Proceedings of

The Radio Club of America, Inc.

Volume 57, Number 2

October, 1983

Founded 1909

THE RADIO CLUB OF AMERICA, INC.
c/o Fred Shunaman, 105 Buckingham Road, Brooklyn, NY 11226

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

The Radio Club of America, Inc.

105 BUCKINGHAM ROAD, BROOKLYN, N.Y. 11226

Price $2.50

Organized for the interchange of knowledge of the radio art, the promotion of good fellowship among the members thereof, and the advancement of public interest in radio.

THE AWARDS OF THE RADIO CLUB

The ARMSTRONG MEDAL, initiated 1935, the initial recipient being Major Edwin H. Armstrong.

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.

The SARNOFF CITATION, initiated 1973, with initial recipient being the Honorable Barry Goldwater.

Established by the Board of Directors to be given annually to a Club member for Significant Contributions to the advancement of Electronic Communications.

The ALLEN B. DUMONT CITATION, initiated in 1979, the initial recipient being Dr. Thomas T. Goldsmith, Jr.

Bestowed by the Board of Directors of the Radio Club of America upon the person who has made important Electronic Contributions to the Science of Television.

The RALPH BATCHER MEMORIAL AWARD, initiated in 1975, with the initial recipient being William H. Offenhauser, Jr.

Presented annually to a member who has assisted substantially in preserving the history of radio and electronic communications.

The RADIO CLUB PIONEER CITATION, initiated in 1975. The initial recipient was Ernest V. Amy, a Founder of the Club.

Designated by the Board of Directors to be given annually to senior members who have contributed substantially to the success and development of the Club, or to the art of Radio Communications.

The PRESIDENT'S AWARD, established in 1974. The first recipient was Dr. George W. Bailey.

For unselfish dedication to the support of the Radio Club of America.

The HENRI BUSIGNIES MEMORIAL AWARD, established in 1981. Wm. H. Forster was the first recipient.

For the advancement of Electronics for the benefit of mankind.

The LEE deFOREST AWARD, established in 1983. D.E. Replogle was the first recipient.

In memory of the many contributions of Dr. Lee deForest to the radio communications industry.

Armstrong Medal

Edwin P. Felch

Edwin P. Felch (M 1939, F 1942, L 1971) was born in Madison, NJ, January 10, 1909, and graduated from Dartmouth College in 1929, joining Bell Laboratories immediately afterward. In the '30's, he designed precise measuring equipment, including direct-reading apparatus, as well as the first all-electronic frequency-following receiver, and received the basic patent on signal-seeking receivers.

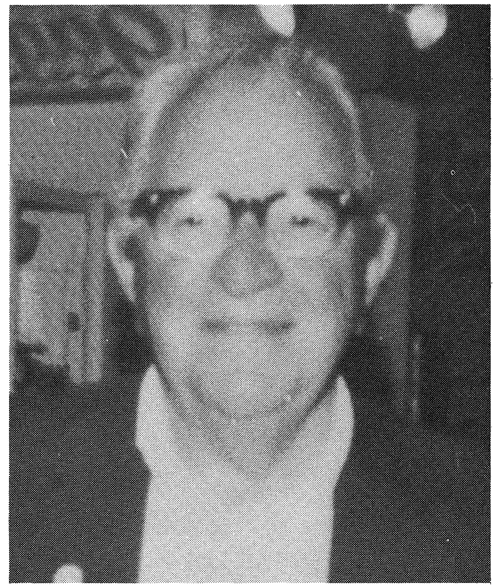
In 1945 he produced the first successful airborne recording magnetometer, for geophysical surveying and mapping. The device is self-adjusting, so it does not require a technical operator and is virtually maintenance free. During the war he also developed a number of classified or secret devices.

In the '50's and '60's, Felch was involved with Bell's military communications development, and was head, successively, of the Military Development, Radio-Inertial Guidance System for Titan and Thor missiles; the Guidance Systems Laboratory, with complete responsibility for developing the guidance system for the Titan I ICBM and all Thor based space vehicles; and of Safeguard Missiles Laboratory, responsible for the SPRINT missile.

In 1971 he was made Director, Kwajalein (Marshall Islands) Field Station, heading a group of over 600 people testing the SAFEGUARD system, "DOD's most successful test program," according to Deputy Secretary David Packard.

Mr. Felch is a Fellow of the IEEE and the Radio Club of America and an Associate Fellow of the American Institute of Aeronautics and Astronautics. He holds 21 patents in electronic instrumentation, frequency standards, magnetometers and magnetic measuring devices. He received the Outstanding Civilian Service Medal from the U.S. Army in 1973, and is a member of the American Defense Preparedness Association (AFCEA) and the American Physical Society.

Sarnoff Citation



William J. Halligan

William J. (Bill) Halligan, Sr., W9AC/W4AK (M 1960, F 1964, L 1979) was born in Boston, MA, December 6, 1899. He received his BSEE from Tufts College in 1923. He says:

"As a youngster in high school, I was a ham, receiving my license around 1914 and my commercial license around 1916. My first job was with the Marconi Co.; the first vessel I served on was the *S.S. Gov. Dingley*, which ran from Boston to Portland, ME. I served on several other vessels as Marconi operator, during which time I got into the Naval Reserve.

When war was declared in 1914, there I was. The Navy transferred me to New York to serve on a vessel that was made into a mine layer. It joined with others to load with mines and drop them in the North Sea.

After the war, I decided to go to college. I chose Tufts and an engineering course. After a year at Tufts I went to West Point and served as a cadet for a couple of years, until I married. As you know, a West Pointer can have 'no horse, no wife, no moustache.'

After working a while for Tobe Deutchman in Boston, I decided to open a store. We opened a small one on Brattle Street and called it The Radio Shack, a name the present owners still preserve. After that I went to Chicago."

Bill goes on to say: "Shortly thereafter, I started a company the name of which was Hallicrafters," and says little more about the most important part of his career, during which his equipment and his voice on the airwaves became famous. "After a lot of years," he says, "I sold Hallicrafters to Northrop."

Retired commercially, Bill is still active as an amateur, and now spends his time between Chicago and Florida. He is a Fellow of the IEEE and a Life Member of the Club, the QCWA, ARRL, and the Antique Wireless Association.

DuMont Citation

Fred M. Link

Fred Link W2ALU (M 1968, F 1968, L 1983) was born in York, PA, October 11, 1904, and graduated from Penn State University in 1927. He reports:

"I was highly honored to have been selected to receive the Allen DuMont Citation for 1983. It was Allen who recruited me away from the New York Telephone Co. in 1927 to join him and the de Forest Radio Co. as his engineering assistant to design and build the first three commercial TV transmitters in the world. These were for Jenkins TV Corp, a wholly owned subsidiary of de Forest Radio Co. at the time. I was not only associated with Allen at de Forest Radio from 1927 to 1931, but was directly associated with him in the formative years of DuMont Labs, from the cellar operation in Upper Montclair through the major activity in Clifton during and after World War II.

This followed through after the war, when I built for DuMont all the VHF TV transmitters the company sold (a sizable quantity of about 25). Bill Fingerle was my assistant Chief Engineer at the time and Bill did most of the design work on these VHF and UHF transmitters. After I sold Link Radio in 1949 I gravitated back to Allen DuMont and joined him at DuMont Labs as Director of Operations, Mobile Radio Department. Allen and his family were extremely close personally as well as in business from 1927 until he died in the 1960's. It is a great honor for me personally to receive the DuMont Award."

Link is known in military circles for his specialized World War II equipment, including the famous AN/TRC 1, 2, 3 and 4 series, and in commercial circles as the "Father of Two-Way Mobile Radio." He built the first successful FM mobile radio system for the State of Connecticut in 1939. Fred has been an amateur since 1919, as 3OV, 3BVA and W2ALU. He is a Life Member of QCWA, Fellow of the Radio Club and Fellow and Life Member of the IEEE. Among his non-technical activities, he was Mayor of the town of Westwood, NJ for nine years (1944-1953).

Batcher Award

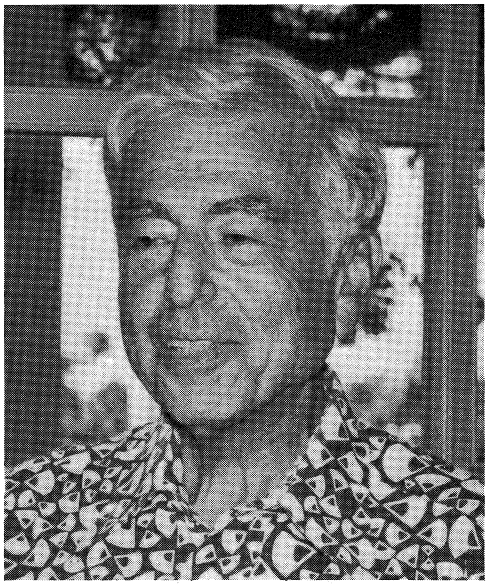
Joseph R. Pavek

Joseph R. Pavek, W0OEP (M 1977) started his radio career building crystal sets for neighbors, beginning in 1919. He bootlegged with a Ford Model T spark coil transmitter and a two-slide crystal receiver (which graduated to a 1-tube regenerative). In 1932 he started a repair shop in his home town of Hopkins, MN, and serviced Buick and Chevrolet car radios for General Motors. Licensed as W9OOEP in 1933, he has been active with the same call for 60 years. In 1934 he moved the shop to Minneapolis. In 1942 and 1943 he taught radio for the U.S. Army Signal Corps evenings, continuing management of the service garage and parts distributorship during the day.

In 1947 he started his own business in automobile refinishes and supplies, travelling the upper Midwest, establishing distributors and servicing them. Spare time was devoted to collecting wireless equipment and radio sets, tubes and parts, receiving and transmitting. Small displays were held periodically at his business location, and he started to exhibit at electronic trade shows. This led finally to the Museum of Wonderful Wireless. The museum is open on request for individuals and groups, without fees or donations. Visitors have been logged from Africa, Europe and South America.

Over 4,000 square feet of floor space is devoted to showcase displays and 800-odd feet of shelving, plus working and storage areas. The collection of vacuum tubes runs from the de Forest spherical Audion to 1920, and there is a panel of over 500 brands of the 200-201 series. The library consists of more than 100 books, some dating from the turn of the century.

Busignies Award



David Talley

David Talley, W2PF (M 1949, F 1957, L 1970) was born October 20, 1903. He started his radio career in Brooklyn in 1915, with an E.I. Co. 3-slide tuning coil, crystal detector and 1-inch spark coil. He received the call 2PF in 1919. A charter member of the Radio Club of Brooklyn, he served as Treasurer or President while he lived there. He helped organize the Hudson Division of the ARRL and served as its assistant Director and treasurer.

When the Army Amateur Radio System was organized in 1926, he was made Radio Aide to the Signal Officer of the Second Corps area, with the rank of 1st Lieutenant, and helped organize ARRS nets. In October 1940 he was promoted to Major and ordered to active duty in Washington, helping to recruit radio operators and electronic technicians. He was active in the European theatre from 1940 to 1945 and was promoted to Colonel.

Resuming amateur activity in 1946, he helped organize the Quarter Century Wireless Association (QCWA) serving as its Treasurer for over 10 years and as Secretary and a director until 1971. He helped reactivate AARS under its present name, MARS, and is still an active member with the call AAR4PN. His professional career includes 23 years with the Bell System, 13 years with ITT, 9 years with GTE and consulting work during the past ten years. He is the author of *Basic Carrier Telephony* (3 editions), *Basic Telephone Switching Systems* (2 editions), and *Basic Electronic Switching for Telephone Systems,* and is considered an authority on telephone switching systems. Mr. Talley was Treasurer and a director of the Radio Club from 1969 to 1977, and is now on the Grants-in-Aid and Finance Committees and is a Director Emeritus.

President's Award

Stuart F. Meyer

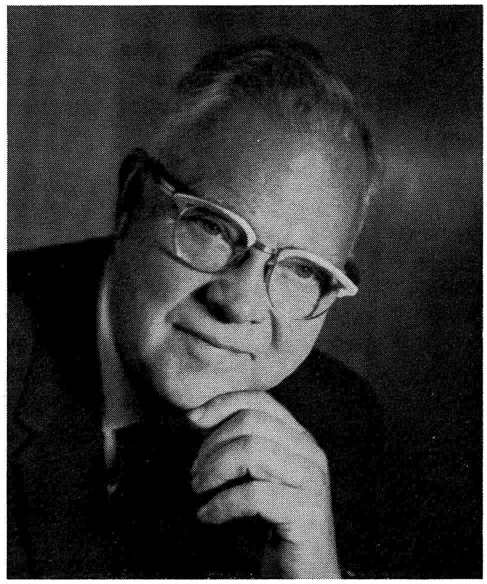
Stuart F. Meyer, W2GHK, (M 1956, F 1967, L 1978) was born in New York City, February 4, 1918. He served five years in the U.S. Navy, maintaining radar and communications equipment, and two and a half years as an instructor. He then, in 1945, joined Link Radio as a receiver design engineer and later became engineering department supervisor of land mobile radio at Allen B. DuMont Laboratories.

In the mid-fifties, he supervised installation of what was probably the world's first cellular system, in Detroit. A 900-cab company, alloted only three frequencies for their whole operation, adopted a plan roughly identical to the present cell system. Without computers to switch from cell to cell, the drivers used "zone maps" clipped to the cars' visors for manual switching as they crossed from one cell to another.

Stu went on to become President of Hammarlund Mfg. Co. and later held management posts with Aerotron, RCA and E.F. Johnson, where he is now manager of government relations. In this role, he takes a prominent part in a number of industry associations. He is chairman of the Commercial Advisory Committee of the Association of Public Safety Communications Officers (APCO), a director of the National Association of Business and Educational Radio (NABER) with particular interest in their educational programs, and is also chairman of the engineering panel of the Telecommunications Group of the Electronic Industries Association (EIA).

Mr. Meyer is President of the IEEE's Vehicular Technology Society and of the Quarter Century Wireless Association (QCWA) and Executive Vice President of the Radio Club of America. He has organized our afternoon technical papers sessions on the afternoon before our annual banquet for the past several years.

de Forest Award



Delbert E. Replogle

Delbert E. Replogle (M 1928, F 1937, L 1971) was born in Douglas (suburb of Juneau), AK, July 31, 1896, and graduated from Pacific College in 1916 with a Master of Arts and Bachelor of Science degree. At Pacific College he established a radio link with a fellow student four miles away, using spark coils and a galena crystal.

Entering government service as a missionary teacher at Noorvik, Alaska, he took with him the elements of a 2-kW spark trasmitter. In 1916 he established the farthest north wireless station on the North American continent—NZO—60 miles north of the Arctic Circle.

In 1922 he entered MIT. As a member (W1MX) of the Radio Club there, he took part in what he believes to have been the first known experiments in television. He graduated from MIT in 1925, with a Master of Science degree.

After brief stints with Boston Edison, Raytheon, and National Carbon he accepted, in 1929, the Executive Vice-Presidency of Jenkins Television Corp, a subsidiary of de Forest Radio. In 1931 he established scheduled television in Jersey City, covering the New York area. In 1933 he became Chief Engineer of de Forest Radio Co., working with Dr. de Forest in developing high-power transmitting tubes and a complete line of receiving tubes and transmitters for the police and U.S. government. In 1935 he developed the first two-way police systems and demonstrated their feasibility in Bridgeport, CT and Boston, MA. In 1936 he became Chief Engineer of the Hygrade Sylvania Radio Division in Clifton, NJ, developing a complete line of transmitting tubes.

In 1938 Replogle went into his own business, founding Electronic Mechanics and later General Electronics, which became Mykroy Mfg. Co. In 1970 he sold Mykroy Mfg. Co. and retired. He now lives in Greensboro, NC.

Pioneer Citation

F. X. Rettenmeyer

F. X. Rettenmeyer (M 1928, F 1929, L 1971) was born in Kendrick, OK, July 27, 1900. He obtained a BSEE from the University of Colorado at Boulder in 1922 and an MS from Columbia in 1928.

He was a member of the technical staff of Bell Laboratories from 1922 until 1926, when he joined F.A.D. Andrea, and worked with the famous popularizer of the Hazeltine Neutrodyne circuit (under the name of FADA Radio) first as assistant chief engineer until 1928, then as chief engineer until 1930.

Mr. Rettenmeyer was director of recording engineering at Bell Labs from 1930 to 1935, than at RCA Victor Division from 1935 to 1945, when he joined Federal Telephone and Radio, where he was chief engineer until 1950. Joining Philco, he was Chief of Aero-Space Engineering (later Ford Aerospace) until 1965. He retired from Ford Aerospace in that year, and was a consultant until 1975, when he retired.

Mr. Rettenmeyer holds some 60 patents in the electronic field. He became a Fellow of the Club in 1929, and of the IEEE in 1944. Mr. Rettenmeyer served as a director of our club in 1929, then as recording secretary in 1933 and as vice president in 1935.

Irving D. McAndrew, formerly with the Vermont State Police, has accepted a position as Director, MRD Program, Bureau for municipal Police, State of New York. His present address is Executive Park Tower, Stuyvesant Plaza, Albany, NY 12203.

CITATIONS TO NEW FELLOWS

Dana Atchley, Jr., *Granville Road, Lincoln, MA.*
For management and leadership in the design and manufacture of sophisticated communications equipment.

William F. Bailey, *Garden City, N.Y.*
Early achievements in color television.

William A. Breniman, *Society of Wireless Pioneers, Santa Rosa, CA.*
Early work in aviation communications and organizational activity in both radio and aviation fields.

Bhagat, Jai, *MCCA, Jackson, MS.*
For specialized system engineering in the field of cellular nationwide paging and related common carrier communications services.

Alan Biggs, K4AA, *Horse Shoe, NC.*
For contributions in the field of international marketing and engineering services of broadcast and communication equipment.

David Bondon, *Prodelin, Inc., Highstown, NJ.*
Contributions in the field of specialized antenna systems and satellite communication.

John A. Bryant, *Watercom, Inc., Owensboro, KY.*
Contributions in the field of gas/pipeline communications and petroleum industry signaling.

Victor Clark, W4KFC, *President ARRL, Newington, CT.*
For leadership in Amateur Radio organization, including WARC preparation and implementation.

Phil Cook, *Mobile Radio Technology, Littleton, CO.*
Contributions in electronic publishing.

Paul W. Dane, *Senior Telecommunications Engineer, University of California, Livermore, CA.*
Contributions in telecommunications systems and security methods.

E. R. Durham, *Radio, Inc., Tulsa, OK.*
Specialized communications and land mobile systems management.

Karl D. Engle, *Chicago, IL.*
Early contributions in the design and manufacture of radio components.

David D. Ferrel, *Midland Land Mobile Radio, Kansas City, MO.*
For contributions and expertise in the field of land mobile communications, equipment and design concepts.

Reed Fisher, W2CQH, *Bell Labs, Holmdel, NJ.*
For engineering contributions in the microwave and cellular mobile telephone fields.

August Gabriel, *Gabriel Communications Corp., Fort Lauderdale, FL.*
Systems development in the field of paging and common carrier mobile telephone.

Joseph W. Gallelli, *State Police, Albany, NY.*
Contributions as Supervisor, New York State Police and President, APCO.

Jack Goeken, *Airfone Inc., Oak Brook, IL.*
For the development and implementation of low-cost long distance microwave telephone service.

Benji Hara, *Boynton Beach, FL.*
Contributions in the fields of troposcatter and early broadcast FM radio.

Robert Hertzberg, *Boca Raton, FL.*
Special achievements in radio journalism.

Larry Hollingsworth, *Ohio Edison Co., Akron, OH.*
For applications work in digital communications in land mobile radio and loop system logic in microwave systems.

Kenneth D. Hopper, *Bell Labs, Holmdel, NJ.*
Contributions in electronic communications security and crime prevention.

Jack M. Janicke, *President, Magnetic Research, Butler, NJ.*
Contributions in the field of magnetics.

William D. Kelly, *Vice-President and Chief Engineer, WNEW-TV, New York, NY.*
Early work in remote control of VHF TV transmitters.

Judy Lockwood, *Lockwood Publishing, Fair Oaks, CA.*
Leadership in the field of technical management and writing.

Frederick Macklin, K4UZI, *V.P. E.F. Johnson Co., International Marketing Operations.*
Leadership in the development of VHF-AM radio for aviation services.

Harry L. Mayo, WB2EDS, *Product specialist for Tektronix in New York area.*
Contributions in introduction, user education and use of spectrum analyzers as measurement tools in industry.

Paul K. McKenney, Jr., *Orlando, FL.*
Promotion of early use of modular concept for improvement in personal radio design.

Charles "Brower" McMurphy, *Fremont, CA.*
Early pioneering in Public Safety communications on the West Coast, USA.

Hazard L. Reeves, *Reeves Sound Systems, New York, NY.*
Numerous achievements in the fields of radio and audio.

Ulrich Rohde, *Director, Radio Systems, RCA Government Communications Systems.*
Contributions in specialized communications systems for military and civil use.

Keith Wycoff, *Chairman, Reach Electronics, Inc., Lexington, NB.*
Pioneer in the development of electronic signalling relating to paging and alerting communications systems.

Fighting The Hi-Rise Fire

Hi-rise fires pose communication problems not previously encountered. Mr. Singer tells how they have been solved in a city of hi-rise buildings.

Fig. 1. A typical hi-rise fire.

by Edward Singer

There are some 900 high-rise commercial buildings in New York City, over 850 of them concentrated in the borough of Manhattan. Fires in high-rise buildings, such as the one shown in Fig. 1, pose special problems for the Fire Department, including problems of communications. Communications between the Chief in charge of the fire and his men becomes crucial for both fighting the fire and directing search and rescue operations.

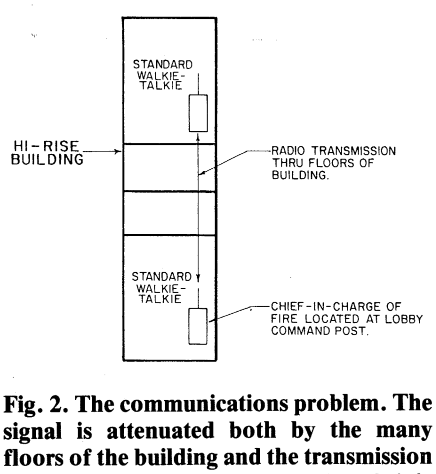


Fig. 2. The communications problem. The signal is attenuated both by the many floors of the building and the transmission characteristic of the walkie-talkie's vertical antennas.

The High-Rise Problem

The Fire Command Post in these buildings has been designated by local law to be in the lobby of the building. Fig. 2 shows the situation. The Fire Chief in charge of the fire has to communicate with a walkie-talkie radio from the command post in the lobby of the high-rise building straight up to the firemen in the upper floors of the building, who also have walkie-talkie radios.

The problem has been that in addition to the attenuation from the signal going up through all the material in the floors, vertical transmission from the vertically polarized antenna of the walkie-talkie radio is minimal. Whatever communication does take place is provided by the radio transmission going out of the building at an angle to the vertical and then being reflected upward by other structures. Above the twentieth floor or so, radio communications become very unreliable because some of the reflections are out of phase, resulting in numerous dead spots.

Solution of the Problem

The solution to the problem has been found to be transformation of the vertical transmission to a more horizontal transmission by using a cross-band repeater as shown in Fig. 3. In this case, the Fire Chief in the lobby uses a UHF walkie-talkie to talk out horizontally to his vehicle radio, which receives the UHF signal, which turns on a VHF transmitter, which transmits the signal up at an angle to the vertical to the firemen in the upper stories of the high-rise building.

The VHF transmitter-receiver is the standard equipment installed in all Battalion Chiefs' vehicles. The UHF transmitter-receiver is added to form a cross-band repeater for two-way communication between the Chief in the lobby and the firemen in the upper stories of the high-rise building. Fig. 4 shows the installation in the Battalion Chief's car. The UHF transmitter-receiver is mounted above the VHF transmitter-receiver. Fig. 5 shows the UHF walkie-talkie in the charging pocket in the front of the vehicle. The Battalion Chief takes it out to the lobby Command Post of the high-rise building.

The VHF antenna of the vehicular repeater is a quarter wave antenna mounted on the metal roof of the car. The roof acts as a ground plane. This effectively makes the antenna a half-wave vertical dipole. The ideal anten-

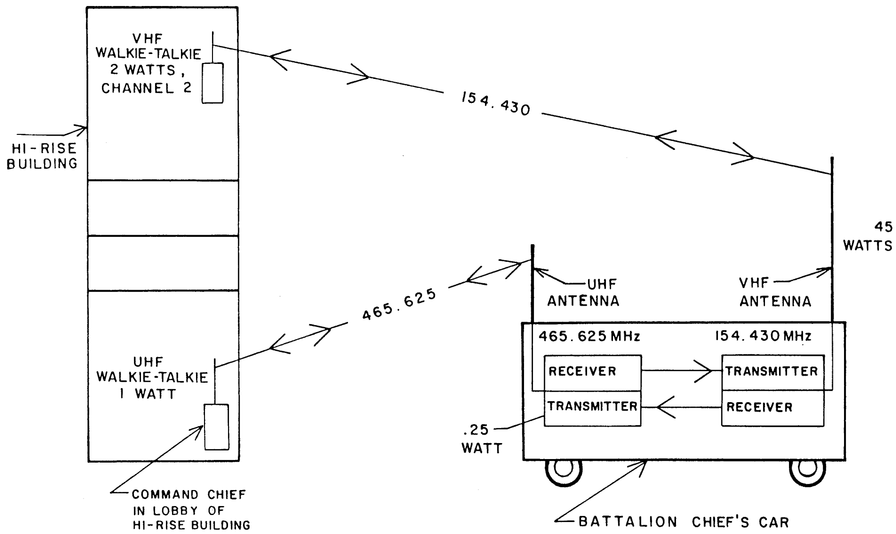


Fig. 3. The signal is picked up a short distance from the building and re-radiated at a different frequency, thus obtaining an unimpeded path at a favorable angle.

na pattern (relative field strength) of a free space vertical half-wave dipole is:

$$F(\theta) = \frac{\cos\theta\ (90^\circ \sin\theta)}{\cos\theta}$$

where θ is measured from the vertical line to the line of transmission as shown in Fig. 6.

For vertical transmission, θ is 0° and the relative field strength is zero. As the vehicular repeater is positioned farther away from the building for transmission to a given floor, the angle θ is increased and the received signal becomes larger and larger.

Positioning the Repeater

For practical reasons the distance of the vehicular repeater from the Fire Command Post has to be relatively small. A number of experiments were performed, using the vehicular repeater at different distances. Except for the special case of the World Trade Center it was found that a distance of some 70 feet was sufficient for a very strong signal.

In practice it was found that if the street in front of the building was wide, good results could be obtained by stationing the vehicular repeater across the street from the building. If the street was a narrow one, the vehicle would have to be parked at least 70 feet up or down the street from the building. In the special case of the World Trade Center a ramp leads down from the street 100 feet to the Fire Command Post for both towers. The vehicular repeater is stationed across the street from the top of the ramp, approximately 630 feet from the closest tower. Communications can then be obtained from the underground Fire Command Post to the highest floors in both towers.

Testing the System

A test program was instituted to try out the above procedures. In the case of the Empire State Building, the second tallest high-rise building in New York City, the vehicular repeater was stationed across the street from the building. This street, Fifth Avenue, is a wide one. Excellent two-way communications were obtained on every floor of the building with the firemen in different fire situations. For example, on the 86th floor, a fireman was stationed inside the fire tower, a reinforced concrete structure, used to take people down from the upper floors. There was no difficulty in two-way communications from the Fire Command Post in the lobby of the building to the firefighter in the fire tower on the 86th floor.

The angle from the vertical of the vehicle antenna to the 86th floor was calculated as follows: The distance from the vehicular repeater to the base of the building was 70 feet. However, at the 86th floor the accumulated set-back from the building line is 152 feet, making the horizontal distance 222 feet from the vehicular repeater. The vertical distance of the 86th floor above ground is 1,045 feet. This gives an angle of $\theta = 12^\circ$.

Tests were made on both towers of the World Trade Center, the tallest buildings in New York City. Excellent communications were obtained with the vehicular repeater stationed as already described. A number of

Fig. 4. A cross-band repeater installation in a Battalion Chief's car.

Fig. 5. UHF radio in charging pocket, with VHF repeater ahead of it.

floors were tested, including the 107th floor. Tests were then made on some additional ten high-rise buildings, also with excellent results. These included a windowless building 25 stories high.

Tests were made communicating from the Command Post of high-rise buildings to the machinery rooms on one of the higher floors. These rooms have metal doors, reinforced floors, etc. and are usually communication problems. They are also where many high-rise fires start. Excellent communications were obtained between a firefighter in the machinery room and the lobby Command Post, using the vehicular repeater stationed as previously described.

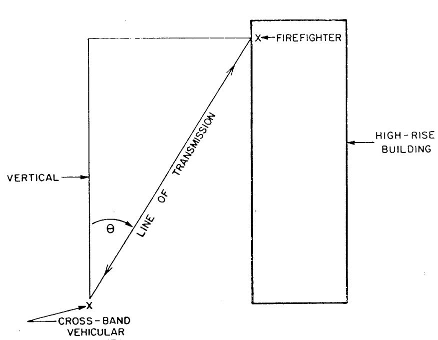


Fig. 6. As the angle increases, so does the signal strength.

Conclusion

This system has been in use for two and a half years in New York City. Some five battalions are equipped with the vehicular cross-band repeaters, which have performed excellently in all kinds of high-rise fires.

References

[1] *Reference Data For Radio Engineers,* Fifth Edition, published by Howard W. Sams & Co. Inc., 1974.

[2] "Radio Communications in High-Rise Buildings" by E.N. Singer, published in *WNYF, the Magazine of the New York City Fire Department,* First Issue, 1981.

[3] "Fire Safety for High-Rise Buildings: The Role of Communications" by Robert A. Glass and Arthur I. Rubin.

NBS Building Science Series 115, published by National Bureau of Standards, April 1979.

[4] "High-Rise Firefighting—Las Vegas Hilton". Slide Show of February 1981 Fire at Las Vegas Hilton. Includes discussion of communication systems. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

[5] "Communications in High-Rise Buildings," Chapter 22, by Robert A. Glass and A.I. Rubin (1977) of *Human Response to Tall Buildings,* D.J. Conway, Ed., Dowden, Hutchinson & Ross, Inc.

[6] "Control of Communications: To Safeguard Life and Property in a High-Rise Fire" by Thomas McKeon, *Factory Mutual Record,* May/June 1973.

New Members

Since the last *Proceedings* was printed, 30 members have joined the Club:

Edward E. Benham, Box 579, Waitsfield, VT 05673

Fredric R. Boswell, E.F. Johnson Co., 209 10th Avenue S.W., Waseca, MN 56093

Donald F. Buhle, Ameritech Mobile Comms., Inc., 1501 Woodfield Drive, Schaumberg, IL 60195

Frederick B. Childs, W0WQ, 2257 Fairmount Avenue, St. Paul, MN 55105

Donald Christiansen, 434 West Main Street, Huntington, NY 11743

Raymond L. Collins, Telewave, Inc., 2166 Old Middlefield Way, Mountain View, CA 94040

Merle L. Demerly, WA2LGH, Gordon F. Bennett, Inc., 3458 Union Rd., Buffalo, NY 14225

Alex F. Dolgosh, K8EUR, Antenna Specialists Co., 12435 Euclid Ave., Cleveland, OH 44106

Bradley F. Dye, WB4JCF, BBL Industries, Inc., 2935 Northeast Parkway, Atlanta, GA 30362

Earl H. Flath, Jr., 13634 Braemar Circle, Dallas, TX 75234

Richard B. Frey, K4XU, 1501 Woodhaven Drive, Sevierville, TN 37862

Richard J. Giacchi, WA2SAJ, PageAmerica Communications, Inc., 228 East 45th Street, New York, NY 10017

Donald B. Hall, APCO, Inc., P.O. Box 669, New Smyrna Beach, FL 32070

C.L. Hallmark, Jr., W5ZWM, 121 Elmwood, Ponca City, OK 74601

Fred H. Hamer, 819 Fifth Avenue S.E., Waseca, MN 56093

Leif B. Holm, Ericsson Communications, 301 Route 17 North, Rutherford, NJ 07070

Bette B. Jenks, Route 7, Box 158U, Raleigh, NC 27614

Joel I. Kandel, KI4T, 5463 S.W. 92nd Avenue, Miami, FL 33166

Morris K. Kunins, W2IFH, 5741 Post Road, Riverdale, NY 10471

Gerald T. Martin, K4DI, 1840 Hibiscus Drive, North Miami, FL 33181

Harold Mordkofsky, Blooston and Mordkofsky, 2120 L St., N.W., Washington, DC 20037

John J. O'Keefe, 16 Banks Street, Waltham, MA 02154

Louis Rabinowitz, 2205 Collier Avenue, Far Rockaway, NY 11691

Michael J. Rentfrow, K7GMR, P.O. Box 19171, Washington, DC 20036-0171

Robert C. Schwartz, E.F. Johnson Co., 10th Avenue S.W., Waseca, MN 56093

N. Arthur Sowle, W7CX, 2273 Sunrise Drive, Reno, NV 89509

Robert P. Walsh, WA8MOA, Arabian American Oil Co., P.O. Box 1613, Ras Tanura, Saudi Arabia

David E. Weisman, Newrath, Meyer & Faller, P.C., 4400 Jenifer Street, N.W., Washington, DC 20015

David N. Wise, N8CNY, 1605 Springfield Lane, Lansing, MI

Maurice Zouary, 56 Marlborough Road, Brooklyn, NY 11226


RCA is a Leader in Communications Command and Control Systems
RCA Engineers Explore the Leading Edge of Technology in:
• Frequency agile HF antenna couplers
• Very fast VLSI frequency synthesizers
• HF-VHF-UHF spread spectrum communications radio design
If you share our commitment to HF long range communications and want to contribute to circuit and system designs of the future, contact:
Dr. U. L. Rohde (DJ2LR)
RCA Corporation
Government Communications Systems
Building 13-4
Camden, NJ 08102
RCA

RADIO CLUB OF AMERICA PROFESSIONAL DIRECTORY

MAX ELLIOTT, P.E.
Communications Advisor
416 Loma Vista Drive
Redding, CA 96001
916-243-5797

ROBERT I. ELMS, P.E.
Mobile Communications Consultant
62 Smithtown Road
Budd Lake, NJ 07828
201-691-9067

ERO E. ERICKSON
Business Radio Comm. Consultant
3009 North Cicero Avenue
Chicago, IL 60641
312-685-6641

LES ETTINGER
2-way Radio Equipment
701-2A Kings Row
San Jose, CA 95112
408-297-1700

R. JAMES EVANS
Comms. Consultant, Land Mobile
2803 Southwood Drive
East Lansing, MI 48823
517-351-3252

OLIVER P. FERRELL (Perry)
HF Receiving Systems
52 Park Avenue
Park Ridge, NJ 07656
201-391-7887

W.G.H. FINCH, P.E.
Fax and Record Communications
3025 Morningside Blvd.
Port St. Lucie, FL 33452
305-334-5147

MILTON R. FRIEDBERG
Management Consultant
2537 Claver Road
Cleveland, OH 44118
216-382-4070

HARRY S. GARTSMAN, W6ATC
Military Avionics Systems Consultant
9921 Sunset Blvd.
Beverly Hills, CA 90210

CHARLES HIGGINBOTHAM
Land Mobile Consultant
7757 Conservatory Drive
Sarasota, FL 33580
813-355-1813

JACK HOFELD
Communications Consultant
1041 East Green, Suite 206
P.O. Box 60039
Pasadena, CA 91106-0039
213-449-5463

ALLAN E. HOLT
Radio Career Consultant
3007 Pacific Avenue, Suite 3
Virginia Beach, VA 23451
804-481-5621

LEONARD KAHN
Communications Consultant
839 Stewart Avenue
Garden City, NY 11530
516-222-2221

BERNHARD E. KEISER, EE, DSc, PE
Consulting Engineer
2046 Carhill Road
Vienna, VA 22180
703-281-9582

FRED M. LINK
Communications Consultant
Robin Hill
Pittstown, NJ 08867
201-735-8310

LOREN McQUEEN
Communications Consultant
2633 South Bascom Avenue
Campbell, CA 95008
408-377-2900
TELEX 34634 (CANDC CMPL)

JAMES MANN
2-way Radio Equipment
P.O. Box 340
Agoura, CA 91301
213-889-6666

WOULD YOU LIKE TO BE INCLUDED IN THE PROFESSIONAL LISTING?

Contact STUART MEYER
Suite 907, 1601 N. Kent St.
Arlington, VA 22209

Office: 703-525-6286
Home: 703-281-3806

ROBERT MASON
Ems. & Pub. Safety Comms. Consultant
P.O. Box N
Cottonwood, CA 96022
916-347-3292

F. STUART MEYER, W2GHK
President, QCWA
c/o E.F. Johnson, Suite 907
1601 N. Kent Street
Arlington, VA 22209
703-525-6286 (O) 703-281-3806 (H)

RAY MINICHELLO, P.E.
Communications Consultant
33 West Water Street
Wakefield, MA 01880
617-245-4640 800-225-4438

JACK R. POPPELE
TV-CATV-CCTV Multi-Media Consulting
145 Main Avenue
Clifton, NJ 07014
201-473-8822

JOHN J. RENNER
Advanced Technology
3426 North Washington Blvd.
Arlington, VA 22201
703-525-2664

ULRICH L. ROHDE, Ph.D., SC. D.
Communications Consultant
Frequency Synthesizers & Wideband Feedback Amplifiers
52 Hillcrest Drive
Upper Saddle River, NJ 07458

THEODORE P. RYKALA, P.E.
Communications Consultant
33247 Cloverdale
Farmington Hills, MI 48024
313-478-6994

F.H. SHEPARD, Jr., P.E.
Consulting Engineer
16 Lee Lane, Countryside
Summit, NJ 07901
201-273-5255

CARL E. SMITH, P.E.
Communications Consultant
8200 Snowville Road
Cleveland, OH 44141
216-526-4386

DAVID TALLEY, W2PF
Telecommunications Consultant
10275 Collins Avenue, Suite 1533-S
Bal Harbour, FL 33154
305-868-4131

The real story's inside!

RUGGED...RELIABLE... SERVICEABLE, with strong sales and service support... from KENWOOD.

BUILT TO LAST.
Rugged die-cast chassis/heatsink and RF shields. Glass-epoxy circuit boards. "ON-BOARD" wiring.

RELIABLE.
Highest quality components plus latest in state of the art technology.

SERVICEABLE.
Easy access construction featuring key test points for fast service and quick return to user service.

COMPETITIVELY PRICED.
More value and performance when compared feature for feature with competitive products.

STRONG WARRANTY.
One year warranty on parts and labor.
Sold through a select few of the top quality sales and service dealers.

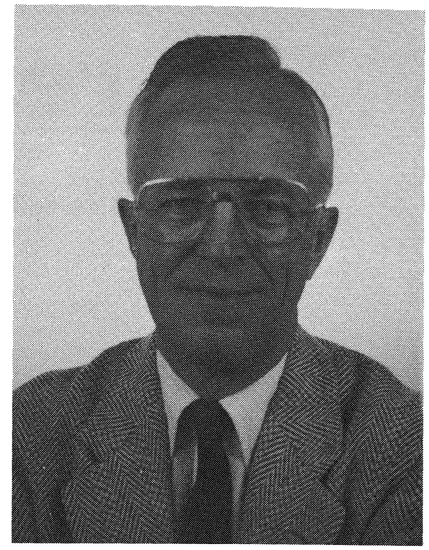
For more information about KENWOOD Land Mobile Radios, contact:
Trio-Kenwood Communications
1111 West Walnut Street
Compton, California 90220.
(213) 639-9000

ANTENNA EFFICIENCY

Is a Ground the Best Ground?

by Arch Doty, K8CFU

Tests show that elevated radials (a counterpoise) give better results than the almost universal 120 buried radial wire system.



Arch Doty, K8CFU

A recently concluded research program indicates that approximately 50,000 miles of bare wire have been buried in the United States alone, as radials under commercial and amateur radio station antennas, in the belief that they will provide the most efficient artificial ground systems possible.

A new test program has shown that buried radials do NOT provide maximum efficiency. This investigation indicates that the wires comprising artificial ground systems should be elevated for maximum efficiency, and if it is necessary to bury these wires for practical or esthetic reasons, INSULATED wire should be used.

There are about 5,000 AM broadcast stations in the United States. If each of these has followed FCC rules and buried a minimum of 120 radial wires (each at least a quarter wavelength long) under its antenna, there are more than 26,000 miles of such wires buried in this country. Many of this country's 400,000 amateurs have also buried extensive systems of radial wires under their antennas. These range from modest arrays to the 25,000 feet of wire "planted" by an ambitious experimenter in the California desert. It is probable that more than 50,000 miles of bare wire has been buried in this country, in the belief that it would provide the most efficient "artificial ground" possible.

This belief is based on a landmark research effort made nearly 50 years ago, by Dr. George Brown and his compatriots.[1] Dr. Brown's paper on buried radial wires used with vertical antennas is a true "classic" work, the excellence of which has established practises in the field ever since. Unfortunately, its very completeness discouraged further research in the area, and the fact that it considered only one of the several possible methods of making artificial ground systems was overlooked.

Yet for more than 60 years alternatives to the buried wire ground system have been known—elevated systems of the counterpoise and ground screen types. Little early data was published on these systems, and apparently no research was conducted on them after the publication of Dr. Brown's paper—until the extensive tests at Fletcher, NC in 1981 and 1982.[2,3]

These tests were comprehensive, and involved more than 16,000 measurements. Like Dr. Brown's work, they covered only a single variation of the many possible ground systems—the one using elevated radial wires. The Fletcher tests showed that elevated ground systems were unusually efficient—perhaps more so than equivalent buried wire systems.

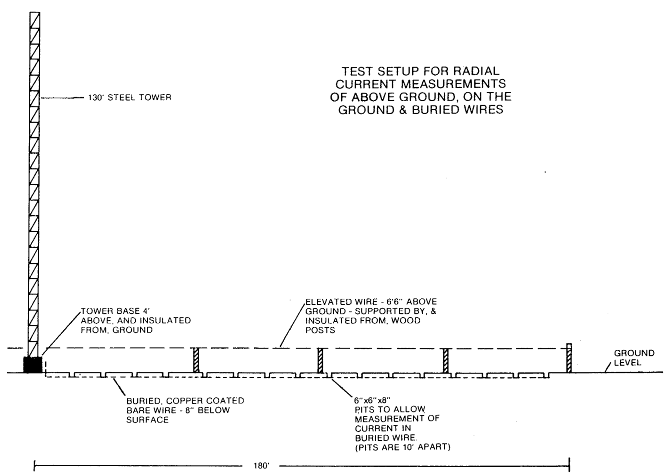


Fig. 1. The test set-up provided means for comparing elevated wires, buried radials, or wires on the ground.

The tests, however, did not compare the performance of elevated *vs* buried radials. Therefore, to obtain data on the relative efficiency of different types of radial systems, a test program was carried out in 1982, using the instrumentation and techniques developed in the earlier tests. Several thousand measurements were made of the return currents carried by elevated wires, wires lying on the ground, and buried wires. In each test the wires terminated at the base of a quarter-wavelength vertical antenna, and were the sole means of collecting the return currents when the antenna was operated at 1805 kHz. Fig. 1 shows the test arrangement.

In all, a total of 28 radial wires, ranging in length from 45 feet to 180 feet were tested, individually and in combination. In the tests the elevated wires were 6 feet, 6

Pye Telecom
456.78
1
2
3
4
5
6
7
8
9
CL
0
I/O

inches above ground level, the "on the ground" wires were lying loosely on the earth and the buried radials were 8 inches below the earth's surface. The elevated and "on the ground" wires were directly above the buried ones.

Results of these tests were compared with and supplemented by data from the 1981-82 tests, which were taken on the same site, with the same techniques and instrumentation. The tests showed that:

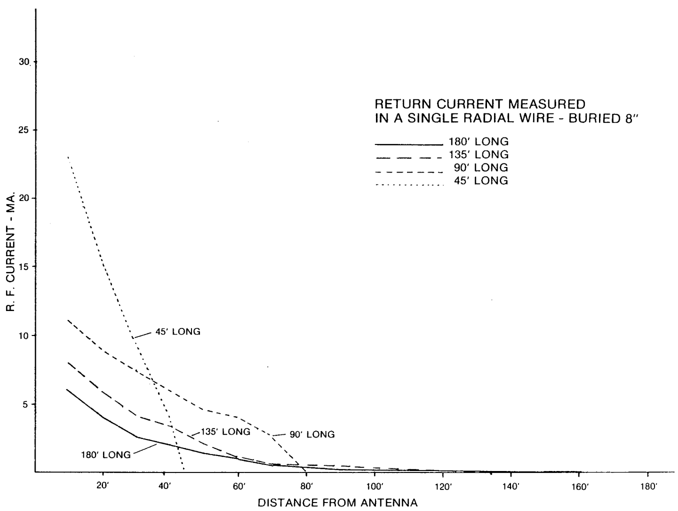


Fig. 2. Currents in buried radials of different lengths compared. There was no explanation of the extremely high current in the buried 45-foot radial.

I: The currents in buried uninsulated radial wires are concentrated near the base of the antenna, and decrease at a constant rate as the distance from the antenna increases (See Fig. 2).

II: As shown in Fig. 3, the distribution of return currents in elevated wires is distinctly different from that in buried radial wires—as long as the elevated wire is more than approximately 0.2 wavelength long.

In elevated wires, the current is at a maximum near the antenna, rises very slightly, remains at an almost constant level for a considerable distance, then gradually decreases to zero.

(The same current distribution pattern in elevated radial wires was found in the very comprehensive previous Fletcher test program.)

NOTE: The current distribution pattern of elevated radial wires results in lower losses than those caused by the high level of currents adjacent to the antenna when buried radials are used. The high level of current near the base of the antenna with buried radials has resulted in such high heating as to set the grass near the base of the antenna afire.

III: The distribution of return currents in elevated wires shorter than 0.2 wavelength is roughly the same as found in buried wires.

IV: The currents in radial wires lying on, but insulated from the ground are similar to those in elevated wires. (Thus, this type of radial provides the same advantage over buried radials as do elevated radials.)

V: Elevated ground systems—counterpoise or ground screen—are extremely efficient in intercepting return currents directly from the antenna—before they can reach the ground. It was found in the tests that return currents in the ground, under elevated wires connected to collect such currents, were insignificant.

VI: RECOMMENDATIONS: The results of the recent test program have prompted further analysis of the earlier and far more extensive series of tests. From the combined data, it is possible to make some specific recommendations concerning the radial wires used as the ground system for a vertical antenna:

Radial wires should not be buried if they are to collect return currents from a vertical antenna with maximum efficiency.

If possible, elevated radials should be used. These can be insulated (a counterpoise) or grounded (a ground screen).

If it is not possible to use elevated radials, insulated wire lying on the ground, or buried as close to the surface as possible, can be used.

Elevated radial wires, or insulated radials at ground level, MUST be at least 0.20 wavelength long.

If the above recommendations are followed, 50 radials utilizing insulated wire should provide the same effectiveness as an artificial ground system for a vertical antenna as 120 buried radials of non-insulated wire.

The author wishes to extend particular thanks to Mr. Edmund A. Laport for his continuing encouragement, friendship, support—and occasional prod!

Sincere thanks, also, to those who spent their personal time to read, and critique, this paper. This includes: HARRY J. MILLS, JOHN A. FREY and RICHARD B. FREY.

REFERENCES

[1] Brown, Lewis and Epstein, "Ground Systems as a Factor in Antenna Efficiency," *Proceedings of the IRE*, June, 1937.

[2] Doty, Frey and Mills, "Characteristics of the Counterpoise and Elevated Ground Screen," *Professional Program, Session 9, Southcon '83* (IEEE) January 1983.

[3] Doty, Frey and Mills, "Efficient Ground Systems for Vertical Antennas," *QST*, February, 1983, pp. 20-25.

(Persons interested in further information on or discussion of this subject may contact Mr. Doty direct at 347 Jackson Road, Fletcher, NC 28732.—*Editor*)

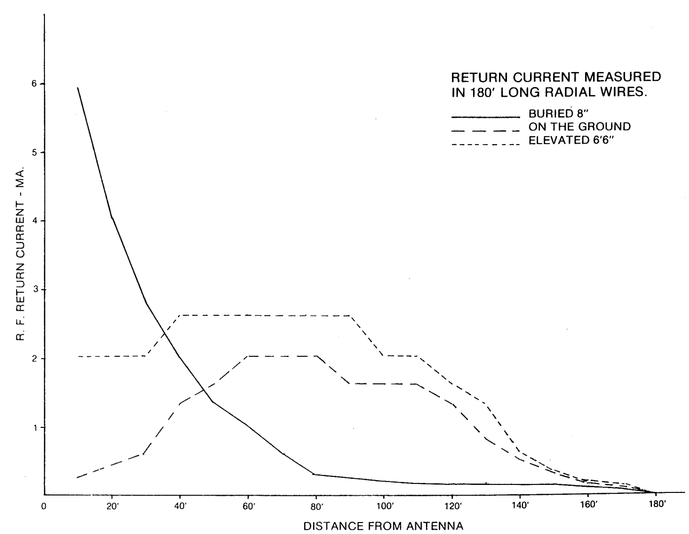
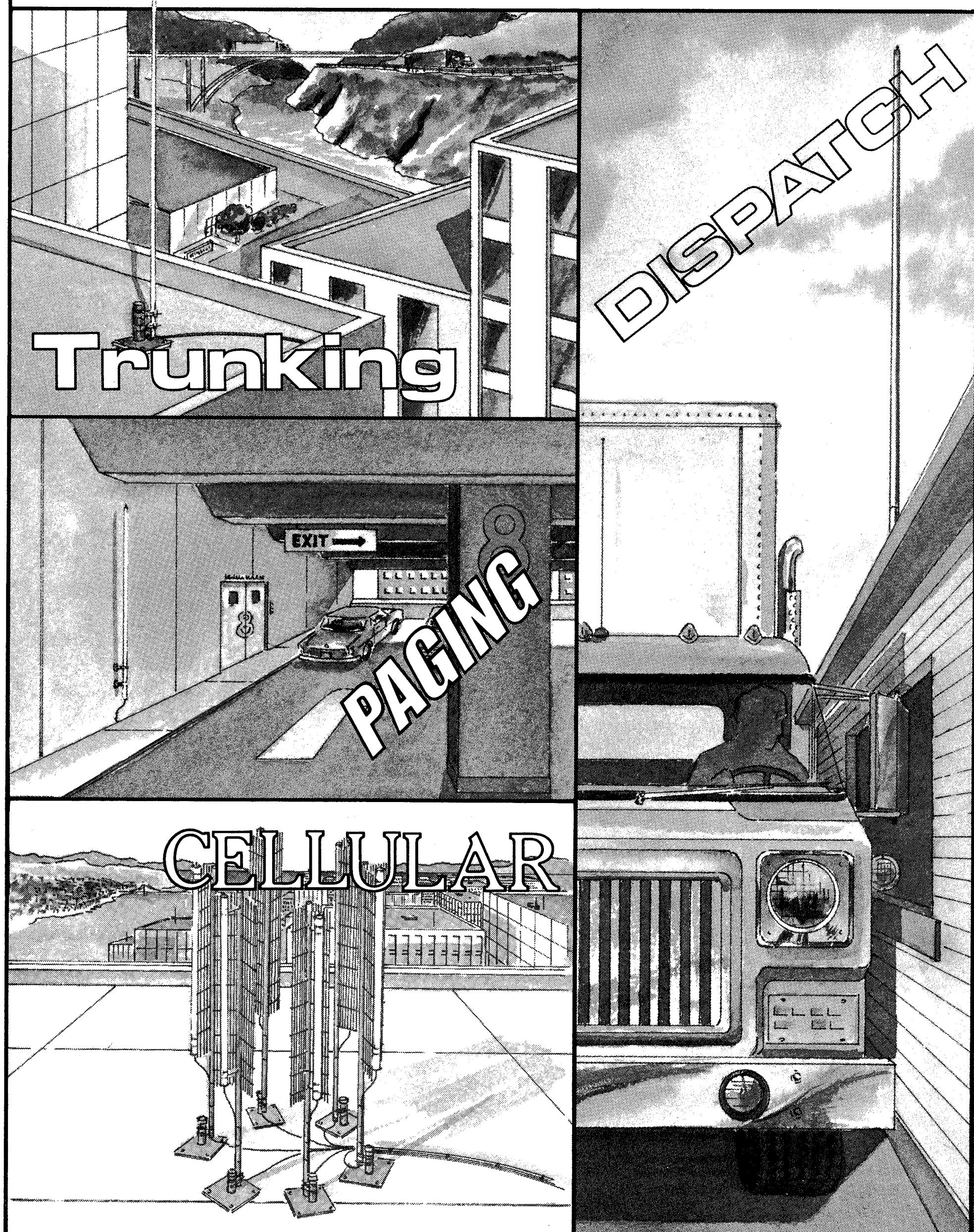
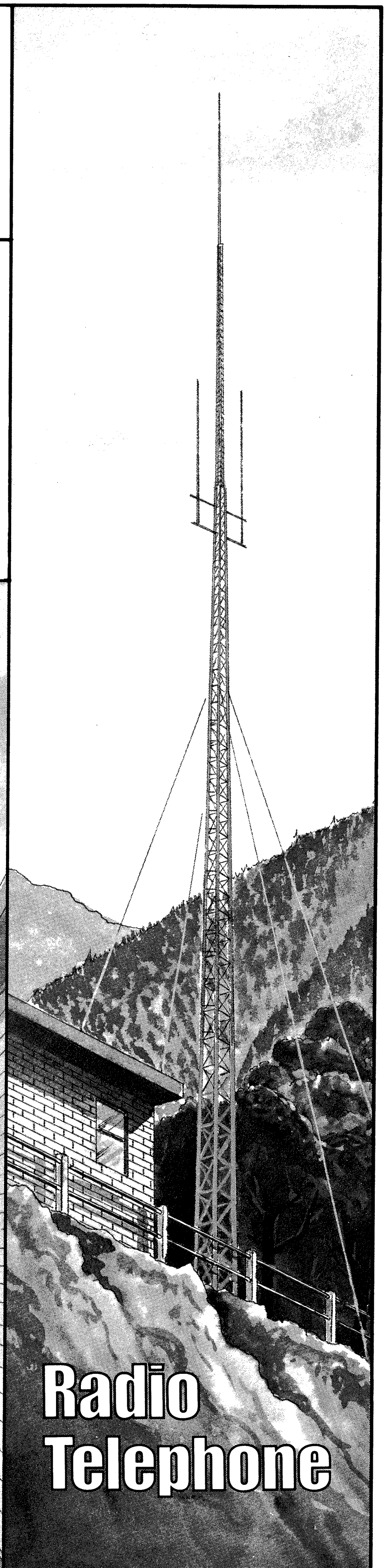


Fig. 3. The more even distribution of current in the elevated-wire "ground" results in much lower losses than in an earthed-radial system.



Trunking
DISPATCH
EXIT
PAGING
CELLULAR



Radio
Telephone

GRANTS-IN-AID ACTIVITIES, 1983

(Mr. Walker's report to his Committee)

Our GIA Committee, in celebration of the Club's 75th Anniversary, has been authorized to make scholarship and research grants in the amount of $7,500 during 1984. Our roster of organizations to be considered for grants will be voted on by the Board of Directors at its November 18, 1983 meeting. The grants—as in the past—will be issued the year following their approval.

The surviving members of the de Forest Pioneers have been elected to Life Membership in the Radio Club. The remaining funds of the Pioneers have been donated to the Club for GIA use. In appreciation of the donation, a new memorial grant to be known as the Lee de Forest Award has been authorized by our Board. It is the concensus of the responses I have received from GIA Committee members that the organization receiving this grant be requested to award it to an individual engaged in advanced study or graduate research in telecommunications.

Dr. de Forest was a graduate of Yale University. Accordingly, it appears appropriate for the Committee to determine if Yale would administer a $500 grant on behalf of the Radio Club. I believe it is a fair commentary that probably anyone attending Yale might not have a bonafide need for financial assistance, as outlined in our guidelines. However, I recommend that Yale should be contacted to determine what their attitude would be regarding a grant. Although our Committee is not obligated to make a grant to any particular institution, it does seem logical that, in view of the nature of the de Forest grant, Yale should be considered.

In view of our authorization to award $7,500 in grants, I would appreciate hearing from each of you regarding any recommendations you may have. Two continuing grants are made at the direction of the Board of Directors—to the Armstrong Memorial Research Foundation and the Foundation for Amateur Radio. In keeping with the Board's instructions, I recommend continuation of a $500 grant to each. Also, it has been Bill Finch's desire that grants from the Finch Fund be made to the Florida Institute of Technology. I am contacting him with this letter for his comments.

Our 1983 GIA grants (approved in 1982) are:

Florida Institute of Technology (Finch Fund)	$1,000
Polytechnic Institute of New York	1,000
Southern Methodist University	1,000
Foundation for Amateur Radio	500
University of Central Florida	500
Armstrong Memorial Research Foundation	500
Amateur Satellite Corporation (AMSAT)	1,000
Stevens Institute of Technology	500

I am sure that it is the desire of the Board of Directors that distribution of our grants this year be made as broadly as possible; however, the recipients of grants during past years have obviously made good use of them.

Cordially yours,

Joseph F. Walker
Chairman

New Addresses

The addresses below have been changed since the last Directory was printed:

Alexander, Bob, 6003 Maple Avenue, #101G, Dallas, TX 75235

Arakawa, Taizo, N2ATT, JA3AER, Sharp Electronics Co., 1 Sharp Plaza, Paramus, NJ 07652

Austin, Richard C., 23 Homeside Lane, White Plains, NY 10605

Brooking, Robert, 4338 Commonwealth, La Canada, CA 91504

Bunday, Dale, 4025 Mountain Pass, Plano, TX 75023

Churpek, George M., N6FL/W6MCZ, Bird Electronics Corp., P.O. Box 28, Ojai, CA 93023

Buzzi, Gene A., Omnicom, Inc., 325 John Knox Road, Suite E-204, Tallahassee, FL 32303

Comber, Graham, VK3ZBO, 30 McComb Blvd., Frankston, Vic 3199, AUSTRALIA

Cook, Phil D., Wiesner Publications, 5594 So. Prince Street, Littleton, CO 80120

Doerle, Bruce C., K4BCD, P.O. Box 1464, Arlington, VA 22210

Druskoff, Marvin, K2VIV, P.O. Box 943, Fall Brook, CA 92028

Edwards, Henry M., Celwave, Inc., Route 79, Marlboro, NJ 07746

Flood, Bernard H., 14001 Palawan Way, #302, Marina del Rey, CA 90291

Gary, William R., K8CSG/5, 14834 Falling Creek Drive, Houston, TX 77068

Hicks, James E., WB4VVB, General Electric, 8525 N.W. 53, Ste. 215, Miami, FL 33166

Huber, F.J., General Electric, 8525 N.W. 53, Ste. 215, Miami, FL 33166

Huckabee, Jay R., W5EPJ, 2201 25th Street, Snyder, TX 79549

Katz, Paul, NBJ & Associates, Inc., 130-41 Nishi Oguchi, Kanagawa-ku, Yokohama, JAPAN

Koczon, William, P.O. Box 1099, St. George, UT 84770

Larkin, Jimmie A., K1ISE, 2012 N.E. 6th Street, Waseca, MN 56093

Ljunggren, Mats, 69 Feldman Court, Mahwah, NJ 07430

Lockwood, Judy S., Lockwood Publishing Co., 5146 Melvin Drive, Carmichael, CA 95608

McBurney, Frank, W1TDF, 21140 Water Oak Terrace, Boca Raton, FL 33433

McClure, Nathan D., Dir. Police Control Dispatch, P.O. Box 626, Muskegon, MI 49440

McCorkle, Chuck, 6700 Warner Avenue, #2F, Hunts Beach, CA 92647

McKenney, Paul K., Jr., 2041 Countryside Circle, Orlando, FL 32804

Meador, Myron E., 4630 Picturesque Circle, Cold Springs, CO 80917

Meyerson, Leo, W0GFQ, 69911 Via del Sur, Cathedral City, CA 92234

Ordway, W.T., Pacific Telephone Co., 220 Montgomery Street, San Francisco, CA 94104

Patterson, Allen C., Applied Comp. Sci., 12356 Northrup Way, Bellevue, WA 98005

Pederson, Robert C., K2IEZ, Radio Service Co., 410 Amboy Ave., Woodbridge, NJ 07095

Perry, Gordon F., 512 N. Palisade Drive, Santa Maria, CA 93454

Pomeroy, Thomas B., 1407 Caval Terrace, Apt. 857, Richardson, TX 75080

Rohde, Ulrich L., 52 Hillcrest Drive, Upper Saddle River, NJ 07458

St. Louis, Roland A., Jr., N2KLH, 110 Lafayette Avenue, Geneva, NY 14456

Sherman, Eleanor, 201-203 Cleveland Street, Elmira Heights, NY 14903

Scott, William, 4716 Parkway Commerce Blvd., Orlando, FL 32804

Shunaman, Fred, 105 Buckingham Road, Brooklyn, NY 11226

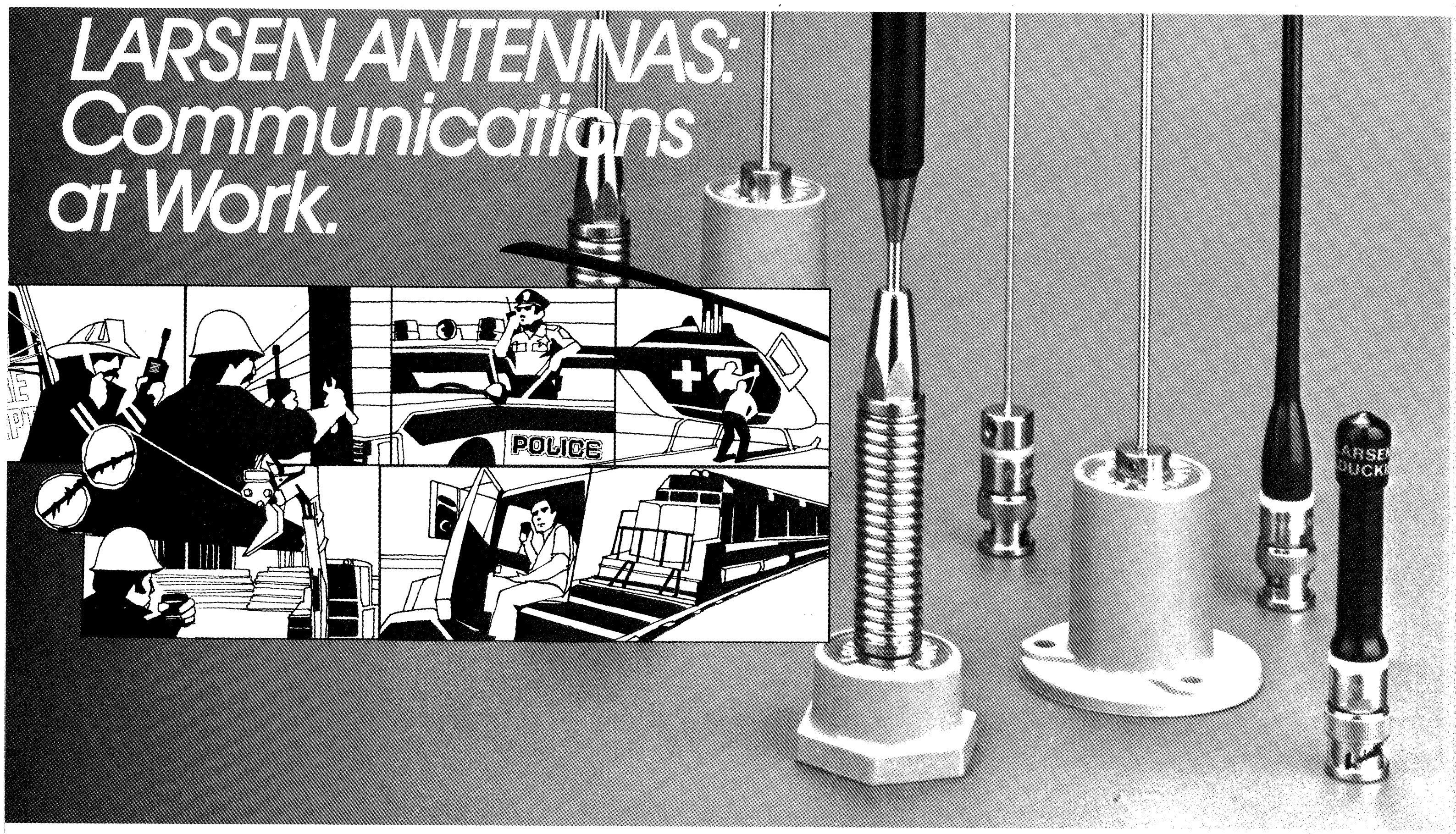
Smith, Gene F., K2DBL, 175A Taylor Avenue, East Brunswick, NJ 08816

Tall, Robert, 1201 Jeff Davis Highway, Arlington, VA 22202

Van Buren, John E., 5529 Bellevue Avenue, La Jolla, CA 92037

Wiesner, E. Patrick, Wiesner Publications, 5594 So. Prince Street, Littleton, CO 80120

Witt, Frederick E., Box 213, Cobbleskill, NY 12043



Whether it's dispatching law enforcement vehicles, coordinating construction crews, or exploring for oil, successful two-way radio communications requires an antenna that gets the job done under even the most difficult conditions.

That's why Larsen antennas are used in two-way systems all over the world. They deliver top performance where it is most important—at work. Larsen's exclusive Kūlrod® whip turns maximum power into communication, not resistance heating. So Larsen Antennas communicate further. And they've proven their reliability in some of the most extreme conditions—from the Canadian Arctic to the Andes Mountains.

Whether your applications call for mobile, fixed base or Kūlduckie™ portable antennas — in low, high, VHF, UHF or 800 MHz frequencies — you'll find high performance and durability with Larsen.

And our service works for you too. With prompt delivery, personal attention and a no nonsense warranty.

So no matter what your two-way communications needs, let us know. We'll show you how Larsen antennas will work for your living.

Larsen Antennas

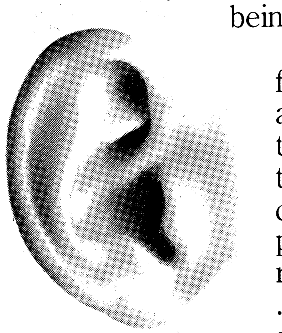
IN USA: Larsen Electronics, Inc.
P.O. Box 1799 Vancouver, WA 98668 Phone 206-573-2722
Toll Free Order Line 1-800-426-1656 and
Washington State 1-800-562-1747

IN CANADA: Canadian Larsen Electronics, Ltd.
283 E. 11th Avenue, Unit 101
Vancouver, B.C., V5T 2C4 Phone 604-872-8517

IF YOU BUY A TWO-WAY RADIO ON NAME ALONE, YOU HAVEN'T BEEN LISTENING.

Before you buy a mobile radio on name alone, there are a few things you should know about Johnson.

Johnson isn't the best-known two-way radio. So we work at being the best-made.



If you spend a few minutes with a Johnson radio... talking on it... listening to it... checking out its performance and reliability features ... we think you'll see what we mean.

WE WON'T SETTLE FOR A SECOND-RATE RADIO. NEITHER SHOULD YOU.

At Johnson, we specialize in one thing only. Making the best two-way radios. And because we concentrate our attention on this one job, we think we do it better.

Johnson radios have pioneered many breakthroughs in the mobile communications industry. Our CLEARCHANNEL LTR™ solved channel crowding problems by utilizing an advanced microprocessor design.

The innovations continue throughout our entire product line, from handheld radios to mobile two-way FM radios to mobile telephones. In fact, Johnson is one of the few approved suppliers of an advanced new mobile telephone system now being introduced in the U.S.

WE DON'T SELL IT UNTIL WE'RE SURE OF IT.

Nobody is tougher on a Johnson two-way radio than Johnson.

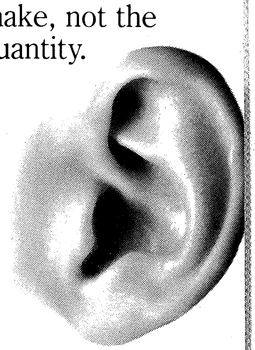
After we build our radio to precise standards, we put them through at least 42 different quality control tests.

Many of our radios are baked at 150°. Others are chilled at 40° below zero. And some are even put through vibration tests for hours at a time.

Why so much testing? Because in the unlikely event that one of our radios has a problem, we want to find out about it before you do.

WHEN YOU'RE NOT THE BEST-KNOWN RADIO, YOU HAVE TO BE THE BEST-MADE.

At Johnson we'd rather be known for the quality, of the radios we make, not the quantity.



That's why every Johnson two-way radio is built to deliver trouble-free performance. It's also why we offer one of the industry's best warranties. Because we know that seldom, if ever, will one of our radios be back for repairs.

Every Johnson radio is also backed by a nationwide network of dealers... providing parts, service and technical assistance whenever you might need it.

It's this kind of commitment that makes Johnson a leader in mobile communications.

It's also why when you're looking for the right two-way radio, you shouldn't just go with a name. You should go with the best. Johnson.

JOHNSON®
RADIO PRODUCTS DIVISION
E. F. JOHNSON COMPANY, WASECA, MINN. 56093