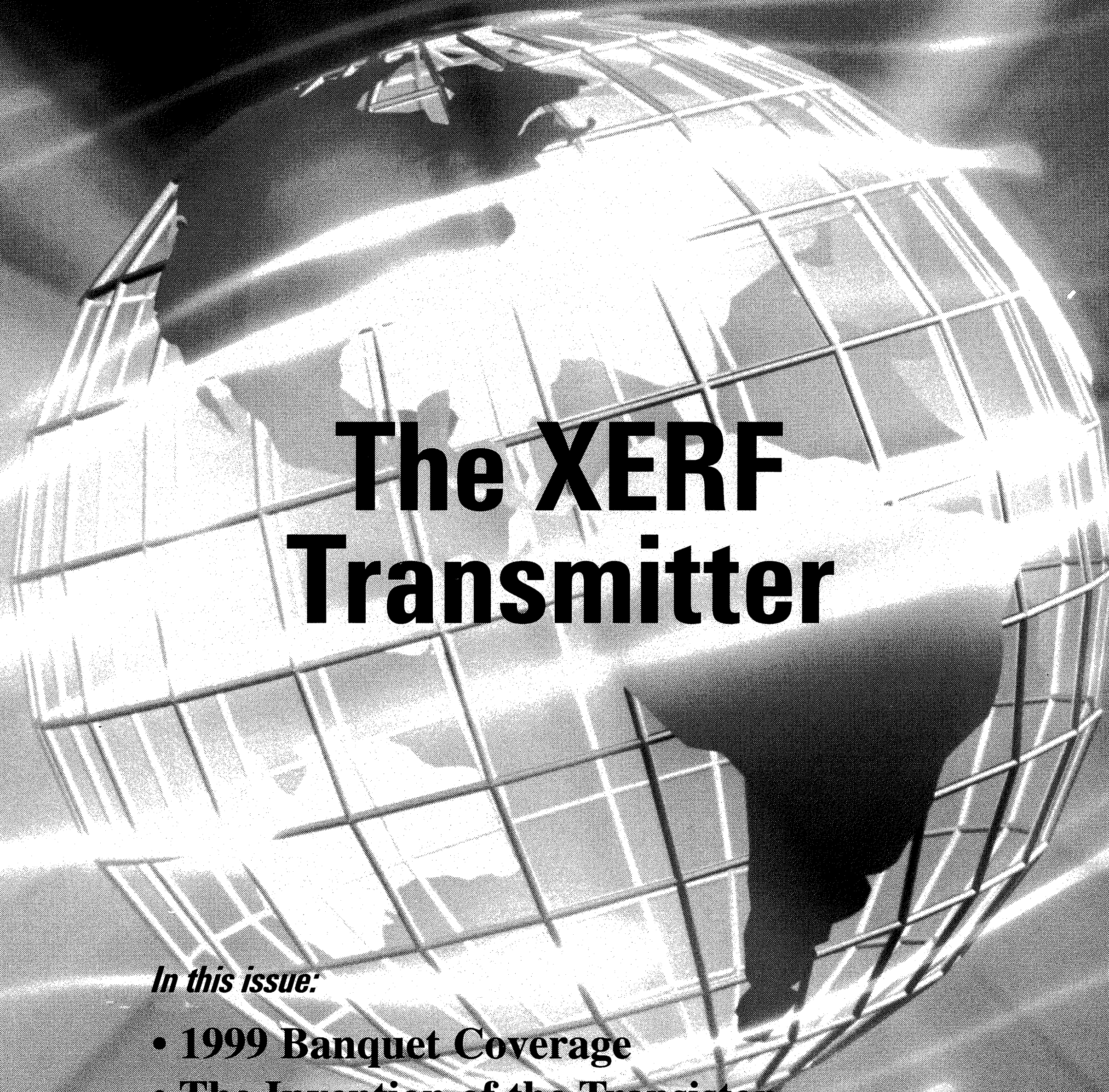
PROCEEDINGS of

THE RADIO CLUB OF AMERICA, INC.

Founded 1909, New York, U.S.A.

SPRING 2000

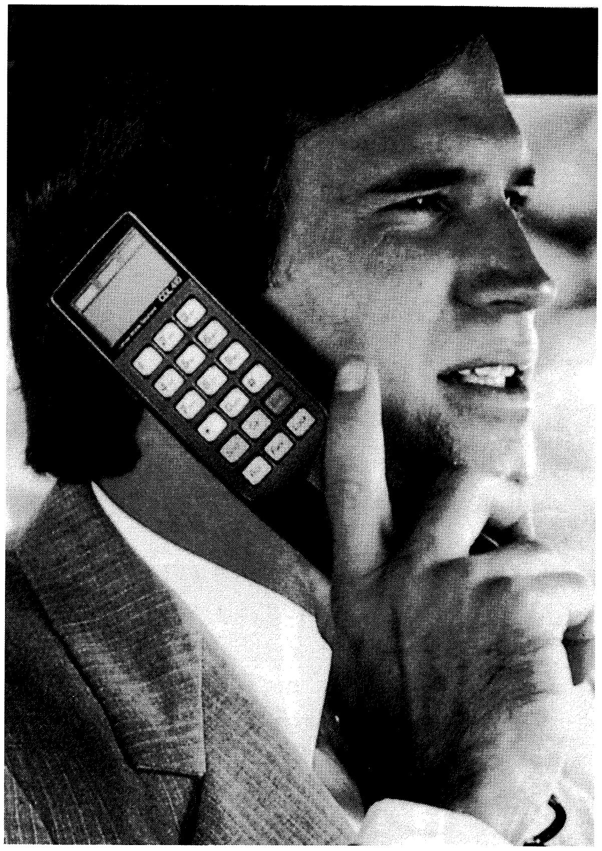


The XERF Transmitter

In this issue:

- 1999 Banquet Coverage
- The Invention of the Transistor

mtol *A Company for the Future*



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MARTIN AMOSCATO
PRESIDENT

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150-47A-12th RD.
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mtol RADIO COMMUNICATIONS SYSTEMS, INC.

main office 150-47A 12th. road, p.o. box 93, whitestone, n.y. 11357 • 718-767-7500

355 Butler Street
Brooklyn, New York 11201
(718) 797-3770

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SPRING 2000

THE RADIO CLUB OF AMERICA, INC

Founded 1909, New York, U.S.A.

Headquarters Office: 244 Broad Street, Red Bank NJ 07701
Tel. 732-842-5070; Fax 732-219-1938
http://www.radio-club-of-america.org
E-mail: info@radio-club-of-america.org

Contents:

Proceedings Editor:
Cindy Stevens,
Consumer Electronics Association (CEA),
2500 Wilson Blvd., Arlington, VA 22201-3834
Tel: 703-907-7609; Fax: 703-907-7690;
E-mail: cstevens@ce.org

By Morgan O'Brien

From a Ragtag Team to a Contender

This is the keynote address delivered by Morgan O'Brien, vice chairman of Nextel Communications Inc.

Here I am alone with the microphone with all of you tucked away in the shadows, ready to listen, I hope. It is a bit intimidating, for me to stand in front of this group in particular because amongst your membership are the real masters of the telecommunications universe, the engineers and scientists whose unparalleled creativity and ingenuity have brought a whole universe of exciting new services into being. To each and every one of you, I mean this from the bottom of my heart, my thanks for creating these technologies upon which my own career and many other careers have been based.

You no doubt are asking yourself who the heck is Morgan O'Brien, what is Nextel and what role does Nextel play in the rapidly expanding cosmos of telecommunications? Those are fair questions and I am going to take a stab at answering them. Hopefully this process will be pleasurable. I'm sure it will be for me because Nextel is my favorite topic, but I hope it also will be interesting for you.

My story spans the last decade of the 20th century. But I think in that story are clues to what the 21st century is going to bring. I doubt that anybody has a clear picture of telecom in the new millennium but I would bet that the role of the entrepreneurial upstart will become more significant in the new millennium. Every time the *Wall Street Journal* has referred to Nextel, they called us the entrepreneurial upstart. I'm going to give you the end of my story first and then flash back.

What is Nextel?

Nextel is ending the '90s with a bang. It has become a national and international wireless operator, and a public company serving more than 4 million domestic customers in literally hundreds of U.S. cities including 92 out of the top 100. Internationally we have operations in Brazil, Argentina, Mexico, Peru, Japan and the Philippines. We have more than 12,000 domestic employees and a stock market capitalization exceeding $30 billion.

My favorite statistic is that in an average week Nextel handles 500 million minutes of calls, that is two billion a month and 24 billion a year. And it keeps growing. On an average business day, 6,500 new customers join the network. Within the last three weeks, Nextel sold $2.8 million in equity, $2 million additional was raised in notes and we established a new $5 million credit facility—more or less $10 million. *The Washington Post* described these millions as Nextel's "war chest." Considering the stakes that we are playing for and the caliber of our competition, a military analogy is all too apt.

The Beginning

So that is a snapshot of Nextel, if not mighty, at least meaty, just 42 days short of the new millennium. Now let's look back, not that many years, to 1987. Nextel was then known as Fleetcall and in 1987 we had no operations, no offices, no employees, no frequencies or any capital to speak of. Fleetcall was a concept, a company in utero.

During the long hot summer of 1987, Brian McCauley and I spent hours writing and rewriting a private placement memorandum seeking to raise $7 million in capital for the purpose of making

SMR acquisitions in major markets. To save money, which was something that Brian was always interested in doing, we did most of the writing ourselves and we used our law firm offices because we didn't have any place of our own.

In July and August the air conditioning would go off exactly at 6:00 and by midnight, not having stopped to eat and with the temperature climbing, I occasionally lost my good humor during a drafting session when Brian would suggest a subtle change in punctuation or a slightly more precise way of stating an FCC rule.

My grandfather used to have a saying: "Trifles make perfection but perfection is no trifle." Brian actually believed that. So that is all there was to Fleetcall back in 1987. Two middle aged guys, an accountant and a lawyer, walked on to an idea with an abundance of energy and enthusiasm, offset by a shortfall of the innate caution that should have been shouting, 'this will never work.'

Much later in a rare moment of introspection and repose, I confessed to Brian that half of the time during those early years, I was scared to death about the tightrope that we were walking. I always knew that we had him as the safety net. And he looked at me and said, "You thought I was the safety net? I thought you were the safety net!" I guess the moral of that story is that an imaginary safety net is just as effective as a real one until you fall.

I'm going to skip over the part of the Nextel story, which stretches, from 1987 to 1999. Maybe some day I'll slow down long enough to write a book and it will fit somewhere between *The Sound of Music* and *Nightmare on Elm Street.* There will be heroes in this story, actually some of them are in this room but I won't embarrass them by mentioning their names. And there would be a few villains in the story, not too many, but a few. Plus in this story a cornucopia of heartaches and disappointments, hard work and an occasional—can't be sacred enough—friend.

By my estimate we have completed more than 5,000 transactions, we have bought more than 150,000 frequencies, a lot of them from people in this room, transactions ranging in size from huge with thousands of channels to very tiny.

Blazing the Trail

To bring this down to the personal level, during those years, I calculated that I spent more than 1,000 nights alone in hotel rooms stretched across the country. I can probably estimate how many birthdays, milestones and special family events for which I was AWOL but you might think less of me if I gave you that number.

My wife Belle who is with me tonight will tell you if you ask her about our romantic 20th wedding anniversary trip to London. Everything was perfect—the tennis, the weather, the hotel—the only thing missing was me. I was back here in a windowless conference room with a small army of bankers and lawyers, trying and failing I might add, to complete a transaction with a company that would prefer to remain nameless but its initials are MCI.

I read recently in the business pages of the *Washington Post* a reference to another company as "no stranger to adversity." And I thought that is a pretty apt description of Nextel. During the 12 years since its creation, we scaled dizzying heights of Wall Street only to experience thereafter a nauseating plunge toward the abyss when we lost for a moment that most elusive factor of investor confidence. Now we have come roaring back under the inspiring leadership of Craig McCaw, Dan Akerson, Tim Donahue—a phenomenal team.

In the regulatory arena, we have been a veritable poster child for the FCC's policies to inject vigorous competition into wireless while at the same time; we have been fighting major battles with the Department of Justice over its contention that Nextel is an anti-competitive force in the dispatch market. To the extent that it is important to be loved by your peers, Nextel has had to learn to get by without that.

'We know where you are' and its equally important corollary, 'We know where you are not.'

Almost without exception, the initiatives that we have launched at the FCC have encountered stiff opposition from our peers. I actually daydream about receiving an award someday as Man of the Year from the communications bar association, not for my skills as a lawyer, but because of all of the legal fees generated by trying to stop Nextel's initiatives at the FCC. I'm still waiting.

We know the price of innovation and commitment to change. We paid it time and again. Therefore, we truly are no strangers to adversity. And in that respect, I think that Nextel foreshadows a new generation of companies in this industry whose origin and core values are competition. And we will embrace competition as a price worth paying for achieving technological innovation and the benefits of speed to market.

We Know Where You Are

You know that since this is virtually the eve of the new millennium, a keynoter would just not be doing his job if he failed to look ahead and direct your attention to what looms out on the horizon. When I look forward, my perspective of course is shaded by where I stand and since my whole professional life, 29 years in case you didn't do the math, has been devoted to what we now call wireless, that is where my observations are.

And with that qualification I'll spend a minute or two talking about what currently interests me the most and holds for me the greatest potential for future excitement in our world. I call it; 'We know where you are' and its equally important corollary, 'We know where you are not.'

To understand it, let's look at the makeup of today's digital wireless networks. Now obviously I think that Nextel is the best of these but we do have a couple of competitors with household names like AT&T, Sprint, Bell Atlantic and SBC. More are on the way. The essential elements of these networks are a sophisticated network of radio transmission cell sites, thousands of them nationally, tied together by high-capacity digital switches. And those switches in turn are networked together so that the infrastructure is truly nationwide. The cell sites support millions of handsets and for these handsets to be fully functional, they must be digital, tiny, cheap, powerful and have a long battery life. That is what I keep saying to Motorola, "Why is that so hard to do?"

Digital, tiny, cheap, powerful, long battery life—all for under $100—can't we do that? Because they are digitized, these second-generation wireless networks have vast capacity and diverse functionality including the obvious telephone but also direct connect, text messaging and other gee whiz stuff that is just beginning to find its way into the marketplace. Because these intelligent networks are designed to deliver telephone calls to handsets in motion, there is an exchange or handshake of information that is carried out by the switches in the handsets whenever a unit is powered on. That is what gets us to the, 'We know where you are.'

E911 Mandate Creates New Applications

Nextel has been developing this technology in response to the federal E911 mandate. The FCC requires that in less than two years all wireless car-

riers are going to have to deploy automatic location identification technology that identifies the exact location of wireless callers within 50 to 150 meters. While this information will undoubtedly enhance emergency response, what is most interesting to me is the opportunity to present or build new services around these 'we can find you' capabilities.

Several companies have devised solutions to acquire the necessary location information in a number of different ways. Many of you in the audience know more about this than I do. But the ones that we are looking at are time difference of arrival and classic triangulation strategies. The system uses geolocation controllers to evaluate the signal from the handset as received from three different towers and then they triangulate.

Or angle of arrival. Somebody here probably invented all of this stuff so I'm embarrassed to be talking about it. Angle of arrival uses an antenna array to locate a sensor at a cell site and measures the angle of arrival of the signal and then a network controller compares the angles from two different sites to calculate the handsets position. RF fingerprinting—by surveying multipath characteristics of each part of the coverage area, it is possible to create a multipath fingerprint identification of each 50-meter square within the network footprint based on surrounding terrain and buildings. This one sounds too complicated. When a call is placed, the collective multipath information is compared to a database to determine the caller's location. The last method is global positioning; we all know what that is—GPS.

Once these technologies are in place, there are endless commercial possibilities. Think about it. As ubiquitous digital wireless networks are deployed and digital handsets become the norm, standard operating procedure for a typical mobile warrior will be to get up in the morning, turn on his phone and it will be powered up for the rest of the day. In a liberated world of tomorrow, time and space are going to expand.

Once these technologies are in place, there are endless commercial possibilities.

The Internet has dramatically changed the way we look at time and space. Being available to your customers is no longer bound by either your clock or your desk. Digital wireless networks that were designed principally to provide effortless voice communications are going to have a major role in moving us toward this future because they know where you are. They know the direction you are moving in. They know where you have been and where you haven't been and with some degree of precision, where you are likely to be heading.

Some Future Scenarios

So let's suppose that your electronic calendar shows you are scheduled to leave at 5:00 p.m. from LaGuardia and travel to Chicago for a dinner meeting. The system knows that you are still in Manhattan at 4:30 because that is where you are calling from. If the travel time on the customary route is taking an hour, then the system will be smart enough to look at alternative routes, check later flight availability to Chicago, check the weather in Chicago to assess the likelihood of waiting there at all, make you a new reservation and notify the hotel and the airport pickup service that you are going to be late. The system of the future can analyze your choices.

Your involvement? You hit the OK button when asked if the new plan meets your approval. Should we send your client a text message asking if he can make it later? Assuming that he has a Nextel phone, which I'm sure, he will. And if it is okay with him, should we delay the dinner reservations? It's unbelievable stuff.

Even more powerful services develop when the location sensitivity of digital wireless networks are combined with my other favorite thing, which is push technology using intelligent agents to individualize retrieval from massive databases. The wireless system knows where you are and that can be combined with technology trained to know your individual likes and dislikes, anticipating your needs and your appetite for information.

So for example, a sales representative flies to Chicago. As soon as she steps off the plane, her unit registers and we know that she is there. This system could have access to her employer's database, which retains records on all customers located in Chicago. It knows what customer complaints have been filed and what orders are on file that haven't been filled yet. It can send her a text message listing those customers, prioritizing their needs and pinpointing their addresses.

With a push of a button, it can give her access to each customer's account file. And of course the wireless system can retrieve from company records the colleague working with her that is the most familiar with each account and can signal him requesting his advice on how to proceed. Since he powered off last night in LA however, the system suggests that it might be courteous to wait till after 8:00 a.m. Pacific Time before calling.

Now these examples are not quite here today. But I think these and other capabilities open up when you combine the wireless 'we know where you are' with intelligent agents working through a push technology, 'we know what you need to know' and 'we know how you like to receive it.'

We are thriving in an unprecedented era of opportunity in which our government really seems to mean it when it says that its focus is on competition rather than on competitors.

Unprecedented Opportunity

As we eagerly await these new wonders, it is worthwhile to look back and see who deserves the credit? Thanks to a succession of enlightened leaders at the FCC and the Congress, outdated boundaries between services have disappeared, techniques for selecting winners and losers have been streamlined and regulations have been deleted or reduced in ways that are startling to most of us who grew up in less complicated times before the reign of competition began. I plead guilty to having a very subjective view on all of this.

Like the runt of the litter, Nextel has been forced to squeeze and wiggle and squeal for attention at times. FCC decisions are never made as quickly as I want them to be and I still marvel at how much process there is in due process. But that is the small stuff and I have to discipline myself not to sweat it. Instead I try to keep focused on the fact that we are thriving in an unprecedented era of opportunity in which our government really seems to mean it when it says that its focus is on competition rather than on competitors.

I feel certain that even as we sit here tonight, somewhere nearby in a conference room, redolent with the smells of yesterday's carryout food, there are a couple of entrepreneurs struggling to write a private placement memorandum to describe with perfect precision their idea for a new venture in telecommunications. And if I indulge my vanity as well as my sense of fantasy, I can imagine them saying to themselves, we can be the next Nextel.

And if they are out there, all my good wishes go with them tonight to find the cash, beat the odds and bring into being a rocket's new flare in our exciting industry. It goes without saying that I hope they are not contemplating competing with us but even if they are, I pledge to engage them honorably on the field of battle. And you might ask me, would I change places with them and go all the way back to the beginning?

Knowing what I know about the heartaches, the pain and the disappointments. Would I risk losing all of the nice perks of seniority at Nextel? My answer would be in a heartbeat. In a heartbeat I would give it back so as to savor one more time, the inexpressible thrill of playing on the ragtag underdog team that takes on the odds and wins.

By Cindy Loffler Stevens

1999 Radio Club Banquet

Members of the Radio Club of America met in New York City on Nov. 20, 1999 at the New York Athletic Club, for the Club's 90th Anniversary Dinner and Awards Presentation, as well as for the Club's Technical Symposium. The afternoon technical session included presentations by James Gazzola, Bell Mobility; Martin Kendall, Nortel; and Dr. Steve Allpress, Lucent. Club members Andy Singer and Tony Sabino moderated the technical symposium.

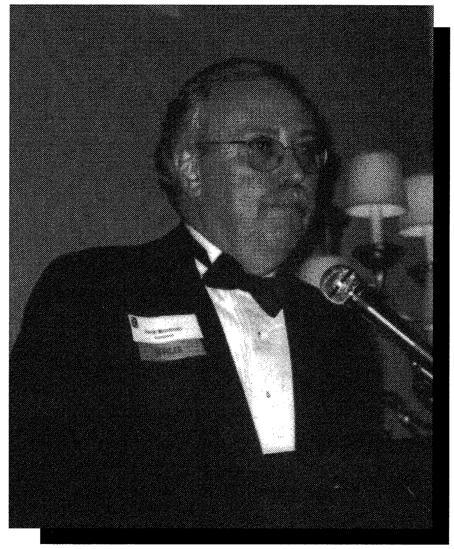
Host Jay Kitchen delivered the Radio Club of America welcome speech.

The banquet commenced as Jay Kitchen delivered the welcome speech. He noted that we were on the brink of the new millennium with a multitude of opportunities ahead for the industry. Jack Brennan, president of The Radio Club delivered the President's address and was also upbeat about the future.

Honoring the Industry Leaders

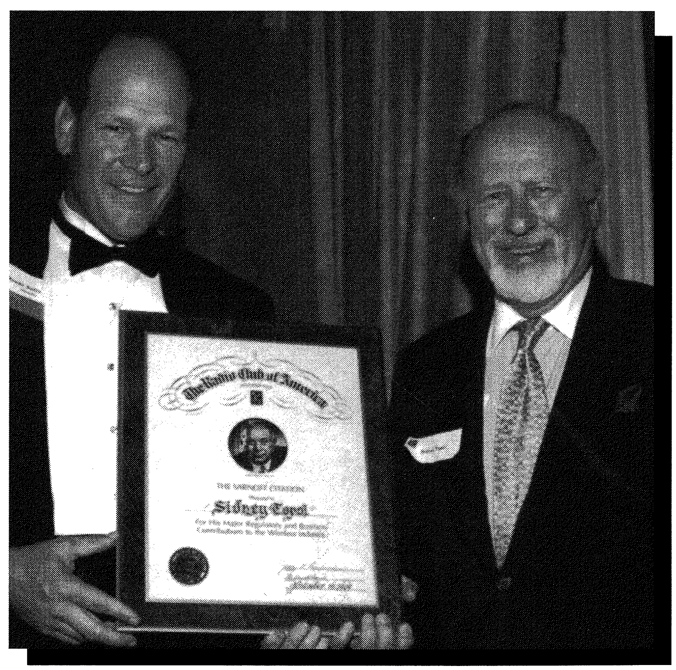
Morgan O'Brien, vice chairman of Nextel Communications Inc., was the keynote speaker. He gave an often-humorous personal account of the trials and tribulations he experienced as he helped to transform Fleetcall from a fledgling company into Nextel, a national and international wireless operator with a stock market capitalization exceeding $30 billion.

Another highlight of the banquet was the awards



Radio Club of America president Jack Brennan gave the president's report.

presentation. Award recipients include **June Poppele,** The Special Services Award; **Vivian Carr,** The President's Award; **Roger Block,** The Fred M. Link Award; **Thomas Traynor,** The Frank



Meade Sutterfield presented the Sarnoff Citation to Sidney Topol.

Maurice H. Zouary was presented the Ralph Batcher Memorial Award by Tom Amoscato.

A. Gunther Award; **Maurice Zouary,** The Ralph Batcher Memorial Award; **William E. Endres,** The Allen B. Dumont Citation; **Joe Franklin,** The Lee De Forest Award; and **Sidney Topol,** The Sarnoff Citation.

At the banquet, the Club recognized members who have demonstrated dedication and contributions to the Radio Club with bestowing upon them the membership grade of Fellow. In 1999, 20 members were elevated to the grade of Fellow. The new Fellows include **Patrick Buller, Tony Crady, J.R. Cruz, James Dombrouski, Sol Grazi, John Harnden Jr., Carroll Hollingsworth, Michael Katzdorn, John Keating, Edward Keller, Theodore Lovell, Stephen Meer, Richard Ostrowski, Philip Petersen, Edward Rankin,**

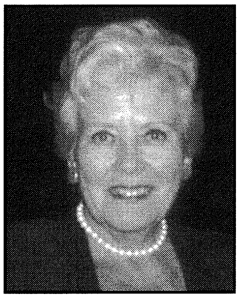
Vivian A. Carr received the President's Award from Jack Brennan.

The Special Services Award was presented to June Poppele by Maxine Carter-Lome.

Thomas Regan, Christopher Resavy, Henry Richter, Carl Stevenson and **David Swan.** Vivian Carr delivered Jim Dombrouski's speech responding for the Fellows since he was unable to attend. The Radio Club of America has bestowed awards to individuals for their achievements and contributions to the advancement of radio and service to the Club since 1935.


Radio Club of America
90th ANNIVERSARY DINNER
AND
AWARDS PRESENTATION
NOVEMBER 19, 1999

1999 Honors & Awards

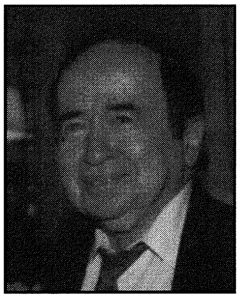


THE PRESIDENT'S AWARD

Vivian A. Carr
In recognition of superior service on behalf of the Fellows program and her many contributions to the Radio Club of America.

THE SPECIAL SERVICES AWARD

June Poppele
For her devotion to the welfare of our members.

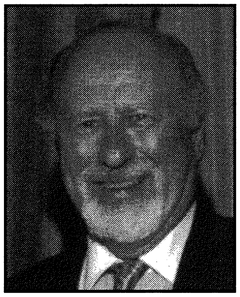


THE LEE DEFOREST CITATION

Joe Franklin
For his significant contributions to the advancement of radio communications.

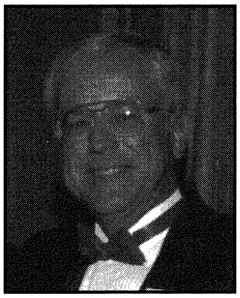
THE RALPH BATCHER MEMORIAL AWARD

Maurice H. Zouary
For his diligence in preserving the history of motion picture technical progress.



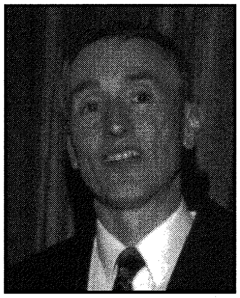
THE SARNOFF CITATION

Sidney Topol
For his major regulatory and business contributions to the wireless industry.



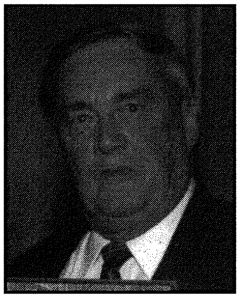
THE FRED M. LINK AWARD

Roger R. Block
For his substantial contributions to the advancement and development of land mobile radio and communications.



THE FRANK A. GUNTHER AWARD

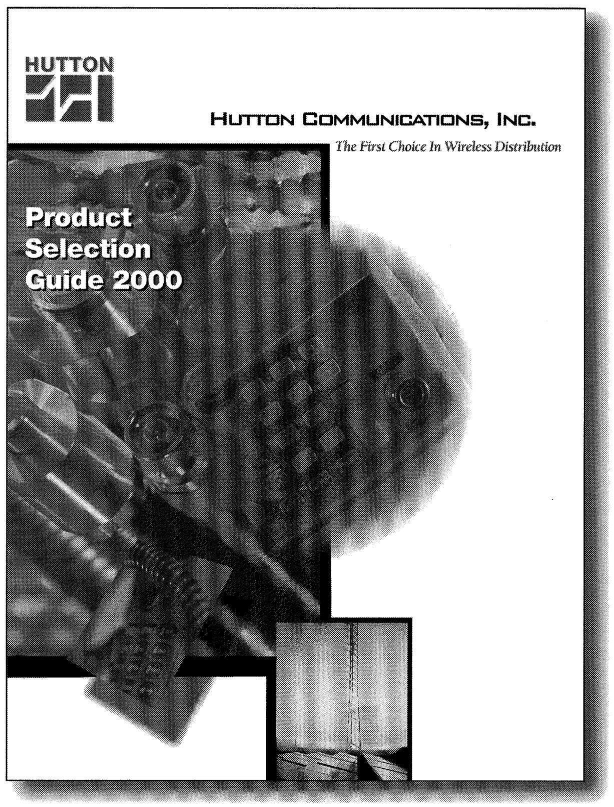
Thomas H. Traynor, P.E.
For his major contributions to the advancement of military electronic communications systems.



THE ALLEN B. DUMONT CITATION

William E. Endres
For his major contributions to the television industry, including the rapid development and construction of the lunar landing color television camera system.

FIND IT HERE!



Hutton Announces A New Full-Line Catalog For The New Millenium

Whatever your wireless communications or power systems requirements may be for the new millennium, you can find everything you need in one well-organized, reliable resource: ***The Hutton Product Selection Guide 2000***. Over 1,000 full-color pages feature more than 14,000 SKUs from over 125 vendors, including enhanced product specifications, expanded indexes, and OEM products and accessories. Also included for 2000 are new product categories such as unlicensed Fixed Wireless microwave systems.

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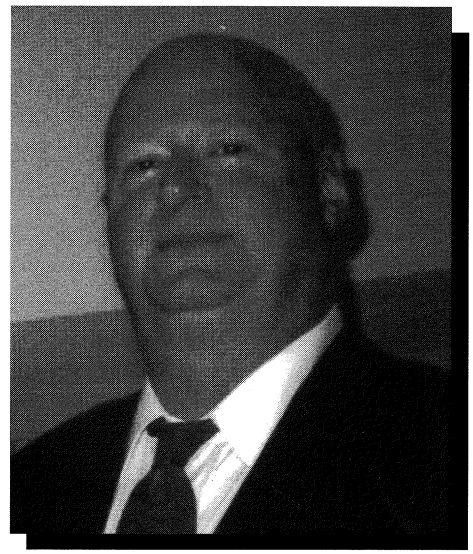
HUTTON

By James Dombrouski

Response for Fellows



President Brennan, directors, distinguished members and guests, thank you very much for the opportunity to address this esteemed audience tonight and to speak on behalf of the Radio Club's 1999 Fellows. Elevation to Fellow status is truly an honor and an event that I will remember with considerable pride well into the next millennium.

At this time of great worldwide reflection, it is important for us to take time to consider the advancements in the radio arts and the influence that The Radio Club has had on many generations of radio professionals. I am certain that we each have a slightly different view of radio's evolution and of those who contributed to it. However, I think that it can be said with confidence that this century's accomplishments are nothing short of amazing and our industry's leaders have epitomized the concept of "visionary." Marconi, Armstrong, and Link — these visionaries, among many others, set us on an exciting course that will continue on beyond our children's children. Along that same course, our Club's founders set in motion an organization that has consistently valued leadership and has advanced visionary pursuits throughout our industry.

When I reflect on my earliest memories of radio, I think of the old Victrola, which, among other things, was a great piece of furniture. I remember its 78-rpm turntable on top and the AM radio underneath. That radio utilized 6 vacuum tubes which, I am sure many of you can still remember. The speaker magnet was used as a coil in the power supply, and it was all wrapped inside a large oak cabinet. What a great advancement in Radio!

Now today, we have radiophones that fit in our pockets and plug into our portable computers. These so-called "radios" can call anywhere in the world and surf the Internet for content at the same time. "Radios" now bring the knowledge of a thousand libraries, as well as tomorrow's weather and our child's voice, to our belt, palm or purse.

Standing on the threshold of the new millennium, we should all dare to imagine the capabilities that the radio industry will give to coming generations. As members of this great industry, we should proudly say that we will continue to diligently provide the ideas, tools and services that are essential to support and enhance the lifestyle of the current and future society. Accordingly, it is important to honor those individuals who have led us in the past. Equally important is our unending search for the youthful spirit that will drive us, individually and collectively, enthusiastically into the future.

Fellow Award Recipients:

Back Row: Christopher Resavy, Patrick Buller, Richard Ostrowski, Michael Katzdorn, Carroll Hollingsworth, Carl Stevenson, J.R. Cruz
Front Row: Henry Richter, John Keating, Sol Grazi, Stephen Meer, David Swan
Not Pictured: Tony Crady, James Dombrouski, John Harnden Jr., Edward Keller, Theodore Lovell, Philip Petersen, Edward Rankin and Thomas Regan

As I close my comments, I again want to thank you all on behalf of the 1999 Fellows, the last such group elevated to this status before the new millennium.

Finally, as fellows, we must endeavor to uphold and further The Radio Club's honored traditions and we must promote the high standards that have typified the Radio Club throughout its history for the past 90 years. Good evening and have a happy new millennium!

1999 RCA Banquet Contributors

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Authentix Network Inc.
Beam Radio
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Carroll Hollingsworth, *Fellow*
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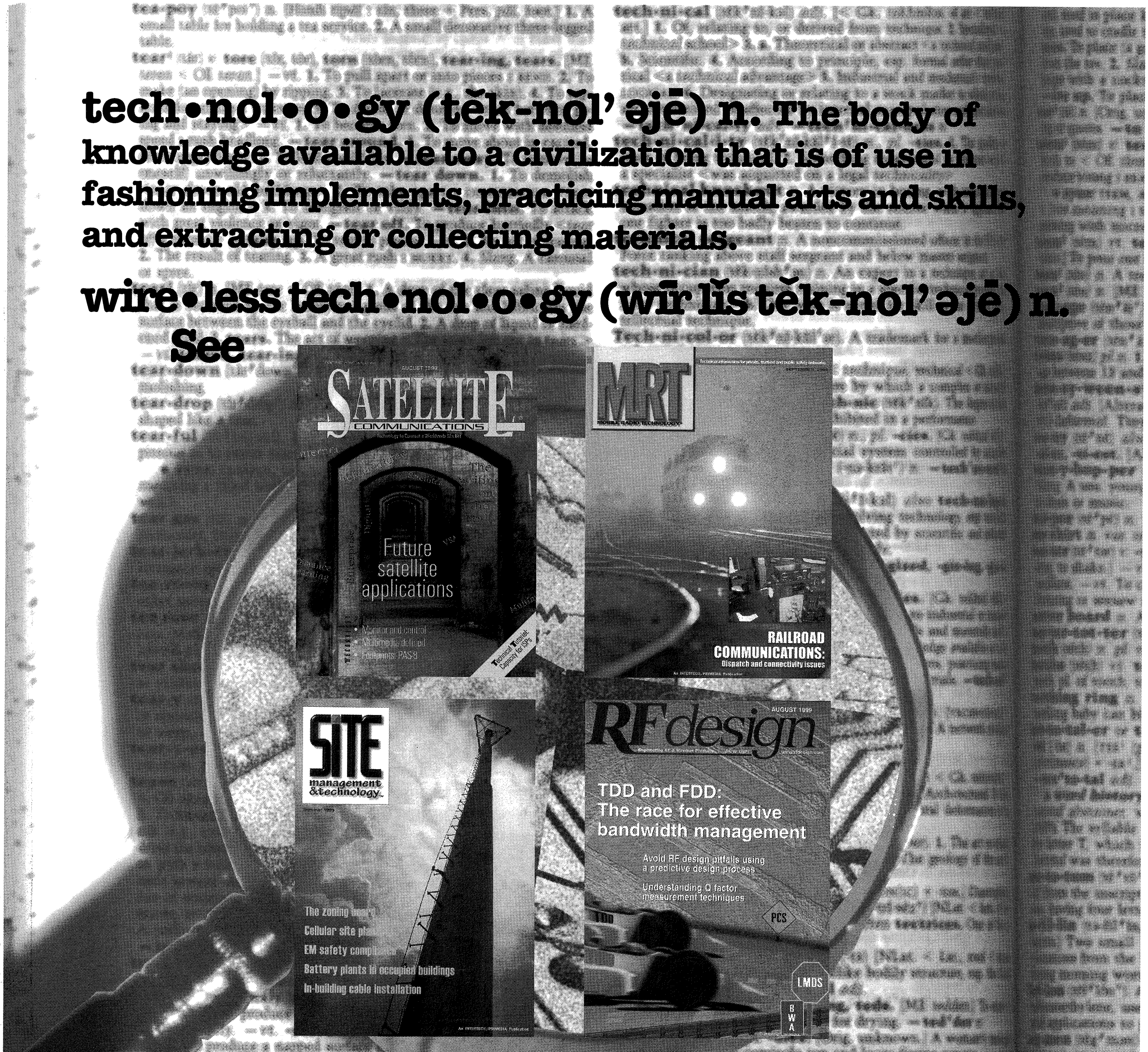
tech•nol•o•gy (tĕk-nŏl' əjē) n. The body of knowledge available to a civilization that is of use in fashioning implements, practicing manual arts and skills, and extracting or collecting materials.
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By Durell Roth

The XERF Transmitter

In 1959, engineers at radio station XERF in Ciudad Acuña, Mexico, purchased a new 250,000-watt transmitter, model BTH-250A, manufactured by the Radio Corporation of America (RCA). The transmitter contains 66 tubes: 12 in the modulator, 18 in the RF section, and 36 in the power supply. Additional tubes contained in ancillary equipment are not pertinent to this discussion. The model BTH-250A uses an RCA high-efficiency modulation system which, when compared to conventional systems of the time, provided a significant savings for the station in terms of operating cost and space requirements.

Using the RCA super-power set and a halfwave vertical radiator, XERF consistently covered Mexico, the United States, and Canada; and reception reports from North and South Pole radio clubs became common. Station announcer Paul Kallinger received reports from as far away as France and much of North America jived to the rhythm and blues played by Wolfman Jack.

The BTH-250A is a one-of-a-kind super-power transmitter employing the RCA version of ampliphase modulation. Given the unique design of the system and the dearth of published ampliphase material, it is important to document the principles of ampliphase modulation and their application to the XERF transmitter.

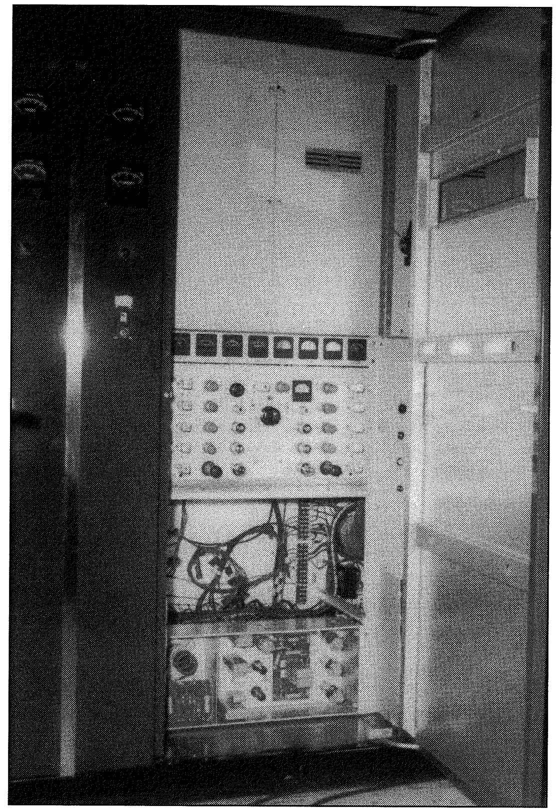
In 1961, RCA engineer George W. Klingaman described the basic concepts of the XERF transmitter in his paper "The BTH-250A: New Ampliphase 250-kw AM Transmitter," published in the August-September issue of the *RCA Engineer.* Klingaman provides details of the XERF transmitter that are not available elsewhere, including minimal construction details, a brief description of the RCA ampliphase system, and a typical transmitter floor plan. It is important, however, to expand this work to include data and references not contained in the original document. The following, therefore, is a discussion of the principles of operation for the RCA, BTH-250A, including photographs, an RCA proof-of-performance report, *(page 24)* and a schematic diagram of the equipment as installed at XERF *(page 25).*

The Beginning

Ampliphase is a modulation technique that synthesizes an amplitude modulated (AM) wave by combining two phase modulated (PM) waves. French radio engineer Henri Chireix introduced the ampliphase system in his paper "High Power Outphasing Modulation," published in the November 1935 Proceedings of the Institute of Radio Engineers. Chireix compares the principles of the standard modulation systems in use at the time to those of the new method, clearly showing a savings in manufacturing and operating costs of the outphasing system. His use of the term "outphasing" relates to the phase relationships of two double-sideband reduced carrier signals and an unmodulated carrier wave used to generate the phase modulated wave.

The system described by Chireix employs a temperature controlled crystal oscillator that produces a carrier wave to drive two independent RF channels. One channel amplifies the carrier wave only. Simultaneously, in the other channel, program audio is introduced through a balanced modulator producing two sidebands having opposing phase vectors. The Chireix system shifts the unmodulated carrier wave by 90° and then combines the three signals to produce synthesized amplitude modulation at the output of the transmitter.

All photos courtesy of Noyes W. Willett



Exciter-modulator chassis BTH-250A.

Once Chireix proposed this system, transmitter manufacturers developed outphasing methods using balanced modulators, frequency triplers, and Doherty amplifiers. Designers of the later systems, however, preferred the term "ampliphase," which more aptly describes the combining of PM signals in the synthesizing of amplitude modulated waves.

Regardless of the technique, efficiency, or reduced equipment size and cost, for more than twenty years the ampliphase technique remained little more than an unpopular and/or impractical method of modulation. With advancing technology, however, in 1935, engineers at RCA recognized the advantages of the method. In September of that year, engineer T. Douma, working at the time in broadcast transmitter engineering at the RCA Camden facility, published an in-house test report titled "Ampliphase Modulation Study."

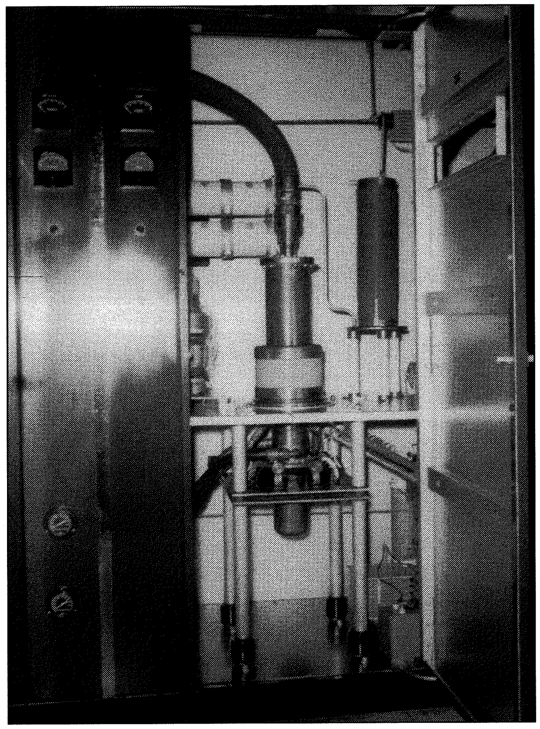
Here, in addition to the Chireix system, Douma identifies four methods of producing ampliphase: the sum of two currents of equal amplitude, the sum of the two currents with linear phase modulation, the sum of two currents which have both amplitude and phase modulation, and the difference of two voltages (1-7). He then provides the mathematical derivation of each method and that of a complete ampliphase system. By early 1956, RCA had designed, tested, and introduced a new transmitter product line beginning with the 50,000-watt; model BTA-50G ampliphase modulated transmitter.

Ampliphase had become the modulation system of choice for super-power transmitters. The reduced size of a given power level combined with the unique RCA electro-mechanical design meant that even significant power increases involved little more than adding equipment cabinets containing higher power, class "C" RF amplifiers. To a station using the equipment, the small size and high efficiency meant a real saving in terms of operating costs and space requirements.

In 1958, when RCA proposed the 250,000-watt medium-wave system for XERF, the engineering staff retained the small transmitter size and the RCA ampliphase modulation method but departed significantly from the complexities of the balanced modulators, frequency triplers, and Doherty amplifiers.

BTH-250A Principles of Operation

The basic concept of the ampliphase system as employed in the BTH-250A consists of a low-level carrier wave that has been split into two signals with opposing phase vectors. In independent channels, these signals are antiphase modulated and amplified to the desired power level. At the output of each channel, the phase-modulated signals are combined in the load that is common to both channels. Each channel provides half of the total output power. And because of the opposing vectors, the signals combine algebraically in the common load



One of the final amplifier tubes.

audio rate, thus producing amplitude modulation of the transmitter output carrier wave.

Crystal Oscillator and Buffer, Signal Flow

The following discussion of signal flow is keyed to the simplified schematic diagram and followed in greater detail in the complete foldout schematic, (*available from the Radio Club of America - see footnote*).

The RF signal source for the BTH-250A is an 807 tube in a temperature controlled crystal oscillator circuit. The circuit uses a fundamental crystal with a frequency of 1570 kilocycles. RF energy from the oscillator is coupled through a d-c blocking capacitor to a 6SJ7 buffer amplifier. The plate circuit of the buffer is a parallel-tuned tank that functions as a signal splitter and provides two carrier signals having a phase difference of 180 electrical degrees. Each signal is applied to a separate voltage divider network composed of a 33 mmf capacitor connected in series with a 9-130 mmf trimmer-capacitor to ground. The networks function as a coupling system and an adjustable RF voltage divider for the input to the two RF channels. Signal voltage for each channel is taken from the junction of the two capacitors.

At the input of each RF channel, the carrier signal phase vectors are 180 electrical degrees apart. If this phase difference were maintained throughout each channel, the carrier voltage at the transmitter output would algebraically add to zero, and no output power would be obtained. It is necessary, therefore, to advance the phase in one channel and retard that of the other to obtain an output signal phase-difference of 135 degrees. This phase difference produces an unmodulated output carrier level of 250,000 watts.

The required phase changes are accomplished in the plate circuit of the first 6SJ7 stage of each RF channel. This stage is referred to in Klingaman's paper as a "dc shifter stage" (52). It is used in conjunction with an adjustable RLC phasing network for setting the output carrier phase angle. Klingaman states, "...if the reactance of L and C are chosen so that $X_l = 2X_C$ the impedance of the combination will be constant and equal to X_l, regardless of the value of R. If R is then varied, only a change in phase will occur without amplitude variation of the applied carrier"(52). This design characteristic is paramount to obtaining the 135-degree phase relationship between the two RF channels. Beyond the dc shifter stage, each section of the two RF channels are identical; therefore, only the operation of one channel will be discussed below.

The Phase Modulated Low-Power RF Amplifier

Following the d-c shifter stage are three cascaded LC-coupled amplifier stages, each using a single 6SJ7 tube in a cathode biased circuit. These three stages, referred to by Klingaman as "a-c shifters," are the phase-modulated amplifiers of each RF channel (52). To obtain maximum linearity, the phase vectors of each a-c shifter is rotated only +/- 7.5 degrees relative to the previous stage for a total shift in each channel of +/- 22.5 degrees in opposite directions. The opposing 22.5 degree shift produces a total carrier wave-angle rotation from 90-180° and a variation in the common-load carrier current from zero to twice the unmodulated carrier value.

The Reactance Tube Modulator

This portion of the transmitter includes two

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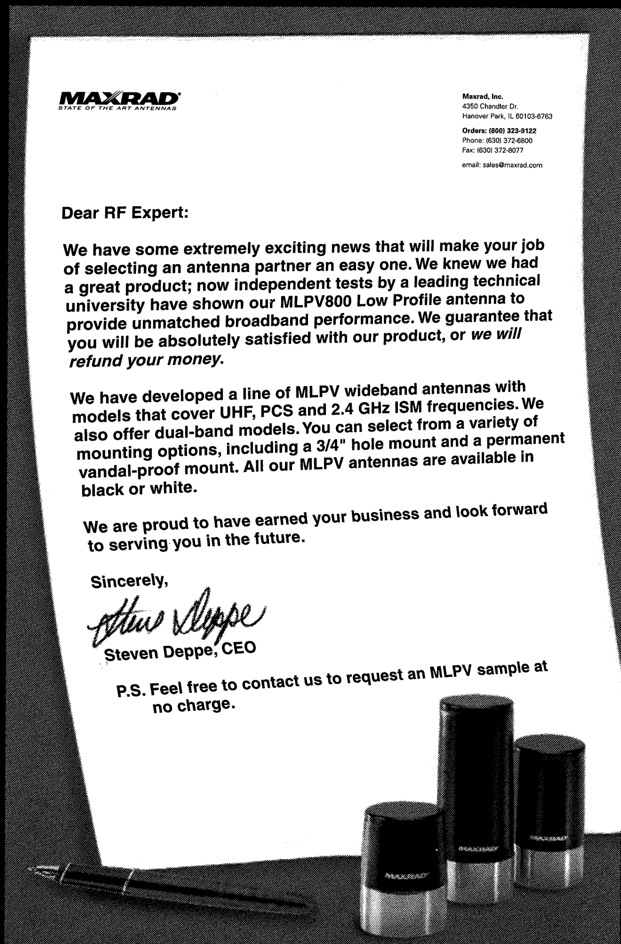

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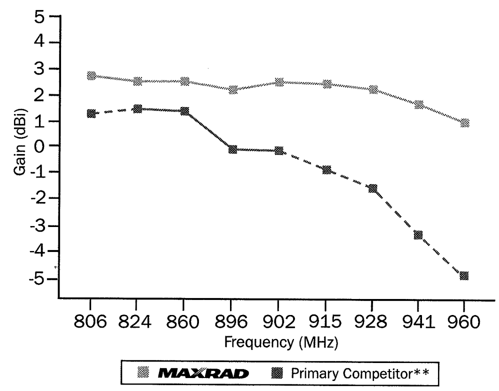

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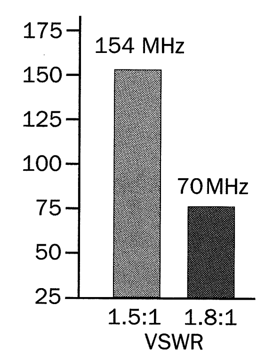

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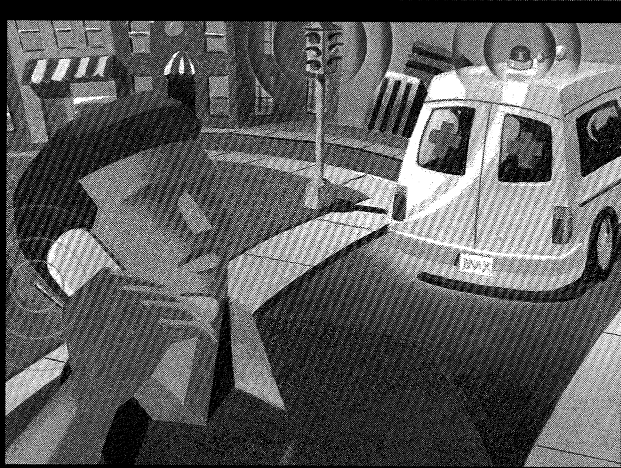

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identical, independent, reactance-tube modulator channels; therefore, except as required, the operation of only one channel is discussed. Each channel comprises a 6AH6 voltage amplifier and two dual-triode 6SN7 tubes used as the reactance tube modulators. The schematic designations for these tubes are V312, V313, and V314, respectively. Audio for the modulator is obtained through a transformer having dual primary and dual secondary windings. To match the impedance of the audio line from the studio, the two primary windings are connected in series. The secondary windings, however, function independently and are resistively coupled to the control grid of the 6AH6 voltage amplifier at the input of each audio channel.

The audio signal voltage from the plate of the 6AH6 is coupled through a capacitor/resistor network to the control grid in the first section of V313. This section of V313 serves as a non-inverting, low-impedance, audio source for the exciter regulator, a section of the modulator to be discussed later. The first triode section of V316, the complement of V313 in the opposite modulator channel, currently serves only to balance the circuit electrically and performs no other function.

Three independent in-phase audio modulation signals are generated by the 6SN7 reactance-tube modulators. The first signal is obtained from the cathode circuit of the second triode in V313, while the second and third modulation signals are derived from the two cathode circuits of V314. The three independent audio signals phase modulate a-c shifters V303, V304, and V305, respectively.

The plate circuit of each a-c shifter contains a series resonate LC circuit that functions both as the plate tank for that tube and part of the phase-shift network. A second series-connect LC circuit composed of two capacitors and one inductor is connected from the plate of each a-c shifter to ground and functions as the primary phase-controlling element. Audio from the associated modulator tube is applied to the junction of the two capacitors in the phase-controlling network and shifts the signal phase +/- 7.5 degrees in each a-c shifter. The a-c shifter and modulator combination is equipped with an adjustable diode limiter that prevents phase excursions beyond +/-22.5 degrees.

The Intermediate Power Amplifier

The phase-modulated signal from each RFchannel is coupled through a .001 mfd capacitor to the control grid of the first intermediate power amplifier comprising a cathode biased 6L6 tube and associated circuitry.

RF signal voltage from the 6L6 plate tank is coupled through a .001 mfd capacitor to the input of the second intermediate power amplifier. The second power amplifier is a class "C" stage and contains an Eimac 4-250A tube that increases the r-f power to approximately 500 watts. The plate tank of this stage is a parallel fed L-network containing two fixed capacitors, one variable capacitor, and a tapped inductor. Output power of the stage is monitored through the use of a resistive voltage divider, diode rectifier and meter circuit from the plate of the tube to ground. The output power from this stage is coupled through a .0015 mfd capacitor to the control grid of the class "B" 4X5000A driver stage that amplifies the power to about 8,000 watts.

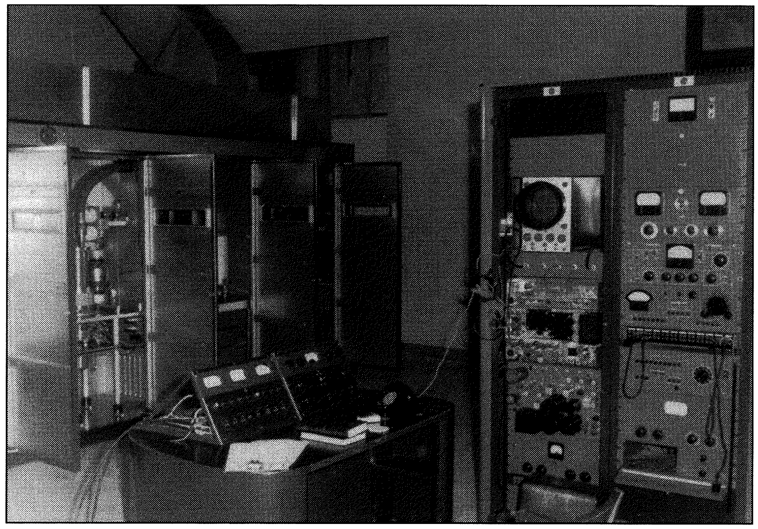
The 250,000-watt Final Amplifier

The plate load of the 4X5000A is an adjustable parallel-fed, parallel-tuned tank. Inductive link coupling is used to transfer power from the amplifier through an impedance matching network to the input of the final amplifier stage. The amplifier tube in each RF channel is a 4CV250,000A. The plate load of each final amplifier consists of a pi-network in which the output loading capacitor is common to both channels.

The coaxial feeder from the antenna tuning equipment normally presents a resistance of 50 ohms to the transmitter terminals. At the XERF installation, if the transmission line were connected to the harmonic filter, as it was in the past, the line impedance would be converted to 20 ohms; and this is the resistance seen as the common load to both RF channels. Because of the opposing RF signal phase-vectors inherent in ampliphase modulation—and which are present across the common resistance—the plate of each 6949 sees an equivalent variable resistance that changes from zero at the modulation trough to four times the carrier value at the modulation crest. The vacuum tube being a constant-voltage device performs poorly when subjected to continually changing load conditions and in the case of ampliphase modulation, would be incapable of correct algebraic addition of the rotating phase vectors.

In his paper, Klingaman shows the typical RCA ingenuity in surmounting such technical challenges and, in doing so clearly defines the term "impedance modulation" frequently applied to ampliphase and similar forms of modulation.

With respect to the RCA BTH-250A, Klingaman refers to the pi-network tank circuit in each amplifier as a 90° matching network that satisfies three requirements of the ampliphase system. Klingaman writes, " . . .first, the impedance is converted to a more satisfactory value; second, a suitable tank circuit is obtained; and third, if the RF voltage is maintained constant at the 6949 plates, the RF current in the termination will be constant, regardless of the manner in which the termination changes" (52). Under these conditions, power delivered to the load will vary from zero at the modulation trough to four times the carrier power at the modulation peak; this is the desired condition for a 100 percent amplitude modulated signal.



Transmitter equipment cabinets 5 through 7, transmitter control and audio input racks.

The varying plate-load impedance, which is the essence of impedance modulation, presents greater engineering challenges than do conventional forms of modulation. In his paper on the BTH-250A system, Klingaman states, "The varying impedance with modulation in the 6949 plate circuits presents a problem in selecting the proper load Q, bias voltage, optimum efficiency, and correct grid drive to maintain constant voltage across the 90° matching sections" (53). To compensate for these characteristics, Klingaman refers to the use of RF-swamping resistors, a grid leak, inverse feedback, and a drive linearity corrector.

The linearity corrector in the BTH-250A includes three parallel connected 807 tubes in a cathode-follower circuit that regulates the grid drive and grid modulates the 4CX5000A driver stage to about 90 percent. The 807 portion of the grid modulator/regulator is driven by three additional lower-power tubes performing the functions of frequency compensation and drive-level control. Audio for the linearity corrector is obtained from the cathode circuit of V313 in the phase modulator then applied to a three-stage wave-shaping amplifier. The amplifier compensates for the frequency deterioration inherent in phase modulation and that created by the algebraic addition of the phase-vector angles required to produce the trough of the synthesized amplitude modulation wave.

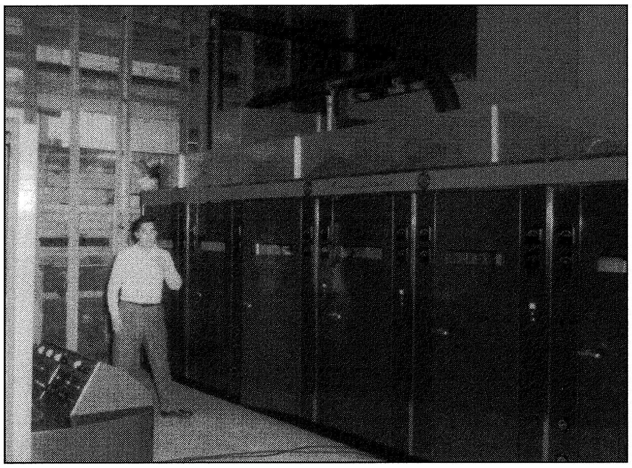
Klingaman states that through proper level adjustment of the drive regulator circuit in the BTH-250A, " . . .it is possible to dynamically adjust the operating point of the 6949 power amplifiers so that at the crest of modulation, grid bias, and grid drive are increased from the carrier value. At the trough of modulation, bias is reduced and the drive almost cut off. Thus the tubes will not be overdriven when the plate impedance is high" (53). Klingaman goes on to say that through the use of the drive regulator system, the exact 180° displacement of the vectors at the trough of modulation is not necessary (53).

The BTH-250A Performance Data at XERF

By 1961, when RCA published Klingaman's article, the BTH-250A had been in operation at XERF in Ciudad Acuña, Mexico for approximately two years. Diesel engine generators supplied power to the transmitter, and the following test data (*page 25*) from Klingaman's paper shows satisfactory performance.

Concluding Remarks

There are four facets of XERF history that re-



6 transmitter equipment racks, air ducts and coaxial cable visible above the racks.

quire additional brief comments. First, there is a common misconception that XERF is merely a continuation of the old XERA owned by Dr. John R. Brinkley. In late 1941, Mexican radio authorities closed XERA. In early 1942, the Mexican Radio Institute began dismantling the station, and on May 26, 1942, Dr. Brinkley died. When XERF began broadcasting in 1947, station engineers installed their first transmitter in the old XERA building. Other than the building and several personnel, the two stations are not related.

Second, such station ancillary equipment as the cooling-water system, control equipment, lightning protection, and even the transmitter's thirty-six tube power supply require an in-depth discussion that I have reserved for a future technical narrative.

Third, in reviewing the principles of ampliphase modulation and the BTH-250A, one gets the impression that XERF always operated at some super-power level, and that the transmitter always functioned a full power. In fact, neither is true, and both subjects warrant additional discussion. However, I will reserve these, too, for a later review of broadcasting regulations of the time and the business practices of other border stations, including XERF.

XERF began regular broadcasting in 1947 but not with 150 kw as indicated by official FCC records and by the Mexican Change List #61 dated May 7, 1946. The station's first transmitter was an RCA BTA-50G, a plate modulated set operating at only 50 kw. Change Lists were required by international agreement when changes were made that might cause interference to other stations in the North American Region, an area that was defined by the North American Regional Broadcasting Agreements.

In 1959, the station moved to a remote desert location about twelve miles from Acuña, and RCA engineers installed the new BTH-250A. Station advertisements and rate sheets now reflected the 250,000-watt level, but the transmitter could only be made to work at less than 80 kw.

The difficulty with the transmitter may never be entirely clear. However, XERF personnel offer the

Test Data, BTH-250A at XERF

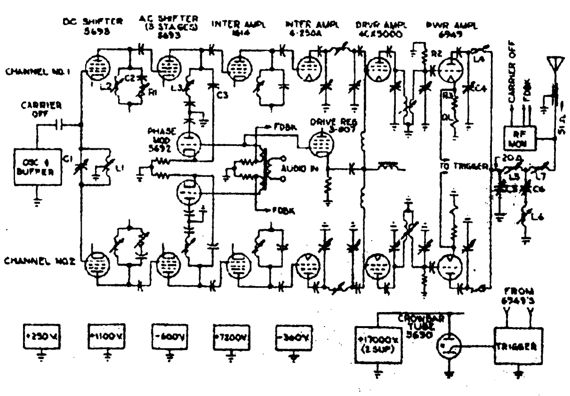
Frequency	Audio frequency response 60% Modulation	Harmonic distortion 90% Modulation	Modulation Capacity
50 cps	+0.7 db	1.5%	100%
100 cps	+0.4 db	0.70%	100%
1,000 cps	0 db	0.60%	100%
7,500 cps	+0.8 db	1.75%	95%
10,000 cps	+0.9 db	3.00%	90%

Power Output (carrier at antenna): 250kw
Frequency Stability: better than +/- 10 cycles
Carrier Shift (90% modulation): 2.5 - 3%
Noise Level (below 100% mod., 1,000 cps) : -56 db
Power Consumption (average program) 400kw

Klingaman (54)

explanation that the RCA engineers could not make the set function at full power, and a rift developed between RCA and the station management that resulted in the RCA personnel leaving with all the technical materials. In a 1997 interview, transmitter engineer Mike Venditi corroborated the difficulties with RCA; however, Klingaman presents a more plausible version of the incident. As Klingaman reports, "The transmitter is powered by a large 2,300-volt Diesel engine generator, a power source having inherent regulation problems" (54) [author's emphasis]. It is most likely that the generators were incapable of supplying the 400 kilowatts required for the transmitter plus other electrical equipment for extended periods of time. The difficulties were simply attributed to RCA, and the station operated at 80 kw—although printed advertisements' claims to super-power remained the same. By 1969, the BTH-250A had begun to work intermittently, and the engineers purchased a new CCA transmitter that operated at only 50 kw. All advertisements continued to claim 250,000 watts, and one boasted of the station's plans to move quickly to 500,000 watts.

Some time in 1969, engineers moved the transmitter site closer to Acuña and applied commercial power to the system. By this time, however, the rig was in such poor condition that the 50 kw CCA became the primary transmitter with the BTH-250A being relegated to backup status, a fact which changed in 1981, when the BTH-250A once again became the primary rig. Venditi repaired the transmitter and worked at the station



BTH-25A simplified schematic diagram Klingman (53)

for three years as Chief Engineer, using the set at its full 250,000 watts. In 1983, he handed control of the station back to the former Chief, Pedro Rodriquez Olivares.

The complexities of the ampliphase system were ill understood by the station personnel, and, again, the super set began to function at less and less power. It became the station's backup set for a second time and was then retired in 1986. Its demise signaled the end of the border-blasting era. Stories, however, are circulating among broadcasters that another American engineer has been employed to restore the station to its super-power capability. Freshly painted on the front of the transmitter building is the statement "XERF—250,000 watts."

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Footnote:

For those interested, a detailed schematic of the XERF transmitter can be obtained from the Radio Club of America headquarters for a club donation of $5.00.

By Pat West

Radar foils a Panzer Attack

During my 64th Fighter Wing reunion, I met Riley McNaught who relayed an experience he had during World War II in Anzio, Italy. McNaught was a radar operator, assigned to Lieutenant Albert Virili's radar team on the beachhead. He operated an SCR-584, a new radar model that used a ten-centimeter beam. A dish antenna mounted on the roof of a van could be rotated and pointed by the operator, and once locked, would automatically track a target.

The set came from an anti-aircraft outfit, where it had been used to aim searchlights and guns at enemy aircraft. It had been modified in the field by Captains Wallace Bixby and George Schiff who combined the SCR-584 with a British Type 14 radar set, and set it up on a hill near Nettuno. This enabled the two sets to provide early warning of low flying aircraft and to control interceptions made by night fighters. This was the first time the SCR-584 was used by air forces for the control of aircraft.

Destroying the Panzers

One night, McNaught was on duty at the radar set when he spotted six objects moving on the ground from the German side toward the American troops. He told his officer, Lieutenant Virili, who reported the position of the objects to the infantry. The next morning, a Colonel from the infantry division thanked the radar team profusely for their efforts as his unit had destroyed six German Panzers, using the information provided by McNaught. Unfortunately, McNaught didn't receive a citation for reporting the event.

The number of air raids against the beachhead totaled 377 during a four-month period with an average of three enemy raids each day. The first day's bag included nine enemy planes that were destroyed, one probably destroyed and six damaged by allied planes. On January 27, 1944, 25 hostile aircraft were destroyed, six probably destroyed and eight damaged. The next day on January 28, 31 enemy planes were destroyed, one probably destroyed and 11 damaged in addition to aircraft destroyed by anti-aircraft artillery fire.

The Ghost Fleet

One incident at Anzio caused apprehension to both the Allied and Axis forces. Radar detected a large fleet moving from the coast of southern France toward Italy. At first the speed of the movement indicated E-Boats. The mystery convoy was skirting the coastline. Artillery crews removed sandbags and depressed their guns to use them on naval craft. As the fleet moved south along the Italian coast, the speed increased.

The Army and Navy stood by to repel a flank attack upon the beachhead. Air patrols winged out to check the movement. They met German air patrols doing the same thing. Both forces wondered what was happening. Plotters on the British Type 14 radar and on the Navy radars kept close liaison and continuously checked the strength and direction of this ghost fleet.

Units of the invading force increased their speed, rushed into the estuary of the Tiber and rose 5,000 feet above Rome. Radar crews breathed a sigh of relief when they found they had been following a formation of clouds. Despite a few mistakes, radar played a significant role in winning World War II.

By Michael Riordan

The Invention of the Transistor

It is difficult to imagine any devices more crucial to modern life than the microchip and the tiny transistor that spawned it. Every waking hour, people around the globe take their benefits for granted—in cellular phones, personal computers, wrist watches, calculators, radios, televisions, fax machines, plus hundreds of other electronic devices. With little doubt, the transistor is the most important artifact of the 20th Century, the "nerve cell" of the Information Age.

The transistor was invented at Bell Telephone Laboratories in Murray Hill, New Jersey, during the years after World War II. Physicists John Bardeen and Walter Brattain fabricated the first working version of this revolutionary solid-state amplifier in December 1947, ten days before Christmas. Called the "point-contact" transistor, their unwieldy prototype had two electrodes poking into a small, silvery sliver of the element germanium. Properly adjusted, this semiconductor device could amplify audio electronic signals a hundredfold.

But Bardeen and Brattain's boss, theoretical physicist William Shockley, recognized that such a flimsy gizmo would be difficult to manufacture reliably in quantity. So the following January he conceived a different kind of semiconductor amplifier called the "junction transistor," which could be made from a single slice of germanium or silicon infused with three parallel layers of impurities. Electrical signals coming in on one lead attached to the inner layer—like the meat in a sandwich—would modulate the current flowing between the other two leads attached to the two outer (or bread) layers.

It took two more years of developmental work at Bell Labs—learning to purify germanium sufficiently, grow large crystals of it and "dope" them with the right combination of impurities—before workers could actually fabricate Shockley's junction transistor. Soon after Bell Labs revealed this new transistor in 1951, it became clear that it was much better suited for consumer electronics. Less than two years later, junction transistors began powering hearing aids made by Acousticon, Maico and Sonotone.

The Birth of the Transistor Radio

Bell Labs did not try to hoard the advanced semiconductor technologies needed to manufacture transistors. Instead it licensed them to industry giants such as General Electric and RCA, as well as to the fledgling Texas Instruments Corporation. Led by engineers Patrick Haggerty and Mark Shepherd, the Dallas firm mastered the challenging technology and started manufacturing transistors cheaply enough for a daring project: to be the first company to produce a portable radio powered solely by transistors. Texas Instruments got the first transistor radio on the market by Christmas 1954. Priced at $49.95 and small enough to fit in a shirt pocket, the Regency TR1 eventually sold about 100,000 units by late 1955.

A Japanese firm called Tokyo Tsushin Kogyo also was trying to achieve the same goal, but its "transistorized" TR-52 radio did not hit stores until 1955. Led by engineer Masaru Ibuka and physicist Akio Morita, the company bought patent rights and soon began producing "entertainment grade" transistors for a pocket radio. But after Texas Instruments beat it to the punch, the Tokyo firm started selling its transistor radios for less—eventually cornering the U.S. and world markets.

And to reach these global markets Ibuka and

Morita recognized that the company needed a better name that was not such a tongue twister. They chose one that has since become familiar throughout the world: Sony. In 1959, Sony brought out a portable, fully transistorized television set, the Model 8-301W, followed a few years later by the famous Trinitron. Sony transistorized the tape recorder and gave the world the Walkman—plus a myriad of other portable electronic devices. The transistor's entry into mass culture has transformed our world in ways even its brilliant developers would find hard to imagine.

Stanford University physicist and science historian Michael Riordan is author of The Hunting of Quark *and coauthor of* The Shadow of Creation and Crystal Fire: The Birth of the Information Age. *Riordan teaches in Stanford's History and Philosophy of Science Program and holds a position as Adjunct Professor of Physics at the University of California, Santa Cruz. He is currently a Senior Fellow at the National Museum of American History.*

Developers of the Transistor

(Reprinted from the Consumer Electronics Hall of Fame)

At the 2000 International CES, the Consumer Electronics Association (CEA) honored its first 50 inductees to the Consumer Electronics Hall of Fame. These leaders were honored because they made a significant contribution to the world and without whom our lives would not be the same. The following nine visionaries due to their creativity, persistence, determination and sheer personal charisma helped develop the transistor and transform the consumer marketplace into what it is today.

John Bardeen

Physicists John Bardeen and Walter Brattain were working at AT&T's Bell Telephone Laboratories when they developed the first transistor in 1947. It was a breakthrough moment, for the transistor replaced the large, inefficient vacuum tubes and paved the way for every electronic device created since the 1950s. Later adapted by William Shockley for wider use, the transistor earned the three men the 1956 Nobel Prize in physics.

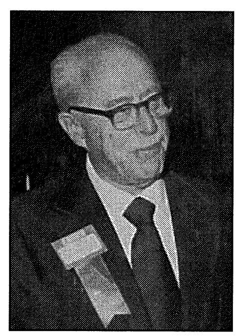
The son of a dean of the medical school at the University of Wisconsin, Bardeen joined the faculty at the University of Illinois in 1951 and soon began the research that made him the first person to receive two Nobel Prizes in the same field.

In 1972, Bardeen again shared the Nobel Prize in physics for developing the theory of superconductivity, in which electricity travels with little or no resistance. A tremendous scientific achievement, the superconductivity theory took nearly two decades to develop. Bardeen's work was done with Leon Cooper and J. Robert Schrieffer.

Bardeen also served on the President's Science Advisory Committee (1959-1962) and on the White House Science Council in the early 1980s. He won the National Medal of Science in 1965 and the Presidential Medal of Freedom in 1976. He earned his B.S. and M.S. in electrical engineering at the University of Wisconsin and his Ph.D. in mathematical physics from Princeton in 1936.

Sony Corp. endowed a $3 million faculty position at the University of Illinois in Bardeen's honor, noting, "Sony's achievements, from Japan's first transistor radio to the latest digital processors, owe a significant debt to the scientific contributions of Professor Bardeen."

Walter Brattain



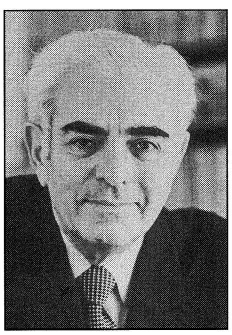
In the late 1930s, Bell Labs was searching for materials that could produce amplification of current in a solid material instead of a vacuum tube. Physicist William Shockley assigned two scientists to the task: Walter Brattain and John Bardeen.

Brattain and Bardeen, working in 1947, observed that when electrical signals were applied to contacts on a crystal of germanium, the power became amplified. It was a breakthrough moment in the development of the transistor, which made possible tremendous advances in electronics. Brattain's investigation of the surface properties of solids, plus his personal creativity and persistence, helped the scientists triumph over technical obstacles.

After AT&T unveiled the transistor, Shockley created a refinement that made transistors commercially practical in 1951. However, Brattain resented publicity that implied Shockley was one of the inventors, and Bardeen left Bell Labs in 1951 because of conflicts with Shockley. Brattain, Bardeen and Shockley won the 1956 Nobel Prize in physics for the transistor, a tiny chip of processed crystal whose name comes from a combination of "transfer" and "resistor." The device regulates the flow of electric current by manipulating the resistance in a semiconductor. Such a switch is crucial to digital communications. As transistors flooded the market, the electronics industry was forever changed.

Brattain was nonetheless modest about his accomplishments. Upon accepting the Nobel Prize, he said, "One indeed needs to be humble...when he thinks how fortunate he was to be in the right environment at the right time." He earned his B.S. from Whitman College, his M.S. from the University of Oregon and his Ph.D. from the University of Minnesota.

Avery Fisher



An amateur violinist, who began a notable career by building radios to improve sound quality for his own enjoyment. His achievements include the first transistorized amplifier and the stereo radio-phonograph combination. He sold his hi-fi components at premium prices, earning them a reputation as the Rolls Royce of sound equipment.

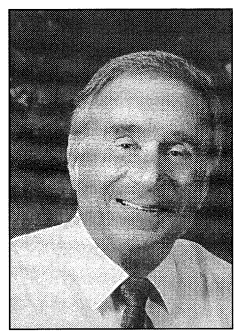
Fisher graduated in 1929 from New York University. He worked for two publishing firms, G. P. Putnam's Sons and Dodd, Mead & Company during which he began his endeavors in audio design. He constructed his radios to obtain better sound than available models delivered. By 1937 he had made significant improvements in the design of amplifiers, tuners and speakers and established his first company, Philharmonic Radio.

In 1945 Fisher sold Philharmonic Radio and founded Fisher Radio, which produced high-fidelity components from a factory on the site now occupied by Lincoln Center. His engineering staff was comprised of the brightest audio technicians lured away from European companies.

In 1956 Fisher produced the first transistorized amplifier. Two years later the company developed the first stereo radio and phonograph combination. From 1959 to 1961, the company improved AM-FM stereo tuner design, and it increased the power and improved the sensitivity of its components.

When the audio market veered toward mass merchandising in 1969, Fisher sold the company to Emerson for $31 million. Emerson later sold it to Sanyo of Japan. Fisher consulted for both Emerson and Sanyo. As a philanthropist, Fisher sat on numerous boards. Lincoln Center's Philharmonic Hall was renamed Avery Fisher Hall in 1973 after he donated $10.5 million.

Sidney Harman



Sidney Harman, the chairman and CEO of Harman International, began his career 47 years ago in 1953 when he and partner Bernard Kardon helped define the home hi-fi industry with the development of the first receiver.

Harman bought out his partner in 1956 and then expanded Harman Kardon into an audio powerhouse. In the early 1970s Harman began experimenting at his Tennessee factory with a new management technique. Nicknamed the Bolivar Project, it involved cooperative labor-management of the plant in which workers set their own schedules. The national publicity from the project led to Harman's appointment as Undersecretary of the Department of Commerce during the Carter administration.

When Harman moved to Washington in 1976, he sold his company to conglomerate Beatrice Foods to avoid a conflict of interest. In 1980, after leaving government service, he pieced together Harman International Industries Inc., by reacquiring a number of the businesses he had sold to Beatrice including JBL, Harman Kardon and Infinity and Epicure loudspeakers. The Harman International Professional Group grew to offer system solutions for the professional audio market with brands including JBL Professional, UREI, Soundcraft, Allen & Heath, Studer, DOD, Lexicon, AKG, BSS, Orban, dbx, Quested and

Turbosound.

The company has been successful in its niche market-high-quality, high-priced speakers-but also Harman International has flourished in the automotive market with its commodity-oriented car speakers. Harman acquired a $5 million business from the wire division of United Technologies Corp. and in five years transformed it into a $100 million business that's become the leading speaker supplier to the automotive OEM market.

Masaru Ibuka

Masaru Ibuka was a co-founder of Sony Corp., the Japanese electronics giant. Ibuka was an imaginative engineer and a perfectionist who helped to create some of Sony's most popular products. Under his technical leadership, Sony introduced the first transistor television set in 1959, the first solid-state videotape recorder in 1961 and the Trinitron TV, launched in 1967.

For more than 40 years, Ibuka and his partner, Akio Morita, developed Sony together, working from adjoining offices to launch dozens of electronic innovations, including the Walkman, the MiniDisc and PlayStation.

The Walkman was a good example of their partnership. Morita observed that the young wanted music around them all the time. Ibuka knew that existing portable cassette players were too bulky. The successful Walkman solved both problems.

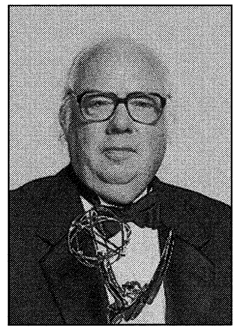
Ibuka was an enthusiastic radio ham from an early age, and studied electrical engineering.

He graduated from Waseda University in 1933. During World War II, he managed a measuring instruments company and also took part in a research project on heat-seeking missiles, where he met Morita.

Toward the end of the war, Ibuka began a new business, Tokyo Telecommunications Research Laboratories. Ibuka and Morita incorporated with $500 of capital and seven employees started work in an abandoned department store amid the devastation of early 1946.

Ibuka was intrigued by the tiny transistor, which consumed very little power. After buying the rights from AT&T, Ibuka and his engineers refined the transistor and launched the pocket-size radio in 1955, which established Sony as market leader and boosted the Japanese consumer electronics industry worldwide.

Henry Kloss

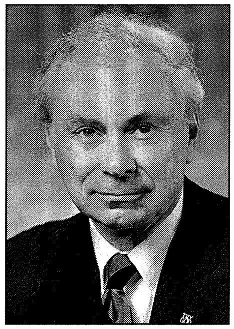


Known for his numerous inventions including the acoustic-suspension speaker and the large-screen projection television, Henry Kloss also founded four successful consumer electronics companies. While a student at the Massachusetts Institute of Technology (MIT) during the early 1950s, Kloss and some friends designed the first acoustic-suspension speaker, considered an audio breakthrough that popularized high fidelity sound. The invention's success encouraged Kloss to drop out of school to start his own manufacturing company, Acoustic Research. Kloss and two partners later formed a second business, KLH, where Kloss created the KLH Model Eleven, the world's first compact, portable stereo.

When Kloss sold KLH, the inventor turned his attention to the video market. It was Kloss, while president of the KLH Research and Development Corp., in Cambridge, Mass., who pushed Ray Dolby to bring the B-Type consumer system to market in 1968. (C-Type was introduced in 1980.) Kloss had an engineer construct a quick version of A-Type to show Dolby, that "If I could do it, somebody could bootleg something like it." The result: Dolby developed its own version-first in a reel-to-reel deck produced by KLH, then in a cassette deck made by the Advent Corp., founded by Kloss in 1967 with the goal of producing projection televisions.

Advent also manufactured and sold loudspeakers. Kloss, an Audio Hall of Fame member, introduced his first projection television in 1973. In 1977 he became founder and president of Kloss Video Corp., where he invented the Novatron(r) projection tube that employs built-in mirror optics as a means of improving the efficiency and performance of projection television. Kloss' fourth business is Cambridge SoundWorks.

John Koss Sr.

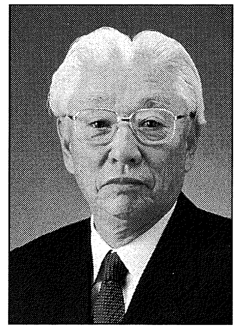


At the dawn of the transistor era, John Koss Sr. along with partner Martin Lange, designed a set of commercial headphones using World War II military headphones. The stereo headphones used two tiny speakers, chamois pads from old flight helmets and red tubing that looked like licorice. It was 1958 and the stereo business was taking off with the advent of rock-and-roll music. The headphones were called "private listening units."

The Koss Corp. was founded in Milwaukee when Koss was 27 and the first carry-around radios were being sold. Portable radios became possible due to the transistor, the identical device that in miniature form makes up today's high-powered computer chips. Previously people didn't need earphones because radios were heavy devices made from glass and hardwood, vacuum tubes and weighty speakers that plugged into a wall socket and were stationary. However, that changed with the two-pound, plastic, transistorized battery-operated radio and the Koss headphone. Tony Bennett and Dizzy Gillespie were early supporters of the headphones.

Extremely successful, Koss diversified into other consumer electronics. In the 1960s, Koss bought a maker of manual turntables-just as automatic record changers were taking over the market. It was Sony's introduction of the Walkman cassette player however, that fueled the Koss plunge into financial trouble. In 1980, Koss unveiled the portable AM-FM radio it had been developing but could not compete with less expensive imports. By December 1984, Koss Corp. was $15 million in debt and filed for Chapter 11 bankruptcy protection. The family-run company emerged one-year later, providing headphones as well as a new line of cordless phones that operate on infrared technology. It also has a multimedia line of amplified stand-alone speakers and headphones for computers.

Akio Morita

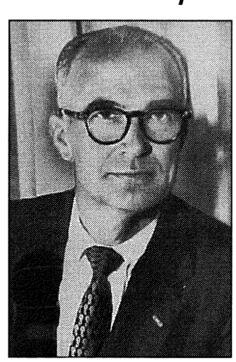


Bold, personable and energetic, Sony's co-founder Akio Morita built his electronics firm into a well-known brand and an international presence. The son of a wealthy merchant family, Morita founded Sony in 1946 with Masaru Ibuka. In 1960, he established Sony Corp. of America, which became the first Japanese company to list its shares on Wall Street.

Under Morita's leadership, Sony became the first Japanese company to produce a tape recorder, a commercially successful transistor radio, the first solid state AM/FM radio and did so at a time when there was no FM broadcasting in Japan, produced the first successful battery portable TV, developed the Trinitron picture tube and set a new world standard for color TV picture quality; launched the home VCR market with the introduction of Betamax, created the personal headphone stereo business with the Walkman cassette player, introduced the first camcorder, created the 8mm camcorder standard, developed the audio CD in a joint effort with Philips and was instrumental in developing the DVD standard.

With Morita at the helm, Sony was the first Japanese electronics company to adopt a multinational stance. It set up manufacturing, R&D and design centers in North America, Europe and Asia as a way to better serve those markets and establish itself as a contributor to their economies. Morita was the first Japanese to be named a member of the board of the IBM World Trade Corp.

William Shockley



William Shockley advanced the idea of the transistor and pointed the way to its development, but was not present at the actual moment of its discovery in 1947. John Bardeen and Walter Brattain, two scientists working for him at Bell Telephone Laboratories, observed that when electrical signals were applied to contacts on a crystal of germanium, the output power was larger than the input.

Over a few weeks, Shockley built on the work of Brattain and Bardeen, greatly extending the understanding of semiconductor materials and proposing a "sandwich" made of a crystal with varying impurities added. By 1951, Shockley's co-workers made his semiconductor sandwich, and it behaved much as Shockley had predicted.

Several companies seized the idea and set out to develop their own versions of the device. Transistors in all sizes and shapes flooded the market. The transistor replaced the vacuum tube and paved the way for the integrated circuit. A new industry, one that underlies all of modern electronics, sprang to life.

Shockley was home-schooled in Palo Alto, CA, before attending Palo Alto Military Academy. Bardeen, Shockley and Brattain shared the 1956 Nobel Prize for Physics for the invention of the transistor. He earned his B.S. degree from the California Institute of Technology and his Ph.D. from M.I.T.

By Kenneth Miller

The Grants-in-Aid Report

As I have for more than the past decade, I am pleased to report to you the status of the most important activity in our organization, the Grants-In-Aid-Scholarship program. At our Board of Directors meeting, the Board supported our Committee's recommendations to provide financial aid in the form of sixteen $1,000 grants to 11 organizations. The money for these 16 grants is derived from the interest earned from the investment of the contributions of more than $250,000 to the grants-in-aid program received from our members and friends.

These grants are awarded to students who are in need of financial assistance in their college level studies of technical communications. To assist in reaching this objective, our Board of Directors approved 16 grants which shall be awarded to the following 11 organizations:

- From the GIA General Fund to Capitol College, Embry-Riddle University, Ranken Technical College, Southern Methodist University, Stevens Institute of Technology and the Foundation for Amateur Radio.
- From the Alfred Grebe Fund to the University of Cincinnati and Virginia Polytech.
- From the Jack Poppele Family Fund to Fairleigh Dickinson University and Montclair State University.
- From the Richard G. Somers Fund to Capitol College, Polytech University and the Foundation for Amateur Radio.
- From the new Barry Goldwater fund to the Foundation for Amateur Radio

Each of these 11 organizations have programs which are professionally managed to award 100 percent of our grants to college students in need of financial aid to assist in the payment of their college tuition and expenses.

A new name appears on our list of grantees this year for the first time. It is the Fairleigh Dickinson University in Teaneck, NJ, which is receiving a $1,000 grant from the Jack Poppele Family fund.

At the time our Board met last year, a new Barry Goldwater fund was created when a $10,000 capital contribution was made from our club's General Fund in addition to nearly $2,000 contributed by Celwave. As a result, this year we are pleased to provide the first grant from the new Barry Goldwater Fund.

In addition, at our board meeting in June 1999, the Board approved the creation of a new Frank Gunther Fund. This new fund was fueled with a $7,000 contribution from our club's General Fund plus a generous $3,000 contribution from our Southwest Division Fund, which also contributed $3,000 to the Fred Link Fund.

Once again, we must give special thanks to the largest financial contributor to our grants-in-aid program, Richard G. Somers, W6NSV, who again made two very sizable and generous contributions this past year. This year four grants are being awarded in the name of the Richard Somers Fund. And just a few weeks ago one of our new members, William F. Stewart, K6HV, a former long-time engineer with Collins Radio made a very generous contribution to our grants-in-aid program. Also, Hans Meurer, N2TO, made a benevolent contribution to our grants-in-aid program to assist young students in achieving their education objectives.

Our grants-in-aid program is one of the strongest and most successful in our industry. It sets a leadership example for others by offering financial aid to meaningfully assist the young women and men who are launching their careers. We hope to transport them to a lifelong successful profession in our industry. The out-stretched hands we offer today will significantly reduce their risks as they walk down the paths leading to their goals.

By Eric Stoll

Treasurer's Report

FISCAL YEAR 1999
(October 1, 1998 – September 30, 1999)

REVENUES

Dues Collected & Applied$	32,731
Other Member Fees	3,094
Banquet (net)	(2,209)
Advertising Sales	10,185
Pins & Plaques Sales	1,381
Interest on General Funds	6,997
Net Gain on Redemption of Bonds	(35)
Publications Sales & Misc.	179
TOTAL REVENUES	**$52,323**

EXPENSES

Publications	
Printing & Supplies	$9,538
Mailing of Pubs.	4,778
Meeting Expenses	4,932
Office	
Printing & Stationery	2,509
Postage	2,440
Office & Computer Expenses	1,037
Trade Show & Web Site Costs	1,244
Executive Sec'y & Other Admin Costs	22,131
Legal & Accounting	1,100
Insurance	1,642
Pins & Plaques Costs	582
Miscellaneous	374
TOTAL EXPENSES	**$52,307**
NET REVENUES less EXPENSES	$16
Other Adjustments (net)	32,147
NET Increase in Fund Balance	**$32,163**

BALANCE SHEET

ASSETS	
Inventory & Receivables	$9,435
Prepaid Banquet Expenses	3,527
Banquet & Section Funds	27,466
Cash in bank - Operating	38,471
Investments	
Short Term Money Fund	1,027
Common Stock	52,148
GNMA Certificates	22,583
FNMA Certificates	
FHLM Certificates	52,595
Mutual and Closed End Funds	120,485
Corporate Bonds	79,885
US Government Bonds	69,463
TOTAL ASSETS	**$477,085**

LIABILITIES

Prepaid Dues	$24,637
Accounts Payable	579
Scholarship Funds – Principal	257,195
For Distribution	16,893
General Funds - Operating Balance	92,786
Reserve for Operating Deficiencies	24,517
Life Member Fund	31,802
Legacy Fund	13,464
Other Assets & Liabilities (net)	15,212
TOTAL Liabilities	**$477,085**

N.B. Other adjustments include contributions to funds, scholarships and grants awarded, earnings on funds and changes in values of investments. Interest rate sensitive investments decreased in value by $15,603 during the fiscal year.

SCHOLARSHIPS & GRANTS FUNDS

	Capital	Available for Distribution	Totals
Opening Balance October 1, 1998	$229,855	$18,057	$247,912
Contributions	27,340		
Interest Earned		14,836	
Scholarships & Grants Awarded		(16,000)	
Ending Balance September 30, 1999	257,195	$16,893	$274,088

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Fax: (516) 674-9600
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Email: *crew@wb2jkj.org*
Web Site: www.wb2jkj.org

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Mal Gurian, Chairman

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Stan Reubenstein
WA6RNU

2018 S Pontiac Way
Denver, CO 80224-2412
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Stephen T. Reynolds, *Manager Network Operations*

6575 The Corners Parkway, Ste.500
Norcross, GA 30092
Nextel Phone: (404) 557-2345
Office Phone: (770) 825-9832
Fax: (770) 825-9065
Email: *stephen.reynolds@nextel.com*

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Eric D. Stoll, Ph.D., P.E.

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Fax: (201) 393-3594
Email: *stoll@att.net.*

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Email: *darren_sextro@intertec.com*

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1425 Greenway Dr, Ste.350
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