fuzes increased. Due to many low flying targets, more time fuzes than VT fuzes were used during this period. Nearly all firing was at night at unseen targets.

"The use of the anti-personnel fuzes in field artillery weapons during and after the Battle of the Bulge must be considered as the preeminent tactical advent of a new weapon in the history of warfare. All the advantages claimed for the fuzes were immediately confirmed as thousands of rounds of heavy shells were poured on road junctions, bridges, and highways over which the heavy columns were advancing. For the first time in the history of warfare, the artillery was able to obtain devastating airbursts over targets as much as 15 miles distant, both by day and night. Thus, guns emplaced in a strategic position could control the roads over a large section of the front."

Other extracts from the official report to the Chief of Ordnance show how the VT fuze helped to turn the tide of this critical battle. The VT artillery fuzes which the Chief of Ground Forces, General Lear, characterized as the most important innovation in artillery ammunition since the introduction of high-explosive shells, came into action against the enemy with absolutely perfect timing. In both the AA and ground role, VT fuzes constituted a factor not foreseen in von Rundstedt's calculations. The terrific execution inflicted and the consternation resulting from night-and-day bombardment contributed materially to halting the advance and hastening the reduction of the salient. The effectiveness of VT fuzes exceeded expectations, and no more timely date for commitment could possibily have been chosen. The absence of serious difficulties or complaints of any kind had been truly amazing. The characteristic reply to inquiries was that we had no trouble. The field artillery commanders repeatedly stated that the malfunctions were fewer than anticipated, that the item had not been oversold.

Field Marshall von Rundstedt planned an insanely desperate thrust to split the Allied armies. He followed Germany's traditional invasion route through the Ardennes Forest, known to be thinly held by the American 8th Corps, a combination of combat-weary and still unbloodied divisions. He struck with terrible power just before Christmas, on December 16. When his troops, Germany's last assault reserves, smashed through the American lines, they were assailed by a new and devastating kind of artillery barrage in which every shell burst overhead. Fantastically, even individual guns appeared to be able to place an air burst over a moving target. The proximity fuze, in action for the first time against ground targets in Europe, was a fearful Christmas surprise which played a major role in destroying the impetus of the German onslaught and then drowning it beneath a rain of hurtling steel. Months, later, General Patton told Ed Salant, from the Laboratory, "The funny fuze (which is what he called the proximity fuze) won the Battle of the Bulge for us."

The "funny fuze" at work

Only a few of the reports from the Allied front will be cited, followed by some comments from the point of view of the recipients:

- It is reported that the 8th Infantry Division caught a German patrol in the Hurtgen Forest. Ninety-six dead Germans were found, and their bodies were reported to have looked as though they had been put through a meat grinder.
- A forward observer of the 82nd Airborne Division saw a bridge carrying heavy traffic of vehicles, horse-drawn artillery and troops on foot. Two salvos of eight inches completely paralyzed all movement with 300 estimated casualties in addition to equipment destroyed.
- About January 10, 1945, an OP of the 104th Infantry Division Artillery observed a Grenadier unit carrying on a review some miles behind the German lines. The OP called for a 60-gun concentration against the parading units. The OP was very excited in trying to describe what he actually observed. He reported that the German ambulances rolled in and out of the area for several hours carrying the casualties.
- A German group of about six tanks was seen bivouacking for the night on the edge of some woods. They were some miles from the Allied artiilery position and could be reached only by a few batteries of six Long Tom guns. After waiting for the crews to get out of the tanks, time on target salvos were fired. The next morning when the area was taken, they found the tanks immobilized by fragments through their lightly armored tops, many dead and a few dazed including the Commanding Officer. This man was bitter about the devastation and said that he should have camped in the open because, as he interpreted it, the super-quick fuzes detonated on the tree branches above the contingent. It is very significant that the tip of the German salient began to wither rapidly within a day or two after the fields of artillery of the 1st and 3rd Armies overlapped so that all supply roads were covered.
- About March 10, 1945, a large German pocket of resistance was holding the ground between American troops of the 9th Army and the Rhine River. It was discovered they were trying an escape across the Rhine in coal and other types of barges. Many volleys of eight-inch howitzer rounds were laid up and down the banks of the Rhine by the 252nd Field Artillery group. Many Germans were killed and several barges were sunk. Until the final surrender, the fuze did yeoman service in what gunners call interdictory fire, the purpose of which is to deny the use of a road, intersection, bridge or a town square by dropping a shell onto it from time to deadly time. One of the immense values of the new fuze was its ability to accomplish this mission while leaving the target area intact for later Allied use.
- A single division artillery officer reported, summarizing the detailed reports of December 1944, two weeks, "It is hard to believe accumulated figures from our observers indi-

cate 2,000 German dead which could be observed and counted. Of course, this does not include those under the bushes."

The Germans were impressed

● In a special report of comments by prisoners of war dated January 17 and 18th, 1945, during the Battle of the Bulge, both the devastating effect on morale and its casualties are noted: "The first time the new shell was used, it accounted for 50 percent of the entire battery personnel." Prisoners of war agreed that it was practically impossible to take cover against these shrapnels. They expressed amazement that soldiers in fox holes up to 50 meters away from the point of burst were wounded. An added attraction of which the POW signalmen complained was the constant destruction of telephone and signal communications.

● Captured POW's have reported that several German infantrymen have been executed for insubordination as a direct result of our employment of VT fuzes. The German personnel had refused to go out on patrol duty in the face of VT fire. A German captain captured January 7 by 82nd Division said he had served four years and had been on every major front but had never experienced such devastating artillery fire anywhere as that which preceded his capture.

● POW's of 84th Division reported the execution of two men in their company for refusal to go out on patrol duty because even diving in ditches and fox holes did not save troops from the American harrassing fire which came at unexpected times and places, night and day.

● Nearly all POW's are much perturbed by the inhumane new artillery shells which they think must be illegal because they are so terrible. They wonder why the *Wehrmacht* had not retaliated with something equally frightful. The trauma induced by the bursting of shells above the heads of enemy soldiers greatly reduced their ability to fight.

● Of the hundreds of anecdotes about the Battle of the Bulge, few could better illustrate the demoralizing effect of the proximity fuze than one recounted by Lewis Azrael, nationally known columnist of *Baltimore News American* and a former war correspondent of the Hearst newspapers:

"I was with the headquarters of an infantry battalion when some of the proximity fuzes were fired against the Germans. The prisoners were coming back in droves, looking absolutely shattered and stunned. They simply couldn't believe what had been happening to them. Among them I spotted a group of German officers, all of whom were wearing Russian campaign ribbons. I started talking to them. To a man, they thought the terrible beating they had taken was due to some new, unbelievably efficient method we had discovered to train our artillery men. I asked them what they had just been through compared with their experiences on the Russian front. One of them shrugged, 'Against the Russian artillery, a man stood a chance of surviving, but against this? My God, the only thing a man can do is grab his bottom in both hands and run like hell!"

● Back to the used car garage (APL) in Silver Spring, Maryland, came the words of commendation from the great commanders on the fronts. General Eisenhower's cabled comment of January 17, 1945, said, "According to our observers, the timely release of VT artillery fuzes has vastly multiplied the lethal effect of interdictory and harassment fire. The unprecedented effectiveness of unseen fire at all hours of day and night has left the enemy severely upset, as confirmed by POW reports."

● Admirals King and Blandy joined in the chorus of praise at the end of the war. Colonel Morton would add for the land use of the fuze: "Never was a secret weapon more appropriately introduced, and never was the help of something more desperately needed." The colonel dramatically closed with: "When the war finally ended in both Germany and Japan, the VT fuze was still a secret weapon unknown to the military chiefs of either of our enemies."

HERB TROTTER

In 1942, Professor of Physics at Washington & Lee University. At APL, he was put in charge of the production and qualtity control of the glass vacuum tubes designed to withstand the 20,000-g forces of being fired from a gun.

I joined the fuze project at the Department of Terrestrial Magnetism of the Carnegie Institution in Washington, in April 1941. The first fuze I worked on was the photoelectric bomb fuze designed to stop massive bombing formations, which were then being used by the Germans over England. The proposal was that a friendly bomber would get above a formation of incoming enemy bombers in daylight, drop 500-pound bombs through the formation, and these bombs would go off from either an increase or decrease in the light as the bomb went through the formation. In other words, it was triggered either from a glint off a plane or from a plane's shadow.

By late Summer of 1941, we had tested these fuzes against radio controlled drones off Cape May, New Jersey, and proved that they would operate satisfactorily. After the tests were completed, however, the Navy informed us that they were not going into production on it because they were afraid that they might be used against our bombers as we attempted to wrestle Europe from the Germans.

At this point, they said they would like to have a similar fuze that would work in a rocket. We immediately set out to see what we could do in this direction. Because of limited space at the Department of Terrestrial Magnetism, this whole project was moved to the Bureau of Standards. The problem with the rocket fuzes was not in building fuzes but building rockets. The fuzes worked properly; the difficulty was that the United States didn't have rockets available. So that project was dropped.

By then, there was a lot of activity on the VT fuze and its components. Dr. R.D. Mindlin was trying to design the mechanical structure of a vacuum tube to withstand the enormous forces experienced in a shell. He was using basic concepts of designing bridges, in designing the mechanical interior of the small vacuum tubes.

At that time, several companies were working on the tubes. Roger Wise, Vice President of Engineering and Development for Sylvania, was spending practically all of his time and that of his staff trying to solve the problem of building the rugged tubes. These tubes were very small — about the size of a pencil — but had to operate under the terrific setback forces of the guns as well as the high spin of the shells. We recognized that, for the fuze to work, it would probably contain four vacuum tubes: one for the oscillator, two for an amplifier, and one for a thyratron that would discharge the stored energy into an electric detonator that would start the explosion. With four tubes in the fuze, each tube had to operate with reliability of 90 percent to get a fuze that would exceed 50 percent in total operation.

In testing the components (the tubes) the program was to fire them vertically from a 57-mm gun; due to the high spin, the shell would return to the earth base first. Therefore, the forces on landing would be in the same direction as they were when the shell was fired. By putting gauges in each shell, we could measure the forces on leaving the gun as well as the forces on impact. Provided a rock was not hit, the force on impact would be less than on leaving the gun, so, if the tubes were broken, we could assume they were broken on leaving the gun rather than on impact. These fuzes were dug up out of the sand and returned to DTM for analysis.

This type of approach also was used in testing early fuze models. The problem was to build radio jammers so that as the fuzes came down, the signal would trigger smoke puffs to show that the overall fuze was operational. In the course of testing, approximately 250,000 of these shells were dug out of the proving grounds and returned for study and analysis. This was a vigorous quality control program, particularly on vacuum tubes.

By January 29, 1942, on a test of 50 fuzes in the 5-inch 38 guns, we had 26 fuzes that operated properly above the water. This was the first test which exceeded the 50 percent that the Navy had set as our goal for proving that the concept would work.

After the results of those tests, Larry Hafstad and I got a call from Captain Shumaker of the Bureau of Ordnance in Washington to stop by his office. When we arrived, he said, "This proves you know what you're doing. From now on, the sky's the limit. We're going into production as fast as we can. Good luck to you."

From then on, the problem was to see how fast we could gear up production of the components as well as of the complete fuzes. Crosley already had a contract. The Navy was anxious that we quickly get other people involved. We offered a contract to Sylvania Electric. Twenty-nine days later, we fired successful fuzes from their pilot production line. From then on, other suppliers came into the picture. By the end of the war, production reached a level of 100,000 fuzes per day. To build these 100,000 fuzes, Sylvania was making practically all the vacuum tubes and, in the latter days of the war, their production reached over 500,000 tubes per day.

Since these tubes were smaller and more difficult to make than the regular vacuum tubes, this represented a terrific effort on their part. They not only had several plants making tubes, but they had feeder plants doing subassemblies. For example, they set up one plant in the upstairs floor above a store in a small town. The man sent there was told to hire a number of girls to start working the following day. That night, one of the men from the headquarters of the Sylvania tube operation arrived. He wanted to know where the material was. He was handed a suitcase and told that it was the work for the next month. In the suitcase were packages of the small micas used inside the tubes. These had been stamped out and had holes punched for assembling the tube components. The mica had to separated into individual layers to be used in the vacuum tube. In one suitcase, then, there was enough work to keep 30 to 40 people busy for a month.

Roger Wise had a great background in vacuum tubes and a confidence in the right way to build one. I remember someone discussing with him the possibilities of using metal instead of glass tubes, figuring that these might stand the forces better. Roger contended that the glass-to-metal seal required in the metal tube was a much weaker point in the tube structure than the all-glass-tube. Later tests proved Roger was correct, and all the tubes used in building fuzes were of the all-glass type.

The reserve battery

The Navy adopted a plan where it would be advantageous to have a number of companies making components. The Navy would then supply these components to the fuze assemblers. These components consisted of not only the vacuum tubes but also the batteries.

The first batteries used were of the wet paste type which are the common radio type of battery. It was recognized that the wet paste batteries had a very short shelf life, particularly if stored a high temperatures. The problem was that fuzes might have to rebatteried in the field. Some of this was done in the Pacific in the early days of the fuzes.

The reserve battery was RUSHED into production. A reserve battery consists of a number of metal plates, with an acid electrolyte in a glass vial in the center. Upon being fired from the gun, the vial would break and the electrolyte would be spun out into the plates of the battery to provide the voltage necessary to operate the fuze. These batteries had to produce about 100 volts to operate the vacuum tubes, have an A supply for the filaments, and a C bias for the cutoff voltage on the thyratrons. They were rather complicated batteries, and were produced by several companies including National Carbon, Hoover, and Eastman Kodak.

One thing that made the fuze project so successful was the close cooperation between the manufacturing companies. New manufacturers sent teams of engineers to the plants already in production to study their methods in detail. After they returned to their own plants, they were in constant contact with the main manufactures: Crosley and Sylvania. Then at regular intervals of every month or so, there would be an engineering meeting at one of the plants where engineers from each of the companies would attend. They discussed new methods found to improve the performance of the fuze and decrease the number of rejects.

The cooperation from the engineering staffs of each company went a long way to speed up the production of the fuze. As an example, McQuay Norris had made only piston rings. Some people doubted their ability to make electronics. However with their good management and the help from other companies, they were quickly able to copy their methods and produce excellent fuzes.

The fuze in Europe

The first fuzes that were produced were for the Navy to combat kamaze pilots in the Pacific and protect our ships. As soon as this demand was met, we went into production on the fuzes for the Army 90-mm anti-aircraft guns.

These fuzes proved of immeasurable help in the Battle of Britain. In fact, with the V-1 fuzes, 90mm guns, 584 radars and electronic gun controls along the coast of England, they were able to knock down and largely neutralize the buzz bombs after the first attack. During the first attack of the buzz bombs, England tried to counter with Spitfires, but these proved unsuccessful. Then Churchill cleared the coast of England of Allied planes and gave the right-of-way to anti-aircraft guns. After that, the number of buzz bombs shot down was better than 90 percent.

When Antwerp was captured during the invasion of Europe, the loading docks were captured intact. This meant that the Allies could bring heavy equipment ashore quickly.

The German realized that and started shooting buzz bombs at Antwerp. They were firing these very low.

We were faced with the problem that earlier fuzes had been made with anti-aircraft type self-destruction built into them. If the shells didn't get close to an airplane they would self-destruct high in the air rather than approach close enough to the ground where they would burst to cause serious damage to ground facilities and troops within range of the burst.

Since the German buzz bombs were coming in at a low altitude, a much shorter self-destruct time was needed immediately. The newer safety devices that incorporated the brand new design of self-destruct were rushed to us. The Navy had trucks standing by at the plant to pick up the special fuzes immediately after the shells had been refitted. As fast as we had them assembled, they were loaded into the trucks, rushed to Boston and flown to Antwerp. Thus, within 48 hours after we had assembled them, the new fuzes were in Antwerp being fired against the buzz bomb. Also, at one time in the war when fuzes were running low in England, Lancaster Bombers flew to Cincinnati to get fuzes directly for the combat zone.

After the requirements for anti-aircraft fuzes had been met, our next project was fuzes for field artillery. Here the thought was to obtain the burst at optimum height above ground, causing the maximum damage. Such a shell would do anywhere from three to five times the damage to personnel on the ground compared with a comparable time fuze in the same shell triggered with the best guess for its time setting. The influence of the target itself makes the result devastating.

We did get some plus marks also for this new field artillery design. They were less sensitive to rough handling than the anti-aircraft fuzes — a decided advantage in combat on the ground — and in manufacture they were a bit easier to produce. But the key to these advantages remained the same thoughout the entire episode: they still did require that superb quality-reliability control that all the other fuzes had before them. Without that, the project could not have started successfully or have wound up as one of the greatest achievements as the first "smart" fuze in history.

At the end of the European phase of the war, the Navy asked me to go to Europe to interview German scientists who had worked on fuzes. At that time, we did not know whether the atomic bomb would work. If if did not, the war with Japan could be a long drawn out affair. We were anxious to know how far the Germans had progressed on their fuze efforts so that we might know what they had passed on to the Japanese that we would have to counter in the Pacific. It was interesting to find out that the Germans had 47 different projects on proximity fuses. These were scattered around under the postal system's control — a lot of old projects that were worthless; a few that were worthwhile.

Self-defeating German bureaucracy

In discussions with their scientists, the startling thing to discover was that there was no cooperation between the military and the scientists. I brought back a fuze that had been built to be fired from a gun. When I tried to find out what kind of test results were obtained, the man contended he had none. He said that he was never allowed to go to a proving ground. He sent his equipment to the proving ground, and they sent back reports. As the war went on, the quality of the men at the proving ground constantly declined until reports that came back did not make any sense. He was shocked when he heard that in the United States we could go to the proving ground and even direct the method in which the tests were to be run. The reason that the V-1 and V-2 buzz bombs were successful programs was that they were entirely independent. They had their own proving grounds and were not tied to the military at all. Therefore, being completely autonomous, they could go ahead and make progress.

I came across another interesting thing in Germany when I talked to the man who had developed the guidance system for the V-1 buzz bombs. He was very proud of the fact that he had overcome an early difficulty. The first V-1's weaved back and forth, with very sloppy controls. So he improved them, tightened them up so that they flew in a straight line. He was very proud of it. Not wanting to hurt his feelings, I did not tell him that he had performed a great service for us. They were much easier to knock down with anti-aircraft fire because their course was very easy to determine.

When the atomic bomb was dropped on Hiroshima, I immediately flew back to Washington. The Navy and Eastman Kodak contacted me about joining them. The Navy had agreed that work should continue at the end of the war to improve the fuzes by overcoming some of the difficulties that had been encountered and making the fuzes not only long-life but also more sophisticated. They picked Kodak because Kodak had been in more elements of the fuze than anybody else. They had not only assembled the complete fuze, but they had the batteries and safety devices. Except for the vacuum tubes, then, they could continue work on it.

Under the leadership of Ford Tuttle at Kodak, we quickly put together a team of people. I stayed with the project until the Spring of 1956. Having worked for 15 years on fuzes, I was anxious to do something different. Before leaving Kodak, I had the satisfaction of designing and building the first fuzes for the Sidewinder missile. Hence our background in fuzes had continued from shells through guided missiles.

In recording the early history of the fuzes, one thing should be recognized: the great service performed by the Erwood Company. The subassemblies of the early fuzes that were tested by the DTM operations and at Johns Hopkins, were made in Chicago by Erwood and shipped to Washington for final assembly, adjustment, and so forth. We had an arrangement with the C&O Railroad who were bringing shipments daily under their armed guards. We picked them up in Silver Spring, Maryland. Erwood was also very helpful in providing information to help the big manufacturers get into production at a rapid rate.

I cannot close this discussion of fuzes without paying respects to the man who spearheaded the whole operation and without whom it could never have been done in the time that was available. That, of course, was Dr. Merle Tuve. He was a dynamic personality. His continued drive kept us all on edge and going full speed. I also have to give a lot of credit to his right-hand man, Dr. Larry Hafstad. Larry had the ability to keep things running smoothly after Merle had stirred them up. It was a pleasure to have the opportunity to work with both of these wonderful men.

BILL OFFENHAUSER

Radio Engineer, Leader in the critical statistical Quality Control group without which the work could not have succeeded. Organizer and Convener of this Conference.

I always referred to Merle Tuve as the mainspring and to Larry Hafstad as the balance wheel. Without both, you couldn't keep perfect time.

JOHN M. PEARCE

Production Manager and general trouble shooter. Toured Pacific Fleet for first-hand observation. Radio Engineering background.

In February 1942, I joined the VT fuze program at DTM.

At the Laboratory I became involved in the development operation, and improvement of the VT fuze through testing of fuzes.

The fuze was fired vertically from a special 57-mm gun, giving it the "G" force it would experience in action. As it was fired, we could listen to the oscillator on a receiver to check its operation. Then we triggered it with a transmitter to explode the "Squib", the small explosive charge — essentially giving it a complete simulated operational test. Each round was numbered and a record kept of its operation and the origin of its components, permitting us to correlate its condition and operation in the Laboratory with the field test. Each unit was analyzed, and every component tested to isolate inoperable units and pinpoint causes of failure. This system worked extremely well. We were able to notice trends in component failure and call for constant improvement to establish reliabilty.

When the fuze went into production, we tested groups of fifties, returning them to the Laboratory for post-mortems. Those groups that met our quality standards were then fired in lots of fifties, in a 5-inch 38 gun. If these met the required reliability we had a good lot to release to the Navy.

At the start of the program, 50 percent reliability could be accepted. The acceptable percentage increased rapidly and steadily as the production quantities came along.

We encountered many interesting and amusing situations as we came into high quantity production; one was that of the wires coming out of the base of the vacuum tubes. It was determined that these wires must have a small kink or half-loop in them. Otherwise the movement or "setback" on firing caused the wires to tighten, breaking the vacuum seal on the tubes and thus making them inoperable. The high-rate manufacturers wanted to discard this kink or loop technique; they claimed it slowed production. It took considerable pressure to convince them that we were right.

Other important discoveries were made from time to time. We were producing anti-aircraft fuzes in large quantities for the British Navy. Technically, they were the same as the U.S. Navy fuzes. However, in proof-testing, they were noticeably below U.S. fuzes in operating reliability. The electronic circuitry was used in a slightly smaller shell with a more pointed ogive. On postmortem, the only consistent difference that Quality Control could find was in the solder at the tip of the fuze, where the conecting wire came through the plastic, and was soldered to the metal antenna nose cap. The solder always seemed to be missing or loosened.

Dr. Unger, who was working with us in Quality Control, speculated that there might be a heat problem, generated by a higher velocity and a different nose configuration, causing heat friction. We decided to try coating the fuze in wax. Fifty British fuzes were wax coated and tested. Sure enough, they operated with practically the same reliability as the U.S. fuzes. Fifty more were assembled with the same wax nose coating. The same test results were achieved. Without delay, we started retesting and shipping fuzes to the British Navy, but instead of a wax protective coating, we cemented a thin plastic cap over the connection. This proved even more satisfactory.

Different guns

As the war progressed, the U.S. Navy reported problems with the new 5-inch 38 guns. They had a slightly higher muzzle velocity, and we suspected the same problem as with British fuze because of a slightly higher incidence of pressure bursts being reported. We set up a special test to shoot inert 5-inch 38 shells in a high-velocity gun in a vertical firing and recovery test. We were not surprised to find evidence of solder melting; so we began cementing the small plastic caps on all anti-aircraft fuze noses. Operating reability was substantially improved.

The overall Quality Control procedure for testing components was complicated. Each new component — condensers, resistors, vacuum tubes, rubber socks for supporting tubes, wax used in potting, etc. was tested, approved, and constantly rechecked to maintain prescribed standards. A detailed lot-by-lot record was compiled delineating every fuze component, supplier, and date of manufacture. With this record, when any problem surfaced, we could pinpoint the component involved and its history.

In 1944, we found evidence of tubes breaking in our recovery tests. It took a few days to determine that the problem was in the rubber socks which cushioned the vacuum tubes; they were much harder than our approved rubber socks. Our investigation revealed that the War Production Board had changed the quality of the rubber being supplied to our suppliers. With the help of the Navy, we got the rubber quality restored and our problem was solved.

Many reports were coming in from the Fleet that the fuzes were beginning to show a problem; many more "duds," or inoperative fuzes were showing up in the field use and in test firings by the Gunnery Officers. This was a crisis situation, and I was asked to leave immediately for Guam and Leyte Gulf to assist with the problem.

A shorted capacitor

At Leyte Gulf, I went to work immediately with the Navy personnel involved. They had already isolated the lot numbers in which the problem occurred, and we began a comprehensive component testing program. We located the problem in the firing condenser — the condenser that built up the charge to fire the "squib" that in turn sets off the auxiliary detonator that fired the shell. This particular condenser had deteriorated because of the high temperatures and high humidity, causing moisture to be absorbed and the leakage resistance to show almost a direct short in our tests. Also, some of the condensers showed a day-by-day leakage deterioration. This would cause the "duds".

Correlating this information and reviewing the microfilm data, we isolated the supplier. In checking with the Laboratory, the dates of the condenser lots were determined, and then the cause of the problem was uncovered. The supplier had changed the process of impregnating this condenser, and that change had been implemented without the Laboratory's necessary approval of humidity tests, etc. (It seems fumes from the original sealant had been giving some trouble to the operators of the process.) The Laboratory ordered the supplier to restore the original approved sealant immediately.

With our records, we could inform the ships of the Fleet as to the lot numbers of the problem fuzes — which ones could and which ones could not be used. And, because fuzes were so urgently required for the invasion, we established air shipment of proximity fuzes, allowing — with Navy approval — as an emergency measure, the refuzing of ammunition on shipboard under strict safety procedures.

RALPH BALDWIN

In building the anti-aircraft fuzes for the British, Dr. Merle Tuve took one of the biggest gambles in history. He went into production on the British fuze when it still was not performing. The idea was that they would be in production when the problem was solved and would be ready to deliver fuzes fast, because the British really needed those fuzes. When John Pearce and his group came up with the answer, they immediately found out how to make the fuzes work and salvaged the fuzes that were on the shelf.

LAWRENCE HAFSTAD

The top echelon was Tuve, Hopkins, Hussey, Parsons and Porter. Looking back, I've concluded that what those people did was to remove from those of us at the working level any excuse for failure. Under those conditions, it was for us a matter of pride. We just had to solve the problem.

My recollection is that this project was like an endless series of high hurdles with one crisis after another. I'd say the Roberts triumvirate should be given very high marks in the early stage of this project because Dick Roberts was sharp and realistic. He brought in his brother, Walter, who had a background in understanding what was going on in the circuits. He was our basic circuit man. The third brother, Tom, took over the firing testing. So this worked out very well.

Several of the things Pearce has said remind me of one of my low points in the whole project when we ran into all those duds. We sent word to the Pacific that we wanted 25 of them flown back urgently so that we could post-mortem them to see what was wrong. This order went out high priority. We said the fuzes should be delivered to the Johns Hopkins Laboratory. The instructions were garbled as they passed through the several transmission centers. In due course, the fuzes were flown back to Dahlrgren where they opened them up. They fired them, and the report said, "Yes, all duds!"

It was lucky for us that it was the Germans who designed the V-1 guidance, because they do things thoroughly. If the French had done it, they would have left the wiggle in the guidance system because they were only trying to hit London and the wiggle didn't make any difference. So it was only because of the Germans' thoroughness that we were able to shoot down the V-1.

We were at the Bureau of Standards — we were working day and night before we got into the war. Because the Civil Service does not work overtime, the doors were locked at night. However, we found a way to sneak in through the heating tunnels. We had a crew working like hell to get the fuzes ready to be fired the next morning. Trotter had the assignment of taking them down to Dahlgren to be tested. He came in through the back way and went to where the fuzes were loaded on the trucks. Unfortunately, the garage doors were locked so that he would not get the truck out. His orders were to let nothing stop this project. So he looked at the doors of the garage and the front of the truck, and drove right through the doors! I got the job of untangling the government property damage. These are the interesting things that happened.

Component problems

The making of the VT fuzes for the British was mentioned as well as the urgency with which they were required. The demand was so high that the RAF flew their bombers direct to Cincinnati to pick them up. We broke all kinds of records getting out the fuzes. Then everything came to a dead stop. A telephone call saying there was no customs officer at the Cincinnati airpot. The war stopped until the Navy could fly a customs officer to Crosley.

The first shipment of fuzes with lucite noses went to Mare Island. When they got there, the noses were crazed. They would fall apart. So Harold Brouse made an investigation to find out why they crazed like that. The only thing he could find out was that the inside of the shipping boxes were painted and the vapor of the paint thinner crazed the noses.

We had trouble with tube filaments. Sylvania had the best performance. We made comparative tests and found that for some unknown reason wire from their tungsten ingot was better than any other. So they provided filament wire for all manufacturers!

One of the first decisions that Merle Tuve made was that we didn't have time to wait for the FBI clearances and things of this type. The only way we could staff this job with reliable people was for each of us to bring in our competent friends. That is what we did. We filtered out through our friends. Each new man who came had more friends, and we collected a really remarkable group. When we told them about the problem and its challenge, they all went for it.

Parsons introduced a technique which I adopted because I did much of the interviewing. That was to bring the candidate in, have small talk, find out whether he was good or not and what his experience was. Then I would start to describe this project. I would draw the story on paper getting all the information down, the numbers, etc. At the end of the interview, I'd tear up the paper, reach for an ashtray and burn it up. Now that impressed the people.

Another aspect of security was that we adopted a double talk procedure very early. We changed the names of the things we were dealing with. We had to do some things in the open; we conducted one of our the tests of the sensitivity of the fuzes on the roof of the buildling. The neighbors got curious. One of the results was a rumor that this was Johns Hopkins University, and they are known to be in hospital work. People thought that this was essentially a blood injection device which we were lifting and lowering. We encouraged false rumors of that kind and they worked well.

Another one along the same line: We had to order nose cones. These were ogives, and any ordnance man would recognize them by their shape as being connected with artillery. That had to be covered. I don't know who made the suggestion, but the order was placed through Johns Hopkins for a half million rectal expanders!

Improvements that hinder

Throughout that early experimental phase our big bugaboo was that we couldn't get 25 units that were identical. Under those conditions, it is really hard to calculate your statistics.

We developed almost an allergy to what I refer as "obvious improvements." Somebody would be making these things and take a shortcut like removing a specified wiggle in the wire introduced to withstand shock, or somebody would change the paint that was used with a different solvent and have the kind of trouble that was mentioned above. I remember one time preaching to the assembled group that if they changed even the color of the paint, we would test 50 of them at Dahlgren. This had to be done to get the statistics under control for the post-mortems. It was about that time that Paul Larsen came in. Under him, we brought in the Offenhauser-Harris group, to get our statistical quality control in gear. That was a tough job.

One of the first things that shocked me when I started working on what was supposed to be the fleet model (as we called it) was tolerances. Every day we put in our day's work at the Laboratory, and afterward I'd have dinner with Paul Larsen. Then we'd get the blueprints out and fight about the tolerances. Being an electronics man, I thought all we had to do on metal parts was to specify the dimensions, and they'd come out that way. Hell, no! We had to set tight tolerances on each part. With this, I thought the job was done. Oh, no! When you assembled them, the individuals would fit, but the overall would not. We had to go to selective fitting in order to have the overall thing come out. We could not have play in it because if you had a little bit of slop there, you knew you were out of control right away.

It was already mentioned that 50 percent was set as the target, and I agreed with Merle Tuve on that. My assignment was to do everything possible to correct errors and mistakes but to postpone improvements until the next model. We welcomed suggestions for improvements, but that was to be model number two. Only corrections could be allowed in model number one.

This brought us to what I would call the transition problem of going from research into production. There's what I would call a classic solution to this, which is hard to follow. That is, as you reach the latter stages of research, you bring in people from production and plant them in your organization. You then let them argue with and persuade the research people that there are easier ways to make this or that component, but they have no authority. Then, when you move the project over to production, it is good to have some of the research people move over to production so that you don't throw away all the experience, the headaches and the mistakes made in the research.

This sounds easy, but the trouble is that when you try to get people from production to go into the research laboratory, they say they cannot spare the men. This is overhead as far as they're concerned. They're non-productive. It's extremely difficult to bridge this particular gap. The only reason we were able to do it as well as we did was that, for once, the accountants were out of the act. All of us were dedicated on the technical part of it, and, with support from on top, we were able to swing it.

Why Crosley was picked

We can move on to how we picked Crosley. I think that's important. Fortunately, the Navy had inspectors in all of the big cities, and it was their duty to know what the capacities and talents were in that area, and how busy they were. The first we visited was Crosley. I expected to have a real sales job on my hands, especially with these money-hungry company people. I thought I was going to be visiting half a dozen companies, each with a sales talk. What I found was that the Crosley people were our kind of people. They were challenged by the technical problem and the opportunity. I guess they did not have to worry about costs. You see, there was no accountant there at the time; so it was much easier than I had expected.

I remember arguing that the first thing to be made was what we call a Chinese copy of what we had made in research. They set up a pilot line and did that. They then started to make modifications in it as we did in our pilot lines. Gradually, we were able to improve the product and stay within the requirement of 50 percent. We looked upon the pilot line as the bridge between engineering and the factory.

I have mentioned several of the high hurdles that bothered me. One of the low points was after we had solved all the other things; we had the rough handling tests and finally, the salt water test. With the rough handling, I thought we'd done a pretty good job when we had taken care of axial loads. Then along comes the Navy saying they're going to drop them sideways. So these were the ups and down we had, but we lived through them. Of course, for the highs, I'd say the *Cleveland* test was certainly the high and the early *Helena* test was good.

We had exceptionally good liaison with the British, especially on intelligence. This was mainly for two reasons: Tuve and Breit had worked with Sir Robert Watson-Watt on ionosphere research; so we had access to the radio group over there. Tuve, Breit and I had been working on atom smashing. That brought in Cockroft and the Cavendish Laboratory people. We were "competitors" and friends so that we could talk to each other.

Very early in the game, I was privileged to see some of the MI5 reports on what they were beginning to learn about some funny tests going on in the Baltic. Swedish fishermen were seeing what we might call UFO's. The reports came back that these were fast and big and extremely maneuverable because they made crazy motions. The English knew better because they had broken the German code, so they had very early information about those V-1 things. Of course, we started working immediately and were able to make up a model in the proper dimensions. We hung it between towers in New Mexico and developed the British fuze to handle it.

GEORGE HUSSEY

It is important to emphasize the fact that a vast variety of fuzes had to be made. There was a sharp division between the fuzes for the Army and the fuzes for the Navy. The Navy was responsible for those that had spinning applications and the Army had all those for non-spinning applications.. When you look at the list of different calibers and kinds of guns, it adds up to a horrendous mix of types.

You probably remember the Army-Navy "E's" that were awarded to various plants that had production successes. These came up very early in the war after a suggestion was made by Spike Blanding who served in the Office of the Chief of Naval Operations. It was from that office that the awards of Navy "E's" were made to gun crews, ships, and so on. The Army said, "Let's make it a joint affair." So it then became the Army-Navy "E". Each presentation of an Army-Navy "E" was made by some officer to stir up enthusiasm in the community.

In spite of all the magnificent work that was being done, no awards were made to the VT fuse plants. Finally, one day, a delegation came to see me. I explained to them that we could not attract the attention of the press, etc. The only answer we could give is: "No." We thoroughly appreciated the work they were doing, but the answer was still: "No." The discussion lasted quite some time. Finally, the guests went off with

Tom Sawyer, of the Ammunitions Section. About an hour after the guests had left, Tom came back and said: "Boss, you know one of those people said you have ice water in your veins."

HAROLD SCHWEDE

Signal Corps officer with radar and communications experience, assigned as combat observer in the southwest Pacific. Background astronomy.

My connection with the VT fuze was as an interested observer in combat. I saw results with the Navy's fuze while on convoy from Aitape in New Guinea to the landing at Lingayen Beach in Luzon. My branch then was Signal Corps attached to Air Corps.

In the southwest Pacific, we had three small detachments — G., H., and I — whose task was to coordinate the plans for a landing. Detachment G was working on a planned invasion of the Halmaheras, when the success at Leyte shifted the next event to the landing on the Island of Luzon at Lingayen Bay.

The convoy loaded on Christmas Day out of New Guinea and threaded its way through the Phillippine Islands, going finally to the west of Mindoro. Shortly thereafter, the Japanese attacked the convoy with kamikaze aircraft. We could see on the horizon that at least one of our troop ships was hit. Within a few moments an enemy plane appeared. My LST was on the right rear of the convoy, just ahead of an ammunition ship. The kamikaze plane chose the LST just west of us as his target. The dropped bombs failed to hit the fan-tail of that LST. The pilot then aimed his plane to crash on the forecastle. He didn't make it. Our gunners had scored hits as the plane went down. The war was over for that Jap pilot.

I looked over the horizon in the direction from which the plane had come. I then noticed puffs of smoke appear, "laid on a clothesline". Inasmuch as I had fired French 75's, I could not but marvel at the very precise control of the height of burst. I saw no plane and was puzzled at the cessation of firing after a few rounds. I now realize that a ship had scored a hit and did not need to fire any longer!

JERRY MINTER

The battleship North Carolina, from which probably the first shells fitted with VT fuzes were fired, was retired and set up as a monument by the State of North Carolina. Mr. Minter was engaged to design and install electronic firing equipment for its guns, for a demonstration or show (a simulated Japanese air and torpedo attack) which was put on nightly for visitors to the Battleship Memorial in the harbor of Wilmington, NC. Mr. Minter is now making and applying specialized TV equipment for the medical field.

The *North Carolina* was set up as a monument by the State of North Carolina. The Navy helped to get it down there and into place on the Cape Fear River. I was called in to help fire the guns electronically. I got to meet a gunner's mate who had been in the Pacific, and he helped a lot because I didn't know anything about big guns. I asked a lot questions of the men assigned there. One was a lieutenant commander on the *North Carolina* and was written into the script. If you ever hear the script, he's the one known as Winston Salem. So I had some first-hand knowledge.

They told me that they were never hit by a kamikaze although they were in the middle of it all the time. They used five-inch guns point blank! That, to me, is really overkill, but it worked. He said they never missed. Every one of them had a VT fuze. He thought they had the first VT fuzes ever used in combat.

DR. DEAN C. ALLARD

Head, Operational Archives, Naval Historical Center. Professional historian specialing in Science and Technology.

Let me close the formal session on behalf of the people who have done the work in getting this meeting together, namely, Bill Offenhauser and Larry Hafstad. It has gone remarkably well, and the material given is very valuable. The objective of getting materials for the archives has been achieved. It is remarkable that this performance, today, exemplifies the VT fuze project. The cooperation of private research and production with the military services has been as evident today as it was during World War II.

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SUPER REGENERATIVE PULSE RADAR*

by

F. H. Shepard, Jr.**

Super-regeneration was invented and developed to become a valuable tool by our fellow Radio Club member, the father of radio as we know it today, the late Edwin Howard Armstrong. All who have worked with this concept have been awed by its simplicity, stability and exceptional sensitivity. When using super-regeneration, some of us have been frustrated by our inability to obtain signal-to-noise ratios in communications equipment equal to those that can be obtained with complex high gain amplifiers operating by other principles.

Since many of us have not analyzed physically and basically how super-regeneration operates, I would like to offer the following considerations:-

(1) Assume a parallel tuned circuit with an A.C. voltage source connected across it through a switch, the circuit being tuned to the same frequency as the A.C. source.

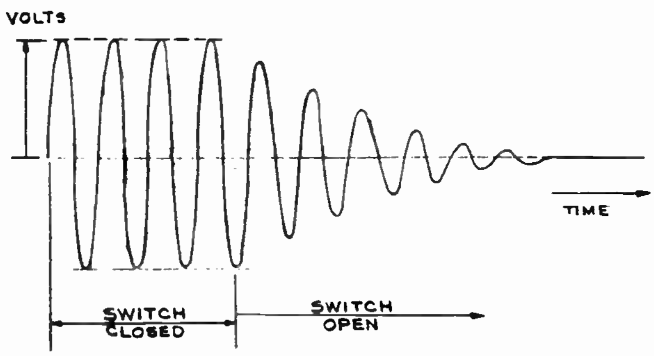


FIG 1

(2) Now if we open the switch at some particular instant, we observe the voltage across the tank circuit will decay in amplitude, not instantaneously on the opening of the switch, but at some rate, determined by the losses in the tuned circuit. Figure No. 1 shows an oscillogram looking across such a tuned circuit. In Figure No. 2 the amplitude of the A.C. voltage is plotted logarithmically against a linear time scale. The slope is linear on this scale because the energy stored in the tuned circuit is dissipated at an exponential rate just as the D.C. energy stored in a condenser is discharged by a shunt resistor, i.e., the power dissipated in the resistance in either case is proportional to the square of the voltage.

* Patents Applied for.

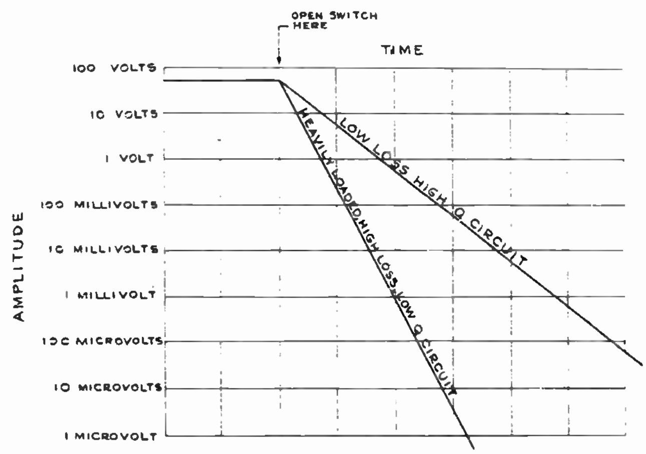


FIG 2

(3) A hypothetical tuned circuit of infinite Q, zero losses, would ring at some voltage amplitude that would be constant as long as the losses remain zero.

(4) If we connect a resistance across the circuit at some instant in time, the curves in Figures No. 1 and No. 2 would obtain, the lower curve in Figure No. 2 being for a lower valued shunt resistor.

(5) As is well known, the circuit having the higher "Q" (with the lower losses) and the higher effective resistance will tune more sharply, i.e., will have the narrower bandwidth and higher selectivity. Conversely, the circuit with the lower shunt resistance will have the broader bandwidth and less selectivity.

(6) Let us assume that we have a tuned circuit with a small A.C. voltage source connected across it. Upon disconnecting the A.C. voltage source and connecting a resistor across the tank circuit at some instant in time the conditions in Figure No. 3 result. If the added resistor has a negative value lower than the effective positive resistance of the circuit the resultant resistance of the circuit will be negative and the amplitude of the A.C. voltage will increase at an exponential rate. If the shunt resistance is negative and equal in value to the circuit resistance, the A.C. voltage across the tank will remain constant. If the shunt resistance is negative but higher than the positive resistance, the voltage will decay. The rate of increase or decrease will be an

** Consulting Engineer;
President, Shepard Laboratories, Inc.

inverse function of the effective resistance value of the parallel combination. In the extreme case, when the shunt resistance varies infinitesimally minus or plus with respect to zero, the rate of increase goes from plus infinity to minus infinity.

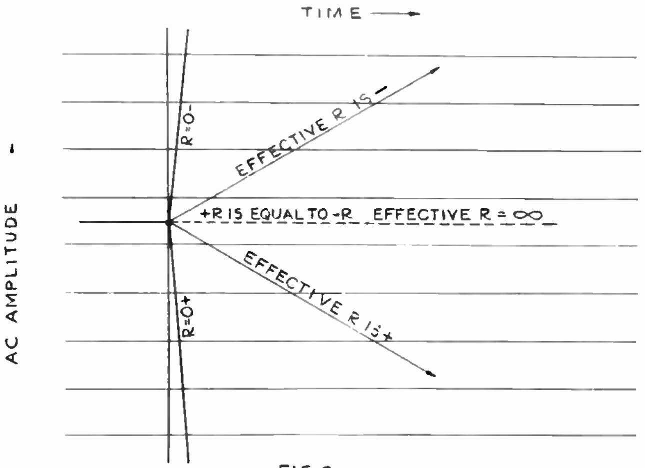


FIG 3

Figure No. 4 shows how the effective circuit-loading resistance varies as the shunt is varied through zero in both directions. The curve in Figure No. 5 illustrates how the selectivity varies as the shunt resistor is varied. The curve in Figure No. 6 shows how the bandwidth of the tuned circuit varies with the external shunt resistor. This curve is effectively the reciprocal of selectivity.

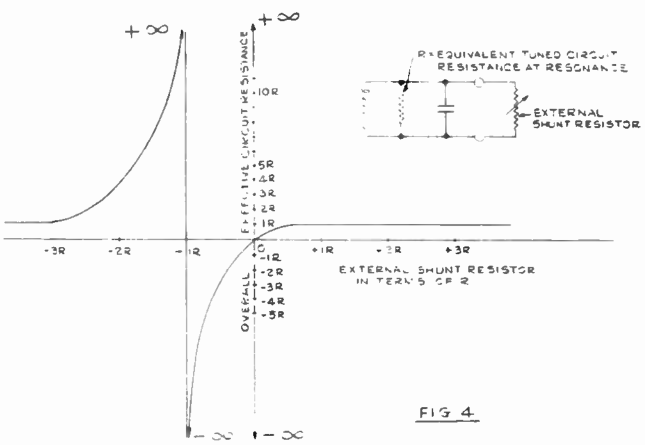


FIG 4

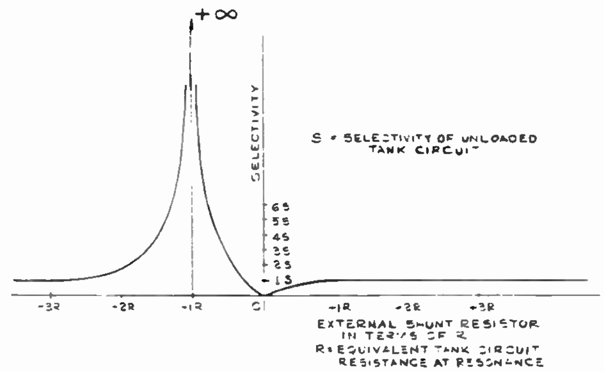


FIG 5

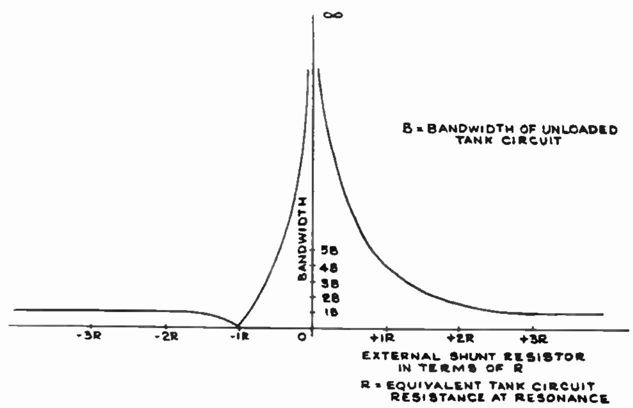


FIG 6

(7) Now when signals of various amplitudes are present in the tank circuit at the time that a negative resistance is connected across it, Figure No. 7 shows, for two values of negative shunt resistance, the voltage time curves for three input voltages. I have arbitrarily shown all values of negative resistance limiting at about 50 volts. This could be any level depending on the characteristic of the negative resistance. If the negative resistor is allowed to remain connected for only a specific number of time units, 4-1/2 time units for instance, and we observe that as long as saturation has not been reached, the peak tank circuit voltages attained are directly proportional to the input voltages and are many times these input voltages. The maximum gain, if sufficient time is allowed, is limited only by the ratio of saturation level to noise level. The lines with negative slope represent the decay rate of the tuned circuit with the negative resistance removed.

If the negative shunt resistor is left connected to the tank circuit for a sufficiently long period of time, the amplitude of oscillations (the AC) will always saturate. If the starting voltage is high, saturation will occur sooner, and conversely, if the starting voltage is low, saturation will occur later. If we measure the area under the A.C. envelope, we will see that this area is proportional to the logarithim of the starting voltage. This is known as the logarithmic mode of operation.

If the time units on Figure No. 7 are in tens of microseconds and the negative resistance is reapplied say every ten units, i.e. every 100 microseconds, and the peak detector is filtered with a time constant of say 200 microseconds, response to signal modulation frequencies as high as 5,000 cycles can be had. The

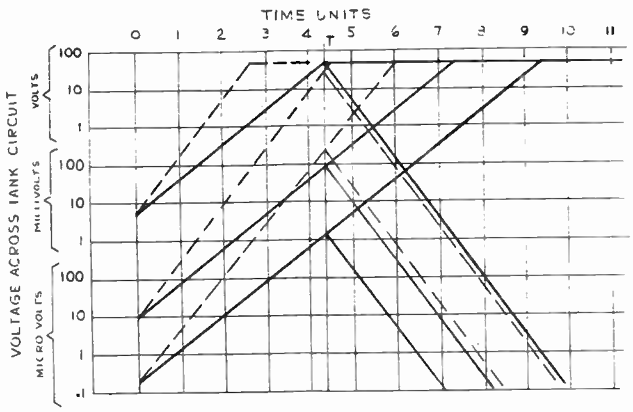
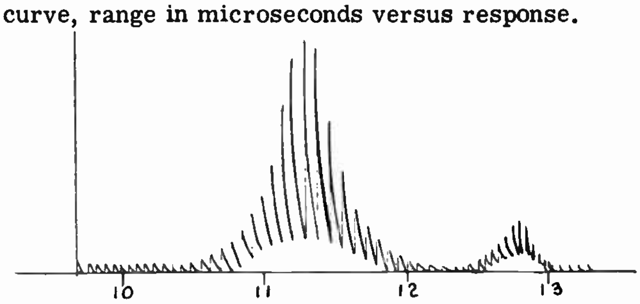


FIG 7

response of the tank circuit to input signals will take place during a part of the first time unit. This means that, using a rate of rise necessary to obtain the desired gain within the available 4.5 time units during which the negative resistance is placed across the tank circuit, the selectivity bandwidth of the circuit will be over 100 kilocycles per second. This is unfortunate because the circuit noise level is controlled by the 100 kilocycle selectivity bandwidth, while the intelligence bandwidth is limited by the repetition rate. This means that, for modulated-signal amplification, super-regeneration is at best only about one twentieth as good as an amplifier having the same selectivity and intelligence bandwidths. However, to amplify pulses of say 1/10 of a time unit duration (1 microsecond), a conventional amplifier needs not less than a 1 megacycle bandwidth to handle such a pulse. If this microsecond pulse is fed to our tuned circuit at the instant the negative resistance is applied, it will need a rise rate that will set its bandwidth at one megacycle to respond. Thus when used for pulse reception, the super-regenerative receiver has the same selectivity and intelligence bandwidths as found with any other type receiver, i.e., the signal-to-noise ratio for pulse reception can be as good for super-regeneration as for any other type of receiver. Using light-house tubes in cavity-type oscillators, noise factors of 6 db at 600 megacycles and 10 db at 3,200 megacycles have been obtained. (At 600 megacycles noise measurements were made with a Measurements Corporation Model 84 signal generator, and at 3,200 megacycles noise measurements were made with a Navy "S" Band signal generator Model TS-403/U.)

In practice, the negative shunt resistance switched across the tank circuit can be supplied by a vacuum tube, a magnetron, a klystron, a transistor, a tunnel diode or any other amplifying device that will operate at the desired frequency.

Even though the receiver gating pulse may last for many microseconds to obtain the desired gain, the sensitivity to signal varies inversely as the logarithm of time after the start of the receiver pulse. Also, since the signal voltage in the receiver tank, before application of the minus R, decays directly as the logarithm of time after the input signal is removed, the range definition can be measured in fractions of a microsecond. Figure No. 8 illustrates a typical Expanded "A" scope curve, range in microseconds versus response.



RANGE IN MICROSECONDS

FIG 8

Up to this point, I have discussed only the operation of super-regeneration as a receiver. Since oscillations are permitted to build up to large amplitudes, and since the tank circuit is coupled to an antenna, energy will be radiated. This makes possible the use of a single circuit as a transmitter and receiver. The circuit in Figure No. 9 shows a single-circuit Super-regenerative Radar Transmitter-Receiver that operates in the logarithmic mode. In

SPOT LIGHT RADAR

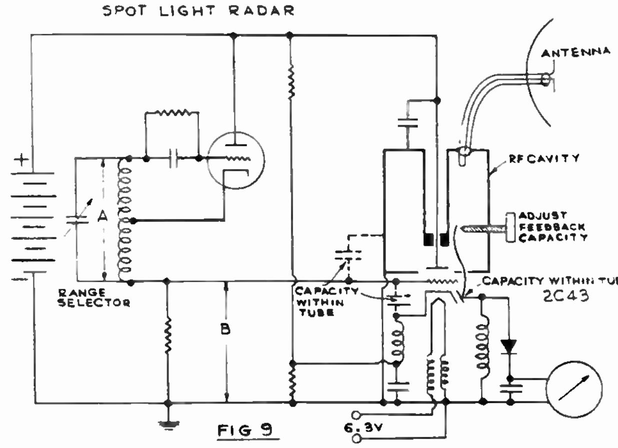


FIG 9

operation, the antenna is aimed at a target, much as a flashlight would be aimed, and the range selector is adjusted until a maximum response is observed on the meter. Figure No. 10 shows the signals at the labeled points in Figure No. 9. This unit was developed to replace optical rangefinders on early anti-aircraft guns, and is probably the simplest form of radar system possible.

The negative resistance supplied by a lighthouse tube is periodically switched on and off by the plate-current surges of the low-frequency class-C oscillator. Since oscillations are always allowed to build up to saturation, high-level radiation is obtained. The time between successive applications of the -R is varied by manually adjusting the frequency of the

PROCEEDINGS OF THE RADIO CLUB OF AMERICA

low-frequency class-C oscillator. The tuning capacitor is calibrated in range.

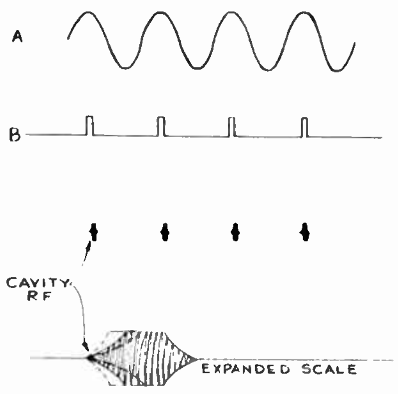


FIG 10

The manner in which a vacuum tube is coupled as a negative resistance to a tuned circuit to obtain the best noise factor in a Super-regenerative receiver is important. Figure No. 11 shows how the effective circuit resistance and the bandwidth vary as the feedback is changed by moving the cathode tap along the tank circuit. Note that there are two points of adjustment for every desired bandwidth. This is done practically in the circuit shown in Figure No. 9 by means of the adjustable cathode-to-plate capacity shown.

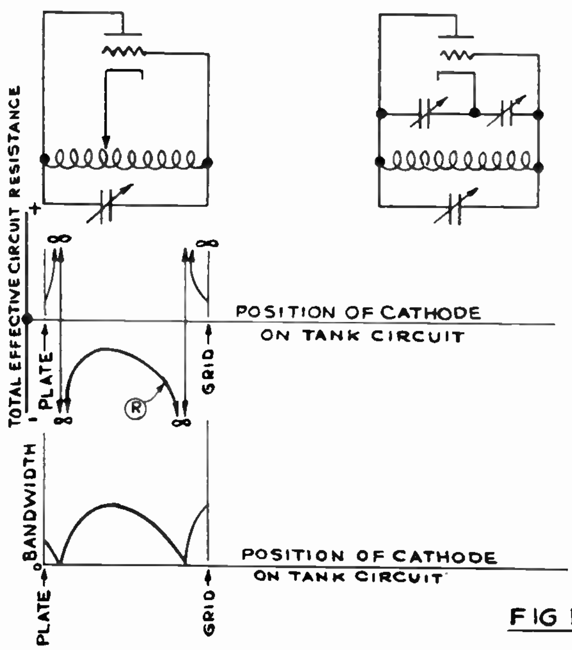


FIG 11

A vacuum tube has a considerable amount of thermal noise associated with the flow of its plate current. If the cathode is tapped all the way towards the grid end of the tank circuit, all the plate-circuit noise is coupled into the tank circuit. On the other hand, if the cathode is tapped all the way towards the plate end, none of the plate-circuit noise is coupled into the tank circuit. Maximum amount of induced grid noise will be coupled into the circuit under this latter condition but this is of secondary importance because the induced grid noise is substantially less than the plate noise. Obviously, significantly superior noise factors can be attained by operating with the cathode tapped as near the plate as possible. Careful attention to these adjustments resulted in the favorable signal-to-noise ratios mentioned above.

To obtain the maximum amount of radiated energy as a transmitter,it is desirable to pulse the tube with as high a voltage as it will stand. However, this is not the best condition for operating the circuit as a receiver. Therefore, the oscillator should be pulsed with a high-amplitude short-duration pulse for transmission; at range-time later, it should be pulsed with a lower-amplitude longer-duration pulse to give optimum performance as a receiver. During the transmit pulse, the detector should be gated off. This manner of operation is known as the double-pulse technique.

If the range delay is varied for successive pairs of pulses, and the detected signal is displayed on a scope while the horizontal spot position is controlled in accordance with the range delay, an "A" scope presentation results.

Since the detector output can be tens or even a hundred volts, no additional amplification is needed between the detector and the deflection plates of the oscilloscope. Also, since the signal pulses can be stretched in the detector circuit, and because the range sweep is slow, neither a wide-band deflection amplifier nor a high-intensity oscilloscope is needed. A few hundred supply volts is all that is required to develop a brilliant presentation. The reduced oscilloscope supply voltage reduces the necessity for high deflection voltages.

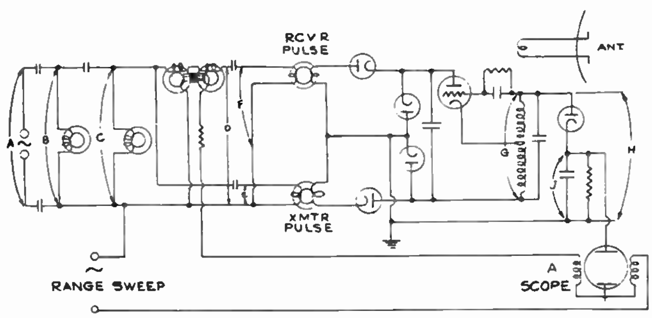


FIG 12

The circuit of Figure No. 12 shows a complete "A" scope radar, utilizing the double pulse technique. The double pulses and the range delay are generated by saturable "Deltamax" toroids directly from a 400 or

2,000 cycle power supply. The range delay is controlled by a premagnetizing current through the range delay reactor. This same current is used to deflect the beam horizontally on the "A" scope, hence no horizontal scope amplifier is necessary.

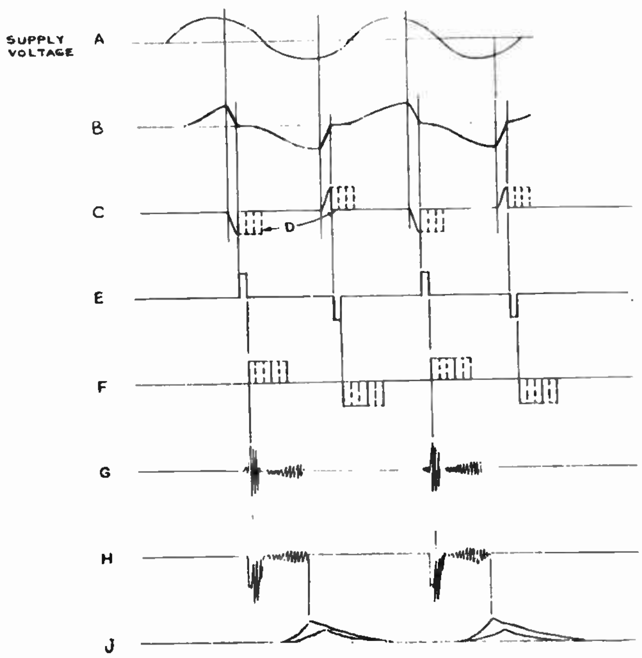


FIG 13

Figure No. 13 shows ideally how saturating reactors are used to create the desired transmit, receive and gating signals. In operation the reactors have high impedance until they saturate, whereupon they suddenly have very low impedance. When these reactors are used as chokes or transformers, voltage can exist across their windings only as long as the flux is changing and will collapse when the flux is limited by saturation. The time it takes a given reactor to saturate is inversely proportional to the applied voltage and is also an inverse function of the amount of premagnetization before the application of the voltage. This is how the receiver pulse time modulation is obtained. A reactor having relatively much iron and many turns is used to form the Wave "B" from the supply voltage. "B" is not an infinitely steep Wave because this reactor after saturation still has substantial inductance. Therefore another stage using a reactor with fewer turns and less iron is needed to develop a wave form having fractional microsecond rise times. The transmit pulses generated by the small tape-wound Deltamax cores may be of the order of a quarter microsecond duration, so that tens or hundreds of volts per turn can be developed. Consequently, very few turns are needed. The toroids used with the equipment were easily wound by hand. The operation of the receiver and the transmit-receive gate should be obvious from the circuit of Figure No. 12 and the curves of Figure No. 13.

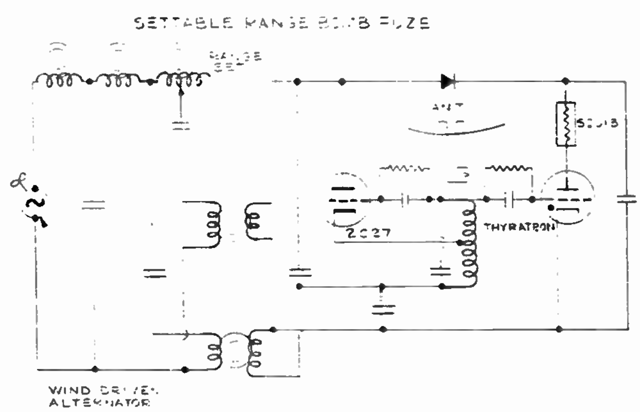


FIG 14

Figure No. 14 shows a typical circuit for a setable range bomb fuze powered by a small wind driven alternator. The mechanical construction of this unit was such that everything shown in the circuit of Figure 14 except the alternator, the squib, and the antennae was contained in a space of approximately two cubic inches. Filaments were energized by a separate low-voltage winding on the alternator (not shown).

A COMPATIBLE AM STEREOPHONIC BROADCASTING SYSTEM

By Leonard R. Kahn, Kahn Research Laboratories, Inc.

It is appropriate first to outline stereophonic system requirements which must be met to satisfy broadcasters, regulatory agencies, and the general public. For an AM stereophonic broadcasting system these requirements are as follows:

(1) The system must be compatible with existing receivers. That is, all AM receivers now in the hands of the general public must monophonically receive the new signal without distortion or other degradation. The program received by existing sets should be well balanced, with no loss of the sound from any instruments which would alter the musical arrangement or tend to make the music flat and lifeless.

(2) The new stereophonic signal should require no increase in spectrum space. This is extremely important because AM now has many cases of severe co-channel and adjacent channel interference. Certainly any system requiring additional bandwidth is unacceptable.

(3) Receivers for stereophonic reception should be simple and relatively inexpensive. Once standards have been set a very large market for such receivers will be established. The cost and complexity of these home receivers must be minimized to insure widespread acceptance of stereophonic AM broadcasting.

The following requirement, while not as important as the above three, is important commercially.

(4) The signal must permit the listener to receive the new signal using two conventional monophonic AM broadcast receivers.

This requirement (4), would be important to the manufacturers of receivers as well as to broadcasters. It has been dramatically demonstrated in the past that the introduction of new broadcasting techniques present "chicken and egg" problems. Few broadcasters will be willing to transmit AM stereophonic programs unless an appreciable percentage of their listeners can immediately receive those programs.

Conversely the public, except for a limited number of technically inclined people or faddists, will not purchase AM stereo equipment until one or more broadcasters regularly transmit stereo programs. This problem could greatly delay widespread acceptance of AM stereophonic transmission.

However, if the public could use existing home receivers for AM stereo reception, broadcasters would have reason for broadcasting AM stereophonic programs. The "chicken and egg" problem would vanish. Thereafter special AM single dial stereo sets would soon find a large market.

This paper outlines a system of broadcasting which meets the above requirements.

System Block Diagram

A block diagram of the system is shown. The left hand stereo information is added to the right in a summing network. This circuit can be a simple resistive network. The output of this circuit is fed to a wideband phase difference network. This network, with its companion phase shift network (part of the phase modulation circuitry) produces a constant 90^0 phase difference relationship.

Thus the audio output of one phase circuit is in quadrature with the phase of the other audio circuit output. Such circuits are frequently used in SSB communications devices, and may be analyzed using Hilbert transforms.

Because the outputs of these phase networks are (ideally) constant in amplitude, relative to frequency, the phase network does not alter the characteristic of the audio wave except to shift its phase.

This audio wave is then fed to an audio amplifier which in turn feeds the modulation input of a conventional AM transmitter. This assures compatibility for monophonic AM receivers.

The left and right hand stereo information is also fed to a difference circuit which produces an L-minus-R component. A phase inverter in the right stereo channel does this.

The output of the phase inverter is fed to one input of a linear summing circuit, and the left channel feeds the second input directly. The resulting audio difference signal is then fed to its associated phase shift network, which in turn feeds a phase modulation system.

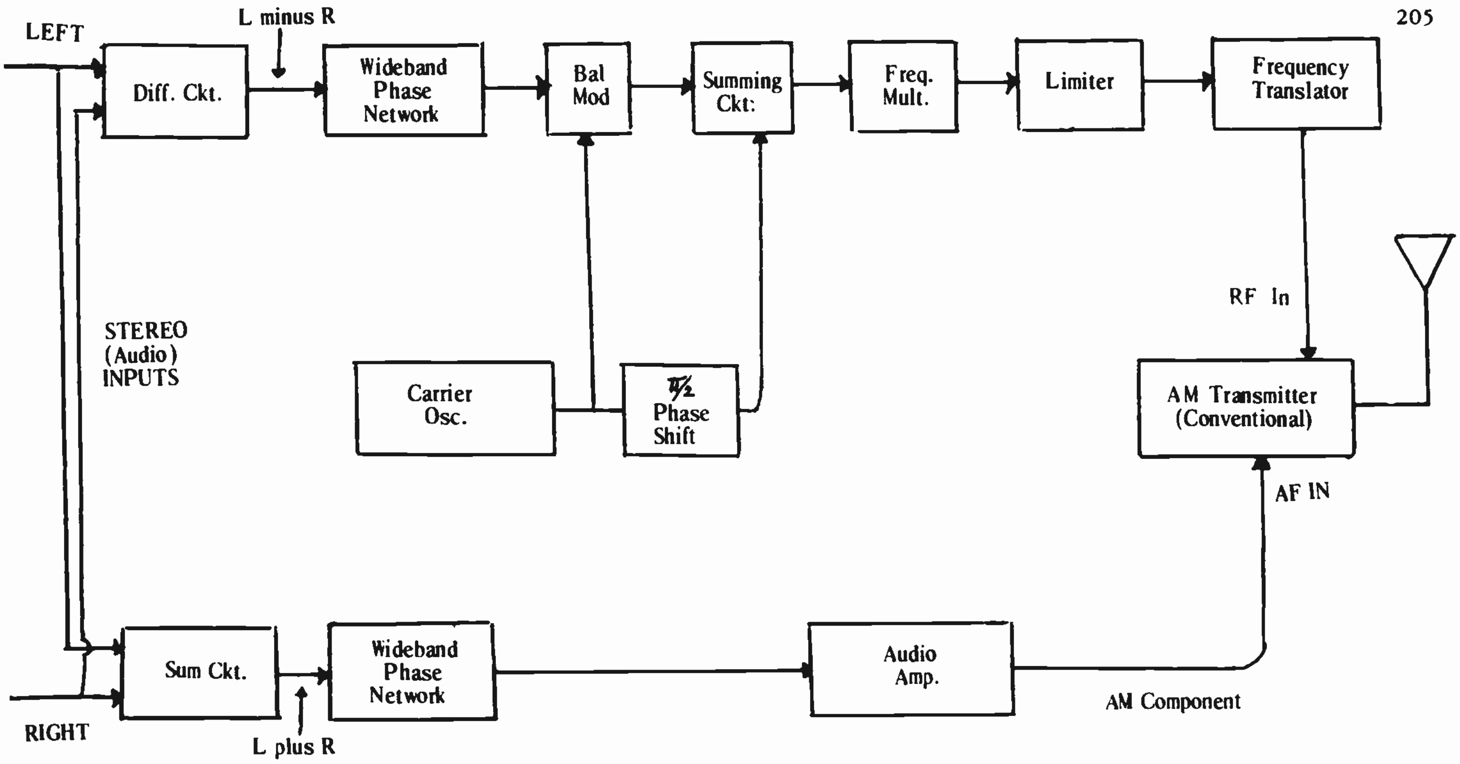
One excellent phase modulation system is the Armstrong phase modulator. In this circuit a balanced modulator produces a double-sideband suppressed carrier signal. This carrier, displaced by a 90^0 network, is added to the output of the balanced modulator to produce a wave in which the carrier and sideband are in quadrature. Such a Quadrature Modulated Wave is similar to a phase modulated wave except for a small envelope component and slight distortion at high modulation levels. Thus it is important to restrict the phase modulation to relatively small amounts. A frequency multiplier may then follow this circuit to produce the desired phase modulation.

The output of the frequency multiplier feeds a limiter which removes the (small) amplitude modulation components. The limiter feeds a frequency translator in which the carrier frequency of the phase modulated wave is translated to the broadcast station carrier frequency. This phase modulated carrier then excites the low level stages of a conventional AM transmitter.

A simplified phasor analysis, demonstrating the separation of the right and left stereo information into two sidebands is shown in Figure 2. Thus a compatible AM stereophonic signal is produced.

Receivers

Since the stereophonic transmission wave displays a single-sideband characteristic, two conventional AM receivers may be used for stereo reception. The receivers should be spaced about six feet apart, with one tuned slightly higher than the carrier frequency and the other tuned slightly lower than the carrier. This simple method of reception has been demonstrated to a number of broadcasters in laboratory demonstrations using two inexpensive table model sets successfully.



Compatible AM Stereophonic Transmitter System, Simplified Block Diagram

A single receiver with two IF strips may be used to receive this type of signal. One IF strip is tuned slightly high, and the other slightly low. Other special requirements for such a receiver will be described in a future paper.

Fulfills Requirements

Laboratory measurements have shown this system satisfies the requirements outlined at the beginning of this paper.

(1) *Compatibility With Existing Receivers.* The distortion characteristics of the system were carefully examined. The data showed that even with a low distortion transmitter (1.2% distortion at 100% modulation) the adapter increased the maximum distortion by only 0.5%. Tests on inexpensive receivers showed increase in distortion caused by the AM stereo signal to be less than 1.0%. Both these measurements and listening tests showed complete compatibility with existing AM receivers of the new system of transmission.

(2) *Spectrum Space Required; No Increase.* Due to the narrowband nature of the new stereo signal, there will be no increase in interference with other stations. A number of other stereo systems have been proposed in which the energy does not go beyond 10 KHz from the carrier frequency. However, an additional requirement must be met if interference in the broadcast band is not to be worsened. This requirement is that the distribution of energy should fall off at audio frequencies above 3 or 4 KHz from the carrier. This fall-off in high frequency energy presently reduces interference in conventional AM transmission of voice and music. Because the energy of this AM stereophonic system falls off in the same fashion as in normal double-sideband transmission no increase in interference will be experienced.

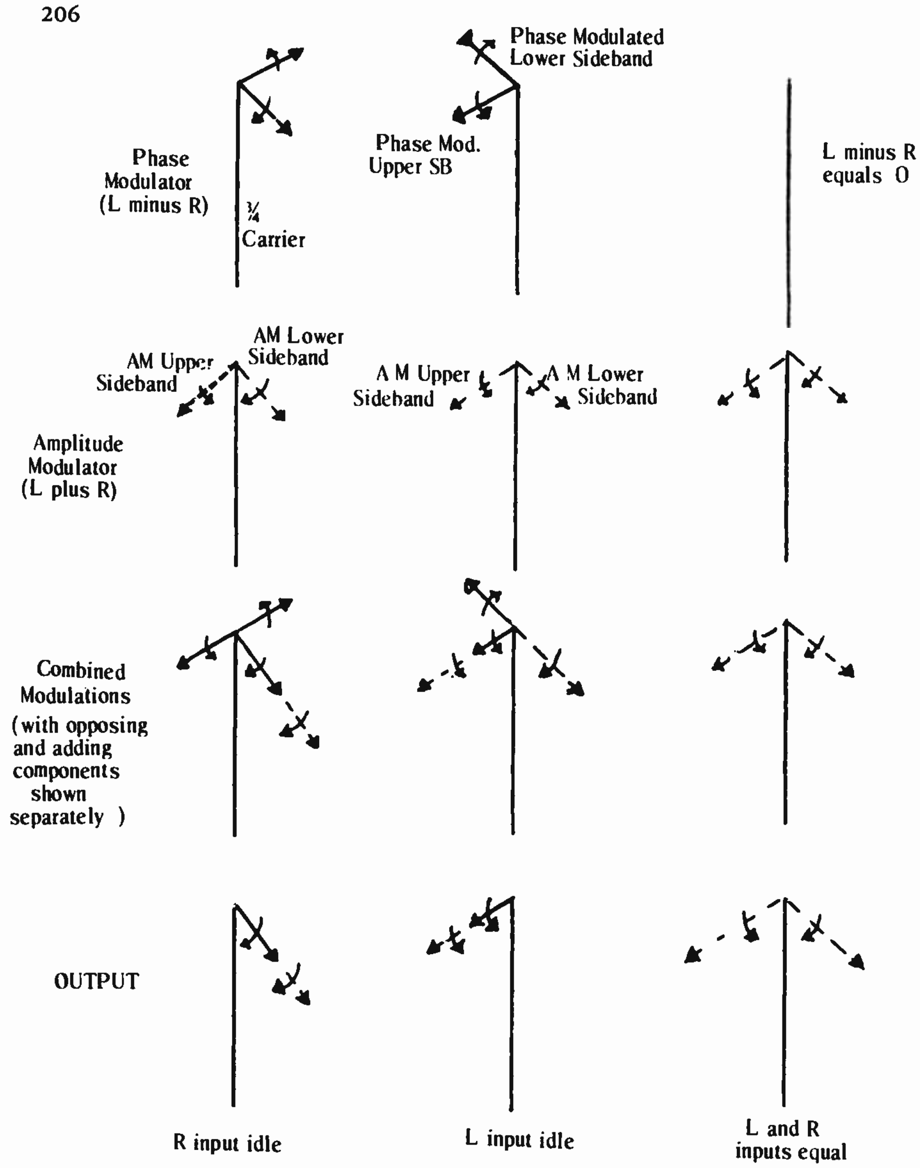
(3) *Receiver Simplicity.* When special receivers are offered to the public it is expected that there will be a large demand for them. These receivers may be made simply and inexpensively by providing an additional, offset-tuned IF amplifier, diode detector, and audio systems. This is the most inexpensive receiving system yet proposed for stereophonic reception. Of course, special sideband-type receivers can be offered for those interested in higher priced sets.

(4) *Stereo Reception With Two Conventional AM Receivers.* Successful demonstrations of two-set stereo reception have been made to a number of leading broadcasting engineers and receiver manufacturers at the Freeport laboratories.

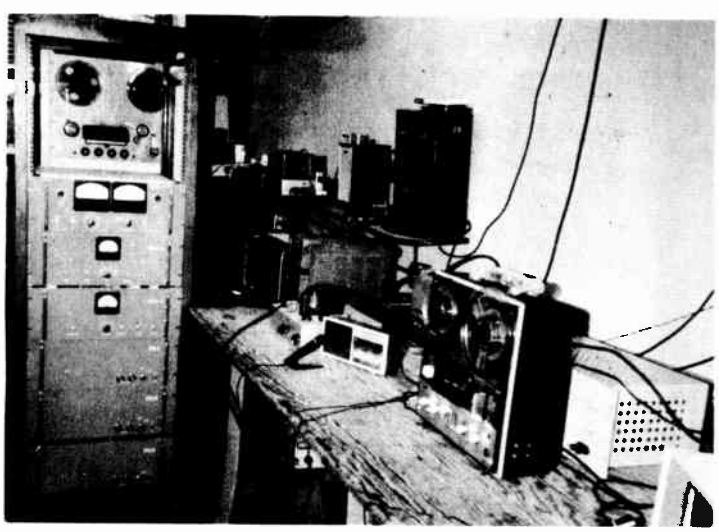
In May 1970, radio station XTRA Tijuana, Mexico, transmitted stereophonic music on 690 KHz which was received in San Diego and Los Angeles. This 50 KW station uses an all music format, and initial listener response in the United States to AM stereophonic broadcasting was very gratifying.

All Type of Transmitters Adaptable

This system may be used by existing AM stations whether high level, low level or Doherty transmitters. An adapter has been made for use with standard broadcast transmitters.



Compatible AM Stereophonic System Simplified Phasor Orawing, Showing First Order Terms Only. (AM sidebands shown as dotted arrows.)



Demonstration Tape for A M Stereo Broadcast At Radio Club Meeting Being Made At Kahn Labs.

The following measurements were made to determine compatibility of the new AM stereophonic system with existent AM (mono) receivers.

TRANSMITTER ALONE WITHOUT ADAPTER

Hz	% Modulation	THD (%)
100	100	0.9
400	100	1.1
1000	100	1.2
5000	100	0.8
100	50	0.7
400	50	0.6
1000	50	0.6
5000	50	0.6

Response at 100% modulation:
± 1.5 dB, 28 to 20,000 Hz

Noise: -53 dB at 1 KHz, 100% modulation

STR-59-1-A ADAPTER

Hz	Audio Output (dBm)	THD (%)
100	10	0.50
400	10	0.52
1000	10	0.54
5000	10	0.34
100	4	0.54
400	4	0.52
1000	4	0.52
5000	4	0.34

Frequency Response at +10 dBm:
±1.5 dB, 50 to 13,800 Hz

Noise: -56 dB

TRANSMITTER WITH ADAPTER

Hz	Total % Mod. Chan. A	Chan. B	THD
100	100	100	1.5
400	100	100	1.7
1000	100	100	1.1
5000	100	100	0.5
100	50	0	1.1
400	50	0	0.8
1000	50	0	0.6
5000	50	0	0.7

Frequency Response: ±1.5 dB,
87 to 9,400 Hz

Noise: -52 dB

BROADCASTING A.D. 2000

(This paper was presented by Mr. Jacobs at the National Association of Business and Educational Radio (NABER) Senior Communications Symposium, held in cooperation with the Radio Club of America, in New York, NY, November 18, 1977.)

By **GEORGE JACOBS**, *Fellow*

Fifty years ago, Lee de Forest, inventor of the Audion vacuum tube, attempted to predict the future of radio and television broadcasting.

This was in 1929, when radio broadcasting was still in its infancy and television was in a rudimentary, crude experimental stage. His remarks appear in the book *Radio and Its Future,* edited by Martin Codel, and published in 1930.

De Forest had this to say:

2 "I often feel that, although radio reproduction has made remarkable strides in the past few years, there is still ample room for improvement. If we compare the reproduction with the original, whether it be human voice, orchestra, band, or organ, we are immediately aware of the wide discrepancy. Nevertheless, listening to radio reproduction day after day, we mentally set up false standards for these various kinds of music and become convinced that we have attained the ultimate of perfection in radio reproduction. It is the unemotional sound analyzer of the laboratory that tell us definitely, in quantitative terms, just how far removed our loud-speakers are from the original sounds—and you may be certain there is ample room for improvement . . . . . and broadcasting will eventually achieve utmost realism."

In the language of today, de Forest was "right on" in his 1929 prediction, (many years before high-quality stereo FM broadcasting) that radio in his future would be of higher technical quality and more lifelike in its sound.

De Forest had this to say about television:

" . . . . I am sure television must develop along the same broad lines (as radio): first, the experimental days, with the experimenters taking part with home-made equipment; then the gradual crystallizing of a practical system, based on knowledge gained in actual work; followed by mobilization of the essential capital, personnel, and production facilities for the creation of an industry quite as well as the founding of a national institution . . . . And when television (is a reality), it will find many applications. I look forward to the unfolding of world events on the home television screen, just as they are happening and not several days or weeks later. I expect the living image of the public man to join his voice in the future home radio (or television) set . . . . . Television, of course, will have an enormous field in the presentation of actual events, particularly sporting events . . . .

Lee de Forest said this in 1929! He continued with a further prediction about radio broadcasting. Said de Forest,

"We are on the verge of international broadcasting (via the shortwaves), when the entire world shall become a single audience taking part in a universal forum of enlightenment."

That's how Lee De Forest saw the future of broadcasting in 1929. The events of the past fifty years have proven him to be quite correct.

What will radio and television broadcasting be like in the future? Taking the start of the 21st century as a convenient reference point (that's just 23 years away), let's take a look at present day engineering developments in broadcasting and allied fields and expected technical advances and see if fact, imagination and deduction can be balanced to paint some sort of picture of what radio and television broadcasting might be like by the year 2001.

Expanded AM broadcasting

Let's first take a look at the familiar AM, or standard broadcasting band, between 535 and 1605 kHz, where nearly 4500 stations are now operating in the United States.

A major international telecommunications conference is coming up in 1979. It will be convened by the International Telecommunication Union in Geneva, Switzerland. The ITU is a specialized agency within the United Nations. The conference is officially called a *World Administrative Radio Conference,* and is more commonly abbreviated as WARC-1979.

The ITU consists of more than 150 member nations, and WARC-1979 is expected to be the most important conference to be held in the 115-year history of the Union. The conference will review regulations, agreements and frequency allocations for the entire radio spectrum through 40 GHz, and possibly beyond. The results will remain in effect, and will shape the course of all forms of radio communications, through at least the early years of the 21st century.

The "frequency pie" will be recut at the conference, and there's no telling how the pieces will be redistributed. The one-country, one-vote rule that governs ITU conferences is almost certain to lead to a clash between the technical and the political aspects of telecommunications. Under these rules little Fiji has as much voting power as the United States!

In the U.S. preparation for the conference to date, certain proposals have already been drafted. There're not final by any means, and they may undergo considerable change before final proposals are submitted to the ITU. The draft proposals appear in the Federal Communications Commission's "Fifth Notice of Inquiry In Preparation For A General World Administrative Conference in 1979." The NOI discusses draft proposals for the entire radio spectrum. As far as AM broadcasting is concerned, the FCC proposes to expand the present AM band to 525 to 1800 kHz. This 20% increase in the band will permit 20 additional channels, which would be capable of handling a considerable number of additional AM stations.

There is also a proposal for a new broadcasting band, at least as far as the United States is concerned, although it is the grandfather of all broadcasting bands in Europe. It's called the *longwave* band, and the FCC proposes an allocation for the western hemisphere in the segment between 115 and 190 kHz.

When broadcasting began in Europe after the first world war, it began in the longwave band. Today, most of Europe's very high power stations, some as high as two megawatts in power, operate in this band. There is an advantage to broadcasting on longwave, since skywave propagation over relatively long distances is possible both day and night. The FCC proposal would permit seven channels for longwave broadcasting in this hemisphere.

Another innovation that might change the family and car AM radio by the end of this century is AM stereo. Several systems for producing stereophonic reception on AM have already been field-tested, and the FCC recently issued a notice of inquiry to explore potential public benefits and technical considerations.

More shortwave broadcasting

Im many areas of the world shortwave broadcasting is very popular. More than 100 countries use shortwave as part of their domestic broadcasting effort; at least 90 countries, including the United States, use the shortwave bands for international broadcasting, along the lines envisioned by Lee de Forest fifty years ago.

It's estimated that there are approximately 130 million shortwave receivers throughout the world and that at least 50 million people tune to shortwave broadcasts regularly. In the field of international relations, shortwave broadcasting plays an important and unique role. It is the only broadcasting medium capable of direct, universal, personal, and immediate communication between peoples of the world. Only shortwave broadcasts are capable of crossing frontiers, spanning oceans and bridging continents.

The worldwide popularity of shortwave broadcasting has risen to the point where the present bands are severely overcrowded, and interference often intolerable. The FCC, in the 5th NOI, proposes an expansion of about 25% in these bands, and chances are good that other countries will propose a greater expansion. If this comes to pass, shortwave receivers will—by the beginning of the new century—contain wider bands, and perhaps several new ones. These will permit clearer reception of shortwave broadcasts.

Quadraphonic FM

In 1929 de Forest predicted that radio broadcasting in the future would tend more and more to greater realism and higher quality. His words are as true now as they were then. Present day FM stereo is almost certain to blossom into FM quadraphonic—or polyphonic—sound reception by the end of this century. Each time another prefix is added to the word "phonic", broadcasting will become more realistic and more lifelike. The FCC has already studied several proposed methods for quadraphonic FM broadcasting, and has recently issued a notice of inquiry to further study the merits of various quadraphonic techniques. It seems safe to predict that by the beginning of the 21st century quadraphonic, or perhaps polyphonic FM broadcasting will be a reality.

TV home communications center

What will television sets look like by the year 2001? According to expert testimony given this past summer before the Subcommittee on Communications of the House Interstate and Foreign Commerce Committee, the family TV set is likely to be transformed remarkably by the end of this century. It will not simply be a television set, but may become the center of a home communications system consisting of a TV receiver, a video tape recorder, two-way cable TV and a home micro-processor computer, all interconnected to offer a variety of entertainment and services.

The video tape recorder, or VTR, explosion seems to have already begun. Prices are coming down, and they are expected to become even more affordable in the near future. More than half a dozen famous manufacturers are offering cassette models for under $1000, and at least one manufacturer is offering a complete home VTR system, including a camera, for less than $1500. Home VTR's ability to record programs off the air for later playback relieves viewers from a fixed time schedule, and the cassette feature opens a completely new source for specialized entertainment and educational programs on a subscription basis.

Micro-processor computers, which are a step beyond the hand calculator, are already available in relatively easy-to-assemble kits and at affordable prices. These simple computers, which use a TV receiver screen for readout, can store more than enough data to handle a family's bookkeeping and record-keeping needs. By the turn of the new century they're expected to be even smaller and cheaper, and a part of the home communications center.

Two-way cable TV

The final ingredient in the home communications center of the future, two-way cable TV, is already a reality, albeit on a very limited basis. Warner Cable's *Qube* experimental system began operating in Columbus, Ohio during late 1977. The experiment, representing a reported investment of more than $10 million, is likely to determine the cable industry's future, and the forecast is optimistic.

The control panel for the Qube system being installed in Columbus homes offers a choice of 30 channels, equally divided between conventional television stations (local and out-of-town), community television and premium programming (with a variety of new and classic movies, sporting events, educational courses, etc., on a pay-per-view basis.)

Added to these are five "response" buttons (yes, no and three multiple choice), which allow subscribers to participate as contestants in local game shows, vote on referenda, purchase products, etc. A "home security option", for fire, burglary and emergency service, will be available in 1978. The posibilities that such a two-way system might offer by the year 2001 seem to be limited only by one's imagination!

Ceefax

In Great Britain, the BBC is presently transmitting an electronic newspaper to subscribers via television. Called *CEEFAX*, the data is transmitted simultaneously with conventional programs, and requires the installation of a special decoder for proper reception. *CEEFAX* news broadcasts are continuously updated by the BBC, so that the latest news is always available to subscribers. In this country, the FCC has allowed the use of a similar system for captioning broadcasts for the benefit of viewers with impaired hearing. By the end of this century it is very likely that such electronic systems will be in common use for producing on the face of home TV receivers not only newspapers and magazines, but electronic mail as well.

Optical fiber cable systems

The biggest drawback to date in the widespread use of home communication centers has been the lack of available spectrum space. There just aren't enough coaxial cable, microwave or radio and television channels to "wire" the nation together. But optical fibers seem to hold a promise for providing an almost umlimited amount of spectrum in the future.

Optical fibers propagate laser-driven light waves in much the same way that coaxial cables transport radio waves. Light waves are capable of a much greater number of communication channels than is possible with radio waves.

Optical fiber cables are prohibitively expensive using today's raw materials and manufacturing and installation techniques, but new methods for fabrication already on the drawing board can reduce future costs drastically. In Japan, the homes in a new city being developed from scratch will be wired together for communications with optical fiber cables. Many experts predict that much of the United States will be wired similarly by the year 2001.

Direct broadcasting satellites

Television receivers at the turn of the century will in all probability have a "12 gigahertz (GHz)" band for direct reception of broadcasts from satellites.

A major conference convened by the ITU during early 1977 assigned channels in this band, and corresponding orbital slots, for direct broadcasting satellites to every country in Europe, Africa, Asia and Oceania. A similar conference, scheduled to the held before 1982, is expected to assign channels to the United States and the other countries in the western hemisphere.

The television system envisioned for the 12-GHz band is not compatible with present day terrestrial systems. It will employ FM video and a greater bandwidth than present signals, and will require a converter for use with existing receivers.

The reception of 12-GHz TV signals from a direct broadcasting satellite has been successfully demonstrated with the US-Canadian CTS satellite. Good-quality signals have been received on conventional home TV sets, using nothing more than a relatively simple and cheap signal converter and an outdoor disc antenna about a meter in diameter. The Japanese plan to inaugurate a 12-GHz direct broadcasting satellite system by 1979, and most of the developed countries of the world may have similar systems by the beginning of the 21st century.

There is also a good chance that future TV sets will have stereo sound and possibly three-dimensional video. Stereo sound is technically possible today, and systems employing two independent sound channels are in limited use in some countries where there is more than a single national language. Three-dimensional video systems may be more difficult to achieve, and would probably require special eyeglasses for viewers, similar to those used at one time for three-dimensional movies. But both Westinghouse and CBS have developed circuitry that allows two color television pictures to be transmitted over a single channel. This could be the basis for three-dimensional television in the future.

TV receivers of the future are also expected to have improved selectivity and sensitivity, particularly for the reception of UHF stations, and better color stability and control.

In summary, a crystal-ball look into the future sees by the year 2001 a family or car AM radio with more channels, a new longwave band, and stereo capability. Shortwave radios will have more channels and new bands for easier and clearier reception. The FM radio of the future will be capable of at least quadraphonic reception, and perhaps polyphonic sound, and television sets may have stereo sound, three-dimensional display and the capability of receiving direct broadcasts from satellites.

The use of optical fiber cable systems, video tape recorders and micro-processor computers is expected to transform the family television set into a two-way home communications center offering a wide choice of entertainment and educational options closely tailored to a viewers taste, as well as having the capability for electronic shopping, banking and mail, receipt of continuously updated visual newspapers, medical checkups without the need to leave home, information retrieval from data banks with a greater store of information than is now available from conventional libraries, home bookkeeping, budget and record keeping, and home security.

Just as this paper began with an assessment of Lee de Forest's predictions for the future of radio and television broadcasting made in 1929, an assessment of the predictions contained in this paper will have to await a similar review to be made by members of the Radio Club of America at the beginning of the 21st century.

It has been said by a noted historian that the past and the present often quite accurately predict the future. Time will tell!

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FROM DRUMS TO MOBILE RADIO

The following is a history of Mobile Radio Communications reprinted from a brochure published by Link Radio Corporation with the permission of Fred M. Link, founder of the company and its president and sole owner for 20 years. When reading this remember that it was written and first published in 1940.

In darkest Africa the black man developed one of the earliest forms of Wireless Communication, the Drum, how long ago no man knows. He needed it for in the heart of his vast country, which was one unbroken forest without roads, traversed only by footpaths, it became necessary to communicate messages to his fellow man.

War, hunting, fishing, sickness, death, were all of prime importance to the savage.

Men went away out into the jungle forests to hunt. Women traveled to cultivate far distant garden clearings. Word came to town that enemy tribes were on the warpath; or perhaps some important member of the tribe had met death, his funeral was of major importance; a man's wife ran away, messages must be sent along her pathway of escape to catch and hold her.

The practical answer to all these important needs was the Drum which, by relay, sent messages from one town to another covering great distances. Messages are sent by "tone" rather than by words spelled out. Certain tone-rhythms convey certain understood sentences.

FIRE

The torch appearing between the flags on the insignia of the Signal Corps is one of the oldest forms of communication known to man—Fire . . .

Beacons kindled on high elevations to communicate vital messages are referred to in early classical literature:

> "Set up a sign of Fire in Beth-haccerem, for evil appeareth out of the north."
>
> Jeremiah 6-1

From Jerusalem to Babylonia the early Jews had a system of fire signals along a chain of hilltops.

The ancient Greeks flashed home the news of the fall of Troy by a sequence of prepared beacon fires built at strategic points on the Aegean Islands and on the mountain tops.

Down through the centuries fire was a most important form of communication. As late as 1775 Paul Revere still used the light of his lantern to carry his message of warning through the night.

SMOKE

Before the Christian era, when the Romans sent expeditionary legions to Britian, it was discovered that the aboriginal Picts had developed a very complete set of communications through the use of smoke puffs produced by blanketing a fire.

Later, when our covered wagons trekked their weary way westward, those hardy Pioneers, looking for new homes in the wilderness, found that the Indians used these same smoke signals to announce well in advance the coming of the pale-faces. In many cases this made possible the annihilation of wagon convoys crossing the western prairies.

At that time no white man had perfected any system of signals so effective.

GALILEO

Early in the seventeenth century, the Italian astronomer, Galileo, invented the Telescope, making it possible to magnify a visual signal from a source too far away to be seen with the naked eye. This was a vital step forward in the realm of communication.

Galileo was greatly honored for the telescope's application to signalling. A device that would bring advanced tidings of the arrival of 'treasure laden' ships was highly appreciated by commercial men.

SEMAPHORE and TELESCOPE

In the eighteenth and early nineteenth centuries the word, 'telegraph', was applied to long visual signalling lines.

The prefix, 'tele', means, 'far off'. The words, telescope, telegraph, telephone, teletype, and television, all bearing this prefix, show the sign of a new phase in signal communication.

A telegraph station consisted of an observer with a telescope to pick up signals and a semaphore to relay them to the next station. This system of semaphore lines was constructed from Cape Cod to Boston and from Coney Island to New York City; still another such system was located on San Francisco's Telegraph Hill, all to report in advance the arrival of some important clipper ship.

Samuel F. B. Morse was by profession a portrait painter. In 1832, returning to America from England on the sailing ship, Sully, he conceived the idea of a magnetic telegraph—and at the same time worked out a code of dots and dashes to carry the message over wires. Three years passed—Morse was penniless—nothing happened.

In 1835, Morse was appointed instructor of Art at New York University. He rented a garret room where he ate and slept; every spare minute he could find he worked on his discovery. He finally obtained the help of a brilliant young student, Alfred Vail, and, in a factory loft in Morristown, N. J., the Electro-Magnetic Telegraph was finally born.

On March 3rd, 1843, after eight years of heartbreaking difficulties, Morse was granted an appropriation of $3,000 by Congress, to build a telegraph line from Washington to Baltimore. The first message sent was: "What Hath God Wrought."

Now many millions of miles of wires carry messages to all parts of the world.

BELL

Alexander Bell in an attic room and his assistant. Thomas A. Watson, in an adjoining room experimented with tuned harmonic reeds. We quote Watson's statement of what happened on June 2nd, 1875:

> "I was plucking a stuck reed, when a sound shaped electric current passed through the wire from my work-room to Bell's; he heard for the first time the tones and overtones of a sound transmitted by electricity."

There followed nine months of ceaseless effort before Bell's "brain child" uttered its first sentence.

Bell had moved to 5 Exeter St., Boston, where he rented two rooms, a shop and bedroom, for $4.00 per week. A wire ran from one room to the other. On March 10th, 1876, Bell was in his shop and Watson was in the bedroom with a receiver to his ear. Bell accidentally upset a jar of battery acid over his clothing. Excitedly he called: "Mr. Watson, come here, I want you." The instruments were so adjusted that Bell's voice carried distinctly over the wire to Watson. Bell's vision had become a reality—it talked.

1876 was the year of the Philadelphia Centennial Celebration. Bell reserved an exhibition space but his funds were so low that he had to borrow money for train fare from Boston to Philadelphia. His small display table was lost in the vast expanses of the hall. No one paid any attention to his fantastic story.

Towards the close of a hot, muggy summer day about the time Bell had given up hope of obtaining any financial help, he saw a group of influential looking men approaching. Suddenly the leader stopped and extended his hand. "Professor Bell, I'm delighted to see you again!" It was Dom Pedro, Emperor of Brazil, whom Bell had met in former years. The Emperor said, "What have we here?" Bell demonstrated his instrument. Dom Pedro placed the receiver to his ear, listened a moment and sprang to his feet exclaiming, "God save us, it talks!"

Lord Kelvin, of Atlantic Cable fame, next listened, saying, "It does speak, gentlemen! This invention is the most wonderful thing in America!"

The next morning, the newspapers blazoned the story, bringing great attention to Bell and his invention.

Once upon a time

The latest

WIRELESS COMMUNICATION

Near the beginning of the twentieth century, a new unit of energy was being investigated by many leading scientists. It was the 'electron', which was destined to advance the science of communication to undreamed-of horizons. The phenomena of our modern radio have resulted largely from the mental feats of an English mathematical physicist, **James Clerk Maxwell.**

Maxwell correlated the theories and surmises of **Faraday** and other electrical pioneers and through intricate mathematics established on paper the fundamentals of radio. He also discovered the speed of light to be 186,000 miles per second. **Einstein** later found this to be the general speed limit of the universe. Maxwell concluded that the light by which we see is a form of electro-magnetic radiation, a conclusion which stands confirmed by modern science.

Heinrich Hertz, a German scientist, put Maxwell's theories to work at Karlsruhe, Germany, in 1888. Hertz first demonstrated in his laboratory the superswift transmission of electro-magnetic oscillations, using two large metal balls and a loop of wire with a gap in the center, across which live sparks jumped through space. Hertz never realized the importance of his vast discoveries, since he died soon after this at the early age of thirty-seven.

Guglielmo Marconi, a brilliant young student of the theories of Maxwell and the accomplishments of Hertz, had the intuition that these waves might furnish mankind with a new and powerful means of communication. At his father's estate in Italy, at the age of twenty-one, Marconi began making his own tests. After several years of hard work he developed sensitive instruments and was able to send 'The Message' for a distance of two miles. Hertz had used two metal balls for his oscillator; Marconi's conception was different. He used the earth, itself a metal ball, as one of his terminals and a great length of wire reaching upward into the heavens as the other. Then and there the Radio Antenna came into being.

One hundred and fifty years after **Benjamin Franklin** sent his kite aloft to learn the secret of electricity, another inquiring mind was sending a kite into the heavens along the coast of Newfoundland to bring out of the ether a message carried by electric emanations from far across the sea.

Guglielmo Marconi had, in 1899, sent wireless communications across the English Channel and in 1901 we find him and his assistants on the bleak coast of Newfoundland. Marconi sat for an hour with his ear glued to a receiver attached to a kite antenna. He knew **Fleming** was at his sending instruments in Cornwall, England, tapping out **Morse's** code letter "S" which is three dots. Finally, just after noon faint clicks were heard. He listened intently—then with a never-to-be-forgotten thrill he heard distinctly the first wireless communication across the broad Atlantic.

STEPPING STONES TO WIRELESS

Theory. JAMES CLERK MAXWELL was born in Edinburgh, Scotland, in 1831. He entered the University of Edinburgh and later went to Cambridge. From 1860 to 1865 he was professor of physics at Kings College in London. There he met Faraday whose theories and surmises on the subjects of 'Time' and 'Space' intrigued him greatly.

Science. HEINRICH HERTZ was born in Hamburg, Germany, in 1857, the son of a lawyer. He became a student of technical science but soon decided to devote himself entirely to physics. After three years of study in Munich and Berlin he became assistant to Helmholtz and later entered Kiel University. He taught at Karlsruhe Technical High School in 1888 and there the Hertzian or Radio Wave was born.

Invention. GUGLIELMO MARCONI was born in Bologna, Italy, in the year 1874. His father, Giuseppe Marconi, was an able business man and a gentleman of means. His mother, history tells us, was a keen-witted blue-eyed Irish girl. Their son was destined to bring everlasting glory to Italy. Marconi grew up to be a clever electrical engineer with a keen mind for business.

STEPPING STONES TO ELECTRONICS

THOMAS A. EDISON, in 1884, unintentionally built the first Vacuum Tube. While developing the electric light he noticed the effect of the play of electrons in the semi-vacuum of an incandescent lamp. To confirm his suspicions that something new was happening, Edison set up a metallic plate in such a position that he was definitely conscious of the flow of electric current through 'space' in the tube. He thus established the basis of the modern Electronic Tube. However, two decades passed before this Edison Effect was utilized.

JOHN AMBROSE FLEMING, Marconi's chief engineer, found, through experimentation, that this Edison Effect placed between the antenna and the ground connection of a receiver could be used as a 'valve', offering means of detecting radio signals. Thus, early in the twentieth century, the Fleming valve theory added to the Edison Effect created the Diode Tube Detector, which marked a new milestone in the advancement of electric communication.

LEE DeFOREST at this time saw great possibilities in this electronic 'Tube-in-the-making'. He realized that means must be found to further direct the electrons' course through space. Fleming's valve had acted as a 'do not enter' sign on a one way street; DeForest added a grid to the diode tube which established 'stop' and 'go' signs. This grid also acted as a speed control system for the regulation of electronic traffic. DeForest's 'Triode' tube became the Electronic Amplifier which ushered in a new day in radio communication.

RADIO ENTERS

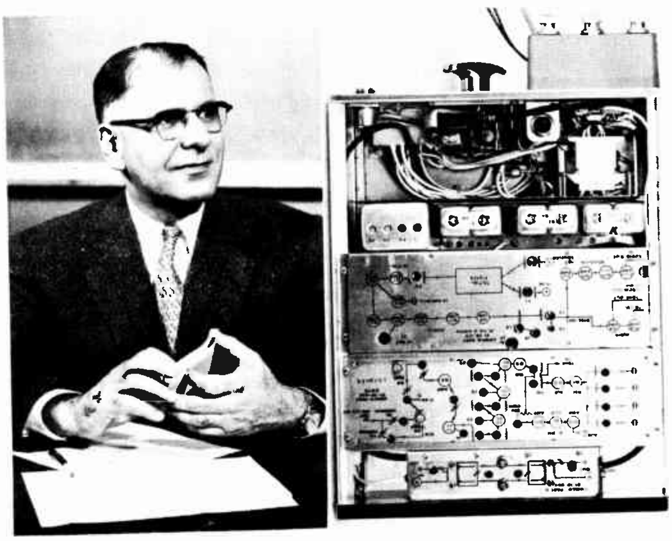
In 1907, Lee DeForest had produced and patented the triode or audion Tube; later **Dr. H. D. Arnold** of Bell Telephone Laboratories and **Dr. Irving Langmuir** of General Electric Research Laboratories added their contribution of "high vacuum" to the DeForest tube and radio started on a dramatic career destined to revolutionize the scope and trend of all modern living.

What a thrill to watch "Junior" in the basement with a table full of contraptions, earphones glued to his head, trying to make his crystal set work! Later another thrill to switch on your first set, turn the dial and pick up **KDKA** or some station nearer home. Quality of reception did not matter, the important thing was to brag next day at luncheon that you "got Davenport, Iowa", or that just after midnight you "almost had Los Angeles".

Broadcasting and reception were in a very formative state. On July 23, 1909, the steamer, **Republic,** flashed an S.O.S. by means of its new wireless equipment. The message brought nearby ships to the scene of the disaster and many lives were saved. April 14, 1912, the **Titanic** went down but not before its radio signalled for help. This greatest sea tragedy of all time proved the value of radio as seven hundred lives were saved. Wireless was becoming an absolute necessity for ocean traffic . . .

World War I again brought radio dramatically to the front as modern science and unlimited sums of money were made available for its development. Scientific investigation for war purposes had done much to improve radios. They could now be found in an increasing number of homes. The demand came for radios in automobiles; these were soon developed and operated successfully. At this juncture an urgent need was felt for police communication to aid in crime detection and the enforcement of law and order in our communities.

THE WHOLE BROAD SUBJECT OF RADIO NOW BRANCHED INTO TWO MAJOR DIVISIONS, BROADCASTING AND COMMUNICATIONS. Broadcasting confined itself to the fields of education and entertainment while communications devoted itself to man's information and protection on sea and land. At this point we stress the accomplishments of man's ingenuity in the field of **Mobile Radio Communication**, which has assumed tremendous proportions in the past few years. Following is the story of the achievements in this field of a small group of earnest radio engineers headed by **Fred M. Link**



In the early days of civilization, man fought for his very existence in order to live in competition with the animal world around him. Finally God gave him dominion over the lower orders of life; he developed a civilization in which the forces of law and order predominated over the forces of evil. Never in the history of the human race has there been a time when man could relax for a moment his effort to uphold that balance of power for good.

Now in the advanced twentieth century we find organized crime flourishing throughout the entire world. Man carries on a ceaseless fight against such crime and also to protect his fellow man from the ravages of the elements, from flood and fire, from disease and famine. Through man's ignorance and stupidity, unnecessary accidents take a staggering toll in all walks of life.

Mobile radio is playing a great role in the world today, doing its part in upholding these important forces of law and order. Statewide Police Radio now covers the greater portion of the United States with the Eastern Seaboard almost solidly protected by modern Link FM equipment. Public Utilities all over this broad land are realizing that the cost of radio equipment, its installation and maintenance, is paid for many times over through the "speed up" of all their activities. Railroads and highways will soon be radio controlled. Our government uses mobile radio communications systems in the U.S. Armored Forces, Field Artillery, Signal Corps, Navy, Marine Corps, Coast Guard, Secret Service, Civil Aeronautics Administration, FCC, FBI, and many others.

As the motor car speeds over super-highways which have replaced the old wagon trails, as palatial steamers plow across the ocean where slow sailing ships fought the waves only a short time ago, and as the modern clipper ship wings its way into the heavens, annihilating time and space, so has come into being a method of radio transmission known as FM (Frequency Modulation) which is revolutionizing the entire field of emergency radio communications.

AM (Amplitude Modulation) is the most generally used method of broadcasting over certain prescribed air lanes. By this method you hear the programs coming from your home radio; but it is not entirely free from interference. Man-made and nature-made static overrides the AM carrier wave and often raises havoc with some favorite program to which you are listening. One could overlook this disturbance on his home radio, but emergency radio communication, especially in war time, was a different thing. Interference was an obstacle that had to be eliminated if possible.

Major Edwin H. Armstrong, internationally prominent radio expert and unquestionably one of the foremost inventors in the field of communication of all time, worked out a successful method of radio transmission and reception; this he called **Frequency Modulation** simply because the radio signal was varied in frequency rather than in amplitude in order to get variations in volume and tone. This relatively new method of radio inherently reduced the interfering effect of both nature-made and man-made static thereby greatly improving the art of communication.

The Ekofisk Project

By JOSEPH F. WALKER, Sr.

The paper below was presented by Joseph F. Walker, Sr., at the "Round Table '77" Radio Club session on the afternoon of November 18, 1977. Mr. Walker is Supervisor of Radio Operations, Phillips Petroleum Co., Bartlesville, OK., and Vice-President of its subsidiary, Phillips Communications, Inc. He has been head of Phillips Petroleum Co.'s domestic and worldwide operations since 1951.

The Phillips Ekofisk project in the North Sea is a $5 billion complex of oil and gas production facilities, crude oil pipelines, gas transmission pipelines and process plants extending from England to the Norwegian sector in the middle of the North Sea and to the Federal Republic of Germany.

Ekofisk has the most complex electronic production control, monitoring and communications network in offshore waters. A $20 million radio system designed and installed by Phillips Petroleum Co. provides all communications via a combination of tropospheric forward scatter radio, microwave and satellite.

Although other radio systems are used throughout Ekofisk, this article is limited to a brief description of the four major systems: Ekofisk to England; Ekofisk to Germany; the field microwave system and the Ekofisk to Norway satellite system.

Ekofisk-Teesside System

The first system was for the Ekofisk to England *one million barrels of oil per day* crude oil pipeline. This required highly reliable communications. After research of virtually every conceivable communications possibility, tropospheric forward scatter radio was selected for the first radio system. This would be a single-hop, 215-mile link from Ekofisk to England. Our path calculations were based on two recognized methods, NBS Technical Note 101 and CCIR recommendations. Minimum performance criteria were established:

1. Annualized time availability, a minimum of 99.9%.
2. Channel signal-to-noise ratio to be 42 dB or better.
3. Maximum data bit error rate to be better than 1 in 10^5 at a rate of 2400 BPS.

With Ekofisk located in the Norwegian sector and the land terminal in England, a private international communications system was involved, requiring approval by both governments. The Norwegian telecommunication administration advised the system concept would be approved by Norway provided the United Kingdom concurred. Approval by the U.K. Home Office Division of Telecommunication was granted with two conditions.

1. The channel capacity of the system would provide communications for possible future users, and
2. The system design would inhibit interconnection to the public telephone network of the U.K. Both conditions were acceptable.

A 96-channel system was designed. It was limited by several factors. Among these were number of frequencies and transmitter power. The frequency used in the North Sea is in the 2.5 gigahertz band with a power limitation of 1,000 watts. Frequency diversity systems are not permitted. It was determined that a system utilizing quadruple space diversity with polarization protection, pre-detection combining and threshold extension capabilities could meet our needs.

An 800-foot escarpment on the east coast of northern England was selected as our land terminal. At this site, two 40-foot parabaloids were erected, each illuminated with 1,000 watts; one in the vertical and one in the horizontal plane, providing an effective radiated power of 50 megawatts. Due to space limitations offshore antennas were smaller. The size on each platform was 30 feet at heights of 150-feet.

Intermediate pumpstations located at 70-mile intervals are served by offsetting feed horns to radiate a portion of the signal from Ekofisk and Teesside to the individual stations. The return paths to Ekofisk and England are relatively straightforward systems.

The Ekofisk-England system has now been in operation more than one year. All design objectives have been achieved. Due to bandwidth required to accommodate the 96-channel capability, an acceptable degradation in signal-to-noise ratio occurred in our voice circuits. A bit error rate of better than 1 in 10^5 at 2400 BPS in data transmission is maintained.

The tropo land terminal is linked to our Teesside, England plant by a 1.5-gigahertz microwave system.

Ekofisk-Emden System

The gas from Ekofisk is delivered to Emden, Germany, through the largest subsea gas pipeline in the world. It is capable of delivering 2.3 billion cubic feet per day. The line, 274 miles in length, is equipped with two compressor stations located at 95-mile intervals and is served by a 2.5-gigahertz tandem multihop scatter system designed to CCIR specifications. Two frequencies were allocated for the system. Stringent specifications were also and placed on antennas at Emden. The latter necessitated addition of serrations to the periphery of the 40-foot antennas to redistribute backward radiation.

The two-frequency system posed the possibility of internal interference, requiring application of a new technique. An automatic power control was developed, permitting the receiver to control the amount of power being radiated by the distant transmitter. Performance is then optimized to predetermined signal set points with levels maintained through a dynamic range of 50 decibels. The system was commissioned in early 1977. Performance has been highly satisfactory.

Ekofisk Field System

The Ekofisk field system utilizes duplicated microwave, operated in the 13 gigahertz band and designed for 99.99% time availability (CCIR). The range is approximately 20 miles, with antenna heights of 180 feet at nine outlying platforms. A combination of frequency, space and polarization diversity is used. The antenna gain is 39.5 dB with a 1.7-degree 3-dB beam width. This system was commissioned in 1976 with required performance the same as that specified for other systems. Infrequent heavy snow in the Ekofisk field causes some signal degradation. Other precipitation has no effect.

Ekofisk-Norway Satellite System

Variation in oil-to-gas ratio in the Ekofisk wells can influence the crude oil flow to England. To provide the capability of field optimization, well test data are recorded for computer storage at Oslo, Norway. Production may then be programmed by computerized information. To provide this, a communication link between Ekofisk, the operations headquarters at Tanager, (Norway) and Oslo was required for this and other communication. The distance from Ekofisk to Norway is 230 miles. The Phillips group and the Norwegian Telecommunications Administration (NTA) agreed to the provision of communication channels via satellite between Ekofisk and Norway.

Norsat, the satellite entity of NTA, leased a half transponder from Intelesat for use by the oil industry. The system operates with nonstandard earth stations and is capable of operation into space segments both in the Atlantic and Indian oceans. Antenna step tracking is used to accommodate space segment orbit variations. Parametric amplifiers are used. The transmit power amplifiers are capable of 1.5 kW output but are operated at lower levels to reduce intermodulation products.

The system utilizes dedicated single carrier per channel for maximum flexibility. The primary modulation is two-phase phase shirft. Secondary voice mode is delta modulation. Data is transmitted at 24 kilobits with an 8-kilobit error correction based on two 2400 BPS data channels multiplexed with 24 50-baud teletype channels. Voice activation of the carriers provides a capability of approximately 120 two-way channels.

Eight channels in the satellite system are now activated. A ninth data channel is used for the transmission of weather data from Ekofisk to the Netherlands for use in North Sea weather research.

The entire communication systems of Ekofisk, including tropo scatter, microwave, satellite, VHF and HF communication have fulfilled all expectations. The integrated systems provide a capability of automatic instantaneous communication between any of 1,000 locations throughout the three-nation network over a distance in excess of 1,000 miles. The systems have been designed with expansion capabilities to meet not only current but long-range North Sea communication needs.

FIFTY YEARS OF MOBILE RADIO

by J. R. BRINKLEY, C. Eng. F.I.E.R.E.

Mr. John R. Brinkley (Fellow 1971) is Chairman and Managing Director of Redifon Telecommunications Ltd., which he joined in 1971. He is on the Board of Rediffusion Ltd., and Chairman or Board Member of several other companies in the group. His career in telecommunications began with the British Post Office at Dollis Hill Research Station, and during the war he was seconded to the Home Office where he was responsible for the development of v.h.f. radio for the police, fire and civil defence services. In 1949 Mr. Brinkley joined Pye Telecommunications as Chief Engineer, becoming Technical Director and subsequently Managing Director. In 1967 he joined ITT as International Manager of Mobile Radio. He has been responsible for many innovations in the mobile radio field and played a leading role in the introduction of 12.5 kHz channelling in the v.h.f. bands in the United Kingdom.

Mr. Brinkley is a member of the Home Office Frequency Advisory and Mobile Radio Advisory Committees. He served as a member of the Institution's Council from 1963-1966.

The early futurologists who so imaginatively predicted space travel, airplanes and submarines seemed—with few exceptions—to have missed out entirely on radio communication. It must therefore have been an astonished world to which Marconi first demonstrated ship-to-shore communication—over eight miles from the S.S. *Mayflower* to the Isle of Wight, in May, 1897. In July 1898 he transmitted the results of the Kingstown Yachting regatta to shore from the *Flying Huntress*—the first commercial transmission, paid for by a national newspaper.

Dramatic incidents packed the early days of marine radio, emphasizing to the public the importance of the new communications medium. In July 1910, Captain Kendall of the CPR liner *Montrose* bound from Antwerp to Quebec radioed that he suspected two passengers, Mr. Robinson and his son, to be in fact Dr. Crippen and Miss Le Neve, wanted in London for the murder of Crippen's wife. Inspector Drew of Scotland Yard took a faster ship and was on hand to arrest Dr. Crippen at the Canadian port.

Even more dramatic in its impact on the public was the loss of the Titanic in 1912. The U.S. Congress passed laws enforcing strict requirements in respect of the equipment and operators on seagoing vessels, and the industry began to assume a prominent place as a public service. In 1914 the British Mercantile Shipping bill laid down that every British ship carrying 50 or more persons more than 150 miles from the coast must have a wireless installation.

Marine radio made rapid progress in those early days, first because the need for communication with ships for safety purposes was great; second, the low-frequency technology of the time, requiring large antennas and bulky transmitters, could be accommodated very readily aboard ship. Moreover, propagation of such frequencies was exceptionally good over water.

No such simple technology was to hand for communication with land vehicles. Large antennas were impractical, propagation of the low frequencies then available is relatively poor over land, and the long waves do not readily penetrate built-up areas. The few early attempts made to fit road vehicles had limited success. Serious interest was probably first aroused by the arrival of the tank in World War I. Meanwhile the interest in crime prevention was stimulating police interest in the wireless medium. Technological difficulties were, however, still formidable.

Early Police Wireless

Despite these difficulties, by the 1930s some of the larger cities in Britain had installed medium-frequency transmitters operating around 2 MHz, transmitting one-way services to police cars. The transmissions were hand Morse, with some limited attempts to use telephony. These services were severely handicapped by high noise levels, fading and long distance interference and were of limited value even to the few cities which were fortunate enough to get a frequency or, more usually, share a frequency.

One remarkable pioneer police installation was put into service in 1932 by the Brighton police. Foot patrol policemen were equipped with "lightweight" receivers (4 lb!) operating on 2·3 MHz. The receivers worked remarkably well but the frequency

1920. An early attempt at mobile police communications.

limitations made a widespread development impossible. Brighton shared a channel with Glasgow patrol cars. The idea was good but it was not for another 35 years with the introduction of the u.h.f. pocketphones that foot patrol radio suddenly became an indispensable part of the beat policeman's life.

The First V.H.F. Systems

With the approach of the 1939 War, the British Government became concerned that police m.f. transmitters might serve as beacons to enemy aircraft. Plans were evolved to see whether frequencies in the region of 100 MHz could be used for police mobile communication. The possibility was not viewed with much optimism because it was believed, not unreasonably, that v.h.f. waves would be screened by buildings even more severely than m.f. transmissions. Nevertheless, a development programme was undertaken jointly at first by the Post Office and the Home Office in the hope that any communication might be better than none.

It was fortunate that some remarkable pioneer equipment design work had been carried out by the GEC at Coventry in the late 'thirties which had resulted in what were probably the first ever crystal-controlled v.h.f. transmitters and receivers working between 80 and 130 MHz. The equipment was very large by modern standards and occupied the entire luggage boot of the car, but it was effective and in its simple ability to communicate it was comparable to the best mobile equipment available today. The same basic equipment designs were used in *Spitfires* and *Hurricanes* and later by all allied aircraft and proved to be far in advance of enemy airborne radio.

With this equipment the Home Office embarked on a comprehensive series of surveys. All the larger cities and towns throughout Britain were tested for two-way coverage. Much to the surprise of all concerned, it was quickly found that, provided the main station was well sited and had a commanding view of the area concerned, excellent telephony was possible over ranges of 15 to 20 miles both to and from the car. The fixed station power was 100 W and the mobile about 10 W. An initial fiat that fixed stations were not to be sited on premises other than police stations, which were always in the centre and lowest part of the town and as a consequence bad sites, was ignored by the enthusiastic development team in the best Nelson tradition!

The Spread of V.H.F.

Before and during the War, because of the very small number of available frequencies, radio communication was available to Government users only. The coming of v.h.f. opened up much wider possibilities however and in 1948 the first non-government mobile radiotelephone system in Europe was installed in the vehicles of a Cambridge taxi company. The installation was carried out by Pye Telecommunications who were to become pioneers of the new development. Today, 27 years later, Europe has about a million vehicles using radiotelephones, with some 200,000 in the United Kingdom alone. These are used for almost every conceivable application in central government, local government, industrial and commercial fields.

Twenty-seven years ago the idea of mobile radiotelephone, even in fairly obvious applications like ambulances, was greeted with much scepticism. Strangely the ambulance authorities seemed lukewarm to the suggestion that communication with ambulances might save life. It would have been a godsend during the War). When it was discovered however, that four ambulances with radio could do the work of five without and save a corresponding amount of money, the development took off, and by

1932. Brighton had the world's first portable police receiver. Small modern digital paging receiver is shown top center for comparison.

the early 'sixties radiotelephones had become a standard fitting to all ambulances.

Electricity and gas authorities were to become amongst the biggest users (25,000 in the United Kingdom today), the first vehicles being fitted in 1950. The Automobile Association was also an early user for its breakdown service and began fitting in 1949. It now has a fleet of some 2500 radiotelephone equipped vehicles.

One of the remarkable features of these mobile services has been their high growth rate, usually about 15% per annum, the numbers thus doubling every five years. It is a matter of some debate how long such a growth rate will be maintained and of course the answer is not known with certainty. Much will depend upon licensing policies and the availability of adequate frequency space.

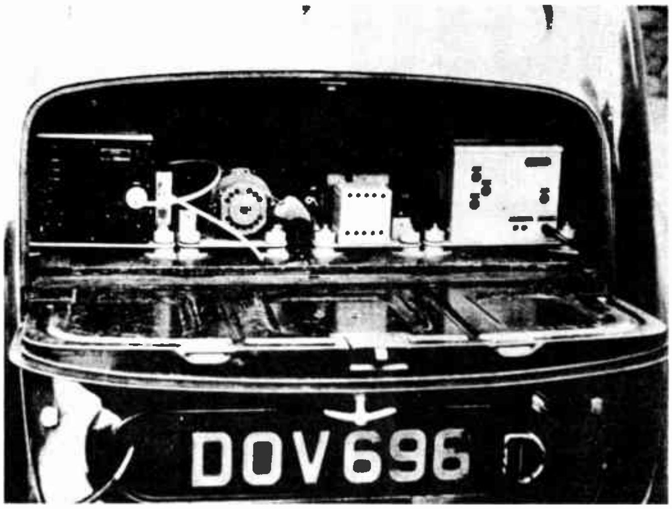
This rate of growth has been accompanied by dramatic improvements in equipment design and technique. Whereas transmitter power and receiver sensitivity are much the same as they were in 1940 nearly all other parameters have been substantially if not radically improved. The most spectacular single improvement lay in the replacement of the thermionic valve by the transistor. Fully solid-state transmitters and receivers began to take over in about 1960. The most important single contribution of this change was to reduce the fault rate of a mobile equipment from about four faults per year to one fault per year. Great improvements in quartz crystal design and manufacture have also taken place over the period and mobile radio as we know it today would not be possible without the remarkable advances in the performance of quartz crystal oscillators and quarts crystal filters.

Despite the improvements in equipment design and the reduction of cost in real terms, the present level of about 2% of all vehicles fitted with radiotelephones seems very low and a good case can be made for envisaging between 10% and 20% before any degree of saturation is reached. If the cost of running and fuelling vehicles continues to escalate over the next twenty-five years, it may well transpire that in time radiotelephones will become compulsory for all land vehicles as they are at present for all but the smallest aircraft and ships.

The Great AM-FM Controversy

No doubt all great innovations have their areas of controversy. In mobile radio the chief contention has centered around rival modulation systems, amplitude modulation and frequency modulation.

British users and manufacturers were well committed to the use of AM before FM equipment on the relevant frequencies became available. When FM did make its appearance a remarkable controversy broke out on the respective merits of the two systems. The controversy began in 1945 and is not even entirely ended today, thirty years later. The arguments had and still have a strong commercial



1945. A "boot-mounted" transmitter and receiver.

bias. No manufacturer wants to carry two versions of equipment, one AM and one FM, and each company has tended to polarize on the system which suited his particular commercial circumstances. The result has been a sustained and vehement argument about the two systems, whose performance differences, in the main, are distinctly marginal.

When the u.h.f. bands were opened up in the 1960s, manufacturers opted out of carrying two ranges of equipment and settled quietly on FM as standard. The standard use of FM in the u.h.f. band has however not stimulated the introduction of narrower channelling at u.h.f. where 25 kHz is still general, in spite of the fact that it was shown very clearly in 1970 that provided low-ageing quartz crystals are used, 12·5 kHz channelling at u.h.f. is entirely practicable. The failure to introduce 12·5 kHz channelling at u.h.f. with the same promptness

1964. This modern u.h.f. radio, the Pye Pocketphone, represented a breakthrough in police portable radio.

with which it was introduced at v.h.f. in 1968 represents in my opinion, a presently lost opportunity which successive generations of users will not appreciate when they run out of u.h.f. channel capacity so much sooner than might otherwise have been the case.

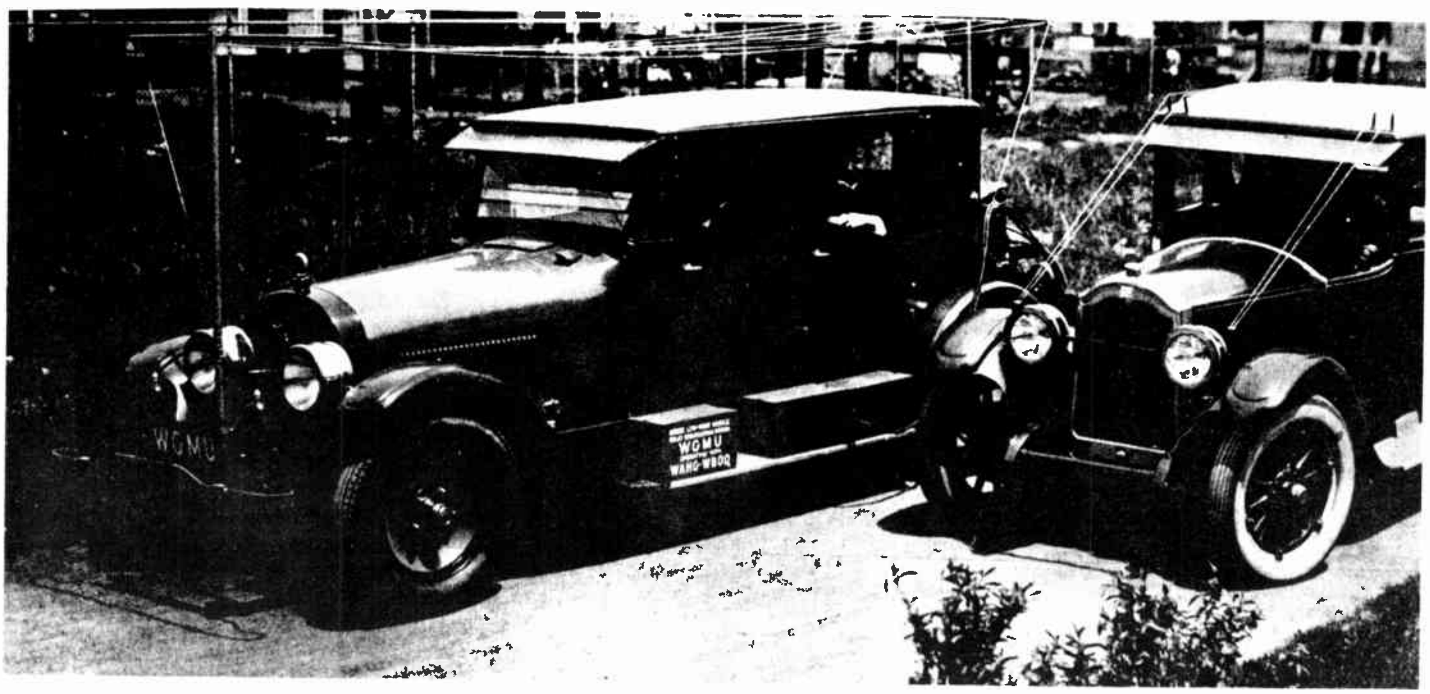
Personal Portables—The Pocket Radiophone

The Brighton Police pioneers of the 'thirties clearly had the idea of personal radiotelephone imaginatively conceived. True, their set was a receiver only and they must have viewed the prospect of a two-way pocket set as remote indeed. That particular cake was to take another thirty-five years to bake. The vital ingredients were the transistor with its tiny size and small power consumption and the miniature monolithic quartz crystal filter which provided the highest receiver selectivity in a tiny package. These component developments did not occur overnight and indeed it is interesting that when the Brighton sets were first operated, primitive quartz crystal filters had already appeared and the transistor had been conceived but not realized.

As always, a main problem was to get a really small antenna, small enough to go in the pocket and yet capable of radiating efficiently to base stations over a radius of several miles. The elegant solution came in the 1960s with the development of v.h.f. in the 450-MHz band with the tiny antenna that this made possible. An outstanding example was the Pye pocket radiotelephone (1964) introduced first for police service and later for every conceivable application where hand-held communication is beneficial. Some 70,000 of these portables are in everyday use today in the UK. There are some 1000 personal portables in use at London Airport alone. When it is considered that 50,000 people are employed at that site, the number now fitted must surely be a very small fraction of the number of those who could benefit from pocket communication.

The use of personal portables is growing at an explosive rate and may well catch up and pass the numbers used in vehicles. As in the case of the vehicle application the demand for frequencies exceeds supply but the use of radiating cable or leaky feeder systems may help to solve this problem in the future. One of the most remarkable systems of this kind has been installed in the London Stock Exchange. In this scheme 400 stockbrokers can speak instantly to their offices over 103 channels spaced at 12·5 kHz in the 450 MHz u.h.f. band. Radiating cable enables excellent two-way coverage throughout the vast building complex yet confines interference to a radius of about half a mile.

The pocket radiotelephone must have an immense and still largely untapped future in wider fields. It does not take too much imagination to look at the hand-held calculator with its miracle of digital processing to envisage it complete with built-in transmitter and receiver giving full access to the public telephone network. I believe this will be one of the great new mobile developments of the future.



MOBILE COMMUNICATIONS 1924

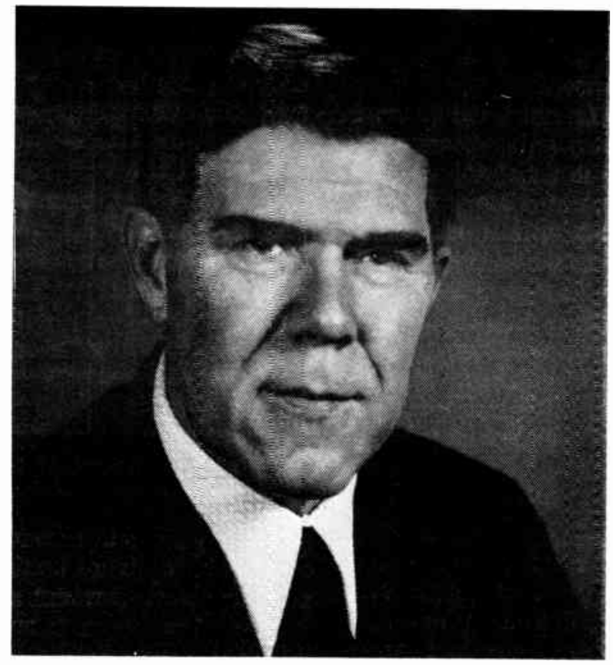
This mobile radio station was used as a part of Alfred Grebe's station WAHG during the early days of broadcasting. The LINCOLN carried a 50 watt transmitter, WGMU (the G for Grebe and the MU for Dr. Mu). The receiver installed in the BUICK coupe was owned by Ralph R. Batcher, design engineer for the Grebe Company at that time. The receiver is a three stage TRF type with a front end "tickler" to increase sensitivity, and operated from a four turn loop that surrounded the whole car.

This combination figured in many public events programs of WAHG—such as racing at Belmont and Jamaica tracks, polo matches, elections, and many of the fantastic stunts dreamed up by imaginative promoters of the time to help fill up the weekly Saturday radio supplements carried by metropolitan newspapers of that era to promote public interest in this "new" radio art. These included such items as the first-hand reporting of the siezure of rum-running boats, parades, fires, etc.

RADIO MUSEUMS
Here and Abroad

by Bruce Kelley
(Fellow 1972; Curator AWA Museum)

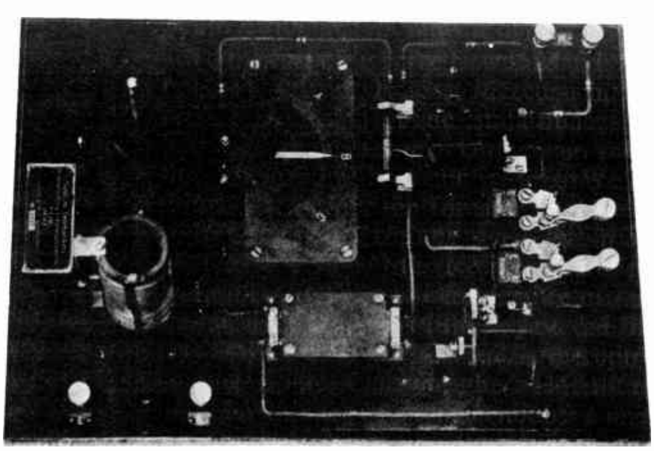
This paper was delivered at the Radio Club's Annual Meeting, November 16, 1979.



Bruce L. Kelley

I am sure you're interested in American museums but first let me mention a few outside our country. One with outstanding displays is the British Science Museum in London (Kensington) which houses some of the earliest radio equipment. Most of it, of course, is Marconi. One can examine early coherer receivers and original Fleming valves as well as items used during the first trans-atlantic transmissions. Another museum of outstanding quality is the Science Museum in Munich. Here the visitor can see equipment used by Heinrich Hertz in his original experiments, plus rare Telefunken apparatus.

Other interesting European museums are Alexander Popov exhibit (USSR) and the Nikola Tesla Museum in Yugoslavia. Even far-off Australia has notable radio displays, such as the Sidney Science Museum and the Tele-Communication Museum in Adelaide. The latter has an outstanding radio exhibit as well as an area with early telegraph apparatus. And nearer to home, one shouldn't overlook the Canadian National Science Museum in Ottawa.

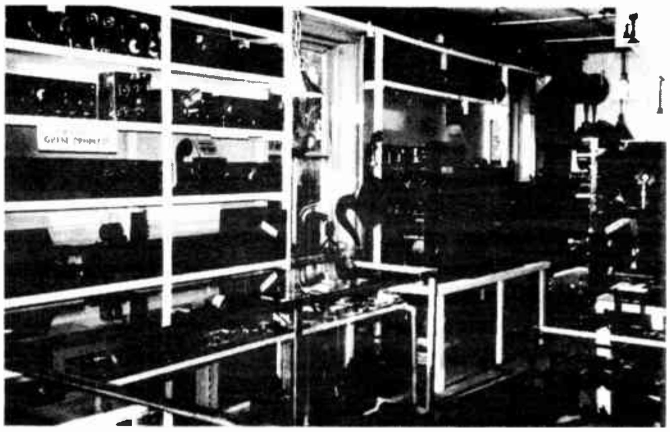


Now for here in the States. We have two outstanding museums: the Smithsonian Institution and the Ford Museum in Dearborn, Michigan. Although the Smithsonian may have the largest collection, only a small part is on display, due to lack of space and policy restrictions. It would be difficult to describe the vast amount of material in the Smithsonian archives and warehouses: rare tubes, receivers, original Morse telegraph and Bell telephone equipment plus items too numerous to mention. As an example, in one of the Smithsonian warehouses is a huge 200 kw. Alexanderson alternator originally used at the Marconi/RCA station at Marion, Mass. One of the prize treasures is the large collection of historical papers and photographs accumulated by one-time RCA historian George Clark. We're indeed fortunate this historical material is safely preserved.

Unlike the Smithsonian, the Ford Museum displays all its artifacts. The visitor can walk through endless aisles of glass showcases and open exhibits. The museum has an exceptionally fine display of early commercial transmitters and receivers made by such companies as de Forest, Marconi and Wireless Speciality Apparatus. I found the McMurdo Silver tube collection impressive and admired the huge rotary spark gap wheel used at old Naval station NAA (Arlington). Plan at least a day when visiting either of those museums.

Two other radio exhibits I found interesting are in our military museums. Nearest is the Fort Monmouth (New Jersey) Signal Corps Museum. Here one can see communication equipment from Civil War telegraph instruments to modern gear. Although most of the equipment is military, many items are not. I saw a rare de Forest audion tube and several pieces of equipment used by Major Armstrong.

The Naval Museum is at the rear of the Washington Navy Yard, rather hard to find but well worth the effort. Like the Signal Corps Museum, it is housed in a huge building with a section devoted to communication. I was



Section of the AWA Museum at Holcomb. Left, a 1925 radio store; right, an old commercial radio station.

particularly impressed with some of the gigantic Navy receivers—one looked to be six feet long! In addition to early radio equipment, there is a modern, working radar/sonar exhibit. A fascinating place.

School, City and Private Museums

Now let's go to some of our smaller museums. One of the few devoted entirely to communication is the Foothill Electronic Museum at Foothill College, Los Gatos, California. It is part of the school's facility and is an outstanding example of what can be done when public and private industry collaborate. Over a dozen electronic industries in the San Jose area helped finance the building, which houses the largest radio museum on the West Coast.

Like most public museums, it has working displays, which show youthful visitors basic principles of electricity. In its large collection of radio apparatus two pieces impressed me most. One was the original 1909 station built by Dr. Charles Herrold and used in his early broadcasts. The other was a seldom seen Federal arc transmitter.

I have found a few city museums with radio displays. The Seattle Museum is worth visiting as well as the Corpus Christi facility. When in Cincinnati be sure to stop at the Community Civic PBS Center which has a large radio exhibit with emphasis on Crosley equipment. Smaller cities have hidden-away museums, an example is the one located at the studios of Television station WSCS at Charleston, South Carolina.

To the east of us is the New England Wireless and Steam Engine Museum in East Greenwich, Rhode Island, a unique establishment consisting of several buildings. One houses large steam engines, which are frequently in operation for visitors. We should be particularly interested in this museum since the Director, Robert Merriam, is here with us today. Bob has been selective in his radio exhibits, with areas devoted to pioneers such as de Forest, Dolbear and others. An outstanding feature of the museum is the technical library, one of the largest and finest in the country. Several have contributed to the book collection, including Radio Club member Lloyd Espenschied. The museum is not open on a daily basis; I suggest you contact the Merriams for an appointment.

While in New England, don't forget the A.R.R.L. Museum in Newington, Connecticut. The exhibit is located in the building's main lobby and is devoted entirely to amateur radio equipment. A visit is a must for the radio ham. On the subject of lobby displays, Bell Labs at Murray Hill (New Jersey) has an exceptional exhibit in its lobby showing the first transistor, early traveling wave-guides, and other historical items developed at the Labs.

And now for one of the more recent and significant exhibits. At nearby Manhattan College (in the Bronx) is the largest historical vacuum tube exhibit of its kind. There are 25 large glass-enclosed panels, with 25 more to be added. Each panel shows the development of a certain type of tube, ranging from early RCA/GE types such as the WD-11 and UV-199 to the nuvisitor. This interesting collection is part of the library on the fourth floor of the Electrical Engineering building.

"Software" Museums

Now for private museums. There are well over 2000 collectors in the country, and maybe 200 maintain a small museum. Some collectors specialize in items such as commercial receivers, others in crystal sets, speakers, tubes and so forth. A few concentrate their efforts on one line. An example is Radio Club member Ralph Williams, General Electric engineer who has become a world authority on Atwater Kent products. Other members with outstanding collections include Ed Raser, Jerry Tyne, John Caperton, Alan Douglas, just to name a few. I might add that some private collections easily surpass those of public museums.

Part of Ralph Muchow's museum. Left, Grebe receivers—right, ancient Navy and commercial equipment.

An example, Dr. Ralph Muchow's Museum in Elgin, Illinois has over 2000 receivers tastefully labeled and displayed.

I must not forget the software museums, of which there are several. The largest that I know of is the Museum of Broadcasting on East 53rd Street at Fifth Avenue (N.Y.C.). Here are stored thousands of radio broadcasts and television shows. A limited number are available for the visitor's use. A similar museum is the National Broadcaster's Hall of Fame in Freehold, New Jersey. If you're looking for history on broadcasting, I strongly suggest you

One of the AWA amateur stations. Elliott Sivowitch of the Smithsonian Institution at the key of 2NA.

contact Cathy Heintz, secretary of the Broadcast Pioneers Library in Washington, D.C.

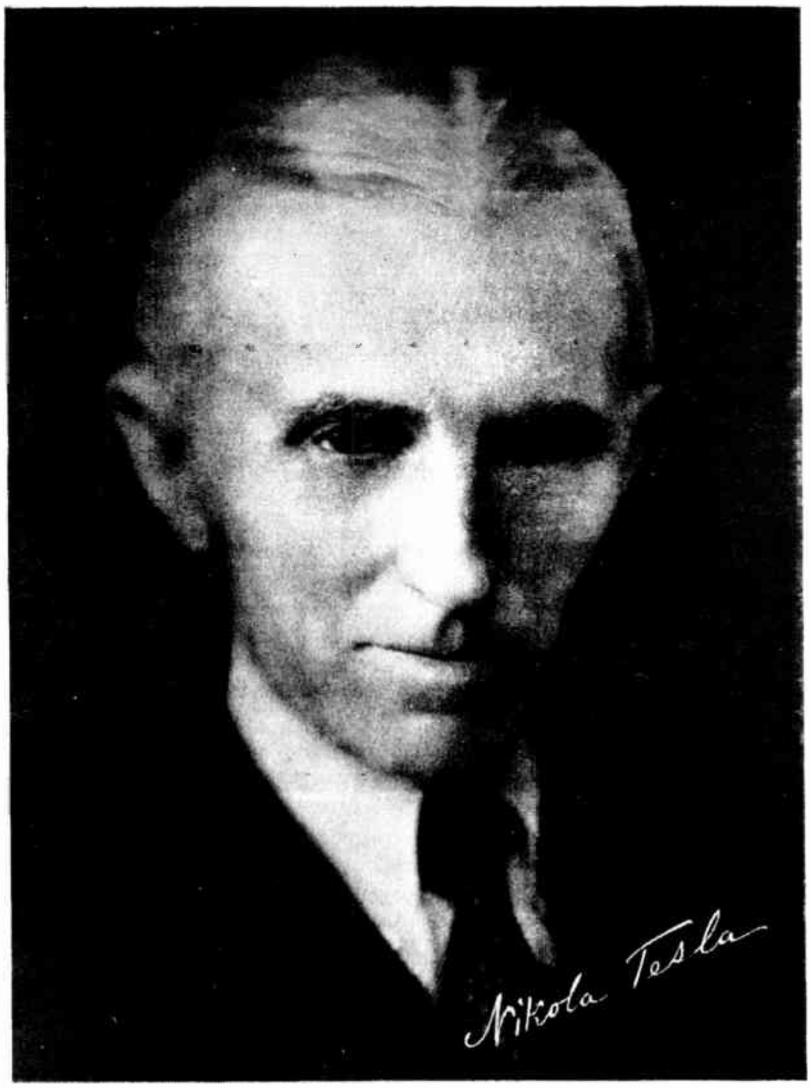
Now, I would like to tell about the Antique Wireless Association and its Electronic-Communication Museum. The Association has over 2300 members, many of whom belong to the Radio Club. AWA shares a historic three-story Academy with the local historical society, where they maintain a public museum. The location is Holcomb (East Bloomfield), New York, about 25 miles south-east of Rochester. The Association has 15,000 items, some of which are displayed on a rotating schedule. Historically oriented, the group has tried to concentrate on a variety of significant items instead of quantity.

One of the showcases in the main room AWA Museum. This one houses early telegraph instruments. Some of the older ones date back to the 1850's.

Examples of what may be seen in this small museum are: a 1905 Fleming valve (gift from the British Marconi Company), a Muir siphon recorder used on an early trans-atlantic submarine cable (Smithsonian), a small 25 kc. Alexanderson alternator (from Rocky Point), Hiram Percy Maxim's personal key, a complete 1919 British Marconi ship installation (multiple tuner, magnetic detector and 10-inch spark coil), a one-ton diversity receiver from Riverhead, original keying relays from WWI Sayville and Tuckerton stations, a section of Major Armstrong's original FM transmitter, artifacts from Byrd's Antarctic expeditions, one of John V. L. Hogan's original W2XR (WQXR) transmitters, a huge collection of developmental radar, klystron and traveling wave-guide tubes and 1905 Marconi and Telefunken coherer receivers.

A small area on the third floor is set aside for old-time radio operators where they can see—and smell ozone—from four spark transmitters in actual operation: a straight spark gap, a non-sync rotary, quench gap and a mighty 1KW sync rotary.

A feature for this coming year (1980) will be a complete 1907 wireless station, which was found intact in a New Jersey attic. If in up-state New York, do plan to visit us.



NIKOLA TESLA, WORLD'S GREATEST ENGINEER

By
Commander E. J. Quinby, USN (Ret.)

Ask any electrical engineering student today to tell you something about Tesla, and you are likely to get a blank stare. Or the counter-question: "Who was Tesla?" It seem preposterous that our educators should have ignored entirely the founder of our a.c. age, but such is the fact. Something should be done about our technical education system.

Born July 9, 1856 in the village of Smiljan in what is now Yugoslavia, Tesla rose from relative obscurity to a top position in the scientific world. He became a millionaire at 32 through his important inventions, only to fade later into obscurity, and died penniless.

His father was a clergyman. His mother, though she never learned to read and write, was known in the community as an inventor of domestic labor-saving devices, and it is to her that Tesla attributed much of his inventive genius. The young Tesla, opposing his father's urging to study for the ministry, insisted on a career in engineering. His mother encouraged him. He attended the polytechnic school at Graz, specializing in physics and mathematics, and continued his education at the University of Prague. There he took a course in foreign languages, so that he could read the foreign technical literature. He became proficient in English, French and Italian, in addition to the German with which he was already familiar, and of course, his native Serbian.

Finishing at Prague in 1880, he took a post-graduate course in Budapest, where he debated the merits of alternating current with his professors. He then went to work for a Paris telephone company, where he acquired considerable experience with d.c. dynamos and motors. While there he invented regulating and control devices to protect the rotating machines he serviced.

Electrical Industry Was Limited

In those early days, direct current was universally acknowledged to be the only practical medium for generating, transmitting and applying electricity for heat, light or power. But d.c. resistance losses were so great that a power plant was needed for every square mile served. Early incandescent lamps, glowing none too bright on 110 volts even close to the power plant, became pitifully dim on the power that dribbled from the lines less than a mile away. And everyone believed that motors could run only on d.c. An alternating current motor was considered an impossibility.

This was the picture when, in 1884, young Tesla stepped off a ship in New York, his head full of ideas, and four cents in his pocket. His experience had convinced him that the commutator in direct current motors and dynamos was an unnecessary complication, causing endless troubles. He realized that the "d.c. generator" actually produced a.c., which was rectified by the commutator into a series of waves, all flowing in the same direction through the external circuit.

Then, to get this d.c. to produce rotary motion in a motor, the process had to be reversed. The armature of each electric motor was equipped with a rotating switch (commutator) that changed the polarity of its magnetic poles just at the right instant as it revolved, to supply a.c. to the motor.

The Inspiration

To Tesla, this was sheer nonsense. It seemed logical to eliminate the commutator at both generator and motor, and use a.c. through the whole system. But no one had ever built a motor that could operate on alternating current, and Tesla struggled mentally with the problem. And one day in February, 1882, while strolling with a classmate named Szigetti in a Budapest park, he suddenly blurted out: "I've got it!" Now watch me reverse it!" At that moment he had visualized the rotating magnetic field, which would revolutionize the whole electrical industry. He saw the magnetic pull racing around the stationary field (stator) of his motor while the armature (rotor), attracted by the moving field, chased around after it faster and faster until it was revolving at the same rate. He would need no switching to the rotating element — no commutator!

Subsequently he worked the whole alternating current electrical system out in his mind — including alternators, step-up and step-down transformers for economical transmission and delivery of electric power, and a.c. motors to supply mechanical power. Impressed by the wealth of available water power going to waste around the world, he visualized the harnessing of this great supply with hydro-electric plants capable of distributing the power to where it was needed. He startled fellow-students in Budapest by announcing: "Some day I will harness Niagara Falls."

Discouraged by Edison

The opportunity and fortune Tesla sought in the promised land did not come easy. When he met Edison, then actively engaged in developing a market for his incandescent lamp through his pioneer Pearl Street plant in New York, Tesla launched with youthful enthusiasm into a description of his alternating current system. "You are wasting your time on that theory," the great man told him, dismissing the idea promptly and finally.

For a year the tall, gaunt Yugoslav struggled to keep from starving in this strange land. At one point he dug ditches to make a living. But the foreman of the Western Union ditch-digging project on which he was working listened to the visionary descriptions of new electrical systems that Tesla related during lunch hours, and introduced him to a company executive named A. K. Brown. Fascinated by Tesla's vivid plans, Brown and an associate decided to take a flyer. They put up a limited amount of money, with which Tesla set up an experimental laboratory at 33-35 South Fifth Avenue (now West Broadway). There Tesla set up a complete demonstration of his system, including generator, transformers, transmission line, motors and lights. He worked tirelessly, and without drawings; the plans for every detail were indelibly etched in his mind. He even included two-phase and three-phase systems.

Professor W. A. Anthony of Cornell University examined the new a.c. system, and promptly announced that Tesla's synchronous motor was equal in efficiency to the best d.c. motors.

Alternating Current Arrives

Tesla then attempted to patent his system under a single comprehensive patent covering all its components. The Patent Office would not approve the all-in-one application, insisting on separate applications for each important idea. Tesla's applications, filed in November and December of 1887, resulted in the granting of seven U.S. patents in the next six months. In April, 1888, he filed for four more patents, covering his polyphase system. These too were promptly granted, as were 18 more U.S. patents later in the year. These were followed by numerous European patents. Such an avalanche of patents, so promptly issued, was without precedent, but so completely novel were the ideas — so completely absent was any element of interference or "anticipation" — that the patents were issued without a single challenge.

Meanwhile Tesla staged a spectacular lecture and demonstration of his a.c. system — single-phase and polyphase — at a meeting of the AIEE (now the IEEE) in New York. The engineers of the world were made aware that the limitations on electric power transmission by wire had been removed, opening the door to tremendous expansion.

But who would adopt this obviously better system? Certainly not the established Edison-General Electric organization — it would have made their whole investment obsolete. Apparently Tesla was stuck — with no market, no customer for what he had to offer.

It was at this moment that George Westinghouse walked into Tesla's laboratory and introduced himself. Tesla was then 32 years old, Westinghouse 42. Both were capable inventors, accomplished engineers and electrical enthusiasts. Westinghouse listened to Tesla's explanations, watched his demonstration, and quickly made up his mind.

"I will give you one million dollars cash for your alternating current patents, plus royalties," offered Westinghouse.

"Make that royalty one dollar per horsepower, and it's a deal," replied Tesla, without apparent excitement.

As simply as that, the two men arranged the historic deal and shook hands on it.

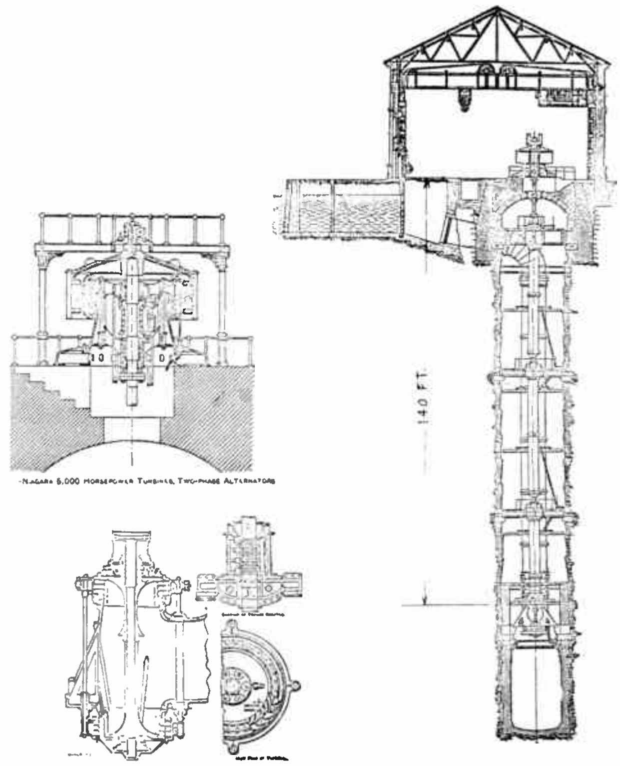
Tesla had arrived! But he was not a man to forget those who had placed their faith in his ideas, and promptly signed over half his million-dollar fee to Brown and his associate, who had financed his laboratory. Although the backers of Westinghouse later forced him to get a release from Tesla on the dollar-per-horsepower part of the agreement, such was the friendship that had developed between the two men that an amicable settlement was quickly reached. Tesla relinquished the royalties that would have supported him and his research efforts for the rest of his life.

The phenomenal success of the Westinghouse a.c. systems across the nation made it clear to General Electric engineers that they would have to get a license from Westinghouse f they were to keep up in the rapidly expanding electrical ndustry. The license — negotiated at a handsome fee — was a feather in Tesla's cap; he distinctly recalled Edison's statement that there was no future in alternating current and that experimenting with it would be a waste of time.

A Dream Realized

In 1890, the International Niagara Commission began trying to determine the best way of using the power of Niagara Falls to generate electricity. The scientist Lord Kelvin was appointed chairman of the Commission — and he immediately announced that a d.c. system would obviously be best! It was not easy to challenge this world-famous authority, but he eventually came to realize that if power were to be transmitted even the 26 miles to Buffalo, a.c. would be necessary. So it was finally decided to use Tesla's system and generate a.c. with massive water turbines. Bids were invited by the newly formed Cataract Construction Co. in 1893. Westinghouse won the contract for the ten 5,000-HP hydro-electric generators, and General Electric the contract for the transmission system. The whole system — the line, step-up and step-down transformers all followed Tesla's two-phase design. He designed the big alternators with external revolving fields and internal stationary armatures, to minimize the weight of the moving members.

This historic project created a sensation, for nothing of this magnitude had been attempted at the time. The ten big 2,250-volt alternators, revolving at 250 rpm and delivering 1,775 amperes each, produced an output of 50,000 HP or 37,000 kW, 25 hertz, two-phase. The rotors were 10 feet in diameter and 14 feet long (14 feet high in these vertical generators) and weighed 34 tons each. The stationary members weighed 50 tons each. The voltage was stepped up to 22,000 for transmission.



One of the 5,000 h.p. Niagara Falls units, with detail at left. Upper drawing shows the hollow drive shaft that goes through the stationary armature to rotate the field, which hangs outside and around the armature.

Remote Radio Control

Tesla's pioneering in the realm of radio ("wireless" as it was then called) went further than Morse code communication. In 1898 he staged a spectacular demonstration of remote control without wires at the original Madison Square Garden, New York City. The first annual Electrical Exhibition was then in progress, and in the center of the vast arena where Barnum & Bailey's circus usually performed he had a large tank constructed and filled with water. Afloat on this small lake he had a 3-foot-long iron-hulled boat, with its mast supporting an antenna. Inside the hull was a radio receiver and an assortment of electric motors, driven by storage battery, to perform various "ship" functions.

From the opposite end of the auditorium, Tesla put the vessel through a variety of manouvres, including sailing forward, steering left and right, stopping, reversing, and lighting the lights in its rigging in response to audience requests. The impressive demonstration of course "stole the show" and made the front page of the daily newspapers. But how many dreamed that one day, using these radio-remote-servo-control principles, we would land some of our citizens on the moon?

Mathematical Wizardry

Tesla's mathematical genius stood him in good stead in the design of the items of a.c. equipment that Westinghouse and G-E undertook to manufacture. (In his early student days, he solved complex problems in his head, without pencil and paper). His teachers suspected him of cheating, and put him to conclusive tests. Young Tesla, it developed, had memorized whole logarithmic tables!) The now established frequency of 60 cycles per second (hertz or Hz) stems from Tesla's mental calculations, which convinced him that it was the most practical frequency for commercial use. At higher frequencies, a.c. motors would become inefficient; at lower frequencies they would require too much iron. Lights would also flicker at low frequencies.

Though the original Niagara Falls plant was designed for 25 Hz to accommodate the limitations of the early Westinghouse turbine generators, subsequent expansion included conversion to 60 Hz. Today this Niagara power is transmitted all the way to New York City, 360 miles away, and at times is fed over the Northeast power grid for much greater distances. (When Tesla arrived in New York, the limit for efficient power transmission was less than a mile!)

High Frequency Pioneering

During his investigations into the unknown realms of high voltage and high frequency, Tesla adopted a most sensible practice. When handling high-voltage apparatus, he always kept one hand in his pocket. He insisted that all his laboratory assistants take this precaution, and to this day it is always employed by sensible experimenters around potentially dangerous equipment.

Tesla's explorations in higher frequencies and in the field of incredibly high voltages paved the way for modern electronics, although the word had not yet even been coined.

With his unique high-frequency transformers (Tesla coils) he showed that he could actually pass millions of volts harmlessly through his body to glow-tube lamps held in his bare hands. They would light up to full brilliancy from the high-frequency, high-voltage currents. In those early days he was actually demonstrating neon-tube and fluorescent tube lighting!

Tesla's experiments up and down the frequency scale sometimes led him into unexplored regions. Studying slow mechanical or physical vibrations, he caused a virtual earthquake in the vicinity of his new laboratory on Houston St. His mechanical oscillator, approaching the natural period of the building itself, threatened to tumble the old structure. Furnishings in the police station over a block away began to dance around mysteriously as Tesla confirmed his mathematical theories of resonance, vibration and "natural periods."

World's Most Powerful Transmitter

Investigations of high-voltage and high-frequency electrical transmission led Tesla to construct and operate the world's most powerful radio transmitter, on a mountain near Colorado Springs. Around the base of a 200-foot mast, he built a 75-foot diameter air-core transformer. The primary was only a few turns of wire. The secondary within it was 100 turns, 10 feet in diameter. Using power from a generating station several miles away, Tesla created the first man-made lightning. Deafening bolts 100 feet long leapt from the 3-foot copper ball at the top of this mast. The thunder was heard as far away as the horizon. He was using voltages of the order of 100 million — a feat not to be equalled for half-a-century.

Tesla burned out the power plant generator with his first experiment, but repairing it, continued his experiments until he was able to transmit power without wires for a distance of 26 miles. At that distance he was able to light a bank of 200 incandescent lamps — a total of 10 kilowatts. Fritz Lowenstein, later to become famous for his own radio patents, witnessed this spectacular accomplishment, as Tesla's assistant on the project.

In 1899, Tesla had somehow spent the last of the money he got from Westinghouse for his a.c. patents. Colonel John Jacob Astor came to his financial rescue, and put up the necessary $30,000 for the Colorado Springs experiments. Now this money was also gone, and Tesla returned to New York.

Enter J. P. Morgan

In New York, Tesla was prevailed upon by his friend Robert Underwood Johnson, editor of **Century** magazine, to write a feature story describing his accomplishments at Colorado Springs. But the story Tesla turned out proved to be an involved discourse on the subject of philosophy and "the mechanical process of humanity." Although of the highest literary quality, the treatise said little about the powerful transmitter at Colorado Springs. Johnson had to return the manuscript three times before getting some coverage of the subject he had requested.

In the end, the article was published under the title, "The Problem of Increasing Human Energy." It created a sensation when it appeared in print. One of the readers who was deeply impressed was John Pierpont Morgan, who had financed the General Electric Co. in its pioneer d.c. days, and more recently its part of the Niagara Falls project. Morgan was fascinated by the genius of Nikola Tesla, by his spectacular accomplishments and his winning personality. Tesla soon became a regular guest at the Morgan home. Impeccably dressed, always the polished gentleman with European manners and cultured speech in several languages, Tesla became a favorite of New York and Newport society. Many prominent matrons regarded him as a "good catch" for their daughters, but Tesla insisted that there was no room in his life for women and romance — that they would interfere with his research efforts.

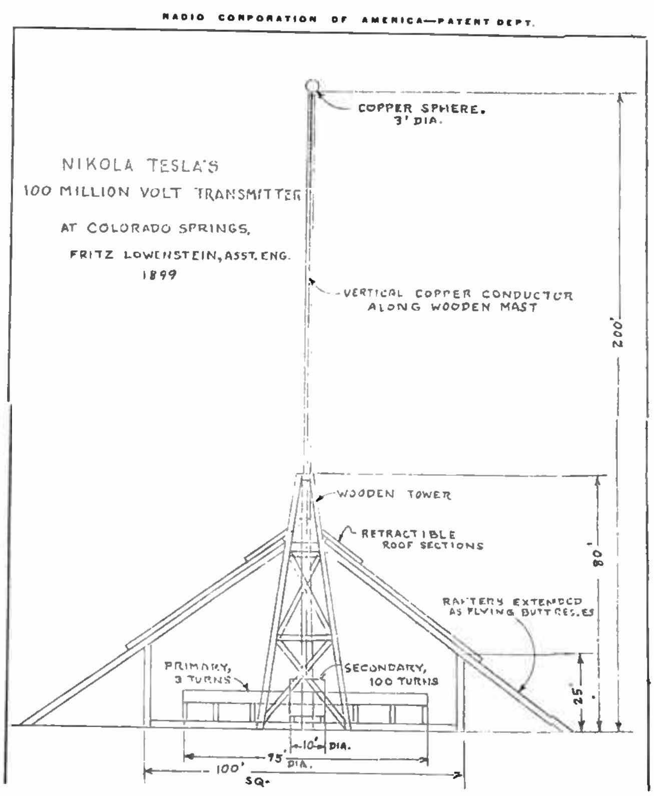
Historians differ on what motivated Morgan to finance Tesla's next big project. Some believe that he was genuinely interested in the wireless transmission of power. Others argue that — in the light of subsequent developments — it seems obvious that Morgan's interest was in getting control of Tesla and his achievements to protect the Morgan investments in the electrical industry.

Finding that Tesla was broke again, Morgan agreed to underwrite Tesla's project of transmitting electric power without wires. In 1904, Tesla acknowledged in **Electrical World and Engineer:** "For a large part of the work I have done so far I am indebted to the noble generosity of Mr. J. Pierpont Morgan."

From this alliance sprouted the fantastic "world-wide-wireless tower on Long Island.

World Wide Wireless

The strange structure that slowly rose near Wardenclyffe, in the hilly portion of Long Island, mystified all observers. Resembling nothing so much as a huge mushroom, except that it was not solid, it had a lattice-work skeleton, broad at the base and tapering toward its 200-foot top. There it was capped by a 100-foot diameter hemisphere. The structure was



The 100-million-volt transmitter, power from which lighted 200 50-watt lamps at a distance of 26 miles.

made of stout wooden members joined by copper gussets bolted to the wood with sturdy bronze bolts. The hemispherical top was draped over its upper surface with copper mesh. There was no ferrous metal in the entire structure.

The famous architect Stanford White became so interested in the project that he did the design work without charge, assigning one of his best designers, W. D. Crow, to the task.

Tesla commuted daily to the construction from his quarters in the old Waldorf-Astoria Hotel on 34th St., riding the streetcars to the East 34th St. ferry, then the paddlewheel steam ferry to Long Island City and the Long Island Railroad to Shoreham. The railroad's dining service prepared special meals for him so that his supervision of the project would not be interrupted.

When the 100-foot square brick power plant was completed near the base of the big tower, Tesla began moving his Houston St. laboratory into the structure. Meanwhile, annoying delays were encountered in the manufacture of the radio-frequency generators and their driving motors. Several glassblowers were busy fashioning special tubes, the design of which still remains a mystery.

The Prophet Tells of the Future

Meanwhile, Tesla issued a descriptive brochure that revealed his far-reaching insight into the future of the great industry that at that time (1904) was limited to dot-and-dash telegraphy. That document has persuaded many that the man was actually clairvoyant. He announced that the World Wide Wireless system was being prepared to provide a variety of facilities, including:

Telegraph Communication, Telephone Communication, News Broadcasting, Stock Market Quotations, Aids to Navigation, Entertainment and Music Broadcasting, Accurate Time Service, Facsimile, Telephoto and Teleprinter services.

Tesla was describing the Radio City of the future, which he actually lived to see come into existence!

Morgan's Support Ends

In **Electrical World and Engineer** of March, 1904, Tesla revealed that the Canadian Niagara Power Co. had offered him inducements to locate his wireless power transmission project at their plant, and that he proposed to employ those facilities to distribute 10,000 horsepower at a potential of 10 million volts.

The Niagara project never materialized, but may have had some influence on the fate of the spectacular Long Island project. For reasons that have never come to light, J. P. Morgan had a change of heart, and Tesla's financial fountain suddenly went dry. At first Tesla refused to believe that Morgan would not arrange for the nearly finished job's completion, but Morgan's withdrawal was abrupt and final. Historians of the industry wonder why. Did Morgan lose patience? Did engineers of high repute convince him that Tesla's visions, so openly revealed in the brochure, were nonsense, and that he was wasting his money on a hopeless dream? Did he suspect that Tesla was diverting time and money to the Niagara project? The facts will probably never be known.

Brainless Desecreation

During World War I much senseless desecration was perpetrated in the name of national defense. For some strange reason (or lack of reason) it was decided that Tesla's spectacular tower at Wardenclyffe, Long Island jeopardized the safety of the United States, and must be destroyed. After vain attempts to topple the lofty structure by attaching cables to it and trying to drag it off balance, it was finally capsized by dynamiting its foundations. Even then, the tower did not collapse nor disintegrate. It simply lay intact on its side, and was finally dismantled piece by piece.

But why did this structure have to be dispensed with? Many taller objects closer to New York City — including the Ramapo Mountains — were allowed to remain intact!

Not all the facts on the mysterious Long Island tower were ever known. Some believe that it was intended to transmit at low frequencies, "shaking the earth" to send signals to distances then believed impossible. Tesla foresaw a complete modern type of service, but never stated how large an area he intended to cover. But, he called it the World Wide Wireless System!

The Radio-Frequency Alternator

As early as 1890 Tesla built high-frequency a.c. generators. One, which had 384 poles, produced a 10-kHz output. He later produced frequencies as high as 20 kHz. More than a decade was to pass before Reginald Fessenden developed his r.f. alternator, which had an output of 50 kW. This machine was scaled up to 200 kW by General Electric, and put on the market as the Alexanderson alternator, named after the man who had supervised the job, and who had constructed some of Fessenden's earlier alternators.

When it appeared that British interests (already in control of most of the world's cables) were about to acquire the patents for this machine, the Radio Corporation of America was organized, at the urgent suggestion of the United States Navy. The new company was formed in 1919, around the Marconi Wireless Telegraph Co. of America, and the powerful but inefficient Marconi spark transmitters were replaced by the highly successful r.f. alternators. The first one was installed in New Brunswick, N.J. at station WII. It produced a 21.8 kHz signal at 200 kW, and handled commercial business previously the exclusive domain of the cables. This was the first continuously reliable trans-Atlantic radio service.*

The writer, as the most junior of the junior engineers on the project, struggled like the rest to keep the first machine running until the next was ready to provide relief. So well did these alternators perform that a whole battery of them was ordered, to be installed at Radio Central, Rocky Point, L.I., almost within the former shadow of Tesla's tower.

Thus Nikola Tesla's World Wide Wireless dream was fulfilled some three decades after he initiated the project and right where he started it, using the type of transmitter he devised.

Radar and Turbines

Tesla continued active research in many fields. In 1917 he suggested that distant objects could be detected by sending shortwave impulses to them and picking up the reflected impulses on a fluorescent screen. (If that doesn't describe radar, what does?) He described cosmic rays 20 years before other scientists discovered their existence.

At various times up to 1929, he devoted his attention to a "bucketless" high-speed turbine for steam or gas. Friction between the increasingly irascible Tesla and some of the engineers and assistants cooperating with him on tests at the Edison Waterside power plant and in the Allis-Chalmers factory did not help his cause, but many respected engineers today agree that we have not heard the last of the Tesla turbines with the smooth rotor discs.

As the years passed, less and less was heard from him. Occasionally some reporter or feature writer would look him up and manage to get an interview. His prophecies became increasingly strange and involved, inclined toward the abstract and delving into the occult. He never acquired the habit of writing notes, always claiming (and proving) that he was able to retain complete detailed data on all his researches and experiments in his mind. He said that he intended to live to 150, and upon reaching age 100, would write his memoirs, which would include a detailed record of all the data he had compiled during his researches and experiments. At his death — during World War II — the contents of his safe were impounded by military authorities, and nothing has been heard as to the contents of the records — if any — it might have contained.

One of the peculiar inconsistencies of Tesla's character was revealed when two high honors were offered him, and he rejected the one but accepted the other. In 1912 it was announced that Nikola Tesla and Thomas A. Edison had been chosen to share the Nobel Prize, including the $40,000 honorarium. Tesla could well have used the $20,000 at the time. Nevertheless, he flatly refused to share an honor with Edison. However, when in 1917 the AIEE's Edison Medal — founded by anonymous friends of Edison — was awarded to Tesla, he was persuaded to accept it, after first refusing.

The Esteemed Eccentric

Tesla's natural demeanor was that of the aristocrat. With the passage of time and the depletion of his resources, he sank into a condition of genteel poverty. Continuing to live in the best hotels, his credit would become exhausted and he would be forced to seek other quarters. Finally, moving into the newly opened New Yorker, he found his problems solved. Some of the organizations for which he had made millions arranged with the hotel management to take care of the aging genius.

***Dr. E. Stuart Davis, of the National Telegraph Office (Museum) in Union, N.J., Happily reports that one of these giant alternators has been preserved in the Smithsonian Institute, where it stands as a monument to Tesla's pioneering, Fessenden's perseverance, Alexanderson's development and Sarnoff's leadership. This one originally served at Trans-Atlantic Transmitter Station WSO at Marion, Mass.**

Having once met Tesla through the mutual friendship of the intrepid Hugo Gernsback (possibly Tesla's last friend) this writer later recognized the distinguished pioneer strolling in the grand concourse of the Pennsylvania Terminal. Impeccably dressed, his head bowed low over his pristine collar and red-and-black silk necktie, his whole bearing was that of a high-born nobleman from the past.

"Good evening, Dr. Tesla," I ventured, disturbing his solitude in the midst of the turmoil. "Are you catching a train for somewhere?" His soft-spoken reply was memorable, "No" he explained, "I often come here to think."

Tesla insisted on carefully wiping each item of silverware, china and glass before starting a meal, using a fresh napkin for each. In view of this effort to achieve perfect sanitation, it seems inconsistent that the maids reported Tesla's room to be an "unholy mess." It wasn't Tesla's untidiness they complained about — it was the pigeons! When he was not feeding them out in the park, he fed them in his room, where he left the window open so they could come and go.

The gold-plated telephone beside his bed, over which he enjoyed a universal frank to talk to anyone anywhere in the world without charge, was the roost of his favorite pigeon, a white one with grey-tipped wings. "When she dies, I will die," predicted Tesla.

And so it was that one day in January 1943, his favorite dove paid him her last visit. "She was dying," lamented the lonely, unhappy Tesla. "I got her message, through the brilliant beam of light from her eyes."

One of the maids, observing that the "Don't Disturb" sign had been hanging on Tesla's doorknob for an unusually long time, used her pass key to investigate. Tesla had passed to his reward, leaving his gaunt 87-year-old frame peacefully in bed. She fed the mourning pigeons, gently ushered them out, and closed the window.

Allen B. Du Mont

"The Man Who Was Responsible for Television"

By
P.S. Christaldi, Fellow
and
T.T. Goldsmith, Fellow

Allen B. Du Mont was born in Brooklyn, N.Y. on January 29, 1901, to William H. B. and Lillian F. (Balcom) Du Mont. His father was Secretary and Treasurer of Waterbury Clock Company, reknowned for the Ingersoll dollar watch; his maternal grandmother was an inventor of some note. At an early age, Allen and his family moved to Montclair, New Jersey; he lived there until his death on November 14, 1965.

While still in elementary school young Allen developed an interest in electricity and wireless. Following an attack of polio at age 11, his recuperation was speeded by working with a crystal radio receiver, and soon he began to construct his own transmitter and receiver. Before long he was owner and operator of amateur radio station W2AYR. By age 14 he had earned his First Class radio operator's license and began a series of summer jobs as wireless operator on coastwise and transatlantic vessels.

On one such trip, aboard a fogbound fruit ship off the New Jersey coast, young Allen was checking out the newfangled radio compass and was alarmed to discover that they were headed straight for Barnegat and disaster. He warned the skipper, who was very skeptical of the mysterious device. But the skipper dropped anchor for the night. Next morning they found themselves sitting just off Ambrose Channel—safe.

Ironically, many years later, Dr. Du Mont was an observer aboard a Naval vessel evaluating a new cathode-ray tube radar display. This time the skipper was not only skeptical but stubborn—and his ship piled up on a rock!

Following graduation from Montclair, N. J. High School in 1919, Du Mont matriculated at Rensselaer Polytechnic Institute. While studying electrical engineering he was particularly interested in the oscillographic display of electrical waveforms; there he had his initial introduction to the cathode-ray tube, then a relatively crude, short-lived device. But even its limited potential impressed him—influenced the direction of his professional career.

Du Mont as Tube Engineer

Shortly after graduation he joined the Westinghouse Lamp Company as an engineer in the development laboratory and later in charge of receiving tubes production. At the time only 500 tubes a day were being produced. With improvements in the design of the tubes, to facilitate fabrication, and the machinery for manufacture of tubes and their parts, for which ten patents were issued to him, Du Mont increased production rates to 5000 tubes per hour. For this achievement and for other accomplishments that helped make production history in the vacuum tube field, Westinghouse gave him the 1927 First Award of $500.

When, in 1928, Dr. Lee De Forest, inventor of the audion tube, started to reactivate the De Forest Radio Company after a year's shutdown, Allen Du Mont's achievements at Westinghouse seemed ideal grounds for his selection as chief engineer, and later vice-president in charge of engineering.

To quote Du Mont: "My immediate problem was to supervise the designing of a complete new line of receiving tubes, lay out and supervise the installation of factory equipment necessary to produce thirty thousand receiving tubes a day, and to get together and organize the necessary engineering and factory staff." The challenge was met, and in less than a year production exceeded thirty thousand tubes a day. Special test equipment and automatic machines were developed to increase production and decrease costs.

With receiving tube production well under way, Du Mont turned his attention to transmitting tubes and soon had a complete line in production. Then came the design and manufacture of c-w and telephone transmitters, as well as a practical facsimile system.

At about this time De Forest purchased the rights to the C. Francis Jenkins mechanical scanning system of television, then capable of producing a 48-line picture, and set up television broadcast station W2XCD in Passaic, N. J., operating in the AM broadcast band. In 1930 W2XCD transmitted the first sight and sound test programs in the United States. A small number of television receivers was manufactured and sold to experimenters and amateurs.

Dr. de Forest and the young Du Mont in de Forest's tube factory at Passaic, New Jersey.

Despite the considerable effort expended to develop this mechanical system, it soon became apparent that the limitations were too severe to permit the development of an entertainment type of television system. Du Mont remembered the cathode-ray tube in the laboratory at Rensselaer and decided, with others, that it held the key to the high-resolution television receiver.

In 1931 Du Mont returned from a vacation in Bermuda to find that the depression had taken its toll and that the De Forest Radio Company had failed.

And so, by a stroke of fate, Allen B. Du Mont was in a position to pursue what had been since 1928 the focus of his interest and ambition: the development of a practical electronic television system. He was certain that the key lay in the cathode-ray tube; yet the tubes then available were mainly imported from Germany, were scarce, very expensive, small, with maximum screen size of five inches, and had useful life expectancies of only about a hundred hours. The problem was to produce tubes at reasonable cost with large screen sizes and that would last for thousands of hours.

Quoting Dr. Du Mont, "The road ahead seemed to clear. Develop the tube, develop the circuits to control the tube, and—presto, we'd have television. I invested $500 and a very good friend (Henry R. Crowley) put in another $500. This was the initial working capital for Du Mont Laboratories. We hired three good men, and a fourth man worked for us part time. One was a glass blower, one a chemist, and two were technicians. Our place of business was the basement of my house in Upper Montclair."

A thorough survey and study was made of all available literature on the cathode-ray tube, and many types of guns and deflection plate designs were evaluated and tested.

Much trial and error was involved in arriving at satisfactory designs. The scarcity of glass bulbs for making tubes meant using chemical flasks and receiving or small transmitting tube bulbs for some of the gun and fluorescent screen tests. The phosphors had to be developed, and the New Jersey zinc mines provided one source of willemite, a component of one type of screen. After hundreds of tubes had been made and tested—many of which ended up in the trash barrel—he was able to achieve several thousand hours of operation in tubes having an electron lens for focusing instead of an inert gas. But since there were no television stations, there was no market for television cathode-ray tubes and no source of income for the fledgling Allen B. Du Mont Laboratories.

The cathode-ray oscillograph

And so, in 1932, Du Mont introduced his first commercial cathode-ray oscillograph, Type 127, to create a market for his tubes. Also in that year he made, in anticipation of color television, a cathode-ray tube with various color phosphors. The Type 127 was followed shortly by a continuing series of new and more versatile cathode-ray oscillographs as the business was built up as a means to the end of developing an all-electronic television system.

During this period Du Mont, in April 1933, disclosed to the U. S. Army an indicating radio locater. He was requested not to file a patent application on the invention, in the interests of national security. This might have been a basic patent in the field of radio/radar location, potentially worth millions of dollars. Later he was to find a French patent on a similar device, issued six years later in 1939.

Du Mont was involved in other approaches to remote detection and location. There was early work in infrared detection; in experiments with the Signal Corps off Atlantic Highlands the heat of ships was detected through fog. During the 1930s Du Mont provided cathode-ray tubes for use as indicators in Potomac River tests in which the Naval Research Laboratory measured distances to remote targets, using radar principles.

The famous "Magic Eye"

Meanwhile Du Mont developed a tuning indicator using the principles of the cathode-ray tube, and sold rights to RCA for $20,000. This was the famous "Magic Eye", used extensively for years in radio receivers.

The new funds made it possible to purchase the first manufacturing plant, a 30,000-square foot former pickle works in Passaic, N.J. There the company of some 20 employees began to expand its tube manufacturing capabilities, bringing out 14-inch diameter electrostatic deflection tubes suitable for television receiver use. In 1938 modest production of 14-inch television receivers was begun. What he had seen of European television during a trip to England, France, and Germany in the late thirities convinced Du Mont that the large-screen receiver had the best hope for commercial success, and he concentrated his efforts there. In addition to table model and console sets, electrostatic deflection 20-inch receivers were produced for commercial sale during 1939 and 1940.

During the decade starting in 1931, the major commercial activity was in the sale of cathode-ray tubes and oscillographs, but toward the end of that period increasing effort was applied to television. Many new and refined oscillograph designs came out of the laboratory and into production, in tube screen diameters of 3, 5, and 9 inches. There was even a 20-inch cathode-ray oscillograph, sold for instructional and demonstration purposes. The tubes were improved in resolution and sensitivity, using the "intensifier" principle of post-deflection acceleration.

Many new phosphors were developed, ranging from very short-persistence, highly actinic blues for photographic application to long-persistence types useful for the study of single transient phenomena. An electronic switch was developed to provide two-signal-channel presentation, later supplemented by two-gun cathode-ray tubes, which did not require time sharing. Multi-gun tubes were produced with up to five independent channels. These were used in military electronic counter-measures analyzers designed and built by Du Mont for the Navy.

Applications of the oscillographic technique in fields outside electronics were explored in an effort to build up business volume. The *Resonoscope* was an instrument for tuning musical instruments, using a microphone to pick up the musical tone from the instrument and presenting its output on a timebase stabilized at a selected reference frequency on the musical scale. Then there was the *Cyclograph*, an instrument for analyzing metals by means of a crt pattern derived from eddy current and hysteresis characteristics of the metal sample compared to a reference sample.

The Military Electronics Period

As the political-military situation in Europe worsened, more and more of Du Mont's activities were in the area of defense. A special oscillograph was developed for testing gunpowder by the closed bomb method. To achieve its precision calibration it was necessary to develop the forerunner of the metallized screen now in universal use. Another special design was used for analyzing the ignition systems in Wright Whirlwind engines. Special circuitry for selecting the number of cylinders, up to the 18 used in the B-29 bomber, permitted expanding the ignition discharge waveform for any cylinder over the full screen. The patent on this delayed and expanded sweep circuit, later used in precision radar ranging, led to improved analysis of high-speed phenomena in many fields. The super-precision *A/R Range Scope*, developed at M. I. T. Radiation Laboratory in cooperation with Du Mont, and produced by him on a crash basis, is generally credited with saving London during the buzz bomb blitz.

Du Mont as Sportsman

Allen Du Mont's love of the water naturally meant that he loved boating, and he spend as much time as he could on his cruisers, successively named Hurricane I, II, and III. Precision navigation was his special interest, predicted-log racing in particular. He was so skillful that he was national champion for three years. In recognition of his special skills in boating and in electronics, he was granted a special license to operate his 35-foot Hurricane II during World War II, making tests in the waterways around New York City of TV ghosts as related to signal transmission and the detection of other objects.

During the early 1940's television manufacturing was at a halt. Experimental Station W2XVT, transmitting at 50 watts from the basement of the Passaic plant, was manned from midnight to 9 am, starting in 1938. Test patterns, slides, and a occasional movie were transmitted to test out new equipment, and many bleary-eyed engineers and technicians spent their days first on commercial and then on military electronics, and their nights operating W2XVT. When regular TV programming was introduced at the New York World's Fair in 1939, Du Mont receivers were on the market, field tested by W2XVT, and Du Mont's W2XWV (later WABD) was set up in New York City.

Meanwhile, production of radar indicators, mortar-fire locators, electronic timers for *Loran C* equipment, and general-purpose and militarized oscillographs, continued. There were no materials and no manpower for television, but many refinements and techniques were borrowed from television and applied to advancing the capabilities of oscillography, radar displays, and related devices. Video amplifiers gave wideband response for pulse analysis for radar and other needs; special oscillographs were supplied for the Manhattan project, Oak Ridge and Los Alamos Laboratories, Sandia Corporation, and others engaged in the development of nuclear weaponry. Triggering and sweep circuits from television practice were adapted to instrumentation. New types of cathode-ray tubes were developed, including polar deflection types for radiolocators and ultra-high-frequency types utilizing coaxial lead structures to deflection plates.

The Beginning of Television

When World War II came to an end, Allen B. Du Mont once again was able to concentrate his attention and energies on his long-time objective—a practical commercial electronic television system. He had participated in the establishment of standards for the 525-line system now used in this country, based on recommendations of the National Television Systems Committee (upgraded from the 441-line system in use two years earlier when regular broadcasting began). Never one to back away from a controversy,Du Mont had urged adoption of a flexible system that would permit future improvement in picture resolu-

•Fellows, Radio Club of America

tion without making existing receivers obsolete, but his recommendations, though supported by impressive field-test demonstrations, in the end were not accepted.

With the transmission standards fixed, and with nine commercial television stations on the air, the age of television had arrived—on paper. It remained to design, produce, sell, and install the many transmitters and receivers necessary to make it a reality.

To this end Du Mont rearranged his internal organization to set up separate operating divisions to produce the major product lines: tubes, receivers, transmitting equipment, and instruments, and proceeded to enlarge his technical staff to carry out the job. Supplementing these four was the television broadcast division. It was not difficult to recruit an outstanding staff, because Du Mont Laboratories had established an excellent reputation for quality and innovation during the war years. The postwar Du Mont technical staff was perhaps one of the finest ever assembled by a company of such size, and it produced very effectively, a tribute to the leadership and inspiration provided by Allen B. Du Mont.

The Receiver Division concentrated on the design of high-quality 12-, 15-, and 20-inch receivers. The Transmitter Division refined the studio equipment that had been in use since pre-war times, up-dated it, and added image orthicon camera chains, high-power vhf transmitters, and started development of uhf transmitters. Design of large-screen magnetic deflection tubes was the assignment at the Tube Division, switching from the electrostatic types used in pre-war sets. The Instrument Division happily found a pent-up demand for cathode-ray oscillographs to replace the suddenly defunct military market, and it continued to produce most of the income to support the television activities during those expensive days of redesigning, retooling, re-equipping, and preparing for large-scale production. Broadcast operations were expanded, and a network of affiliated stations was developed, that at one time was the largest in the country.

While the business was a-building, it was not a case of "All's quiet back at the plant". Study, development, and innovation continued apace. Allen Du Mont continued to encourage an extensive search for new applications of the cathode-ray oscillograph, with a generous supporting budget. Although 1939-40 development of a cathode-ray electrocardiograph, encephalograph, and a stimulator proved premature, postwar studies included the application of television to microscope viewing, an electronic counter of bacterial cultures, and even a study of the determination of fertility in unincubated eggs.

Further refinements were made on the *Cathautograph*, invented by Allen Du Mont more than a decade earlier as a means for transmitting signatures or other information via wires for display on a remote cathode-ray tube.

In the field of cathode-ray tubes there were many innovations for both oscillography and television. To overcome the frequency limitation resulting from transit time of electrons in electrostatic deflection systems, distributed deflection plates were used, borrowing from transmission line theory. Improved phosphors were developed, and extensive applications notes were published on the photographic recording of oscillographic traces.

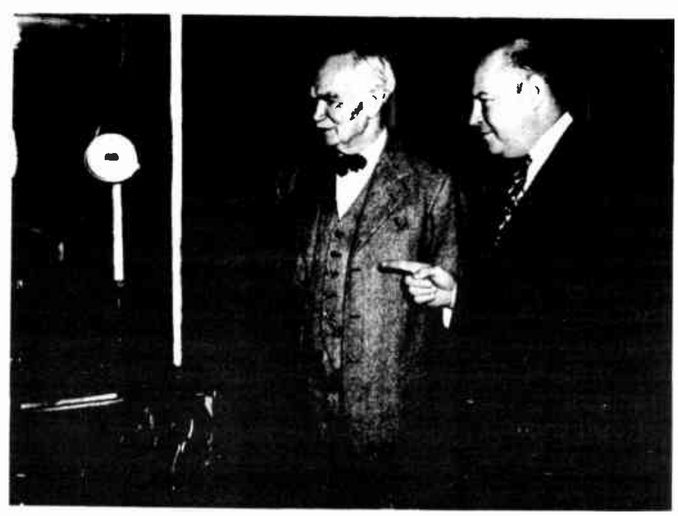
The search for the TV picture on the wall display resulted in techniques for light multiplication. Color crt's took a large share of development effort, and many approaches were explored, the Lawrence tube showing unusual promise. However, it failed to win sufficient support from some of the corporate directors, and funding ceased.

The broadcast equipment engineers contributed their share of new ideas. One of these, the *Electronicam*, offered a means of recording on film with TV techniques. Another, largely the brainchild of Allen Du Mont, was *Photovision*, a method for transmitting sight and sound on a beam of light.

As broadcasting grew and new stations came on the air—there were 37 by 1948—, it became apparent that the existing plan for allocating broadcast channels was inadequate. Accordingly, the FCC put a freeze on the licensing of new stations, and thereby a damper on the industry. Then the question of color television was taken up, prolonging the freeze, and the FCC authorized a non-compatible mechanical system that would obsolete all existing receivers. There was an immediate protest from industry, and the fight was on for a compatible all-electronic system. Needless to say, Allen Du Mont was in the thick of the fight, and his inimitable way demonstrated at an FCC hearing just how monstrous—and dangerous—would be a mechanical scanning system for a large-screen receiver, complete with 5-horsepower motor to drive the color wheel. In due time a compatible system was adopted.

Financial Problems

Television receiver business peaked in the early 1950s. Prior to that time Du Mont was supplying luxury receivers to an expecting market. As the market became saturated and sales began to level off, low-cost sets were produced in competition with large companies having well-established dealer networks. In broadcasting, a limit to the number of Du Mont-owned stations that resulted from the financial relationship with Paramount Pictures stymied growth. As the situation worsened, for reasons that have had wide discussion, the pressures on Allen Du Mont grew stronger. One might speculate whether the possibility of more independent action would have led to a different outcome. In 1955, the Broadcast Division was separately incorporated and sold to Metropolitan Broadcasting Co. Three years later the receiver business was sold to Emerson



De Forest and Du Mont discuss a new tube exhausting and sealing machine in the Du Mont factory.

Radio and Phonograph Corp., and TV tube production was discontinued. The Fairchild Camera and Instrument Co., purchased the surviving Instrument, Tube and Government Divisions in 1960, with Dr. Du Mont serving as Senior Technical Advisor.

Allen B. Du Mont was the recipient of many awards and honorary Society of Sigma Xi upon graduation from Rensselaer Polytechnic Institute. Later, the Institute awarded him the honorary degree of Doctor of Engineering, in 1944, as did the Polytechnic Institute of Brooklyn in 1949. The degree of LL. D. was conferred on him in 1955 by Fairleigh-Dickenson University and in 1960 by Montclair State College. New York University awarded him the degree of Doctor of Science in 1955.

He was for many years a Life Trustee of Rensselaer Polytechnic Institute and vice-president of the Board of Trustees.

More directly concerned with television were his many years of activity in professional and trade organizations. These include membership from 1940 to 1944 in the National Television Systems Committee, on the New Jersey Television Commission (concerned with the state TV network), and service as United States Delegate to the CCIR, an international standards body, concerned with television standards.

Dr. Du Mont was a Fellow of the Radio Club of America, the Institute of Radio Engineers, the American Institute of Electrical Engineers, the Society of Motion Picture and Television Engineers, and the Television Society of England. He was the first president, in 1943, of the Television Broadcasters Association (TBA). Other organizations of which he was a member include the Radio and Television Executive Society, Veteran Wireless Operators' Association, American Rocket Society, Radio Pioneers, Television Pioneers, De Forest Pioneers (Past President), Montclair Society of Engineers, Sigma Delta Chi, Champlain Society, Hugenot Society, Holland Society, Eastern Cruiser Association (Commodore 1955-56).

Lee de Forest

The Father of Radio

By FRED SHUNAMAN

Lee de Forest — like too many other important figures in the history of electronics — is already becoming a victim of neglect by those who write the histories of radio. Given the honorific "Father of Radio" for his invention of the amplifying vacuum tube, practically none of his other work is mentioned — nor remembered. And illiterate historians — because of a superficial resemblance between the two devices — are prone to describe de Forest's most important invention as a mere improvement on the Fleming valve rectifier. Yet de Forest was the prime figure in the early development of radio communication in the United States.

Graduating from Sheffield Scientific School, Yale, in 1899, he had chosen for his Ph.D thesis, "The Reflection of Hertzian Waves from the Ends of Parallel Wires." Marconi was then demonstrating his equipment in England (where he was denounced by some as using the apparatus of Lodge), Popov was experimenting between his station at Kronstadt and ships of the Russian Navy, and Ducretet had sent signals from the Eiffel Tower in Paris to the Pantheon, 4 kilometers distant. Tesla had — in 1899 — actually demonstrated remote radio control in Madison Square Garden, New York City. There was enough "wireless" in the air to fire the imagination of the newly hatched Ph.D., and he immediately sought work in the communications field, meanwhile starting to work on a detector of his own, which he called the Responder.

The first de Forest detector was patterned on a principle described by the German scientist Aschkinass. A drop of liquid (de Forest spent many weeks trying to find the right one) between two contacts carried current until the arrival of an electric wave. Then its resistance rose suddenly, due to the breakdown of "little trees and bridges" of metal in the liquid. Its great weakness was that after a time — ranging from minutes to days — it would "clog" and pass current continuously.

Working in Chicago, first for Western Electric, then part-time as assistant editor of the *Western Electrician* and receiving some support from a fellow-worker, Ed Smythe, de Forest brought the Responder to a point considered usable, and — jointly with Smythe — took out a patent on it.

The famous "gas mantle" incident occured during this period. Smythe and de Forest noted their spark discharge caused the gaslight to brighten, and devised an interesting theory to account for it. When they found it was simply the sound waves from the spark gap that caused the effect, de Forest refused to abandon the "ionized gas" theory. (Finding that a gas flame was, indeed, a crude detector of wireless signals, he patented during the next several years some 11 devices using that effect, the last one being the Audion.)

Having developed equipment that would work reliably over at least four miles, de Forest went East to cover the upcoming International Yacht Races by wireless for the Publishers Press Association, in competition with Marconi, who was working for the Associated Press. Loading his equipment on a tug, he went out to write a new page in the history of wireless.

That new page was the discovery of interference. Both Marconi and de Forest had heard of tuning, but neither considered that refinement necessary. They jammed each other hopelessly, and the race reports were transmitted to shore — wirelessly, sure enough — by wig-wag flags.

De Forest in business

Organizing a small firm, (the American Wireless Telegraph Co.), to raise capital to improve his apparatus, de Forest struggled to keep alive through the rest of the year. In

What actually was this Audion, de Forest's most important invention? Was it — as some say — simply an improvement on the Fleming valve ["de Forest inserted a third electrode"] or was it an entirely separate invention?

The answer is that the Fleming valve and the de Forest Audion are not only two distinct inventions, but belong to two different families of detection devices. The Fleming valve is a rectifier. As such, it takes its place with Fessenden's Wollaston wire detector and the crystal detectors of Pickard and Dunwoody. The de Forest Audion is a relay — a device that uses the radio signal to trigger or control a greater amount of power supplied by a local source [de Forest's "B" battery.]. It belongs to the same family as the Branly coherer and de Forest's earlier Responder.

Because the Audion can control a greater amount of power with a smaller amount, it can amplify. It can also be made to regenerate. Oscillation and radio transmission are, of course, a product of that effect.

Dr. de Forest experimented for a number of years with devices fundamentally similar to the Audion, using the ionized gases of Bunsen burners. In 1904 he turned to partially evacuated lamp bulbs to produce the same ionization. It is reasonable to suppose that the idea of using a lamp bulb may have been suggested to him by the Fleming valve. It is equally possible that, since both were working with glass bulbs in 1904, that they may have been working in ignorance of each other's work.

But even if de Forest had known of Fleming's valve, and [as an extreme case] had obtained one of them, opened it, placed his grid in it and resealed it, it would still have been in no sense a modification of nor an improvement on the Fleming valve, but a separate and independent invention. Lee de Forest was persuaded of the importance of ionized gas, and found that a partly evacuated bulb gave him an opportunity to work with ionized gas. It was a more reliable and rugged device than his earlier open flame devices. Fleming's rectification did not enter into his calculations — in fact one of his earliest patents on what we now know as the Audion was entitled "A Device for the Amplification of Feeble Currents."

January 1902 he met the first of the "businessmen" destined to move the de Forest fortunes into affluence and bankruptcy not once, but three times. Abraham White was a highly successful professional promotor, who was convinced there was money in the glamorous wireless field. He was not as critical as de Forest's technical friends, and asked only that the equipment show up well enough to persuade investors to buy stock. Absorbing de Forest's company, he formed the American de Forest Wireless Telegraph Co., and de Forest found himself with capital to work with — plus a regular salary of $30 a week!

His first development was an ac-operated spark transmitter, with a "high-frequency note" of 120 Hz, which produced a sharper and easier-to-read signal than the low notes of the dc interrupters previously used. He then set up stations in lower Manhattan and Staten Island, and exchanged messages between them. The Navy became interested, though continuing to depend on the main on German apparatus, which could print messages out on tape. They bought de Forest equipment, both for shipboard use and to outfit two new stations, one at Washington and one at Arlington. This kept the de Forest plant working full time through the winter of 1902-03.

In 1903, de Forest finally succeeded in reporting the International Yacht Races by radio instead of light waves. 1903 also saw the introduction of wireless to Canada. The first press station, with which the *Providence Journal* kept in contact with Block Island, and the first commercial wireless telegraph — between Nome, Alaska, and Fort St. Michael, a distance of 107 miles, were also installed that year.

The year 1904 was even better, with de Forest's wireless exhibit the main attraction of the St. Louis World's Fair, and a contract for five powerful Government stations — at San Juan, in Puerto Rico; Key West and Pensacola, Florida; Guantanamo, Cuba; and Colon, in the future Canal Zone.

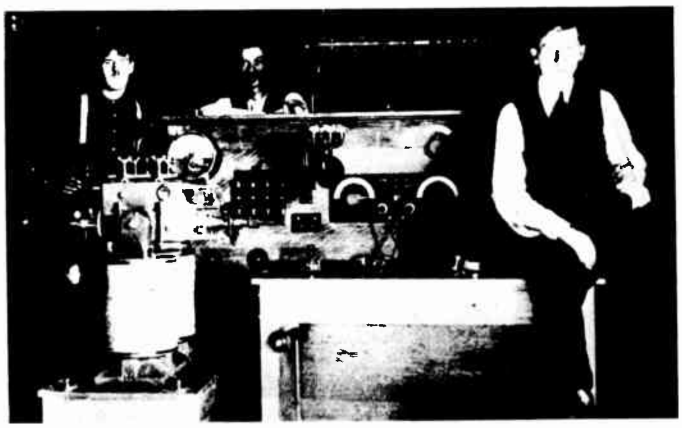
In 1906 de Forest first ran afoul of his stock-selling associates. White and his pals gutted the company by organizing a new outfit, United Wireless, and transferring to it all the assets and none of the debts of the older company. Quitting the organization in disgust, de Forest turned in all his stock, asking nothing but the patents on the nascent Audion and on the Aerophone, an arc telephone with which he had been experimenting, plus $1,000 in cash. The United Wireless Telegraph Co. continued till 1911, when its president and a number of its directors went to jail for stock frauds. A year later it was absorbed by American Marconi, increasing the facilities of that company from five wireless stations to approximately 50 coastal stations and 14 on the Great Lakes, and from a half dozen ship stations to about four hundred. Dr. de Forest pointed out bitterly that at the time of its forced sale, this (which might be called his first child) amounted to more stations than those of all other wireless companies in the world combined!

Organizing the de Forest Radio Telephone Co., almost without capital, he moved into the Parker Building, New York City (now famous as the birthplace of the Audion) and started to make radio telephones. During 1907 and 1908 he installed equipment on two dozen Navy craft for a round-the-world cruise. Because of hurried installation and untrained operators, results were good only in odd cases, according to de Forest. But even these results persuaded Admiral Evans of the value of the radiophone, and he became a strong supporter of it.

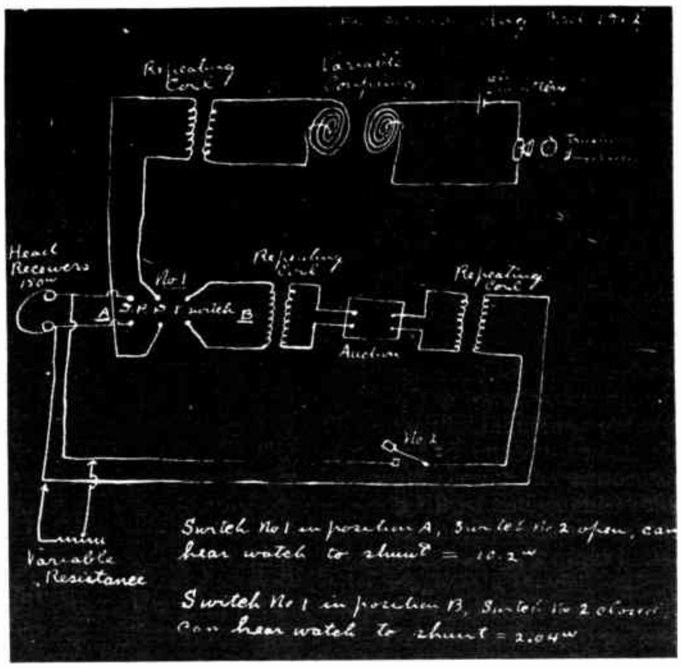
In 1908 the Italian government bought four sets of equipment for use on warships, and a little later the British bought two, after tests showed reliable communication over more than 50 miles.

Out of business again

In 1909 de Forest again found himself the victim of stock-



Arc transmitter used by Federal in 1912, in San Francisco. Extreme left is D. Perham, pre-pioneer broadcaster, whose collection is preserved with de Forest's in the Foothills Museum. At right is Peter V. Jensen, later famous for loudspeakers.



Schematic of the world's first amplifier. "Repeating coil" is an old telephone name for transformer. Variable resistor across the phones is a crude device to measure gain.

jobbing associates. The company president announced to a directors meeting that the last 20,000 shares sold, presumably to raise working capital, had been his own and not the company's and that the treasury was empty, with debts of $40,000. Allowing himself to be persuaded not to prosecute the officer and to attempt to save the remains of the company by reorganization, de Forest was able to continue research and manufacture on a reduced scale, as the North American Wireless Corporation. An order from the Army Signal Corps to install de Forest quenched spark equipment on two transports in the Pacific offered some help. Thus de Forest arrived in California, later to be his home for many years. No funds were coming from his reorganized company, and he found it advisable to take a job with Federal Telegraph Co., now a part of ITT.

As head of Federal's research department, de Forest developed a wireless form of duplexing, switching the transmitters between two frequencies many times a second, with one operator sending on each frequency, and employing two receivers at each station. Thus two sets of messages could be exchanged simultaneously between San Francisco and Los Angeles.

On March 29, 1912, de Forest was arrested by a United States marshall, for "using the mails to defraud." Two directors of Federal Telegraph Co., "men whom I had never met," says de Forest, arranged for immediate bail, and he continued working for Federal while waiting for the case to come to trial.

Amplification and regeneration

Working on a method of recording signals, de Forest found they were often too weak to be recorded properly. One of the earliest patents on the Audion had been entitled "A Means for Amplifying Feeble Currents," and with two assistants, Charles Logwood and Herbert van Etten, de Forest set about to make it earn the title. But the Audions of that day would glow blue and stop amplifying if more than a few volts was applied to the plate. Realizing that the trouble was probably too much gas (de Forest was still sure that some gas was necessary for Audion action) he had a local X-ray manufacturer evacuate some tubes to a higher vacuum. The new Audions would take 120 volts, and were immediately successful as amplifiers.

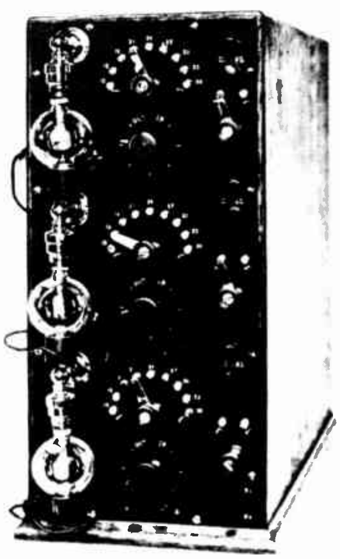
While working on the amplifier, de Forest and van Etten one day connected the output of the second stage back to the first. That historic day, August 16, 1912, was the birthday of feedback, regeneration and oscillation. They heard (and described in van Etten's notebook) a high musical note as a result of the feedback experiment, and noted that it could be varied by varying the capacitance or inductance in the circuit. Further experiments — on a day when only one good Audion was available — showed that the same results could be obtained with a single tube — self-regeneration or oscillation.

Years later, when Armstrong claimed the invention of regeneration, van Etten's notebook was the instrument that convinced the judge of de Forest's priority.

De Forest decided to go East and demonstrate his new amplifier to "The Telephone Company" (AT&T and its subsidiaries, Bell Labs and Western Electric) who had long been searching for a way to boost signals on long-distance telephone lines. He was encouraged by the attitude of the Telephone Co. and decided to remain East. After nearly a year of waiting, with no money coming in from the North American Wireless Corp., de Forest found himself literally broke, with his watch in pawn.

Sale of the Audion rights

At this time he was approached by a young lawyer, Sidney Meyers by name, who said he represented parties interested in the Audion as an amplifier. He would not reveal his backers, only pledging his "word of honor as a gentleman," that he did not represent the Telephone Co. He offered $50,000, a much smaller sum than de Forest thought he could get for the amplifier rights. But his company, owner of the patents, was in a precarious position and might soon find the patents and other company assets put up at auction to satisfy creditors. And de Forest himself was on the verge of starvation. So he agreed, only to find a few weeks later that his customer was indeed the Telephone Co., and that its directors had allegedly been prepared to pay as much as half a million dollars for the rights he sold for $50,000.



This three-stage audio amplifier was first built in 1912 by the Federal Telegraph Co. (predecessor of ITT) during the period that de Forest was head of Federal's research department. The earliest commercial cascade amplifier, it had a gain of 120. It was demonstrated to the U.S. Navy in September, 1912.

The deal was not as bad as it has been represented; de Forest did not sell the Audion patent — simply the right to use it as an audio amplifier on wire lines. And if his company had been forced to sell its assets at auction, he might well have lost the basic patent.

The $50,000 gave the company a new lease on life, and in 1913 — with the "using the mails to defraud" case still hanging over his head — de Forest began manufacturing audio amplifiers at High Bridge, Bronx, NY. The Navy was, as usual, a good customer.

It was also in 1913 that — by a hookup error — the Ultra-Audion circuit came into being, a circuit that de Forest used for some time in both transmitters and receivers, believing it to be superior to the two-coil method of regeneration.

The fraud case came to trial late in 1913, and some of the stock-jobbing directors of the company were found guilty and sent to Federal prison. The jury found de Forest innocent, even though the prosecutor produced unassailable proof that de Forest had claimed that it would soon be possible to send the human voice across the Atlantic with what the prosecutor described as "a queer little tube that had proved worthless — not even a good lamp!"

In 1914 de Forest ran into new legal trouble. The Marconi Co. charged that the Audion infringed the Fleming valve patent, and won the case. But the court also decided that the Audion patent was valid as well. The result was that neither de Forest nor Marconi could make Audions. The resulting confusion lasted until the Fleming patent expired in 1922, and produced some absurd effects. For example, Marconi had licensed the Moorehead Co. in San Francisco to make Fleming valves. So de Forest's company ordered Audions from Moorehead, and sold some of them to Marconi!

Also in 1914, Sidney Meyers appeared again — in the open this time. The Telephone Company was interested, he said, in securing radio signaling rights in the Audion, and offered $10,000 for such rights. More cautious this time, de Forest asked for $100,000, and obtained $90,000. The de Forest company retained the right to manufacture Audions "for amateur and experimental use."

In 1915 de Forest used the Audion to make the first music synthesizer, selling the patent to Wurlitzer.

Broadcasting established

In the winter of 1909-1910 de Forest had pioneered broadcasting by putting the Metropolitan Opera on the air — for one performance. Now he began a regular broadcast service from his High Bridge station. Because he transmitted phonograph records, lent by Columbia, he claims the title of world's first disc jockey. He also became the first newscaster, broadcasting the results of the 1916 Presidential election (four years before KDKA's heralded broadcast). The High Bridge station closed at the outbreak of World War I.

By 1916 the Telephone Co. had decided it needed still more rights in the Audion, and re-opened negotiations. Finally, de Forest sold all rights in the Audion and in radio service for public pay, plus rights in all patents pending and to be filed during the next seven years. The price was $250,000. The de Forest Radio Telephone and Telegraph Co. retained foreign and government rights.

This deal has not been nearly as well publicized as the first one, for $50,000. Altogether, de Forest received in the end $390,000 for the Audion and developments based on it.

Broadcasting from High Bridge started again after the war, and de Forest moved his station to midtown Manhattan, where he had access to a better antenna. The number of listeners had swelled "into the hundreds" when the station was closed by the Federal radio inspector, Arthur Bachelor. The legal reason was that the station had changed location without a permit. But Mr. Bachelor made it clear that interference with commercial radio stations would not be tolerated, and that "there is no room in the ether for entertainment."

de Forest Phonofilm

De Forest now turned to the movie sound field. He had already experimented with magnetic wire recordings synchronized with the film, but now decided to try to put the sound on the film itself. The world's first talking picture, a Swedish film called "Retribution" in translation, was produced by de Forest Phonofilm in 1925. Phonofilm had some 34 theaters "wired for sound" at that time, but competition was strong and the movie moguls moved to another system. He retired from the field in 1929, with only $60,000 as a settlement from one of his commercial and legal competitors.

To get capital for his sound-on-film work, he had sold control of the de Forest Radiotelephone and Telegraph Co. to a group of Detroit automobile capitalists. Hired by them as a consulting engineer, he was able to watch the company go downhill to ultimate absorption by RCA. Thus the last of the de Forest companies — like the first — finally became part of RCA.

The busy period of de Forest's life ended with sound-on-films. In the '30's and '40's, he experimented with television, devising a color filter hardly larger than the tube screen, instead of the bulky and alarming color wheel. In his work with television he also invented the principle of radial scanning, patented in 1941. He disposed of the patent to RCA, at a lower price, he said, than he would if he could have forseen radar (only a year or two later) and the PPI display, which depends on the radial scan.

Continuing to experiment and invent, he again found himself not oversupplied with funds. A contract entered into in the '40's with the Bell Telephone Labs supplied him with means to equip a new laboratory and eased his financial situation considerably. In return, he was to license Bell under all patents that might be granted him.

Dr. de Forest remained more or less active until his retirement in 1958, when he was 84 years old. His last patent — on an automatic telephone dialing device — was issued in 1957. He went to France the same year, to receive the Cross of the Legion of Honor, which was added to a number of earlier honors, including the degree of Doctor of Science from both Yale and Syracuse Universities, and awards from various learned institutions and organizations. He died June 30, 1961, after a long illness.

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Obituary and short biographical sketch.

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[Illustrations courtesy of ITT.]

David Sarnoff

(An Evaluation)

by Wm. H. Offenhauser, Jr.

The flood of articles, lay and technical, that have already reported his words, thoughts, adventures and efforts would make an obituary at this late date superfluous. Yet, The Radio Club of America, older by a decade than "the other RCA," cannot ignore or even treat glibly the passing of one of its most prominent, most controversial and early Honorary Members. Knowing the man, you could never be undecided, "No Opinion" about The General. He may be disliked and even very heartily in some quarters, but he cannot be ignored. Only history can pronounce the final judgment—whatever it will be.

Frederick M. Sammis, Chief Engineer of Marconi of America, hired DS first as an office boy. He was both diligent and ambitious; an early story indicates that he took letter filing very seriously. "I read every letter given to me for filing before I filed it.", said the young Sarnoff. "That way, within a month I knew more about the business than any other man in the company." It was not an idle boast, but rather a keen commentary on an observable shortcoming in business acumen among many of his fellow employees.

Since many of the outstanding men of the time combined both the high-speed "key and sounder" ability of a good telegrapher with a working knowledge of the apparatus of wireless, DS at first set his sights upon both; he studied at Pratt Institute in Brooklyn. Joe Stantley Sr., Treasurer-Emeritus of The Radio Club, has often remarked over the years that his classmate, DS, worked like a beaver, never missed a class, and was outstanding in his diligence. He was eager to learn everything that was to be learned. Stick-to-it-iveness was even then characteristic of DS; it was not long before he became an astute student of people as well as of things and events.

Although wireless was glamorous and had its full share of genius-level minds such as Bob Marriott, Emil Simon, Haraden Pratt and A. N. Goldsmith, to mention just a very few, the pay of operators was neither glamorous nor reliable. DS had observed, with the help of E. J. Nally, that the attitude of people who controlled money is that business money income is productive and very desirable, while engineering is overhead, and those who make money disappear are undesirable. Obviously, the key to success is to "make money where it is coming in."

His enthusiasm for wireless engineering was badly mauled when Lee deForest, the acknowledged inventor of the Audion, was indicted for fraudulent stock selling practices in 1913. Since Bob Marriott was the spark plug behind the petition that was drafted by A.N. Goldsmith and Emil Simon to the Assistant District Attorney in deForest's behalf and signed by 49 IRE members, DS phoned Bob to ask him for lunch in 1914. After listening closely to Marriott's account, DS told his guest that he decided to give up wireless engineering. He did not think that he could be as good a wireless engineer as "you fellows," and would concentrate henceforth on selling wireless contracts and service—"bringing in the money." By April 24, 1915, when the second IRE banquet was held, DS had transferred engineers out of his "We" group into the "You fellows" category—where they remained for the rest of his lifetime, never to return.

History has already separated out the few grains of truth from the much overblown camouflage flak in the story of the Titanic. The sinking was a dramatic event: an examination of the stock market options bought after the close of the market on the fateful day, and their subsequent sale after the great news was released, would suggest that something more than mere happenstance rewarded DS with a desk just outside Nally's office, his job as Commercial Manager at 26, leading on to General Manager at 30.

His rise was meteoric; the rough-and-tumble experience in the early stock market stood him in good stead later on when he worked with Joseph P. Kennedy and FDR behind the scenes, and Mike Meehan was "out front." In a later manipulation, RCA common stock jumped from $22 per share in June to $550 in November of the same year without ever paying a single penny in dividends. This was merely one facet of Joe Kennedy's very profitable pasttime of "cornering the shorts"—a game well known in Wall Street and now hopefully outlawed by the SEC.

History seems clear that DS was the right man in the right place at the right time. The sales figures of RCA tell a mute but indisputable Horatio Alger-like story of a poverty-stricken Russian Jewish boy who made good in a then WASP-dominated financial world. Without a university education, he had obtained a high school equivalency diploma to take an EE course at Pratt Institute.

With figures such as these, who needs a university education, even at the Harvard School of Business Administration!

Year	*RCA Gross*	*Other Data*
1921	$ 1.5 million	Less than 10 broadcast station licenses
1922	11.3	28 licenses
1923	22.5	583 licenses
1929	182.1	NBC (subsidiary) grossed $22 million alone

The significance of such growth was not wasted on Harvard; they encouraged publication of some of the RCA story.

Throughout 1920 to 1930, RCA was a sales agent only: although radio sets and other apparatus carried the RCA label, they were manufactured by General Electric (circa 60%) and Westinghouse (the remainder). DS had Elmer E. Bucher as his man Friday; he trusted EEB with everything except money. That he handled himself.

It was Bucher who was transferred from 326 Broadway to master-mind the coordination and marketing of radio; he was an outstanding success. Later (1928) when Owen D. Young decided that the Radio Group should "declare war" on ATT in sound films, DS moved Bucher into that slot at RCA Photophone Inc., another new industrial frontier.

Bucher was "a practical man"; he wrote "Practical Wireless Telegraphy"—a volume every old time brass pounder can not forget. What is still virtually unknown today is that Bucher was a teacher-historian at heart; he has written some 39 volumes of about 500 pages each on the history of RCA. These repose quietly in the Library of the David Sarnoff Research Center at Princeton, New Jersey. If as often seems the case, engineers abhor history, neither Bucher nor DS were engineers by that queer definition. Both were scholars, each in accord with his own unique and valid definition. "Those who ignore history," wrote Santayana, "shall be condemned to relive it." Neither ignored history or its teachings; such is evident today.

During that crucial decade, Owen D. Young of General Electric, perhaps the finest of America's farsighted genius industrialists, watched DS carefully indeed. Sarnoff's very mildly expressed but persistent beefs to Young about poor coordination of manufactured RCA products through the Manufacturers Design Committee and his astute observations on American finance struck a highly responsive chord with Young. When the President asked Young to negotiate a revision of the Dawes Plan for German Reparations (WW I), Young asked Sarnoff to go along as a financial technician. Both sailed from New York on Feb. 1, 1929; they had expected to return within less than two months. Negotiations with Dr. Hjalmar Schacht, the German representative, proved very sticky; it was the middle of June 1929 when they finally returned with the Young Plan as a signed document. Young never hesitated to credit Sarnoff's bulldog determination in getting the German signatures. Schacht's language, referring to Messrs "X and Y", the Americans, is not complimentary.

Before DS left for Europe, he had already obtained Young's approval of his provisional plans to take over the Victor Talking Machine Company in Camden and to start manufacturing in Camden under the RCA label. And he was more than happy to put the steam behind Young's plan to compete with the Telephone Company through RCA Photophone Inc., the sound motion picture equipment subsidiary. Obviously, too, RCA manufacturing in Camden would include not only radio equipment but sound films as well—and everything else that would be sold under the RCA label. "DS had it made." RCA started its own manufacturing in 1930. He had become the undisputed boss.

DS recognized very early that solid success in marketing derives not from advertising, but from a basic product filling a basic economic need. With GE and Westinghouse doing the manufacturing, he quickly saw his function as deciding what should be manufactured. He did not hesitate to adopt A. N. Goldsmith's magic music box and dress it up in his own language; RCA-Victor became the chosen modus operandi. Since music, and especially classical music, was an essential, he was deeply impressed in 1925 by the appearance on Station WEAF, the Telephone Company outlet, of the Victor Orchestra and singers John McCormack and Lucrezia Bori—and resolved to sponsor and encourage the best in music, which he did. Milton Cross and the Metropolitan Opera, the New York Philharmonic Orchestra and the NBC Symphony Orchestra should never be forgotten in American cultural history.

The more DS accomplished, the more he recognized must still be done to provide a growing industry with a supporting growing American culture; Governor Nelson Rockefeller gave eloquent testimony at Temple Emanu-El to that side of his accomplishments. As a child, DS had been deprived of that culture through a devastating poverty; he was determined to use everything he had ever learned to eliminate poverty for his family and his children—and many of his (presumed) peers never knew and never understood. In so doing, he would continue to be the kingpin and therefore could feel assured that his family goals would be realized.

In 1928 while on a visit to Westinghouse in Pittsburgh, DS had an opportunity (which he had contrived) to study Vladimir Zworykin closely. Sizing up his man, he decided that Zworykin was the one he wanted to become the fountainhead of the development of television by RCA at Camden. A. N. Goldsmith had already started daily service in television transmission from the RCA Technical and Test group at Van Cortlandt Park, the "country club" of RCA. Experimental transmission started with a Nipkow disk and soon had Felix The Cat turning around slowly on a phonograph turntable as the subject to delight the very small select audience. In 1929 that setup moved to 411 Fifth Avenue, top floor, the office of the management of RCA Photophone, along with Goldsmith. In 1930, NBC took over the chore and operated the setup under the call letters W2XBS. The rest is recorded history.

What should be quite obvious by now is that DS in seeking command of RCA never shirked or neglected the duties and responsibilities that are an integral part of that command function. At the beginning the decisions that he made and carried through were neither large nor far-reaching; they did not affect large numbers of people or large sums of money. After 1921 that changed rapidly. By his very planning procedure he had set a collision course with Edwin Howard Armstrong, inventive creative genius and superb engineer from Columbia University, the protege of Prof. Michael Idvorsky Pupin, inventor of the (telephone) loading coil, the fundamental device for circuit loading. ATT had paid apparatus royalties to Pupin, making him a millionaire. Pupin often used his own money to buy for the Engineering Laboratories equipment that was purchased by him primarily for the teaching and training of Columbia University School of Engineering students; such bore a modest small nameplate; "M. I. Pupin, Columbia University New York City." Armstrong had been one such student, his favorite.

In 1929, Pupin would drive to 116th Street, parking his chauffeur-driven Rolls Royce, with uniformed chauffeur of course, in front of Alma Mater, rain or shine, instructing "his man" when he would expect to be taken home after his lectures and chores as a professor. It was Pupin who had invited the very skeptical ATT to see the closed black box that Armstrong had used earlier to demonstrate regeneration, formally disclosed as U.S. Patent 1,113,149. That number was displayed clearly on a nameplate of virtually all RCA-licensed apparatus, the makers of which paid royalties thereon. RCA and DS did well financially on this and Armstrong's later patents such as the superheterodyne. The Radio Club had been quick to recognize the outstanding work of Armstrong; he was elected President.

In 1926 The Radio Club honored two new Honorary Members. Professor Pupin and David Sarnoff. A. N. Goldsmith had been elected an Honorary Member earlier in 1922. But only Edwin Howard Armstrong has been honored by the Radio Club by having the Armstrong Medal Award, our highest award to this very day, named for him.

The stock market crash of October 1929 and the Depression that followed did not shake DS in his confidence in his long-range plans. Although Kennedy was completely out of the market when the crash occurred, some key RCA employees, originally with GE and Westinghouse, who had invested their hard-earned savings in such RCA affiliates as RKO, recommended to them by DS, were virtually wiped out. Doggedly DS held on to his big idea that the future for DS and for RCA as run by him would be television; it was nip-and-tuck in 1932 when the gross dropped to one-third of its comfortable level of 1929 and the net became a loss of over $1 million, a loss for the first time in more than a decade.

As each year passed after that, he saw business improving, and television development costs rising rapidly. But he also saw tangible results—and they were truly tangible—Zworykin's work was beginning to show results on the boob tube as well as in patent applications in the Patent Office. To many at the time, the optimism displayed by DS was "whistling in the dark." DS knew better. Humorists have often said, "If you want to bet on a horse race, you'd better speak to the horse in horse language." Maloff, an outstanding RCA television man, once hinted with a wry smile that for television at Princeton maybe Russian is the language. Solid accomplishments were already theirs—and DS knew it.

By the time Armstrong had patented his frequency modulation and offered it to RCA, DS was already committed far too deeply in television to back out. Perish the thought that RCA would ever go on without him but with FM. The magnitude and cost of FM operations required to buy and to market FM from the Major was far too high; and after all, a picture is worth 10,000 words. The collision, head on, was dead ahead. With full speed ahead ordered by both, the Armstrong decision made after the Sarnoff rejection, the result was devastating.

After the collision occurred, David Sarnoff had lost a life-long admired friend, perhaps the only man in the "You fellows" category that he would wish to have as one of "We." And Howard Armstrong had acquired what seemed a really vicious enemy. Neither man was entirely correct and neither was entirely wrong.

The truth, harsh as truth always is, lay in the gray area between black and white. Each man had acquired in his amazing lifetime, one in which his accomplishments can be properly called superhuman, a different set of values. The clashing values were poles apart, and a rigid setting of course with the compass heading unerringly guided by those unbending rigid values could result only in a devastating collision, with permanent injury to both.

And thus it was that when Major Armstrong died, there appeared at the church services a silent lonely man who never exchanged a word with any of the Radio Club officers or members who had come to show their respect for their fallen hero. The silent man was David Sarnoff, whose heart was filled with grief, for he had lost forever a man he had once loved and admired as a fellow man whose friendship he could now never regain.

And when the General died, a tall silent ghost was present at Temple Emanu-El. It was the ghost of Howard Armstrong. He too was silent but was not seen by any human. Perhaps at that point, Howard, who had crossed the River Styx earlier, was again joyful since the Major and the General could now discard their uniforms and ignore their military ranks, and re-establish in Valhalla that friendship which had been so rewarding to both in the beginning.

Both men were geniuses. It is a fact of life that geniuses, being what they are, are hard to live with. But this world must have genius—and it must soon prepare itself for the inconvenience and downright cussedness of genius—if it is to survive, as it most certainly will.

The Radio Ham's Universe

Left: Dr. Goldsmith; right: Director George Bailey.

An address to the Radio Amateur Luncheon Club meeting sponsored by the Metropolitan New York Chapter of Quarter Century Wireless Association and the Radio Club of America, at the Engineers' Club (New York) March 21, 1972.

By Dr. Alfred N. Goldsmith

My fellow radio amateurs, I propose now to take you on the longest trip you have ever made—to the very end of space and time and to the incredibly distant limits of the universe as well as the short ranges of daily communication.

Much of what I say is a hope and a dream of the future. And I start with space communication. Light, or radio, can speed around the earth more than 7 times in a second. In other words, it takes radio about 5 seconds to travel a million miles (or a megamile, to use an interesting descriptive term).

Two-way communication with the moon is over about a half-million mile span, so radio takes about 3 seconds to flash from the United States to the rocky craters of the moon and back to earth. Accordingly, the time required from the earth to the moon and back by radio is measured in seconds and is quite noticeable.

But consider what happens when we try to communicate between Terra—our own earth—and the planet Mars when Mars is at the opposite side of the sun from Terra. Radio must then travel out and back approximately 400 megamiles. If a man speaks on Terra to his companion on Mars it will take over a half hour before the reply can reach him. This will be slow communication and will have to be conducted by new methods. Probably all the comments from Terra will have to be recorded, on tape or other medium, and then sent in a constant stream with a reply beginning when the recorded tape begins to be received on Mars.

And now let us take a big jump to the nearest star to our sun, Alpha Centauri—the brightest star in the constellation of the Centaur. And let us assume that there is radio equipment on a planet orbiting Alpha Centauri. Then comes the question—how long will it take for a communication from Terra to reach the distant destination and then for the answer to be heard on Terra? The answer is astounding—more than 10 years!

Clearly, comfortable and speedy chats between such a planet and our earth are more or less out of the question. We shall require either suspended animation to permit our earthlings to await such delayed conversation or we shall have to depend upon some theoretical faster-than-light method of reaching the nearest star and its possible planet companion.

Now if we want to jump to the nearest galaxy or nebula—the galaxy of Andromeda with its billions of suns and possibly a myriad of planets—we find that it would take radio messages millions of years to travel from Andromeda to us. In other words, we seem to be really isolated in the huge universe which we are far from being able to understand or conquer.

You can begin to agree at this point that the Unidentified Flying Objects (UFO's) must take a long time to travel from even the nearest star to earth and communication with them must indeed be difficult.

To get closer to some of the possibilities of today, the United States was considering sending a space ship with communications equipment on "The Grand Tour" from the earth to such distant planets as Jupiter, and beyond. Such a trip will take a long time, and communication will be far from speedy even using the winged messenger: radio. But let us come still closer to earth and consider the synchronous satellite which is now so well known. This satellite, poised in space approximately 22,000 miles above the equator, is capable of communication over large segments of the earth's surface. Typical examples are communications of the Olympic Games from Japan to the United States via satellite. Another example will be programs to villages and schools in India and its teeming population.

Among the oddities of today is laser communication over one to ten miles, from ship to ship for example, using a modulated laser beam to carry the telephone messages over the ocean. Using a device that resembles a large binocular or hand telescope, one can speak from ship to ship directly by this new device.

All sorts of new communication methods loom up before us. For example, facsimile communication will enable us to send documents, drawings, or messages directly from the home to any desired destination. Thus we will realize the old dream of the "printing press in the home."

Also on the horizon, and as a most attractive addition to our present day broadcasting, will be the three-dimensional color television of the future. In such a system the home viewer will in effect be attending a so-called "legitimate theater show" and will see before him, in full depth and realism, the broadcast event or other program material of the future. In effect, 3-dimensional television annuls space and takes the viewer to the scene of action!

I would like to suggest that somewhere in this setup, the amateur will find his well-deserved place. A satellite for amateur communication could be placed in space and allotted, on a scheduled basis, to those eminent amateurs who have made especially interesting or useful additions to the amateur communications field. Such a prize would indeed be a fine reward for the enterprising and inventive amateur of the future.

If time permitted, I could go on indefinitely telling you of new applications, new methods, and new capabilities of the radio of the future. But I believe it is enough to say that the horizons are indeed wide and that the amateur will play his enterprising and helpful part in the future of our chosen and exciting field.

THE WRITING OF RADIO HISTORY—A PROJECT FOR R. C. A.

by

I. S. Coggeshall*

By and large those whom the Radio Club of America has chosen to present papers for its Proceedings have been too busy making radio history to write it.

This is not to say that the papers collected by title in your Jubilee Golden Book of 1959 are not historical gems -- far from it! Radio history flashes from their facets. It would be difficult to find their match as a collection, to pour through the fingers and catch up, one by one, radio's vast spectrum of colors.

But the compilation of useful radio history is more than a recounting of its bits. It involves a systematic, philosophical explanation of their relationships -- the interplay of cause and effect -- what led to what. It is the stringing of the beads into a necklace by means of a vital but hidden strand. It results in the creation of a thing better thought out, more unified, hence more precious, than the fistful of gems from which it was created -- a whole, if you will, greater in value than the sum of its parts.

When Ralph Batcher asked me to give the address this evening, the shortcomings of engineers as historians occurred to me as a fit subject for discussion. He had said that, in addition to entertaining you, I ought to seize the opportunity to make some detached suggestion which would give your Club additional purpose. So I do suggest that you set a goal of making your Proceedings a recognized repository of the world's most frequent and outstanding articles on the history of radio. To such a repository, scientists, engineers, the industry, the profession, historians, and others would instinctively turn, either to settle questions of the past, or at least to find satisfactorily documented the noble controversies of Who Got There First which have enraged the principals and enlivened the bystanders. I can think of a number of reasons why you should do this.

First, your records already constitute a good beginning. Apart from papers which themselves represent disclosures, I count in your Proceedings at least a dozen papers which, from their titles, are sources of historical material. You also have a number of recordings, in addition to the priceless record by Rounds and Armstrong brought out in connection with your 50th Anniversary.

Second, your relationships with Columbia University are so close that you have unusual access to source material available there in the form of memorabilia recorded on tape by Old Timers, some of them your members.

Third, the roster of your Club membership contains an unusual number of men whose roots tap historic soil all the way from 1959 back fifty years to 1909, and some of them prior to that date.

Fourth, the very detachment of your Club commends it as a mentor and repository of history. While the engineering societies are not beholden to vested corporate interests, their memberships do include blocs of loyal company employees who perceive the inconveniences and diversionary aspects of making historical claims in engineering papers; such statements are, therefore, left by common consent to the House organs. By contrast, your smaller organization is not concerned with grinding out current papers by the hundreds for national consumption. Your debt to units of the industry for support is closer to zero. You therefore have fewer people to offend when your researches are so rigorous that they turn up facts not entirely slanted toward vested interests.

Fifth, you can nicely take a mid-position between engineering and science. These branches of learning have more or less separate literatures, hence they tend to become departmentalized. The Radio Club of America can dip into both disciplines without diluting any obligation it may hold its members to specialize on the one side or the other.

Sixth, because your membership contains younger and older members in an ideal mix, you can produce authorities capable of evaluating history within its various decades. It is a mistake to assume that radio history is concerned alone with the Marconis, Fessendens, and de Forests. Profitable historical papers might be written right now on developments which took place under cover of secrecy in World War II, such as radar, proximity fuzes, printed circuits, and so on. The same goes for radio receiver circuits, loud speakers, modulation, feed-back, and such matters of an earlier generation. The burgeoning out of electronics in its audio, industrial, and other forms, is a subject of manifold interest. Going farther back, we run into such questions as who was first to think of putting amplifying stages in cascade; who started the C-biasing of filaments. All these subjects, of course, are to be found buried in the technical literature. It is one of the duties of historians to make the proper selection and interpretation of such facts and to cite their authorities so that statements may be substantiated by later researchers.

Seventh, what we have by way of history is inadequate. Biographies and memoirs are notoriously one-sided. The books we have are valuable as to some of their features and periods of time covered, but they stop too soon and often omit salient facts. A periodical, like your Proceedings, offers a great advantage in that in it history can be continuously produced, and controversial points may be cleared up by letters to the editor or supplementary articles which will give all sides a fair hearing.

Eighth and last, the continuum of a periodical affords the required space to spread out. Even an encyclopedia, though calling for precision in every statement, lacks room to support its assertions or for the contributor to cite his authorities. A history not documented isn't worth much to future historians -- nor for that matter to contemporary disbelievers.

If embarked upon by your Club, such a program would require a lot of working up. Papers -- as in other situations -- would have to be obtained the hard way, by dint of persuasion. It would not be easy but, in my opinion, the project would be eminently worth while.

I would be naive and unrealistic indeed were I to propose that a sense and pursuit of history is all-sufficient for your members, or that a recounting of history alone is a satisfying program for a Club like this. But there is a certain momentum gained in pursuing the past into the present which carries over usefully into a projection of the future. And a constant looking ahead is a source of dynamism which will attract the youth of our industry and profession, and perpetuate the vitality and influence of the Club for many years to come.

A review of the achievements of only the one year now ending is replete with possibilities of extrapolation into the Sixties and far beyond that. This has been going on ever since the Radio Club of America was founded, 51 years ago. We have the "feel" of having been swept up in the stream of history. What could be more interesting than to define its banks, identify its shoals and channels, and plot its course onward towards the sea?

*Extracted from the 51st Anniversary Banquet speech at Columbia University Club, December 16, 1960. Dr. Coggeshall was President of IRE in 1951.

TEN COMMANDMENTS OF ELECTRONICS

It is traditional that all trades and callings have their Ten Commandments — the Fighting Services, the printing trade, medical students, the Civil Service: they have all, at some time, produced some wag who circulated, under the very noses of his masters, some ironic code of behavior. Telecommunications technicians and engineers are no exception and we imagine that as soon as the wonders of telegraph, telephone and radio were launched upon the world and the new breed of men were evolved who dealt with this new dark art, then a set of commandments appeared. Variations have continued to appear from time to time; and those quoted below appeared, from a source unknown, upon our desk. It seems only right and proper that they should be seen in our pages. After all, we are trying to fit pieces of the history of our art together and such commandments are surely a part of that history and should be recorded for posterity.

1. Beware of the lightning that lurketh in an undischarged capacitor, lest it cause thee to be bounced upon thy buttocks in a most ungentlemanly manner.

2. Cause thou the switch that supplieth large quantities of juice to be opened and thusly tagged, so thy days may be long in this earthly vale of tears.

3. Prove to thyself that all circuits that radiate and upon which thou workest are grounded, lest they raise thee up to high-frequency potential and cause thee to radiate also.

4. Take care that thou use the proper method when thou takest the measure of high-voltage circuits so that thou dost not incinerate both thyself and the meter; for verily, though thou hast no account number and can be easily replaced, the meter hath one and, as a consequence, bringeth much woe into the Supply Department.

5. Tarry thou not amongst those who do deal in intentional shocks, for they are surely unbelievers and are not long for this world.

6. Take care that thou tamperest not with interlocks and saety devices, for this will incur the wrath of thy seniors and bringeth the fury of the safety officer down upon thy head and shoulders.

7. Work thou not upon energized equipment, for, if thou dost, thy buddies will surely be buying beers for thy widow and consoling her in other ways not generally acceptable to thee.

8. Verily, verily, I say unto you, never service high-voltage equipment alone, for electric cooking is a slothful process and thou mightst sizzle in thine own fat for hours on end before thy Maker seeth fit to end thy misery and drag thee in His fold.

9. Trifle thou not with radioactive tubes and substances lest thou commence to glow in the dark like unto a lightning bug, and thy wife be frustrated nightly and have no further use for thee except thy wage.

10. Commit thou to memory the works of the prophets, which are written in the books of instruction, which give the straight dope and which console thee, and thou canst not make mistakes.

[From a publication of the British Directorate of Telecommunications.]

THE PROCEEDINGS
OF THE
RADIO CLUB OF AMERICA, INC.

THE PROCEEDINGS OF THE RADIO CLUB OF AMERICA, INC.

Prior to 1913:

Date	Title of Paper	Author
	A Square Law Condenser (Straight Line Capacity)	George J. Eltz, Jr.
	Thermionic Vacuum Tube	Ernest V. Amy
	A Telephone Relay Amplifier (an original loud speaker designed by him)	Dr. Walter G. Hudson
	Radio Arc Telephony	George J. Eltz, Jr. and Frank King
	Directional Radio Transmission	Frank King
	Selenium as a Photoelectric Element	George Burghard

1913 to 1934:

Date	Title of Paper	Author
May 1913	Theory of Tuned Circuits.	Edwin H. Armstrong
Dec. 1913	Theory of Tuned Circuits.	Edwin H. Armstrong
Feb. 1914	A Device for Minimizing Interference.	Walter S. Lemmon
Mar. 1914	The Construction of a Sensitive Galvanometer.	George J. Eltz, Jr.
Apr. 1914	Working Principles of a Wavemeter.	Louis Gerard Pacent
May 1914	(1) Telegraphone (2) An Audio-Frequency Amplifier	Charles V. Logwood
Nov. 1914	The Heterodyne Receiving System.	John V. L. Hogan, Jr.
Nov. 1914	The Development of the Hudson Audion Filament.	Dr. Walter G. Hudson
Dec. 1914	The Kolster Direct-Reading Decrement and Wavemeter.	Robert H. Marriott
Feb. 1915	Distributed Capacity and Dead End Effect	Harry Sadenwater
Apr. 1915	The Regenerative Circuit.	E. H. Armstrong
May 1915	Foreign Radio Apparatus.	Dr. A. N. Goldsmith
Oct. 1915	Quenched Spark Sets.	Fritz Lowenstein
Nov. 1915	Discussed expert testimony tending to show that Marconi's was a genuine invention and not merely a development of Hertzian waves.	Emil J. Simon
Dec. 1915	The Development of Radio Sets for Aeroplanes.	L. J. Lesh
Jan. 1916	Portable Aeroplane and Trench Radio Sets.	William Dubilier
Mar. 1916	The Efficiency of Radio Sets.	Fritz Lowenstein
May 1916	Fundamental Considerations in Oscillating and Resonance Circuits.	Dr. John Stone
June 1916	Applications of the Audion.	Paul F. Godley
Sept. 1916	A Modern Experimental Radio Telegraph and Telephone Station.	Alfred H. Grebe
Dec. 1916	Radio Laboratory Measurements and the Elimination of Radio Losses.	L. W. Stevens
Jan. 1917	Inductance and Capacity Phenomena.	Prof. J. H. Morecroft
Feb. 1917	Losses and Capacity of Multi-Layer Coils.	Louis A. Hazeltine
Mar. 1917	Motional Impedance Circle of the Telephone Receiver.	Hawley O. Taylor
Apr. 1917	Army and Navy Signaling Systems.	David S. Brown and Walter S. Lemmon

Date		Title of Paper	Author
May	1917	This represents the period of the World War, and no record exists of any papers read before the Club.	Nov. 1919
Dec.	1919	A New Method of Receiving Weak Signals for Short Waves.	Edwin H. Armstrong
Jan.	1920	The Vacuum Tube as a Detector and Amplifier.	L. M. Clement
Feb.	1920	Recent Development of Radio Telephones.	Walter S. Lemmon
Mar.	1920	Navy Receiving Equipment.	L. C. F. Horle
Apr.	1920	Bulb Oscillators for Radio Transmission.	Louis A. Hazeltine
May	1920	2ZM's Radiophone and C. W. Transmitter.	L. Spangenberg
Sept.	1920	The Bureau of Standards—A.R.R.L. Tests of Short Wave Radio Signal Fading.	S. Kruse
Oct.	1920	Determination of Resistance, Inductance and Capacity by the Wheatstone Bridge Method.	Julius G. Aceves
Nov.	1920	The Resonant Convertor.	Walter S. Lemmon
Dec.	1920	Amateur C. W. Set at 2ZL.	J. O. Smith
Jan.	1921	Design of Loop Antenna.	David S. Brown
Feb.	1921	Modulation in Radio Telephony.	R. A. Heising
Mar.	1921	Some Operating Notes on the Larger Sizes of Transmitting Tubes.	William C. White
Apr.	1921	Notes on Design of Vacuum Tube Transmitters.	A. W. Kishpaugh
May	1921	Commercial Radio Telephony.	Francis M. Ryan
Sept.	1921	Description of Radio Station 8XK.	Frank Conrad
Oct.	1921	Audio and Radio Frequency Amplification.	George J. Eltz, Jr.
Nov.	1921	Methods of Modulation in Radio Telephones.	L. C. F. Horle
Dec.	1921	Station 1BCG.	George E. Burghard
Jan.	1922	Radio Central.	Pierre Boucheron
Feb.	1922	Trans-Atlantic Reception.	Paul Godley
Mar.	1922	The S-Tube Rectifier.	Howard J. Tyzzer
Apr.	1922	Multi-Stage Amplifiers.	M. C. Batsel
June	1922	The Super-Regenerative Circuit.	Edwin H. Armstrong
Oct.	1922	The Armstrong Super-Regenerative Circuit: its Operation and Construction.	George J. Eltz, Jr.
Dec.	1922	Vacuum Tube Amplification.	S. E. Anderson
Mar.	1923	Tuned Radio Frequency Amplification with Neutralization of Capacity Coupling.	Louis A. Hazeltine
Apr.	1923	Eighteen Years of Amateur Radio.	George Burghard
May	1923	The Thoriated Tungsten Filament.	William C. White
June	1923	How to Build a Super-Heterodyne Receiver.	George J. Eltz, Jr.
Sept.	1923	The Fundamentals of Loud Speaker Construction.	A. Nyman
Nov.	1923	Why No Receiver Can Eliminate Spark Interference.	Louis A. Hazeltine
Jan.	1924	A New Method of Radio Frequency Amplification.	C. L. Farrand
Feb.	1924	The Story of the Super-Heterodyne.	Edwin H. Armstrong
Apr.	1924	Solving the Problems of the Neutrodyne.	John F. Dreyer, Jr.
Oct.	1924	A Single Control Receiver.	C. L. Farrand
Dec.	1924	An Induction Loud Speaker.	Dr. C. W. Hewlett
Feb.	1925	Anti-Radiation Devices.	R. A. Weagant
May	1925	Influence of Wiring in Resonant Circuit Design.	Oscar C. Roos
Dec.	1925	Modern Radio Reproduction.	Arthur Van Dyck
Jan.	1926	Loud Speakers.	C. L. Farrand
Feb.	1926	Electrical Instruments and Their Adaption to Radio.	A. F. Corby
Mar.	1926	Tendencies in Modern Radio Receivers.	Julius G. Aceves
Apr.	1926	Transformer Coupled Amplifiers for Radio Receivers.	A. W. Saunders
May	1926	Problems of Three Broadcasting Stations.	Harry Sadenwater
June	1926	A Short-Wave Superheterodyne Receiver.	George J. Eltz, Jr.

Date		Title of Paper	Author
Sept.	1926	A New System of A. C. Power Supply and its Application to a Commercial Broadcast Receiver.	B. F. Miessner
Oct.	1926	The Theory and Application of the Constant-Coupled, Non-Reactive Plate Circuit Radio-Frequency Amplifier.	S. Young White and E. H. Loftin.
Nov.	1926	Development, Design and Operation of an S. W. Receiver in which Regeneration is Practically Constant.	W. R. Diehl and F. B. Ostman
Dec.	1926	A Fundamental Analysis of Loud Speakers.	J. F. Nielsen
Jan.	1927	A Combination Power Amplifier and "B" Eliminator.	Daniel E. Harnett
Feb.	1927	Tubes and Methods of Measurement.	Keith Henney
Mar.	1927	Description of Radio Station 2AG.	C. R. Runyon, Jr.
Apr.	1927	Use of Tubes having High Amplification Factor.	Arthur V. Loughren
May	1927	Three-Element Vacuum Tube.	B. F. Miessner
June	1927	Factors Governing the Service Area of the Broadcast Transmitting Station.	Lloyd Espenschied
Sept.	1927	Characteristics and Performance of Rectifier Tubes.	Roger M. Wise
Oct.	1927	Amplifier Circuits.	G. C. Crom, Jr.
Dec.	1927	Experiences of a Radio Engineer.	Robert H. Marriott
Jan.	1928	Life Test Data on Paper Condensers.	A. A. Leonard
Feb.	1928	Application of the Four-Electrode Receiving Tube.	Alan C. Rockwood and B. J. Thompson
Mar.	1928	Acoustics and Microphone Placing in Broadcasting Studios.	Carl Dreher
Apr.	1928	Practical Design of Direct Coupled Amplifiers and Detector-Amplifiers.	E. H. Loftin and S. Young White
May	1928	Overall Measurements on Broadcast Receivers.	Lewis M. Hull
June	1928	Overall Measurements on Broadcast Receivers.	Lewis M. Hull
Oct.	1928	Radiotron UX250—A High Power Output Tube.	K. S. Weaver
Dec.	1928	High Frequency Experiments in Aircraft.	F. H. Schnell
Jan.	1929	Seasonal Variations in Short Wave Transmission.	H. E. Hallborg
Feb.	1929	The Description of an Automatic Voltage Regulator.	Claude F. Cairns
Mar.	1929	Servicing Radio Receivers.	Julius G. Aceves
Apr.	1929	The Characteristics of Audio Frequency Transformers as Modified by Design and Operating Conditions.	Prof. H. M. Turner
May	1929	The Grid Suppressor Circuit.	Sylvan Harris
June	1929	A New Type of Precision Modulation Meter.	Dr. E. H. Greibach
Sept.	1929	Circuit Combinations that Provide Substantially Uniform Signal Selection.	E. A. Uehling
Nov.	1929	Sensitivity Measurements and Performance Test on Radio Receivers in Production.	N. E. Wunderlich
Dec.	1929	The Application of Shielded Grid Tubes to Audio Frequency Amplifiers.	J. Glauber
Jan.	1930	The Pentode Tube, Theory and Possibilities.	Keith Henney and Howard E. Rhodes
Feb.	1930	A Study of Disc Recordings.	C. F. Goudy and Prof. W. P. Powers
Mar.	1930	A Practical Television System.	D. E. Replogle
Apr.	1930	Automobile Radio Receivers.	Arthur V. Nichol
May	1930	The Development of the Equipotential Indirectly Heated Cathode as Applied to Receiving Tubes.	V. O. Allen
June	1930	Design and Application of Adjustable Tone Compensating Circuits for the Improvement of Audio Amplifiers.	Julius G. Aceves
Sept.	1930	Broadcast Program Protection.	W. A. R. Brown
Oct.	1930	Kinematic Type Remote Control.	James Millen and M. B. Sleeper

Date		Title of Paper	Author
Nov.	1930	The Stenode Radio Receiver.	Dr. James Robinson
Dec.	1930	Engineering Aspects of the Broadcast Antenna.	H. E. Hallborg
Jan.	1931	Development in the Art of Telegraphy.	R. B. Steele
Feb.	1931	The Multicoupler Antenna System for Apartment Buildings.	J. G. Aceves
Mar.	1931	The Design and Construction of Standard Signal Generators.	C. J. Franks
Apr.	1931	Design of a Complete Television System. Practical Operation of a Complete Television System.	C. E. Huffman and Allen DuMont
May	1931	Test Methods and Equipment.	William F. Diehl
June	1931	The Synchronization of Westinghouse Radio Stations WBZ and WBZA.	S. D. Gregory
Sept.	1931	Condensers Past and Present.	R. A. Lane
Oct.	1931	The Problem of Continuity Testing during Radio Service Week.	J. F. Rider
Nov.	1931	Sound Absorption Balance in the Acoustics of Auditoriums.	V. A. Schlenger
Dec.	1931	Selectivity Limitations in Modern Radio Receivers Due to Modulation Distortion at the Transmitter.	David Grimes
Jan.	1932	Radio Communication on the International Air Lines of the United States.	H. C. Leuteritz
Feb.	1932	Recent Development in Radio Frequency Control Practice.	D. E. Replogle
Mar.	1932	The Application of Permeability Tuning to Broadcast Receivers.	Ralph H. Langley
Apr.	1932	Man and His Contracts.	G. Willard Rich
May	1932	Notes on Receiver Design.	Lincoln Walsh
June	1932	Remote Pickup Equipment for Broadcast Service.	R. S. Lyon
Sept.	1932	Recent Development in Direct Sound Recording.	S. Young White
Oct.	1932	Measurement of Resistance as the Basis of Service Analysis.	John F. Rider
Nov.	1932	Short Wave Transoceanic Telephone Receiving Equipment.	F. A. Polkinghorn
Dec.	1932	Antenna Transmission Line Systems for Radio Reception.	C. E. Grigham
Jan.	1933	Recent Developments in Cathode Ray Tubes and Associated Apparatus.	Allen B. DuMont
Feb.	1933	Development of Air Transportation.	P. R. Bassett
Mar.	1933	The Emission Valve Modulator for Superheterodynes.	Harold A. Wheeler
Apr.	1933	Radio, Electrons and Stars.	Orestes H. Caldwell
May	1933	The Problems of Economic Reconstruction.	Prof. W. Rautenstrauch
May	1933	The Design of instruments for Radio Testing and Servicing.	John H. Miller
June	1933	Inter-Channel Noise Suppression in Sensitive AVC Receivers.	Wm. S. Barden
Sept.	1933	The Micro-Ray System of the I. T. & T. Corp.	W. J. Cahill
Oct.	1933	The Correlation of Practical and Theoretical Data in the Operation of R. F. Amplifiers.	W. J. Cahill and R. J. Davis
Nov.	1933	Recent Development in the Guidance of Aircraft by Radio.	Harry Diamond
Dec.	1933	The Application of Electronics to the Piano.	Benjamin F. Miessner
Jan.	1934	Behavior of Gaseous Discharge Television Lamps at High Frequencies.	H. J. Brown
Feb.	1934	The Design of Resistance Attenuators for Radio Frequency Measurements.	Malcom Ferris
Mar.	1934	Symposium on Remote Controlled Radio Receivers.	J. T. Filgate
Apr.	1934	Symposium on Remote Controlled Radio Receivers.	Virgil Graham, Lee McCanne and C. J. Franks
May	1934	The Photronic Photo-Electric Cell and Photronic Control.	R. T. Pierce

Date		*Title of Paper*	*Author*
June	1934	Multiple Address Radio Printer Systems.	W. G. H. Finch
Sept.	1934	The Importance and Technique of Performance Measurements on Radio Telephone Transmitters.	W. C. Lent
Oct.	1934	All-Wave Receiver Problems.	Murray G. Clay
Nov.	1934	The Broadcasting Antenna.	A. B. Chamberlain and W. B. Lodge
Dec.	1934	Broadcast Antennae and Transmission Lines as used by the Crosley Stations, WLW, WSAI and W8XAL.	J. A. Chambers

1935 to 1958

Date	*Vol.*	*No.*	*Title of Paper*	*Author*
June, 1935	12	1	Miscellaneous Applications of Vacuum Tubes	F. H. Shepard, Jr.
Sept.	12	2	An Analysis of Coupled Tuned Circuits at Radio Frequencies	L. A. Kelley
Oct.	12	3	The Cathode Ray Tube in Television Reception	I. G. Maloff
Nov.	12	4	Problems of All-Wave Noise Reducing Antenna Design	J. G. Aceves
Feb., 1936	13	1	Soundproofing Apartment Houses for Radio	Vesper A. Schlenker
July	13	2	Cosmic Cycles and Radio Transmission	Harlan True Stetson, Ph.D.
Oct.	13	3	Ignition Disturbances	Leslie F. Curtis
Nov.	13	4	Some Aspects of Interference and Noise Reduction in Communication Type Receivers	James J. Lamb
			Radio Interference	Allen W. Hawkins
Mar., 1937	14	1	Factors Relating to Faithful Reproduction	C. M. Sinnett
			High Fidelity Radio Reception	Lincoln Walsh
Aug.	14	2	The Surface Wave in Radio Propagation	Charles R. Burrows
			Experiments in Generation, Detection and Measurement at one Meter Wavelengths	Paul Zottu
Dec.	14	3	The Application of the Broad Band Crystal Filter to Broadcast Receivers	Alexis Guerbilsky
Feb., 1938	15	1	A New Inductance Tuning System	Paul Ware
Feb.	15	2	The Application of the Automatic Radio Direction Finder to Aerial Navigation	H. Busignies
Mar.	15	3	The Present State of Development of Radio Instrument Airplane Landing Systems in this Country and Abroad	E. N. Wendell
May	15	4	An Analysis of All-Wave Receiving Antenna Systems	J. G. Aceves
			New Paths to Guide Centimeter Radio Waves	G. C. Southworth
			Television and the Radio Engineer	Albert F. Murray
Sept.	15	5	Unbending the Ginks	J. N. Whitaker
			The Finch System of Home Facsimile	Described by R. H. Marriott
Dec.	15	6	Push-Button Tuning	Garrard Mountjoy
			Organization of Plant in a Central Radio Telegraph Office	R. E. Mathes
Apr., 1939	16	1	An Automatic Spectral-Sensitivity Curve Tracer	T. B. Perkins
			Transmitter Circuit Design for Frequencies above 100 Megacycles	O. E. Dow
July	16	2	Frequency Modulation in Radio Broadcasting	
			A New Armstrong Frequency-Modulated-Wave Receiver	G. W. Fyler and J. A. Worcester

Date	Vol.	No.	Title of Paper	Author
July	16	2	Comparative Field Tests of Frequency Modulation and Amplitude-Modulation Transmitters	Irwin R. Weir
			Electrical Wave Analyzers	H. H. Scott
Sept.	16	3	Ultra-High-Frequency Propagation	M. Katzin
Feb., 1940	17	1	Recent Progress in Television Technique	Donald G. Fink
Mar.	17	2	Intercontinent Telegraphy via Long Ocean Cables	A. E. Frost
Apr., 1940	17	3	Motorboat Ship-Shore Radio-communication System	H. B. Martin
May	17	4	High-Q Coils at Audio Frequencies	J. B. Schaefer
June	17	5	The Television Picture Tube	R. C. Hergenrother
July	17	6	Recent Improvements in Master Antenna Systems	J. G. Aceves
Oct.	17	7	Bibliography on Radio Equipment in Aviation	F. X. Rettenmyer
			FM and its Economic Advantages	J. R. Poppele
			New Transmitter Circuit for FM	J. F. Morrison
			Audio Facilities for FM	E. J. Content
			Studio Acoustics for High Fidelity	J. P. Maxfield
Jan., 1941	18	1	Extending the Range of Acoustic Reproducers	Harry F. Olson
Feb.	18	2	Signal-Measuring Devices	Jerry Minter
Apr.	18	3	Crystal Cutter and Channel for Lateral Recording	Frank W. Stellwagen
Aug.	18	4	Measurement of Carrier Deviation and Average Value in Frequency-Modulation Transmitters	Henry P. Thomas
			The Orbital-Beam Multiplier Tube for 500-Megacycle Amplification	W. R. Ferris H. M. Wagner
			Applications of the Inductive Output Tube	O. E. Dow
Dec.	18	5	Communication Circuits of the Federal Airways	J. H. Nicholson
			Radio Teletype Transmission to Ground Stations and Aircraft	P. Deforrest McKeel
Apr., 1942	19	1	Impedance Measurements Over a Wide Frequency Range	L. E. Packard
Dec.	19	2	Wire Transmission of News Pictures	James R. Hancock Frank T. Turner
Dec., 1943	20	1	Taming the High Frequency Signal Generator	J. M. Van Beuren Jerry B. Minter
Jan., 1944	21	1	Television Broadcast Coverage	Allen B. DuMont Thomas T. Goldsmith, Jr.
Dec.	21	2	Sun, Earth, and Short-Wave Propagation	Henry E. Hallborg
Nov., 1945	22	1	Application Techniques for Cathode Ray Tubes	Dr. P. S. Christaldi I. E. Lempert
Dec.	22	2	Fluctuation Voltages in Receiver Input Circuits	John R. Ragazzini
Jan., 1946	23	1	Audio Distortion in Radio Reception	Jerry Minter
Feb.	23	2	Controlled and Uncontrolled Multivibrators	Eugene R. Shenk
Mar.	23	2	The Radio Proximity Fuze	Dr. L. Grant Hector
			Radio Countermeasures: The Science of Immobilizing Enemy Radar	Oswald G. Villard, Jr.
Apr.	23	4	Frequency Deviation Reception	D. A. Griffin
May	23	5	Color Television	Dr. P. C. Goldmark
			Projection Television	Dr. I. G. Maloff
			Inductive Tuning System for FM-Television Receivers	Paul Ware
Oct.	23	6	Guided Missiles in World War II	Dr. Harner Selvidge
Jan., 1947	24	1	Top-Loaded Antennas	Thurlow M. Gordon, Jr.
			Summary of:	A. H. Stillman
			Facsimile Communications	
			Measurements on FM Receivers	Jerry Minter

Date	*Vol.*	*No.*	*Title of Paper*	*Author*
Feb.	24	2	Hazeltine Lanac System of Navigation and Collision Prevention	Knox McIlwain
Mar.	24	3	The Megacycle Meter	Jerry B. Minter
			Summary of: Pulse Time Modulation	Fred C. Wallace
			A Radio Man's Scenic Moments	Joseph A. Waldschmitt
1948	25	1	Laboratory Antenna Distribution System	Frank Mural
	25	2	Cost vs Quality in Audio	John M. Van Beuren
	25	3	A Study of the Operating Characteristics of the Ratio Detector and its Place in Radio History	Dr. Edwin H. Armstrong
1949	26	1	The Serrasoid FM Modulator	James R. Day
	26	2	Germanium Crystal Diode and Triode Developments	Dr. Stuart T. Martin Harold Heins
1950	27	1	Direct Drive Horizontal Scan System	Robert R. Thalner
	27	2	Traffic Handling Capacity of 100 Channel Distance-Measuring-Equipment (DME) Standardized by RTCA SC-40 and ICAO	Charles J. Hirsch
			Summary of: Television Receiving Antennas	David C. Kleckner A. E. Joust
	27	3	Saturable Reactor Considerations	F. H. Shepard, Jr.
Oct.	1BCG issue		"The Story of the First Transatlantic Short Wave Message"	
1951	28	1	Half-Tone Cuts Produced Electronically	George Washington, Jr.
			Summary of: The Simplification of Television Receivers	W. B. Whalley
			The Attic Inventor	Charles F. Jacobs
	28	2	Survey of Radio-Frequency Transmission Lines and Wave Guides	E. S. Winlund
			Summary of Loudspeakers	H. C. Hardy
1952	29	1	Fault Location Techniques for Transmission Lines and Cables	Martial A. Honnell
	29	2	Negative Feedback	W. O. Baldwin
	29	3	Submerged Telegraph Repeaters Current Developments and Applications	C. H. Cramer P. H. Wells
	29	4	Practical Aspects of the R-J Speaker Enclosure	W. Joseph F. Robbins
1953	30	1	The World's Sources of Energy	Lloyd V. Berkner
	30	2	Transistor Circuit Considerations	J. G. Weissman
	30	3	Some Recent Developments in the Multiplexed Transmission of Frequency Modulated Broadcast Signals	Dr. Edwin H. Armstrong John H. Bose
1954	31	1	Applications of High Frequency Saturable Reactors	Carl G. Sontheimer
1955	32	1	Air Navigational Facilities	H. S. Christensen
Dec.	32	2	Desk Size Electronic Computer for General Purpose Use	James L. Rogers
1956	33	1	E. H. Armstrong: The Hero as Inventor	Carl Dreher
Mar., 1958	34	1	A Compatible Single-Sideband Modulation System	L. R. Kahn
			A Discussion of L. P. Lessing's Unusual Biography "Man of High Fidelity: Edwin Howard Armstrong"	Capt. P. Boucheron
Sept.	34	2	Accurate Time Measurement	Dr. Frederic A. Fua

1959 *to* 1984

Date	*Vol.*	*No.*	*Title of Paper*	*Author*
Oct. 1959	35	1	General Review of Missile Telemetry An Account of the Discovery of Jupiter as a Radio Source	Dale Samuelson K.L. Franklin
Dec. 1959	35	2	Problems of Ballistic Missile Defense	W.R. Hutchins
Summer 1960	36	1	The Evolution of Radio	Hugo Gernsback
Fall 1960	36	2	50th Anniversary Yearbook	
Winter 1961	37	1	Super Regenerative Pulse Radar The Writing of Radio History — A Project for The Radio Club	F.H. Shepard, Jr. I.S. Coggeshall
Spring 1961	37	2	The CBS NetAlert — A System for Network Signalling	A.A. Goldberg, A. Kaiser, G.D. Pollack, and D. Vorhes
Fall 1961	37	3	Anatomy of an Electronic Typer Salute to Pioneer Radioman Harry Sadenwater (1894-1961) Editorial — Science Safaris	Walter Hladky Capt. Pierre Boucheron, (USNR Ret.)
Dec. 1961	37	4	A New Method of Accurate Frequency Measurement	Harry W. Houck &, Norman W. Gaw, Jr.
June 1962	38	1	The Dynaquad — A Solid State Electronic Switch	C.E. Atkins
Aug. 1962	38	2	Philips Telegraph Switching System	E.R. MacMillan
Oct. 1962	38	3	Simplified Automation Economics of Test Equipment Purchases	Ralph R. Batcher W.A. Knoop
April 1963	39	1	The Teleglobe Pay-TV System	Ira Kamen
July 1963	39	2	The Importance of Reliability and Maintainability of Electronic Devices Student Science Honor Award	S.R. Calabro
Nov. 1963	39	3	New York's Modern Fire Communications Center (Part 1)	A. Dettori, and N.J. Reinhardt
Feb. 1964	40	1	New York's Modern Fire Communications Center (Part 2) Portable TV Tape Recorder Elmer Bucher Reports In — Obituary — George Ehret Burghard (1895-1963)	A. Dettori, and N.J. Reinhardt F.J. Haney, and R.L. Pointer
Summer 1964	40	2	Optimizing High Frequency Telegraph Transmission Radio Club Archives Project Student Science Honor Program Obituaries — Melville Eastham (1885-1964) Dr. Louis Alan Hazeltine (1886-1964)	Walter Lyons
Summer 1964	40	3	Whales, Porpoises and Sonar Radio Museums	William E. Schevill
Nov. 1964	40	4	Membership Directory — 1964 The Heritage of The Radio Club of America Deceased Members (1909-1964)	Lloyd Jacquet
May, 1965	41	1	Modulated Optical Alarm System Report on 55th Anniversary Banquet	Samuel M. Bagno

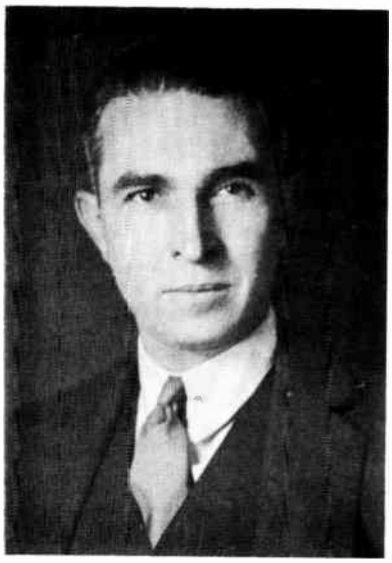
Sept. 1965	41	2	The OSCAR Amateur Satellite Program Educasting Systems	Nicholas K. Marshall Ira Kamen
Dec. 1965	41	3	Computer Produced Movies Application of Time-Diversity to Multi-Link Data Transmission	Kenneth C. Knowlton Walter Lyons
April 1966	42	1	Communications to the Moon and Planets Report on 56th Anniversary Banquet	Dr. Eberhardt Rechtin
June 1966	42	2	Mosquito Metrology and Communications Auditory Stimulation by Modulated RF Computer Typesetting	Wm. H. Offenhauser & Peter Williams Dr. Henry K. Puharich Dong W. Lew
Nov. 1967	43	1	The Twintron (A New Electro-Mechanical Tunable Resonator) Listing of PROCEEDINGS Papers (1959-1966)	Hugh Baker, and John Casey
1st Quarter 1968	44	1	From Drums to Mobile Radio Wire-to-Radio and Back-to-Wire Obituary — Capt. J.H. Round (1881-1966) Editorial — The Radio Club Member	Fred M. Link Leo G. Sands
2nd Quarter 1968	44	2	Reginald A. Fessenden FCC Efforts to Improve Mobile Radio The Hammarlund Story Echo's End Near	Ormond Raby Rosel H. Hyde
3rd Quarter 1968	44	3	Night Vision The Wireless Piano The COMSAT Antennas	 Cmdr. E.J. Quinby
Mar. 1971	45	1	A Compatible AM Stereo Broadcast System Microelectronics in Communications PCM Microwave for Voice and Data New York Transit Communications Awards at 1969 & 1970 Annual Banquets	Leonard R. Kahn C.F. O'Donnel Fred Brunsdon Seymour Dornfeld
Fall 1971	45	2	Who Was Tesla? New York Police Department Communications Rosters of Fellow and Life Members (Oct. 1971)	Cmdr. E.J. Quinby
Midsummer 1972	46	1	A Lifetime of Radio David Sarnoff Radio Hams' Universe Report on 62nd Anniversary Banquet	Edgar F. Johnson Wm. F. Offenhause: Dr. A.N. Goldsmith
Feb. 1973	47	1	Evolution of Spectrum Management Membership Directory — January 1973 Report on 63rd Anniversary Banquet	A. Prose Walker
Mar. 1974	48	1	Lee de Forest, Father of Radio Why Good Technology Can't Get Off the Ground First Atlantic Message on the "Short Waves" First Sarnoff Citation to Barry Goldwater Report on 64th Anniversary Banquet	Fred Shunaman Chandos Rypinski Ray Meyers
Nov. 1974	48	2	450 MHz. vs. 900 MHz. Mobile Radio Some Views on Deregulation 500 cycle Tone from 60 cycle Transmitter (How We Did It Back in 1913) Dr. George W. Bailey — New Honorary Member Club's First Man-and-Wife Teams	Stuart F. Meyer C.A. Higginbotham Cmdr. E.J. Quinby

Mar. 1975	49	1	An Interview With Paul Godley	
			Maritime Communications — A New Era	Don deNeuf
			Constitution & By-Laws	
			Report on 65th Anniversary Banquet	
Oct. 1975	49	2	First Transoceanic Links	Don deNeuf
			Mobile Digital Communications	William A. Shand
			Membership Directory — Sept. 15, 1975	
Mar. 1976	50	1	Changing Concepts in Regulation	C.A. Higginbotham & Robert E. Tall
			From Quenched Gap to Fiber Optics	Frank P. Barnes
			The Dirigible's Contribution to Radio Progress	Don deNeuf
			Bill Eitel Wins 80 wpm Award	Ero Erickson
			Washington D.C. Section Established	
			Constitution & By-Laws	
			Report on 66th Anniversary Banquet	
Oct. 1976	50	2	Fifty Years of Mobile Radio	J.R. Brinkley
			Washington Section Holds First Meeting	Smiley Ashton
			An Early Power Supply Problem	Cmdr. E.J. Quinby
			California Section Membership Listing	
			Obituary — Carl Dreher (1896-1976)	
Mar. 1977	51	1	Is Business a Dirty Word?	William J. Weisz
			Oriental Approach to Trans-Pacific Transmission	Don deNeuf
			FCC and OTP Communicate	Robert E. Tall
			What Uncle Charlie Told Them	Ero Erickson
			Obituary — Dr. George W. Bailey (1887-1976)	
			Report on 67th Anniversary Banquet	
Oct. 1977	51	2	Allen B. DuMont "The Man Who Was Responsible for TV" (Part 1)	Dr. P.S. Christaldi & Dr. T.T. Goldsmith
			Edgar F. Johnson Honored by University of Minnesota	
			Ray Meyers Receives AFCEA Award	
			Radio Club Holds Spring Banquet in Florida	
			Membership Directory — Oct. 1, 1977	
Mar. 1978	52	1	Broadcasting — AD 2000	George Jacobs
			The Ekofisk Project	Joseph F. Walker
			Communication and Air Traffic	William Flener
			Allen B. DuMont (Part 2)	Dr. P.S. Christaldi & Dr. T.T. Goldsmith
			Report on 68th Anniversary Banquet	
Oct. 1978	52	2	Fessenden "Builder of Tomorrows" (Part 1)	E.J. Quinby
			Tribute to Bill Lear (1902-1978)	Fred M. Link
			Washington DC Meeting Hears Judge Naumowicz	
			Constitution & By-Laws	
Mar. 1959	53	1	Fessenden "Builder of Tomorrows (Part 2)	E.J. Quinby
			High Cost of Communications	V. Adm. S.L. Gravely
			The Rural Radio Network	Don deNeuf
			June Poppele & The Executive Committee	
			Report on 69th Anniversary Banquet	
Oct. 1979	53	2	Automatic Power Control for Troposcatter Systems	Thomas D. Estes
			First Citizens' Communication System Was for Bad News Only	Don deNeuf
			50 Years of RADIO-CRAFT	
			Obituary — Lewis M. Clement (1892-1979)	
			Membership Directory — Sept. 15, 1979	
Mar. 1980	54	1	New Horizons in Communications	Robert E. Lee
			Radio Museums, Here and Abroad	Bruce Kelley
			"Inventor of CB" Honored in Europe	

			Grants-in-Aid Gets Heavy Support	
			Report on 70th Anniversary Banquet	
Oct. 1980	54	2	Proximity Fuze — Secret Weapon of World War II (part 1)	Jerry Minter
			The Heliograph Operated at Higher-than-High Frequencies	Don deNeuf
			What Makes The Radio Club Tick	Fred M. Link
Mar. 1981	55	1	The Proximity Fuze (part 2)	Jerry Minter
			Dispatching a Large Taxi System	James A. Craig
			Southern California Section Meets	
			Washington DC Section Active	
			Report on 71st Anniversary Banquet	
Oct. 1981	55	2	The Proximity Fuze (part 3)	Jerry Minter
Apr. 1982	56	1	Telecommunications Pioneering Today	William H. Forster
			Cooley Honored in Nevada	Don deNeuf
			Special Award to Mrs. Connie Conte	
			Report on 72nd Anniversary Banquet	
Oct. 1982	56	2	Amplitude Compandored Single Sideband	Niles Barlow
			Unique Light Signalling Used by U.S. Navy	Don deNeuf
			Man of Distinction — Ray E. Meyers, W6MLZ	
			A Club is Born (QCWA)	Uda Ross
Apr. 1983	57	1	The Communications Business	John Bain
			A Touch of Immortality	John W. Morrisey
			E.A. Ducretet, Radio Pioneer	Don deNeuf
			Report on 73rd Anniversary Banquet	
Oct. 1983	57	2	Fighting the Hi-Rise Fire	Edward Singer
			Antenna Efficiency — Is a Ground the Best Ground	Arch Doty
Spring 1984	58	1	CSSB — ACSB, The Progression of Narrow Band VHF/UHF Technology	Fred B. Childs
			The Grenada Connection	
			Club Members Honored by IEEE	
			Report on Diamond Jubilee Banquet	
Summer 1984	58	2	Membership Directory — June 30, 1984	
Fall 1984	58	3	75th Anniversary Diamond Jubilee Yearbook	

PAST PRESIDENTS
OF THE
RADIO CLUB OF AMERICA, Inc.

W. E. D. Stokes Jr.
1909–1911*



Frank King
1911–1914

George J. Eltz, Jr.
1915

Edwin H. Armstrong
1916–1920

George E. Burghard
1921–1925

Ernest V. Amy
1926–1928

*President, Junior Wireless Club, Ltd.

Lewis M. Clement
1929

Louis G. Pacent
1930

Harry Sadenwater
1931

Lawrence C. F. Horle
1932

Charles W. Horn
1933

Harry W. Houck
1934

Ralph H. Langley
1935–1936

John H. Miller
1937–1938

Paul F. Godley
1939

Keith Henney
1940

John L. Callahan
1941

Paul Ware
1942–1943

Fred Klingenschmitt
1944–1945

Louis Alan Hazeltine
1946–1947

Jerry B. Minter
1948–1949

O. James Morelock
1950–1951

John H. Bose
1952–1953

Francis H. Shepard Jr.
1954–55

Frank A. Gunther
1956–57

Walter A. Knoop
1958–59

Renville H. McMann, Jr.
1960-62

Ralph R. Batcher
1963-64

Jerry B. Minter
1965-66

Harry W. Houck
1967

William H. Offenhauser, Jr.
1968

Fred M. Link
1969-84

Past Vice Presidents

George J. Eltz, Jr.	1909-1914 (J.W.C.)
Louis G. Pacent	1915
Theophilus Johnson, Jr.	1916-1918
David S. Brown, Jr.	1919
Louis C. Pacent	1920
Lawrence C.F. Horle	1921
Ernest V. Amy	1922
Paul F. Godley	1923-1925
John DiBlasi	1926
C. Randolph Runyon, Jr.	1927
Lewis M. Clement	1928
Carl Dreher	1929-1930
Lawrence C.F. Horle	1931-1932
Charles E. Maps	1933
Harry W. Houck	1934
F.X. Rettenmeyer	1935
John H. Miller	1936
John F. Farrington	1937
Fred A. Klingenschmitt	1938
Keith Henney	1939
John C. Callahan	1940
Paul Ware	1941
Charles E. Dean	1942-1943
James O. Morelock	1944-1947
Robert M. Atkin, Jr.	1948
George C. Connor	1949
John H. Bose	1950
Ralph R. Batcher	1951-1953
Frank A. Gunther	1954-1955
Walter A. Knoop, Jr.	1956-1957
Renville H. McMann, Jr.	1958-1959
George Washington, Jr.	1960-1961
Ralph R. Batcher	1962
Samuel N. Harmatuk	1963-1964
George Washington, Jr.	1965
Ralph R. Batcher	1966
Jack R. Poppele	1967-1970
Samuel N. Harmatuk	1971-1979
Mal Gurian	1980-to date

Executive Vice President

Stuart F. Meyer	1976-to date

Vice President - Counsel

Joseph Rosenbloom	1978-to date

Past Executive Secretaries

Leo G. Sands	1971
Fred Schunaman	1972-to date

Past Treasurers

Frederick Seymour	1909-1910 (J.W.C.)
Ernest V. Amy	1911-1920
John DiBlasi	1921-1925
C. Randolph Runyon, Jr.	1926
Joseph J. Stantley	1927-1966
John Finlay	1967-1970
David Talley	1971-1977
Nat Schnoll	1978-1979
George Apfel	1980-to date

Past Assistant Treasurers

Nat Schnoll	1976-1977

Past Recording Secretaries

W. Faitoute Munn	1909-1911 (J.W.C.)
George E. Burghard	1911-1913
Louis G. Pacent	1914
Theophilus Johnson, Jr.	1915
Thomas J. Styles	1916
Walter S. Lemmon	1917-1920
Lewis M. Clement	1921
Lawrence C.F. Horle	1922
Pierre Boucheron	1923
Arthur H. Lynch	1924-1926
David S. Brown, Jr.	1927
William T. Russell	1928
Charles E. Maps	1929
Harry W. Houck	1930-1933
F.X. Rettenmeyer	1934-1938
Charles E. Dean	1939
Carl F. Goudy	1940
Elmar H. Lewis	1941
Lucius E. Packard	1942-1943
John H. Bose	1944-1948
Perce B. Collison	1949
Bernard D. Loughlin	1950
Frank H. Shepard, Jr.	1951
Virgil M. Graham	1952-1953
William G. Russell	1954
Albert F. Toth	1955
John H. Bose	1956-1957
C. Randolph Runyon III	1958-1959
Albert F. Toth	1960-1963
James O. Morelock	1964
Norman W. Gaw, Jr.	1965
Albert F. Toth	1966
C. Edward Atkins	1967
Leo G. Sands	1968-1970

Past Corresponding Secretaries

Frank King	1909-1911 (J.W.C.)
David S. Brown, Jr.	1912-1916
Thomas J. Styles	1917-1920
Renville H. McMann	1921-1924
Thomas J. Styles	1925-1927
J.L. Bernard	1928
Willie K. Wing	1929-1932
R.H. Langley	1933
Fred A. Klingenschmitt	1934-1937
Fred Muller	1938
John L. Callahan	1939
Charles E. Dean	1940
Lincoln Walsh	1941
James O. Morelock	1942-1943
Milton B. Sleeper	1944-1945
Harry Sadenwater	1946-1947
George C. Connor	1948
John H. Bose	1949
Ralph R. Batcher	1950
Bernard D. Loughlin	1951
Francis H. Shepard, Jr.	1952-1953
James O. Morelock	1954-1963
Robert Finlay	1964-1966
George K. Moss	1967
Bernard Osbahr	1968-1970

Secretary

Francis H. Shepard, Jr.	1971-to date

WHO'S WHO
IN THE
RADIO CLUB OF AMERICA, INC.

Honorary Members

Ernest V. Amy*	1964
Dr. George W. Bailey*	1974
Ralph R. Batcher*	1967
Dr. Harold Beverage	1983
Dr. Lloyd Espenschied	1959
Paul F. Godley*	1964
Dr. Alfred N. Goldsmith*	1922
Dr. Raymond A. Heising*	1964
John V.L. Hogan*	1915
Harry W. Houck	1983
Frank King	1972
Richard W. Konter*	1970
Robert H. Marriott*	1915
William H. Offenhauser, Jr.	1983
June Poppele	1981
Prof. Michael I. Pupin*	1926
Capt. Henry J. Round*	1952
Brig. Gen. David Sarnoff*	1926
Joseph J. Stantley	1967
William E.D. Stokes, Jr.	1972
John Stone Stone*	1915
W. Walter Watts*	1972
Dr. Harold A. Wheeler	1983
Prof. Jonathan Zenneck*	1916

Presidents Emeriti For Life

Frank King	1983
William E.D. Stokes, Jr.	1983

Directors Emeriti For Life

Ernest V. Amy*	1976
Capt. William G.H. Finch	1978
Samuel N. Harmatuk	1983
Harry W. Houck	1978
Jerry B. Minter	1983
Jack R. Poppele	1983
David Talley	1978

* Denotes Deceased

HONORARY MEMBERS

John V.L. Hogan
Honorary Member 1915

Robert H. Marriott
Honorary Member 1915

John Stone Stone
Honorary Member 1915

Jonathan Zenneck
Honorary Member 1916

Alfred N. Goldsmith
Honorary Member 1922

Michael I. Pupin
Honorary Member 1926

HONORARY MEMBERS

David Sarnoff
Honorary Member 1926

Henry J. Round
Honorary Member 1952

Lloyd Espenschied
Honorary Member 1959

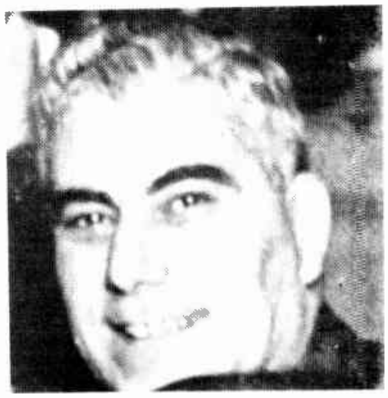
Ernest V. Amy
Honorary Member 1964

Paul F. Godley
Honorary Member 1964

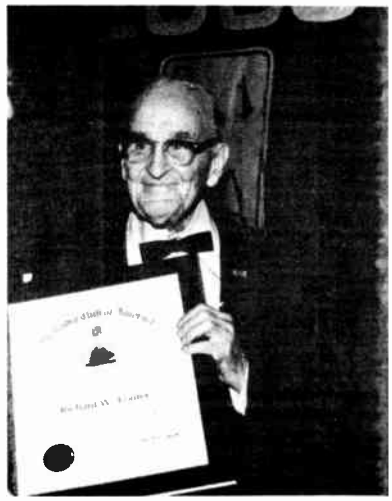
Raymond A. Heising
Honorary Member 1964

HONORARY MEMBERS

Ralph R. Batcher
Honorary Member 1967



Joseph J. Stantley
Honorary Member 1967



Richard W. Kontor
Honorary Member 1970

Frank King
Honorary Member 1972

W.E.D. Stokes, Jr.
Honorary Member 1972

W. Walters Watts
Honorary Member 1972

HONORARY MEMBERS

George W. Bailey
Honorary Member 1974

June Poppele
Honorary Member 1981

Harold Beverage
Honorary Member 1983

Harry W. Houck
Honorary Member 1983

Wm. H. Offenhauser, Jr.
Honorary Member 1983

Harold A. Wheeler
Honorary Member 1983

HONORS AND AWARDS

The Armstrong Medal

Initiated in 1935. Bestowed by the Board of Directors of The Radio Club of America upon any person within its membership who shall have made, in the opinion of the Board of Directors and within the Spirit of the Club, an important contribution to Radio Art and Science.

Prof. Louis Alan Hazeltine	1937
Dr. Harold H. Beverage	1938
Greenleaf Whittier Pickard	1940
Harry W. Houck	1941
Carman Randolph Runyon, Jr.	1945
Charles Stuart Ballatine	1946
John V.L. Hogan	1947
Ernest V. Amy	1950
Major Edwin H. Armstrong.	1950
George E. Burghard	1950
Minton Cronkhite	1950
Paul F. Godley	1950
John F. Grinan	1950
Walker P. Inman.	1950
Captain Henry J. Round	1952
Raymond A. Heising	1953
Melville Eastham	1956
John H. Bose	1959
Paul Ware	1962
Harold A. Wheeler	1964
Ernest V. Amy	1965
John Bertrand Johnson	1967
Jerry B. Minter	1968
Francis H. Shepard, Jr.	1969
Frank A. Gunther	1970
Renville H. McMann, Jr.	1972
Lewis M. Hull	1974
Dr. Henri G. Busignies	1975
Capt. William G.H. Finch	1976
Arthur A. Collins	1977
Murray G. Crosby	1978
Leonard R. Kahn	1980
Arthur V. Loughren	1981
Edwin P. Felch	1983

The Sarnoff Citation

Initiated in 1973. Established by the Board of Directors to be awarded annually to a Club member for significant contributions to the advancement of electronic communications.

The Hon. Barry M. Goldwater	1973
Jack R. Poppele	1974
Edgar F. Johnson	1975
Fred M. Link	1976
William P. Lear	1977
William W. Eitel	1978
Donald G. Fink	1979
Monte Cohen	1980
Jerry S. Stover	1981
Julian Z. Millar	1982
William F. Halligan, Sr.	1983

The President's Award

Initiated in 1974. Designated by the Board of Directors to be awarded at the discretion of the President of The Radio Club of America to a person for unselfish dedication to the support of The Radio Club of America.

Dr. George W. Bailey	1974
Ernest V. Amy	1975
Joseph J. Stantley	1978
Jerry B. Minter	1981
Mrs. Vivian A. Carr	1982
Stuart F. Meyer	1983

The Ralph Batcher Memorial Award

Initiated in 1975. Presented annually to a member who has assisted substantially in preserving the history of radio and electronic communications.

Morgan E. McMahon	1976
John F. Rider	1977
Bruce L. Kelley	1978
Robert W. Merriam	1979
Edward G. Raser	1980
Ernest A. DeCoste	1981
Louise Ramsey Moreau	1982
Joseph R. Pavek	1983

A special award was made in 1975 to William H. Offenhauser, Jr., for his efforts in preserving historical materials of the late Ralph Batcher; this led to the establishment of the Batcher Award.

The Pioneer Citation

Initiated in 1975. Designated by the Board of Directors to be awarded annually to long-time members who have contributed substantially to the success and development of the Club, or to the art of Radio Communications.

Richard W. Konter	1975
Dr. Harold H. Beverage	1976
William E.D. Stokes, Jr.	1977
Lewis M. Clement	1978
Clair L. Farrand	1979
Frank King	1980
James J. Lamb	1981
J. Keith Henney	1982
F.X. Rettenmeyer	1983

The Special Services Award

Initiated in 1975. Awarded at the discretion of the Board of Directors to persons who have contributed substantially to the support and advancement of The Radio Club of America.

Ernest V. Amy	1975
William H. Offenhauser, Jr.	1975
David Talley	1976
Mrs. Connie Conte	1982

The Allen B. DuMont Citation

Initiated in 1979. Awarded by the Board of Directors to a person who has made important contributions in the field of electronics to the science of television.

Dr. Thomas T. Goldsmith, Jr.	1979
Dr. P. Samuel Christaldi	1980
Horace Atwood, Jr.	1981
William Fingerle	1982
Fred M. Link	1983

The Henri Busignies Memorial Award

Initiated in 1981. Awarded by the Board of Directors upon any person who has contributed substantially to the advancement of electronics for the benefit of mankind.

William H. Forster	1981
James O. Weldon	1982
David Talley	1983

The Lee de Forest Award

Initiated in 1983. The award was established concurrently with the joining of the de Forest Pioneers with The Radio Club of America, and is made in memory of the many contributions of Dr. Lee de Forest to the radio communications industry. Awarded by the Board of Directors to a person for significant contributions to the advancement of radio communications.

D.E. Replogle	1983

IEEE Centennial Medalists

As a part of the celebration of its 100th anniversary, The Institute of Electrical and Electronics Engineers, Inc. (IEEE), awarded their Centennial Medals to 1984 persons who were selected by IEEE Societies, Sections, major boards, and other Institute entities for outstanding contributions in their respective areas of activity. Of those 1984 honorees, 28 were members of The Radio Club of America:

William F. Bailey
Harold H. Beverage
Charles D. Bodson
Vivian A. Carr
Arthur A. Collins
Martin Cooper
Lloyd Espenschied
William G.H. Finch
Donald G. Fink
Arthur Goldsmith
Bernhard E. Keiser
John J. Kelleher
Fred M. Link
Arthur V. Loughren
George F. McClure
William W. Mumford
John R. Neubauer
Alvin Reiner
John D. Ryder
Chandos A. Rypinski
Ruel P. Samuels
James F. Scoggin, Jr.
Benjamin E. Shackelford*
Neal H. Shepherd
Jerry S. Stover
Frederick G. Suffield
John J. Tary
Harold A. Wheeler

* Denotes Deceased

WE HONOR THESE PIONEERS WHOSE MEMBERSHIP IN THE RADIO CLUB OF AMERICA, INC. SPANS TWENTY-FIVE YEARS OR MORE

75 YEARS

Frank King, 1909
W.E.D. Stokes, Jr., 1909

60 YEARS

R.M. Atkin, Jr., 1924
Harold Beverage, 1920
Lloyd Espenschied, 1923
Joseph J. Stantley, 1920
Willis H. Taylor, Jr., 1920*

50 YEARS

John W. Arnold, 1929
Albert K. Bohman, 1926
John M. Borst, 1934
Meade Brunet, 1928
Frank E. Canavaciol, 1934
Louis F.B. Carini, 1930
E.T. Dickey, 1927
Karl D. Engle, 1929
Wm. G.H. Finch, 1927
Donald G. Fink, 1934
Thomas T. Goldsmith, Jr., 1932
Manning W. Grim, 1926
J. Keith Henney, 1927
Harry W. Houck, 1920
Arthur V. Loughren, 1924
D.E. Replogle, 1928
F.X. Rettenmeyer, 1928
John F. Rider, 1932
W. Gordon Russel, 1926
Nathan Schnoll, 1928
Myron T. Smith, 1934

45 YEARS

John H. Bose, 1938
George C. Connor, 1936
Howard T. Cervantes, 1939
Hugo Cohn, 1939
Lawrence Cook, 1939
John D. Crawford, 1939
Edwin P. Felch, 1939
Robert C.S. Finlay, 1939
K.W. Jarvis, 1935*
Leo A. Kelley, 1938
James O. Morelock, 1937
Wm. F. Offenhauser, Jr., 1936
C.W. Palmer, 1935
F.H. Shepard, Jr., 1936
Edward Sieminski, 1935
Harold A. Wheeler, 1935

40 YEARS

H.S. Bernard, 1942*
Kenneth A. Chittick, 1941
P.S. Christaldi, 1940
Robert V. Crawford, 1940
Marcus Glaser, 1943
Frank Gunther, 1940
J. Kelly Johnson, 1941
Renville H. McMann, Jr., 1944
Jerry B. Minter, 1942
Perry H. Osborn, 1944
George Papamarcos, 1941
Jack R. Poppele, 1941
A.H. Quist, 1940
Avery G. Richardson, 1941
Benjamin E. Shackelford, 1943*
W.O. Swinyard, 1941
John M. Van Beuren, 1942
Wm. H. Vogel, Jr., 1940
Harry Vorporian, 1941

35 YEARS

Joseph Behr, 1948
Alan Biggs, 1949*
Norman L. Chalpin, 1948
Robert D. Darrell, 1946
Raymond J. Edinger, 1949
Alexander A. McKenzie, 1948
Arthur G. Miller, 1949
T.T. Ronald, 1946
Hubert L. Shortt, 1945
Lionel C. Skipper, 1946
Jerome R. Steen, 1947
David Talley, 1949
Wilbur E. Thorp, 1948
Frank R. Zayac, 1948

25 YEARS

Fred W. Albertson, 1957
Horace Atwood, Jr., 1956
Alfonso Avallone, Jr., 1956
Alfred W. Barber, 1952
Ray E. Bolin, 1959
Bruce G. Cramer, 1955
Leo C. Cunniff, 1958
E. Stuart Davis, 1955*
Henry J. Fowler, Jr., 1956
Alfred H. Grebe, 1953
Paul Gruber, 1956
Benji Hara, 1956
Samuel N. Harmatuk, 1957
Lewis M. Hull, 1951*
Leonard R. Kahn, 1953
Edmund Kardauskas, 1951
Jordan I. Kunik, 1952
James J. Lamb, 1958
Peter L. Langer, 1954
Henry R. Mallory, 1958
Frank L. Marx, 1956
Stuart F. Meyer, 1956
Art H. Meyerson, 1957
Edmund Osterland, 1950
Armand Perretto, 1954
S. Edwin Piller, 1957
Edward G. Raser, 1957
Nicholas J. Reinhardt, 1956
John W. Richardt, Jr., 1952
Wm. W. Roberts, 1952
John B. Runyon, 1955
Richard A. Schomburg, 1957
Henry L. Shenier, 1952
E.K. Stodola, 1958
Nils Tuxen, 1953*
Ernest H. Ulm, 1950
Anthony F. Yellin, 1957
Mathew W. Zaret, 1951

**Denotes deceased during Diamond Jubilee Year*

1984 OFFICERS

Fred M. Link
President

Stuart F. Meyer
Executive Vice President

Mal Gurian
Vice President

Joseph Rosenbloom
Vice President Counsel

Francis H. Shepard, Jr.
Secretary

George J. Apfel
Treasurer

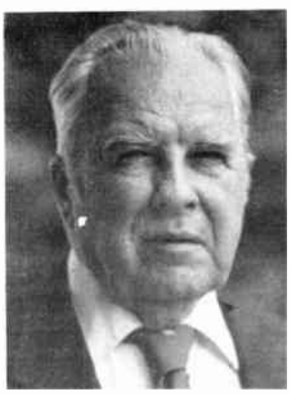
Fred Shunaman
Executive Secretary

Connie Conte
Administrator

W.G.H. Finch
Director Emeritus 1978

Samuel N. Harmatuk
Director Emeritus 1983

Harry W. Houck
Director Emeritus 1978



Jerry B. Minter
Director Emeritus 1983

Jack R. Poppele
Director Emeritus 1983

David Talley
Director Emeritus 1978

1984 DIRECTORS


Gaetano (Tom) Amoscato


Willard D. Andrews


Vivian A. Carr


Phillip D. Cook


Ero Erickson


William Fingerle


Charles A. Higginbotham


Jay Kitchen


Loren R. McQueen


Kenneth M. Miller


O. James Morelock


John W. Morrisey


Jerry S. Stover


Joseph F. Walker, Jr.

MEMBERSHIP LISTING JUNE 30, 1984

Abbott, John, K6YB (M 1980), Box 111, Room 760, Los Angeles, CA 90051

Abrams, Ralph D. (M 1979), c/o General Electric Co., 701, Papworth Ave., Metarie, LA 70005

Abrams, Stephen J., W2OKU (M 1961), 3 Charlotte Drive, Spring Valley, NY 10977

Ackerman, John R. (M 1984), Ackerman Communications, 191 High St., Waltham, MA 02154

Affelder, Charles J., N3AYU (M 1980, F 1982), 2114 Ruatan St., Adelphi, MD 20783

Agliata, Gerald L., WA2WPR (M 1979), Westchester Multiphone System, Inc., 300 Hamilton Ave., White Plains, NY 10601

Akin, R.M., Jr., K2LCU (M 1924, F 1944, L 1972), 28 Evergreen Way, No. Tarrytown, NY 10593

Albers, R.H., W4ER (M 1978), 5597 Seminary Rd., Falls Church, VA 22041

Albertson, Fred W., W4BD (M 1957, F 1973, L 1974), 310 Harbor Dr., Key Biscayne, FL 33149

Aldinger, Steven L., (M 1982) Phelps-Dodge Communications Co., Rte 79, Marlboro, NJ 07746

Alexander, Bob (M 1973, F 1982) Bob Alexander Associates, 6003 Maple Ave., #101G, Dallas, TX 75235

Alf, Edward A., (M 1975), 400 S. Flower #84, Orange, CA 92668

Alimpich, Nicholas, W8PYW (M 1972, F 1972), 25036 Donald, Redford, MI 48239

Allen, Hugh S., Jr., W6MFC (M 1967, F 1974), 3601 Royal Woods Drive, Sherman Oaks, CA 91403

Ammeraal, Ronald H., WA6VCQ (M 1981) 2650 Kayjay St., Riverside, CA 92503

Amoscato, Gaetano (Tom) (M 1973, L 1975, F 1981), Amtol Radio Communications, 150-47A 12th Rd., Whitestone, NY 11357

Amundson, Kenneth (M 1982), Tactec System Inc., Country Club Rd., Meadowlands, PA 15347

Anderson, Donald T., W5TGS (M 1978) 641 Circleview Dr. South, Hurst, TX 76053

Anderson, Harold D. (M 1980), Kennedy Engineering, Box 155, San Leandro, CA 94577

Anderson, Jack G., W1FDH (M 1970, F 1973), 28 Winged Foot Rd., Dover, DE 19901

Anderson, Roy E., W2VXD (M 1980), P.O. Box 1405, Schenectady, NY 12301

Andrews, Willard D., WB2LCF (M 1981, F 1982), 247 Green Ridge Rd., Franklin Lakes, NJ 07417

Apfel, George J., W2GHV (M 1975, F 1979), 105 Rivervale Rd., Park Ridge, NJ 07656

Arakawa, Taizo, N2ATT, JA3AER, (M 1981, F 1984), Sharp Electronics Corp., 2 Sharp Plaza, Paramus, NJ 07652

Ardery, James E., WB4PLV (M 1973), 111 Warfield Rd., Lynchburg, VA 24503

Armitage, Alan L. (M 1969, F 1977), Hunterdon Comms. System, Admin. Bldg., Main St., Flemington, NJ 08822

Arnold, Donald B., (M 1980) 2900 Sunglow Drive, Mechanicsville, VA 23111

Arnold, John W. (M 1929, F 1938, L 1971), 623 East Broad Street, Westfield, NJ 07090

Arnold, Michael (M 1983) 83 Michigan Ave., Wharton, NJ 07885

Ashby, Frank, W6AJU (M 1977), Box 280, Eatonville, WA 98328

Ashton, Shirley S., Jr. (M 1972, F 1974), Box 31231, Washington, DC 20031

Atchley, Dana W., Jr., W1CF (M 1970, F 1983), Concord Rd., Lincoln, MA 01773

Atwood, Horace, Jr., W2SXW (M 1956, F 1961, L 1981), 13 Valhalla Road, Montville, NJ 07045

Augustus, L.M., W8DKA (M 1969, F 1972), 1680 Cliffs Landing Dr., Ypsilanti, MI 48197

Austin, Richard C. (M 1978), 23 Homeside Lane, White Plains, NY 10605

Avallone, Alfonso (M 1956), 882 First Ave., Franklin Square, NY 11010

Ayd, David (M 1981) RD 1, Box 113-B Abbey Rd., Mt. Tremper, NY 12457-9713

Babkes, Jack, W2GDG (M 1974), 7410 S.W. 20th St., Planation, FL 33317

Bach, Norman G., W1HGI (M 1969, F 1971), 7807 Moorland Lane, Bethesda, MD 20014

Bade, Clifford E., W8CJB (M 1978), 26565 Locust Drive, Olmsted Falls, OH 44138

Badger, George M.W., W6TC (M 1980) Eimac Div., Varian Assocs., 301 Industrial Way, San Carlos, CA 94070

Bailey, H.E. (M 1977), Harmon Electronics, 1310 W. Colonial Drive, Orlando, FL 32804

Bailey, Thomas (M 1982) 31056 Fairfield, Warren, MI 48093

Bailey, Wm. F. (M 1960, F 1983), 37 Chestnut St., Garden City, NY 11530

Bain, John S. (M 1982, F 1982) Lehman Bros. Kuhn Loeb, 55 Water St. 40th floor, New York, NY 10041

Baker Bentley G. (M 1969), 3559 Primrose Rd., Philadelphia, PA 19114

Baker, James H. (M 1976, F 1981), Forest Industries Comms., Box 5446, Eugene, OR 97405

Balding, Edward A.R. (M 1981) Spinney House, Old Town Hill, Tockington, Nr. Bristol, Avon BS 12 4PA, ENGLAND

Barber, Alfred W. (M 1952, F 1957, L 1972), 32-44 Francis Lewis Blvd., Flushing, NY 11358

Barettella, Mark, KA2ORK (M 1983), 688 Maple Ave., Ridgefield, NJ 07657

Barlow, Niles I. (M 1975, F 1980), 33 Crest Road, East Rochester, NY 14445

Barnes, Frank P. (M 1969, F 1970), 37 West 11th St., New York, NY 10011

Barnhart, Edward F., K8WYT (M 1981) Columbia Gas Transmission Corp—Telecommunications, Box 616, St. Albans, WV 25177

Barnhill, Robert B., W4OXL (M 1970), 26 Olmstead Green, Baltimore, MD 21210

Barrett, Richard F., W6CFK (M 1978), 1520 Santa Maria Avenue, San Jose, CA 95125

Bassett, Rex, W4QS (M 1972, F 1977), Box 4163, Fort Lauderdale, FL 33304

Bates, Frank, III, AA6C (L 1979), American Embassy, APO NY 09253

Batts, Robert L. (M 1976, F 1977), 13 Todd Way, Imperial Terrace, Tavares, FL 32778

Baugh, Elaine, (M 1983) Cardiff Publishing Co., 6430 So. Yosmite St., Englewood, CO 80111

Baughman, Robert J. (M 1977), Phillips Petroleum Co., Comms., 107 N. Dewey, Bartlesville, OK 74004

Beaman, John C., (M 1981) Larsen Electronics Inc., Box 1686, Vancouver, WA 98668

Bechberger, Paul F., K2GH (M 1976), 51 Palmer Ave., Tenafly, NJ 07670

Becken, Eugene D. (M 1975, F 1976), 52 Rutland Road, Glen Rock, NJ 07452

Becker, Herb, W6QD (M 1971), 12522 Foster Road, Los Alamitos, CA 90720

Beeferman, Steven J., K2VWI (L 1977), 12 Northfield Gate, Pittsford, NY 14534

Behr, Joseph (M 1948, F 1952, L 1980), 270A Heritage Hills, Somers, NY 10589

Bellar, Bobby J., K5AHT (M 1979), 3300 Buckle Lane, Plano, TX 75023

Benham, Edward E. (M 1983), Box 579, Waitsfield, VT 05673

Best Lewis E. (M 1971, F 1984), 1344 Starbush Lane, San Jose, CA 95118

Betteridge, Robert L (M 1981) Westech Systems Ltd., 12852 141 St., Edmonton, Alta, CANADA, T5L 4N8

Beverage, Harold (M 1920, F 1926, L 1971, H 1983), Box BX, Stoney Brook, NY 11790

Beverly, Jack G. (M 1974), Rt. 1, Atchison, KS 66002-9801

Bhagat, Jai P. (M 1978, F 1983), MCCA, Box 2367, Jackson, MS 39205

Biresch, Donald F., WB3CDE (M 1983) Tabor Rd., Otisville, PA 18942

Bishop, William T., WOUI (M 1973), 4936 N. Kansas Ave., Kansas City, MO 64119

Bitcon, Wm. A. (M 1971) 152 Liberty Rd., Beaconsfield, P.Q., CANADA H9W 3HB

Black, John C., W7HIL (M 1978, F 1982), 14312 N.E. 16th Place, Bellevue, WA 98007

Black, Robert S. (M 1971, F 1976) 5304 Holly, Bellaire, TX 77401

Bloor, Robert E. (M 1974), 24338 Smith Avenue, Westlake, OH 44145

Bodson, Charles D., W4PWF (M 1976, F 1981), 233 N. Columbus St., Arlington, VA 22203

Boehm, Edward F. (M 1976, F 1979), Phelps Dodge Comms. Co., Route 79, Marlboro, NJ 07746

Bohman, Albert K. (M 1926, F 1952, L 1970), 181 Banner Farm Road, Horse Shoe, NC 28742

Bolin, Ray E., W0HN (M 1959), 704 S. Boyle Ave., St. Louis, MO 63110-1678

Bonanno, Ernest J. (M 1980) FCC, Common Carrier Bureau, 1919 M. St., N.W. Washington, DC 20554

Bondon, David L. (M 1977, F 1983), 24 North Point Drive, Colts Neck, NJ 07722; MACOM, 621 Shrewsbury Ave., Shrewsbury, NJ 07701

Bondon, Lewis A. (M 1974, F 1976), LAB Assocs., 12 S. Park St., Montclair, NJ 07042

Borden, Edward W. (M 1969, F 1975), 22 College Ave., Upper Montclair, NJ 07043

Borman, William M. (M 1976, F 1978), 18 Orchard Way, N., Rockville, MD 20854

Borsody, B.F., K4EC (M 1982, F 1984) 8056 Claries Dr., Sarasota, FL 33580

Borst, John M. (M 1934, F 1940, L 1971), 335 West 88th St., New York, NY 10024

Bose, John H. (M 1938, F 1940, L 1978), Maquam Shore, Swanton, VT 05488

Boswell, Fredric (M 1983), E.F. Johnson Co., 299 Tenth Ave., S.W., Waseca, MN 56093

Bottani, Aldo, A., Jr., (M 1979), 116 Union St., Emerson, NJ 07630

Bourne, Kenneth M., W6HK (M 1974, F 1981), 1923 E. Palm Ave., Orange, CA 92666

Bower, A.T., W1BJQ, K1NZW (M 1975) 14 Orchard St., Niantic, CT 06357

Bowles, Charles O., WB5RID (M 1981) 3310 Matador, Garland, TX 75042

Braddock, Edward, W1XV (M 1979, F 1984), Box 452, Route #1, Orleans, MA 02653

Bradshaw, Carl J. (M 1972, F 1973), Oak Industries, Inc., Box 28759, Rancho Bernado, CA 92128

Brandel, Robert W., WA0UHS (M 1980, F 1984), 342 Pearl St., Owatonna, MN 55060

Brittain, James E. (M 1983) Georgia Institute of Technology, North Ave., Atlanta, GA 30332

Breniman, William, (M 1982, F 1983) Society of Wireless Pioneers, P.O. Box 528, Santa Rosa, CA 95402

Brodie, Wm. A. (M 1973), Brodie Communications Co., Box 687, Brandon, FL 33511

Brooking, Robert E. (M 1981), 4338 Commonwealth, La Canada, CA 91011

Brown, Arthur F. (M 1981) Ocean County Sheriff's Dept., 110 Hooper Ave., Toms River, NJ 08753

Brown, Charles A. Jr., W0SFY (M 1982) 7245 Dudley, Lincoln, NE 68505

Brown, James M., W6VH (M 1984) 1802 Redesdale Ave., Los Angeles, CA 90026

Brown, Louis E. (M 1970, F 1972), Comm-Ind Inc., 1100 Frito-Lay Bldg., Dallas, TX 75235

Brown, Robert E., WA2DPV (M 1983) CesCo Communications Inc., 201-203 Cleveland St., Elmira Heights, NY 14903

Brown, Roxanne (M 1980) CesCo, Box 2104, Elmira, NY 14903

Brunet, Meade, (M 1928, F 1952, L 1971), Millsdale Farm, Mendham, NJ 07945

Bruns, Dennis L., (M 1983) 1807 24th St., Longmount, CO 80501

Bryant, E. Tyler, N4CZR (M 1983) Wilson Electronics Inc., 405 Hacienda, Las Vegas, NV 89118

Bryant, John A., W4UX (M 1974, F 1983), 1542 Linden Avenue, Owensboro, KY 42301

Bryson, William B., W2VHP (M 1969, F 1972), 403 Middle Rd., Hazlet, NJ 07730

Bucknell, J.M. (M 1975), Director Intelsig (Cambridge Ltd.) 1, The Causeway, Burweal Cambridge, ENGLAND CB5 OHA

Buhle, Donald F. (M 1983), Ameritech Mobile Communications Inc., 1501 Woodfield Dr., Schaumberg, IL 60195

Bunday, Dale, (M 1973), 4025 Mountain Pass, Plano, TX 75023

Burchard, Earl O., (M 1971), 2017 Sumter Ave., Tallahassee, FL 32301

Burns, David L., (M 1984) Southwestern Bell Mobile, 17730 Preston Rd., Dallas, TX 75252

Burns, George D. (M 1979), 310-A Hilltop Court, Barrington, IL 60010

Burton, Jan A. (M 1970), 1239 South Iris, Lakewood, CO 80226

Buster, Claude F. Jr. (M 1969, F 1984), 5407 Richenbacker Ave., Alexandria, VA 22304

Buzzi, Gene A. (M 1982) 325 John Knox Rd., Suite E204, Tallahassee, Fl 32303

Caiger, Robert E. (M 1981) 15110 Stevens Rd., S.E., Olalla, WA 98359

Calafut, George, W6PZO (M 1980) 24811 Redcliff Court, Sunnymead, CA 92388

Camp, Lynne P. (M 1983) Centurion International, P.O. Box 82846, Lincoln, NE 68501

Campbell, Bernard J., K6ZPE (M 1977, F 1978), 167 Fisher Court, Calimesa, CA 92320

Campbell, Frank D., W9CJF (M 1983) 555 Delbrick Lane, Indianapolis, IN 46229

Campbell, James W. (M 1978), 18121 Blue Ridge Drive, Santa Ana, CA 92705

Campbell, Marion Jr., W5VFG (M 1982), Motorola C&E Inc., 3320 Beltline Dr., Dallas, TX 75234

Campobasso, Thomas A. (M 1975, F 1976), Rockwell International, M.S. 001 PD12, 600 Grant St., Pittsburgh, PA 15219

Canavaciol, Frank E. (M 1934, F 1941, L 1971), 7119 Juno St., Forest Hills, NY 11375

Candy, Edwin R. (M 1980), (address unknown) Victoria, AUSTRALIA 3152

Caperton, John H. (M 1969, F 1979), 3114 Boxhill Court, Louisville, KY 40222

Capone, John J., Jr., WA0ADV (M 1979), CW Electronic, 1401 Blake, Denver, CO 80202

Carella, Daniel J., W2ENV (M 1979), 39 Mechanic St., Millburn, NJ 07041

Carini, Louis F.B. (M 1930, F 1942, L 1971), 246 Wolcott Hill Road, Wethersfield, CT 06109

Carlton, John W., G2GEP (M 1979, F 1981), Pye Telecommunications Ltd., St. Andrews Road, Cambridge, ENGLAND CB5 8PD

Carr, Vivian A. (M 1973, F 1975), 645 Hoey Ave., Long Branch, NJ 07740

Carter, Thomas F. (M 1969, F 1969), North Highway 90, Gun Barrel, TX 75147

Caskey, Karen M. (M 1982) Sinclair Radio Labs, Inc., 14614 Grover St., Suite 210, Omaha, NE 68144

Caspers, George E., W9WAY (M 1975), Coolidge Dr., Box 6, Lake Nebagamon, WI 54849

Cassidy, Francis F. (M 1976, F 1976) 1648 East 56th St., Brooklyn, NY 11234

Castanera, Juan R. (M 1975) Box 331, Loquillo, PR 00673

Ceragno, Carl R., WB2CRS (M 1983) Tele-Measurements, 145 Main Ave., Clifton, NJ 07014

Cervantes, Howard T., W2DB (M 1939, F 1940, L 1971), 316 Hiawatha Ave., Iverness, FL 32650

Chadbourne, H.L. (M 1979), 530 Midway St., La Jolla, CA 92037

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Troe, James L., W2GRX (M 1978, F 1981), 111 Skyline Dr., Morristown, NJ 07960

Troster, John G., W6ISQ (M 1975), 82 Belbrook Way, Altherton, CA 94025

Trott, Raymond C. (M 1976, F 1978), 1425 Greenway Drive, Suite 350, Irving, TX 75062

Tsao, T.C. (M 1966, F 1973, L 1983), 351 E. 84th Street, New York, NY 10028

Turdo, Malcolm M., WB2ANM (M 1973), 3106 Harrison St., Wall, NJ 07719

Turner, Derek, (M 1975), Pentland North Rd., Whittlesford, Cambridge, ENGLAND

Turney, Don, WB2EDR (M 1982), 15 Grove St., Pompton Plains, NJ 07444

Twitchell, Herb, W6BL (M 1980), Imperial Oil, 10960 Wilshire Blvd., #527, Los Angeles, CA 90024

Ulm, Ernest H. (M 1950, F 1957, L 1984), 372 Demarest Drive, Orange, CT 06477

Underdown, Jay W., W0OGS (M 1983), 58 Judy Drive, St. Charles, MO 63301

Van Beuren, John M. (M 1942, F 1944, L 1975), 5529 Bellevue Ave., La Jolla, CA 92037

Van Stavern, Earl T., W4NXP (M 1980), Commonwealth Communications Industries, Box 312, Ashland, VA 23005

Vargas, John F., W2ULO (M 1979), 49 Fairview Ave., Park Ridge, NJ 07656

Vashrow, Leo M., W2ZPO (M 1975), 284 Vly Road, Schenectady, NY 12309

Vickers, Michael W. (M 1980), 800 Aventura Court, Lee's Summit, MO 64063

Viele, James H., W1BRG (M 1979), 101 Henry St., Burlington, VT 05401

Villastrigo, Judith (M 1979, F 1984), General Comm. Engineering Co., 9850 Kitty Lane, Oakland, CA 94603

Villers, Ralph L (M 1975), 1645 Oregon Ave., Box 1, Steubenville, OH 43952

Vogel, Wm. H. Jr., W1GPS (M 1940, L 1971, F 1972), Strawberry Lane, New Preston, NJ 06777

Voorhis, Harold V.B. (M 1964, F 1976, L 1978), 105 New England Ave., Summit, NJ 07901

Vorporian, Harry (M 1941, L 1971), 60-20 B 194th St., Flushing, NY 11365

Vrana, Othal D. (M 1978, F 1984), 800 Peterson St., Wichita, KS 67212

Waite, Amory H., Jr., W2ZK (M 1974, F 1976), 3248 Valencia Drive, FL 33595

Walcutt, David L (M 1984), RFE-RL Inc., 1775 Broadway, New York, NY 10019

Walker, A. Prose, W4BW (M 1971, F 1972), 1087 Tung Hill Drive, Tallahassee, FL 32301

Walker, James A. (M 1980), Motorola, C&E, 2333 Utah Ave., El Segundo, CA 90245

Walker, Joseph F. Sr., W5ZPO (M 1977, F 1978), 1601 S.E. Lariat Drive, Bartlesville, OK 74006

Walker, Robert E., W4MLX (M 1971), 607 E. Brevard St., Tallahassee, FL 32308

Wallace, Don C., W6AM (L 1981, F 1981) 28503 Highridge Rd., Rancho Palo Verdes, CA 90274

Wallenburg, Robert C., WA5WGO (M 1970), 3513 Evangeline Ave., Chalmette, IA 70043

Wallin, Gary P. (M 1970), 11 Crestview Road, Manchester, NH 03104

Wallis, Robert A. (M 1983), Tactec Systems Inc., Country Club Rd., Meadowlands, PA 15347

Wallover, Donald R. (M 1975) MTI., Box 735, Camp Hill, PA 17011

Walsh, Dale M. (M 1981), Communications Engineering Co., Box 45686, Dallas, TX 75245

Walsh, Robert P., WA8MOA (M 1983), Arabian American Oii Co. Communications, Box 16131, Ras Tanura, SAUDIA ARABIA

Walton, Robert C., W6CYL (M 1972), 680 South 15th St., San Jose, CA 95112

Warner, Edward J., K3RPH (M 1979), 9911 Carter Rd., Bethesda, MD 20034

Warren, Carl R., W0KWS (M 1983), 946 S. Campbell, Springfield, MO 65801

Warshaw, David (M 1974, F 1975), Box 141, Quaspeck Blvd., Valley Cottage, NY 10989

Warshaw, Marguerite (M 1974, L 1983), Box 141, Quaspeck Blvd., Valley Cottage, NY 10989

Watson, Herbert M., W6EW (M 1971, F 1972), 76-955 Sandpiper Dr., Indian Wells, CA 92260

Watson, Wm. P., W5UNY (L 1981), 920 Center St., Minden, LA 71055

Wayman, N. Jack (M 1970, F 1972), 3612 Ridgeway Terrace, Falls Church, VA 22044

Webb, John G., W6RCW (M 1981), 6267 Squiredell Dr., San Jose, CA 95129

Weber, Carolin B., WB6SJK (M 1980), 9064 La Colonia Ave., Fountain Valley, CA 92708

Wehking, Ralph T. (M 1977), 1987 Fossway Court, Cincinatti, OH 45230

Weingart, Edward, WA2DFM (M 1982, F 1984), RD #1, Box 346, Whispering Hills Dr., Annandale, NJ 08801

Weir, Robert, VE3WY (M 1983), Sinclair Radio Labs Ltd., 122 Rayette Rd., Concord, Ont. CANADA LK4 1B6

Weisman, David (M 1982), Newrath, Meyer & Faller, P.C., 4400 Jenifer St., N.W., Washington, DC 20015

Weisz, Wm. J. (M 1976, F 1976), 721 Apple Tree Lane, Glencoe, IL 60022

Weldon, James O. (M 1980, F 1981) Continental Electronics Mfg. Co., Box 270879, Dallas, TX 75227

Wells, Ray, G3RIN (M 1979), Pye Telecommunications Ltd., Portable Laboratory, Lab 2, St. Andrews Rd., Cambridge, ENGLAND CB4 1DW

Wentsel, Amandus G. Jr., W2HX (M 1975), 318 Gardner Ave., Trenton, NJ 08618

Werner, Donald G., WA6KKR (M 1980), 1055 Hermosa Ave., Sierra Madre, CA 91024

West, Gordon V., WB6NOA (M 1977), 2414 College Drive, Costa Mesa, CA 92626

West, Graham C.K. (M 1982, F 1983), 1 Cedarwood Close Central Gardener Estate, Greystanes, N.S.W., AUSTRALIA 2145

West, Wm. L. Jr. (M 1980), 1923 Oakhurst St., Jackson, MS 39204-4922

Wheel, Wm. E. (M 1976) Pye Telecommunications Ltd., St. Andrews Rd., Cambridge, ENGLAND CB4 1DW

Wheeler, Harold A. (M 1935, F 1936, L 1971, H 1983), 59 Derby Place, Smithtown, NY 11787

White, Charles M., W5LPU (M 1979), 5618 Valerie, Houston, TX 77081

White, Richard M. (M 1980), Vision Cable Communications, 270 Sylvan Ave., Englewood Cliffs, NJ 07632

Whiting, John V. (M 1977, F 1980), 1731 Adams St., Longwood, FL 32750

Wickline, William A., WA8WBO (M 1976), 29017 W. Willowick Drive, Willowick, OH 44094

Wiesner, E.P. (M 1977, F 1980) Satellite Publications Co., 5594 South Prince St., Littleton, CO 80120

Williams, Dorsey (M 1971, L 1972), Box 456, Hendersonville, NC 28793

Williams, Perry F., W1UED (M 1980), 225 Main St., Newington, CT 06111

Williams, Ralph O., N3VT (M 1978), RFD #1, Box 44, Orient, NY 11957

Williams, Roger L., W0WUG (M 1982), Williams Vocational Technical Institute, P.O. Box 1097, County Road 24, Willmar, MN 56201

Williams, Val J. (M 1970, F 1977), 2 Farcroft Ct., Laytonsville, MD 20879

Williams, Walter B., W8HP (M 1982), 13103 Corbett Ave., Detroit, MI 48213

Willmot, William C., K4TF (M 1981), 1630 Venus St., Merritt Island, FL 32952

Wilner, John T., KA2FYW (M 1977, F 1978), 23 Continental Lane, Titusville, NJ 08560

Wilson, Don, K2DSV (M 1983), 644 Lorraine Ave., Middlesex, NJ 08846

Wilson, Wm. A (M 1970), 7051 Highway 106, Union, WA 98592

Winans, Henry M., Jr., W5KNY (M 1976), 3707 Gaston Ave., Suite 220, Dallas, TX 75246

Winter, David W., W2AUF (M 1971), 84-26 87th St., Woodhaven, NY 11421

Winter, William D., K3JPB (M 1984), S.I.C. Inc., 1701 Second Ave., Folsom, PA 19033

Wise, David, N8CNY (M 1983), 1605 Springfield Lane, Lansing, MI 48912

Wiskoff, Marc B., KA2EUF (M 1978), 3090 Voorhies Ave., Brooklyn, NY 11235

Witt, Frederick E., K2HUY (M 1961), RFD 1, Box 213, Cobleskill, NY 12043

Witt, Leonard T., W2DTH (M 1971, F 1978), Box 890, Amagansett, NY 11930

Wofford, Delbert R. (M 1975, F 1981), 624 Suffolk Dr., Owensboro, KY 42301

Wolf, Peter P., N6US (M 1980), 6511 Bedford Ave., Los Angeles, CA 90056

Wolfe, Benjamin, W3BC (M 1977, F 1978), 6300 Red Cedar Pl., Apt. 402, Baltimore, MD 21209

Woodin, R.H., KL7IHH (M 1970), 40 Mill Street, Westwood, NJ 07675

Worthen, K.J., W6JTV (M 1972), 100 Jocelyn Court, Santa Cruz, CA 95060

Wright, Elise M. (M 1982), 2430 Nottingham Dr., Falls Church, VA 22043

Wright, G.R., W3KUH (M 1979), 202 Piping Rock Dr., Silver Spring, MD 20504

Wycoff, Keith H. (M 1981, F 1983), Reach Electronics, Inc., Box 10, Lexington, NE 68850

Wynne, W. Avery, K4RU (M 1979), Radio WEED, Inc., Nashville Hwy., Rocky Mount, SC 27801

Yeager, Clair J. (M 1972), 502 Davis St., Endwell, NY 13760

Yefsky, Sheldon A. (M 1971, F 1979), 5033 Morse St., Skokie, IL 60076

Yellen, Anthony F., W2EDA (M 1957), 84-46 117th St., Richmond Hill, NY 11418

Zayac, Frank R., W2FYY (M 1948, F 1955, L 1972), R.D. #3, Box 55, Boonton, NJ 07005

Zellmer Allen M., K6MGQ (M 1977), 5311 Callister Ave., Sacramento, CA 95819

Ziegler, Malcolm L (1982), 2055 Clearview Court, Walnut Creek, CA 94598

Zimmelman, Ronald B. (M 1980), 3577 Mountain View Ave., Los Angeles, CA 90066

Zouary, Maurice (L 1983), 56 Marlborough Rd., Brooklyn, NY 11226

In Memoriam

Aceves, Julius G.
Adelman, Leon L.
Alexander, Louis D.
Allen, George Y.
Amerman, Edward A.
Amy, Ernest V.
Andrew, Dr. Victor J.
Armstrong, Edwin H.
Arnson, Ludwig
Atkins, Carl E.
Aull, Wilson W, Jr.
Ayer, Oliver G.
Aylor, Raymond P., Jr.

Bailey, Dr. George W.
Baker, Thomas S.
Baker, Walter R.G.
Ballantine, Stuart
Barclay, Robert H.
Barone, Salvatore A.
Batcher, Ralph R.
Baunach, Edward L.
Bernard, Herbert S.
Biggs, J. Alan
Billings, Ray H.
Bingham, Dr. Anson H.
Bingham, Wilbur Fisk
Binns, John R.
Bishop, William T.
Booth, Robert M. Jr.
Boucheron, Capt. Pierre H.
Boyle, Harry G.
Bradford, William J.D.
Bremmer, Leroy J.
Brett, Harold M.
Brinkley, John R.
Brizzolari, Anthony J.
Brown, David Seymour
Browne, Walram S.
Bucher, Elmer
Burghard, George E.
Burlingame, Bruce O.
Busignies, Dr. Henri G.
Buttner, Harold H.

Caldwell, Orestes
Callahan, John L.
Capen, William H.
Caywood, William
Chestnut, Lee
Clark, George H.
Clark, Herbert A. Jr.
Clark, Leroy
Clark, Victor C.
Clement, Lewis M.
Cobb, Howard L.
Cohen, Monte
Cooney, J.K.
Cooper, Charles B.
Cotterell, Charles M.
Cowan, Thomas H.
Craig, James A.
Crane, Edwin E.
Cronkhite, Minton
Crosby, Murray G.
Cumeralto, Quinten G.
Cumming, Larry G.

Davidson, Charles
Davis, Dr. E. Stuart
Day, Howard B.G.
Day, James R.
DeVine, Alexander A.
DiBlasi, John
Dietrich, Frederick
Dreher, Carl
Dubilier, William
DuMont, Dr. Allen B.
Dunlap, Orrin E.
Dunn, Gano
Duskis, Ephraim F.

Eastham, Melville
Eggert, Jacob E.
Ehrmann, Gustav J.
Eltz, George J.
Engel, Francis H.

Farrand, Clair L.
Felt, Marcus A.
Fennimore, Roland M.
Ferrell, Oliver P.
Ferris, Malcolm
Fine, C. Robert
Fisk, James R.
Flewelling, Edmund T.
Forbes, Henry C.
Forster, William H.
Freed, Joseph D.R.
Freeman, Edgar W.
Freseman, William L.D.
Fridman, Olof G.R.
Fuller, Stephan H.

Gawler, Henry G.
Gensler, Barry
Gernsback, Hugo
Girard, Paul A.
Glaven, Edward F.
Godfrey, Dr. Charles C.
Godley, Paul F.
Goebel, Eugene S.
Goldsmith, Dr. Alfred N.
Goudy, Carl F.
Gould, William B., III
Goulden, Stanley W.
Graham, John J.
Graham, Virgil M.
Grebe, Alfred H.
Grinan, John F.
Guggenheim, Dr. Sigmund
Guilfoyle, Thomas J.
Guy, Raymond F.

Haas, John G.
Hall, F. Sumner
Hamilton, Hugh G.
Hanley, John F.
Hansell, C.W.
Harnett, Daniel E.
Harris, Charles S.
Hawkins, Stanley L.
Hazeltine, Dr. Louis Alan
Hebert, Arthur A.
Hees, George C.
Heintz, Ralph M.
Heising, Raymond A.
Hervey, James P.
Hinners, Frank A.
Hirsch, Charles J.
Hogan, John V.L.
Holacek, Frank
Hold, Henry W.
Hollister, Frank J.
Hoppenberg, Joseph A.
Horle, Lawrence C.F.
Horn, Charles W.
Hubley, Warren F.
Huffman, Charles E.
Hull, Dr. Lewis M.
Hutchens, Ray

Inman, Walker P.
Ireland, Frederick

Jacquet, Lloyd
Jackson, Samuel, Jr.
Jacobs, Charles F.
Jaffe, D. Lawrence
James, Wallace M.
Jansky, Dr. C.M., Jr.
Jarvis, Kenneth W.
Jenkins, Victor E.
Johnson, Dr. John Bertrand
Johnson, Douglas J.
Jones, Dr. Thomas F., Jr.
Jones, Walter R.

Kanz, William J.
Kennedy, Robert E.L.
Kent, Roscoe
Kishpaugh, A.W.
Klingenschmitt, Fred A.
Klusacek, Emil R.
Knapp, Joseph F.
Konter, Richard W.
Kraus, Michael B.
Krupansky, Frank
Kruse, Robert S.

Lacault, Robert E.
Lear, William P.
Leonard, Paul J.
Lescarboura, Austin C.
Lewis, Harold M.
Lidbury, F.A.
Lindberg, C. Edward

Lindenblad, Nils Erik
Logwood, Charles V.
Long, F. Vinton
Loughlin, William D.
Lovejoy, D. Ross
Lynch, Arthur H.
Lyons, Walter

MacCoun, Townsend D.
MacDonald, William A.
Mackay, John R.
Maddox, Ralph G.
Manson, Ray H.
Marriott, Robert H.
Marshall, Bertram G.
Marx, Ernest A.
Mather, Robert B.
Mayer, William G.
McCann, John
McMann, Renville H., Sr.
McNicol, Donald
Menegus, Alfred A.
Miessner, Benjamin F.
Miller, Donald H.
Moses, Dr. Samuel
Moulton, Albert B.
Munn, W. Faitoute
Munns, Ernest F.
Murdock, Daniel R.W.

Nafzger, Lester H.
Nelson, Wayne M.
Niblack, David
Nicholas, Edwin A.
Nieson, Norman

Otis, G. Edwin

Pacent, Louis G.
Packard, Lucius E.
Page, Esterly
Parks, A.W., Jr.
Peck, Gordon V.
Peterson, Robert M.
Pfeifer, Clarence H.
Pickard, Greenleaf W.
Pickerill, Elmo N.
Porter, H.F.
Potts, John H.
Pratt, Haraden

Pupin, M.I.

Quinby, Edwin J.

Ranger, Richard H.
Redington, Edmund B.
Reeves, Dr.Alec Harley
Regan, Thomas A.
Reinartz, John L.
Richardson, Kenneth
Rietzke, Eugene H.
Roger, William
Rogers, Albert P.
Roos, Oscar C.
Round, Capt. Henry J.
Rosenthal, Leon W.
Ross, Uda B.
Rowe, Fred D.
Runyon, Carmen R., Jr.
Runyon, Carmen R., III
Russell, William T.

Sadenwater, Harry
Sampson, Harvey
Sara, Joseph
Sarnoff, David
Schalkhauser, Eric G.
Schermer, Arthur M.
Schumacker, Allan L.
Secor, Harry W.
Seeley, S. Ward
Seibt, Dr. Georg
Shackelford, Benjamin E.
Sharp, Watkin W.
Shaw, James D.
Shipman, Waldo
Shonhale, Charles L.
Siegel, Seymour N..
Silver, McMurdo
Simmons, M. Theodore
Simon, Emil J.
Simon, William C.
Singer, Benjamin
Singer, Charles H.
Slater, Ira M.
Sleeper, Milton B.
Sloat, Orison B.
Smith, James E.
Smith, Luther C., Jr.

Snyder, Harvey C.
Starrett, John S.
Stevens, Archie McD.
Stewart, Charles H.
Stone, John Stone
Stong, Clair L.
Styles, Thomas J.

Taussig, Charles W.
Taylor, Willis H., Jr.
Thomas, Leslie G.
Thompson, Sylvester T.
Toegel, Burt J.
Trube, Carl E.
Tsubauchi, Akira
Tunick, Harry
Tuxen, Nils
Tyne, Gerald F.J.

VanDyck, Arthur F.
Vansize, William B.
Vaughan, Wilbur S.
Vermilyea, Irving
Vette, William J.
Villers, Ralph I.

Wainwright, Wayne
Walsh, Dr. A. LaFayette
Walsh, Lincoln
Ware, Paul
Warner, K.B.
Washington, George, Jr.
Watts, W. Walter
Weare, John
Weber, Victor J.
Wehner, John H.
White, Lowell E.
Whiting, Donald F.
Williams, Col. Grant A.
Williams, Roger
Wilson, John W.
Winslow, Louis J.
Winterbottom, William A.
Wise, Roger M.
Wunderlich, Norman E.

Yocum, Charles H.
Yokochi, K. Shin-ichi

Zaret, Matthew E.
Zenneck, Jonathan A.W.

CONSTITUTION
OF
THE RADIO CLUB OF AMERICA, INC.

ARTICLE I

NAME AND PURPOSE

SEC. 1. The name of this organization shall be THE RADIO CLUB OF AMERICA, Inc.

SEC. 2. Its purpose shall be:

a. To operate exclusively for charitable, educational and scientific purposes, entitling the corporation to exemption under the provisions of Section 501 (c)(3) of the Internal Revenue Code of 1954, and more specifically to study and contribute to the development of radio communication programs and provide a scholarship fund for needy and worthy students for the study of radio communication.

b. In furtherance of its corporate purposes, the corporation shall have all general powers enumerated in Section 202 N-PCL together with the power to solicit grants and contributions for corporate purposes.

c. Nothing herein shall authorize this corporation, directly or indirectly, to engage in or include among its purposes, any of the activities mentioned in Not-For-Profit Corporation Law, Section 404 (b) - (p) or Executive Law, Section 757.

d. No part of the income of the corporation shall inure to the benefit of any member, trustee, director, officer of the corporation, or any private individual (except that reasonable compensation may be paid for services rendered to or for the corporation affecting one or more of its purposes) and no member, trustee, officer of the corporation or any private individual shall be entitled to share in the distribution of any of the corporate assets on dissolution of the corporation.

e. No part of the activities of the corporation shall be carrying on progapanda, or otherwise attempting to influence legislation, or participating in, or intervening in (including the publication or distribution of statements) any political campaign on behalf of any candidate for public office.

f. In the event of dissolution, all the remaining assets and property of the corporation shall after necessary expenses thereof be distributed to such organizations as shall qualify under Section 501 (c) (3) of the Internal Revenue Code of 1954, as amended, subject to an order of a Justice of the Supreme Court of the State of New York.

g. The corporation shall distribute its income for each taxable year at such time and in such manner as not to subject it to tax under Section 4942 of the Internal Revenue Code of 1954, as amended; and the corporation shall not (a) engage in any act of self-dealing as defined in Section 4941 (d) of the Code; (b) retain any excess business holdings as defined in Section 4943 (c) of the Code; (c) make any investments in such manner as to subject the corporation to tax under Section 4944 of the Code; or (d) make any taxable expenditures as defined in Section 4945 (d) of the Code.

ARTICLE II

MEMBERSHIP

SEC. 1. The membership of the Club shall consist of those persons who have signed the Certificate of Incorporation together with all persons who are hereafter received in or elected to membership as herein provided.

SEC. 2. Any person is eligible for membership who has been interested in the investigation of the principles of radio communication and in radio operation for at least one year.

SEC. 3. The classes of membership and the fees therefor will be prescribed in the By-Laws.

SEC. 4. Any member may withdraw from the Club by presenting to the Secretary a written statement of resignation.

SEC. 5. A member may be expelled for violation of the By-Laws of the Club or for other cause prejudicial to the best interest of the Club. Such expulsion may be effected by a two-thirds vote of the Board of Directors at a duly called meeting.

Any resigned or expelled member forfeits all rights and priveleges of the Club.

ARTICLE III

GOVERNMENT

SEC. 1. The general management of the affairs of the Club shall be vested in the Board of Directors who shall be elected as provided in the By-Laws.

SEC. 2. The governing body of the Club shall be the Board of Directors comprising the Officers and fourteen Directors.

SEC. 3. The officers of the Club shall consist of a President, Vice President, Secretary and Treasurer, and such other Officers as the Board from time to time may designate.

SEC. 4. The Board of Directors shall meet at least once each year and at the call of the President. At least one-half of the Board members shall be present to constitute a quorum.

SEC. 5. If a vacancy occurs among the Officers or in the Board of Directors, such vacancy shall be filled for the unexpired term by the Board of Directors.

SEC. 6. The President shall be a member ex-officio of all Committees.

ARTICLE IV

MEETINGS

SEC. 1. The Club shall hold an Annual Meeting before the end of each calendar year at a time and place to be designated by the Board of Directors.

SEC. 2. Other meetings of the Club may be held throughout the year, the time and place to be designated by the Board of Directors.

ARTICLE V

FINANCIAL OBLIGATIONS

SEC. 1 No financial obligation shall be incurred on behalf of the Club except by the approval of the Board of Directors as covered in the By-Laws.

SEC. 2. All obligations incurred by the Club shall be solely corporate obligations and no personal liability whatsoever shall attach to, or be incurred by any member, Officer or Director of the Club by reason of any such corporate obligation.

ARTICLE VI

AMENDMENTS

SEC. 1. Proposed amendments to this Constitution must be reduced to writing and signed by not less than twenty-five Members or Fellows and be submitted to the membership who shall vote thereupon by letter ballot. The amendment shall be adopted if seventy-five per cent of the votes received are in favor of such action, the polls having been open for at least one month after mailing to the qualified membership notices of the proposed amendments.

THE RADIO CLUB BY-LAWS

ARTICLE I

MEMBERSHIP

SEC. 1. The membership of the Club shall consist of the following grades:

a. Members; b. Senior Members; c. Fellows; d. Life Members; e. Honorary Members.

They shall be entitled to all privileges of the Club except that Honorary Members may not hold office or be elected to the Board of Directors.

SEC. 2. A Senior Member shall have been a member of the Club for at least three (3) years and whose contributions to the art and science of radio and electronics are such as to qualify for the grade of Senior Member.

SEC. 3. A Fellow shall have been a member of the Club for at least five (5) years, or one whose contributions to the art and science of radio and electronics are such to qualify for the grade of Fellow.

SEC. 4. An Honorary Member shall be a person of high professional standing who is interested in the activities of the Club.

SEC. 5. Elevation to the grade of Senior Member shall be by a majority vote of the Executive Committee. Election or transfer to the grade of Fellow or Honorary Member shall be by a majority vote of the Board of Directors.

SEC. 6. A person eligible for membership may apply by making application, on the form prescribed by the Board of Directors, to the Executive Secretary; and submitting with the application the entrance fee and initial dues payment.

SEC. 7. Each application for membership shall be considered by the membership committee and its recommendation shall be submitted to the Board of Directors. If the applicant is approved by the Board of Directors, the Executive Secretary shall notify the applicant of election to membership.

SEC. 8. Each application for Senior Membership must be supported by written sponsorship of three or more members in good standing submitted individually to the Executive Secretary.

ARTICLE II

ENTRANCE FEE AND DUES

SEC. 1. The entrance fee for new Members shall be Thirty-five Dollars ($35.00) which includes the cost of the Club pin, membership certificate and dues for three years. The fee for elevation to a Senior Member shall be Ten Dollars ($10.00) which includes a Senior Member pin and certificate.

SEC. 2. The dues payable by Members, Senior Members, and Fellows shall be Twenty-five Dollars ($25.00) for a three (3) year period payable on the first day of each three (3) year period in advance of the ensuing three (3) years. It shall be the duty of the Executive Secretary to notify each Member, Senior Member, or Fellow of the amount due. Honorary Members and Life Members shall be exempt from payment of dues or fees.

SEC. 3. All members in good standing shall be furnished with permanent membership cards bearing the signature of the Executive Secretary.

SEC. 4. Persons elected to membership on or after November 1 of any year shall pay dues to be credited to the following three-year period.

SEC. 5. Any Member, Senior Member or Fellow whose dues become two months in arrears shall be so notified by the Executive Secretary. Should dues then become four months in arrears, notification by the Executive Secretary will again be made. Should dues then become six months in arrears, the name shall be submitted to the Board of Directors for further action. The Board of Directors may, however, for sufficient cause temporarily excuse from payment of annual dues any Member, Senior Member or Fellow or extend the time for payment.

SEC. 6. Every person admitted to the Club shall be considered as belonging thereto and liable for the payment of all dues (except as per Sec. 7 of this Article) until such person shall have resigned, been expelled, or have been relieved therefrom by the Board of Directors.

SEC. 7. Any Member, Senior Member or Fellow not in arrears, upon payment of Two Hundred Dollars ($200.00), shall be exempt for life from the payment of annual dues. Any Member, Senior Member or Fellow not in arrears shall be exempt for life from the payment of annual dues providing that age plus years of membership equal one hundred (100); or provided that the person is sixty (60) or more years of age, upon payment of Fifty Dollars ($50.00) if a member for twenty (20) or more years, or upon payment of One Hundred Dollars ($100.00) if a member for ten (10) or more years.

ARTICLE III

OFFICERS AND DIRECTORS

SEC. 1. The Board of Directors shall manage the affairs of the Club in conformity with the provisions of the Constitution and the By-Laws. It shall direct the care and appropriation of the funds of the Club; act upon applications for membership as heretofore provided; elect Honorary Members; exercise discretionary power in the election to the grade of Fellow; and take measures to advance the interests of the Club and generally direct its business. It may appoint an Executive Secretary and fix compensation therefor. It may appoint an Executive Committee to carry out certain specified responsibilities in the interim period between meetings of the Board of Directors. It may designate past Officers and Directors to honorary non-voting status.

SEC. 2. The Officers shall consist of a President, Executive Vice-President, Vice-President, Vice-President-Counsel, Treasurer, and Secretary.

SEC. 3. No Officer or Director shall receive renumeration for his services in any capacity.

SEC. 4. The Officers and Directors of the Club shall serve for a term of Two (2) Years or until their successors are duly elected, the term of each to commence on January 1st following such election. One-Half (1/2) of the Fourteen (14) Members of the Board of Directors shall be elected each year.

SEC. 5. The Executive Committee, appointed by the Board of Directors, shall consist of the President, Executive Vice-President, Vice-President, Vice-President-Counsel, Treasurer, Secretary, not to exceed (5) Five Members of the Board of Directors other than Officers, and such other members of the Club as may be appointed by the Board of Directors upon the recommendation of the President.

SEC. 6. The Executive Committee shall carry out only the specific responsibilities that are authorized by the Board of Directors in the interim period between meetings of the Board of Directors. These responsibilities shall include approval of new applications for membership, approval of elevation to the grade of Senior Member, arrangements for meetings and general direction of the Club's operations including those of the Treasurer and the Executive Secretary. The Executive Committee shall not control the care and appropriation of the funds of the Club. All actions of the Executive Committee shall be subject to approval by the Board of Directors.

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ARTICLE IV

DUTIES OF OFFICERS

SEC. 1. The President shall have general supervision of the Club which shall include but not be limited to presiding at meetings of the Club and the Board of Directors and the appointment of such committees as the President or the Board of Directors shall deem necessary.

SEC. 2. The Executive Vice-President shall assist the President in the performance of the President's duties.

SEC. 3. The Executive Vice-President, Vice-President, Vice-President-Counsel, in that order, shall assume all duties of the President during the President's absence from meetings or when the President is otherwise unable to perform such duties. In the event of all the foregoing Officers' inability to perform such duties, a Chairman pro tem shall be appointed by majority vote by those members present at the meeting.

SEC. 4. The Treasurer shall be responsible for the funds of the Club and accountable to the Board of Directors, which shall include but not be limited to making such payments for the Club as directed by the Board of Directors; and reporting on the Club's financial status at each meeting of the Board of Directors.

SEC. 5. The Secretary shall be responsible for the records of the Club, and shall duly record the minutes of the meetings of the Board of Directors and of the Executive Committee.

SEC. 6. The Executive Secretary who shall be appointed by the Board of Directors shall conduct the administrative operations of the Club and shall be generally responsible to the Board of Directors. Duties shall include but not be limited to conducting the correspondence of the Club; collecting and receiving all dues and fees; recording the proceedings of all meetings; and maintaining custody of all applications of persons admitted to membership as well as all other necessary records of the Club.

SEC. 7. The President, within fourteen (14) days after the Annual Meeting of the Club, shall appoint from the membership the following Standing Committees: (a) Awards; (b) Banquet; (c) Constitution & By-Laws; (d) Finance; (e) Grants-in-Aid; (f) Meetings; (g) Membership; (h) Papers; (i) Publications; and (j) Publicity.

ARTICLE V

NOMINATIONS AND ELECTIONS

SEC. 1. At least sixty (60) days prior to the Annual Meeting each year, the President shall appoint a Nominating Committee subject to the approval of the Board of Directors. The report of this Committee shall be submitted to the membership at least twenty (20) days prior to the Annual Meeting in each year together with a ballot form. The Nominating Committee shall submit eligible candidates for President, Executive Vice-President, Vice-President, Vice-President-Counsel, Treasurer, and Secretary every two years, and one-half (1/2) of the Directors each year.

SEC. 2. Notwithstanding the foregoing, a petition signed by twenty-five (25) members in good standing may be submitted to the Secretary postmarked at least sixty (60) days prior to the Annual Meeting, nominating any eligible member in good standing for any office or directorship to be filled at the Annual Meeting.

SEC. 3. The election of the candidates shall be by written ballot vote of a majority of the members in good standing voting before closing of the polls. The polls shall close twenty-four (24) hours before the opening of the Annual Meeting.

ARTICLE VI

CLUB EMBLEM

SEC. 1. The emblem of the Club shall be that shown in the margin. This emblem shall be made in the form of a pin and may be purchased from the Executive Secretary.

SEC. 2. The emblem for Fellow shall be the reverse of that for Member, or as approved by the Board of Directors.

SEC. 3. Honorary Members shall be presented with the Club pin.

ARTICLE VII

SECTIONS AND AFFILIATED ORGANIZATIONS

SEC. 1. SECTIONS may be formed on approval of the Board of Directors. The requirements for a SECTION shall be:

a. A SECTION must have at least fifteen (15) members residing in the same geographical area, or who are members of an organization affiliated with the Radio Club of America, Inc.

b. Each SECTION member must be a member in good standing of the Radio Club of America, Inc., and shall remit the prescribed annual dues directly to the Club.

c. SECTION members shall be governed by the Constitution and By-Laws of the Radio Club of America, Inc.

d. Each SECTION may elect its own officers and Board of Directors, which shall include a Chairman and Secretary who shall correspond with the Radio Club of America, Inc., and keep the Club currently informed of the activities of the SECTION.

e. Each SECTION must be financially self-supporting. It may have such local business and social meetings as it wishes, the purposes of which shall conform to the principles of the Radio Club of America, Inc., as expressed in the Constitution and By-Laws.

f. Each SECTION member may attend all meetings and functions of the Radio Club of America, Inc., and enjoy all its benefits and privileges.

SEC. 2. Kindred non-profit organizations may affiliate with the Radio Club of America, Inc. upon approval of the Board of Directors. The general requirements for affiliation shall be:

a. The affiliated organization must have at least twenty-five (25) members in good standing, and must agree to be bound by the Constitution and By-Laws of the Radio Club of America, Inc.

b. Each member of the affiliated organization shall qualify as a member in good standing of the Radio Club of America, Inc., and shall remit the prescribed annual dues directly to the Radio Club of America, Inc.

c. The affiliated organization may elect its own officers and Board of Directors, which shall include a President and Secretary, who shall correspond with the Radio Club of America, Inc., and keep the Club informed of the activities of the affiliated organization.

1. The affiliated organization must be financially self-supporting. It may have such local business and social meetings as it wishes, the purposes of which shall conform to the principles of the Radio Club of America, Inc., as expressed in the Constitution and By-Laws.

e. Each member of the affiliated organization may attend all meetings of the Radio Club of America, Inc., and enjoy all its benefits and privileges.

ARTICLE VIII

AMENDMENTS

SEC. 1. These By-Laws may be amended from time to time by affirmative vote of a majority of the Board of Directors at any regularly called meeting of the Board of Directors.

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We gratefully acknowledge the generous contributions made by those members and friends who, as The Committee For Seventy-Five, helped to make this Diamond Jubilee Yearbook possible.

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