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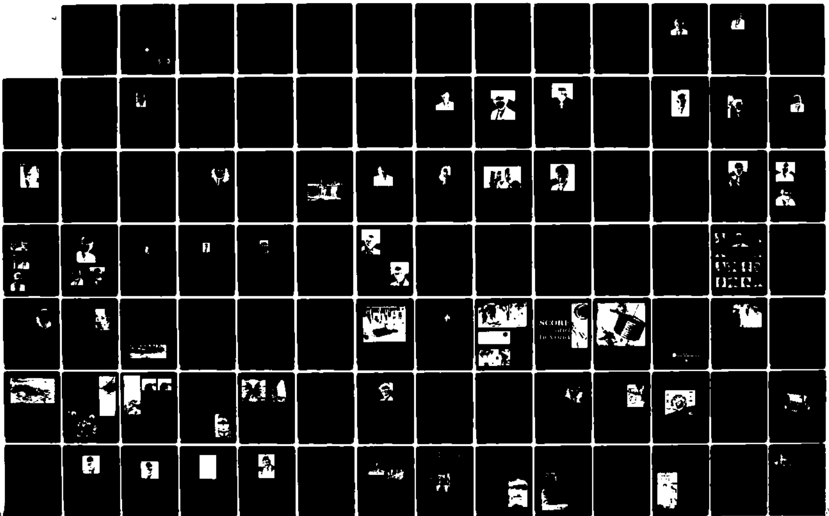

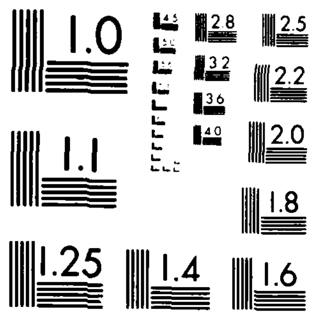

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THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

NEW JERSEY COAST SECTION

CENTENNIAL JOURNAL

9 MARCH 1984

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Several papers of historical significance to the history of Fort Monmouth, NJ and Bell Laboratories of Holmdel, NJ are given with the fellowship citations of the NJ Coast Section IEEE Fellows and major IEEE award winners with biographies and accomplishments.

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NEW JERSEY COAST SECTION

CENTENNIAL JOURNAL

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I

EDITORIALS

FROM THE CHAIRMAN

DAVID USECHAK

May 13, 1984 marks the centennial of the founding of the world's largest engineering and scientific society. That event, the founding of the IEEE under the original name of AIEE, signaled the emergence of electrical engineering as a recognized profession.

In celebration of the 100th anniversary of the Institute, the New Jersey Coast Section has prepared this journal which delineates the past 100 years in the Section. This journal contains discussions of significant outstanding achievements within the Section by the various companies and government agencies. In addition to the Section's most significant technological accomplishments, the reader will find a list of the Section IEEE Fellows, major award winners and past Section officers who have made valuable contributions to the electrical and electronics engineering profession.

As part of its 100th anniversary celebration the IEEE will award centennial medals to persons who have been selected as having made outstanding contributions in their respective areas of activity. The individuals who were selected by the NJ Coast Section and are recipients of the centennial medal are presented along with a short description of their individual accomplishments.

On behalf of the NJ Coast Section I want to congratulate all the engineers and scientists who have made the 100 years so very exciting and we all are looking forward to many more years of accomplishments in the art of communications.

SEYMOUR KREVSKY

FROM THE EDITOR

We thank ATT-Bell Laboratories of Short Hills and Holmdel, NJ, the U.S. Army Communications Electronics Command (DRSEL-IO), Dr. Hans K. Ziegler, Dr. Douglas O. Reudink, Mr. Irving Reingold, Joseph Ryan, Mr. Robert Kulinyi and the MITRE Corporation for their courtesies, time and material contributions to this journal.

The ATT-Bell accomplishments noted herein are those of the Crawford Hill and Holmdel Laboratories and specifically are germane to the NJ Coast Section's annals.

We owe a special thanks to our industrial supporters who helped make this journal possible and to Ms. Nancy Cross of MITRE Corporation for her dedication at the word processor.

More words here would not add to those golden statements presented by the IRE's founder, Alfred N. Goldsmith nor to those given by Ian M. Ross, President of ATT-Bell Laboratories nor those of that illustrious teller of chronicles, Dr. Harold A. Zahl.

Finally, to the current 2469 members of the NJ Coast Section - may your next 100 years be as fruitful!

Seymour Krevsky was born on 2 July 1920 in Elizabeth, New Jersey. He received the BS in EE degree from the Newark College of Engineering, Newark, New Jersey in 1942 and the MS in EE in 1950.

Mr. Krevsky's career has included [illegible] radio [illegible] engineering with the Signal Corps Engineering Laboratories in Fort Monmouth from 1942 to 1944 and 1946 to 195[illegible] with a gap for military service with the Army Air Corps' Air Technical Service Command at Wright Patterson Air Force Base, Dayton, Ohio. From 1950 to 1959 he was Chief, Microwave DF and Antenna Section of the SCEL Countermeasures Division. Mr. Krevsky joined RCA's Advanced Communications Laboratory in New York City from 1959 to June 1968 and returned to Fort Monmouth in June 1968 to the position of Deputy Director of the Engineering Directorate of US Army Communications Systems Agency. Currently he is a Member of the Technical Staff on the [illegible] Program with the MITRE Corporation, having retired from Government service in August [illegible].

Mr. Krevsky was chairman of the NJ Coast Section in 1972-73 and the NJ Coast Society Chapters on Communication 1966-67, Aerospace and Electronic Systems 1967-68 and is currently the Coast Section EMC/VT Chapter Chairman (1982-83 and 83-84). This EMC/VT Chapter won the "Chapter of the Year" award by the VT Society for 1983.

Shortening Shadows

ALFRED N. GOLDSMITH
Anniversary Editor

THE LIFE of a man or an organization has been aptly compared to the sequence of lights and shades during one day on earth. In the early morning, long shadows lie to the West as the sun rises. Then these shadows shorten as the day advances until no shadows are visible in the noonday blaze of light. And later, the shadows lengthen as the sunlight wanes, and twilight and night approach.

The Institute of Radio Engineers is fortunate in that it is still in its early morning amid the slowly shortening shadows. Its career is young and promising. Its hopes and accomplishments, while great and inspiring, are as yet only partly fulfilled. It has the cheerful stimulus of still being far even from the noon of its life, not to mention the evening.

Yet even at this early stage of the career of the Institute, an assessment of its accomplishments and an estimate of its future may be attempted. To this end, let us return in imagination to 1912, the year of the Institute's formation. It was a very different world from that of today. Knowledge of the communications and electronics field was limited. Vistas now clear were then dim or obscure. Professional standing and cooperation were not at today's encouraging levels. And the number of persons skilled in the electronics field was small indeed.

It was our privilege to be associated at that time with the other two founders of The Institute of Radio Engineers. Great tribute should be paid to these farsighted pioneers. Robert H. Marriott, President of the Wireless Institute (one of the merged societies which formed our Institute of Radio Engineers) was ever resourceful, determined, questioning, and analytic. And above all, he was an indefatigable worker and a thoughtful planner. John V. L. Hogan was a highly skilled, inventive, and forceful pioneer. He was that rare combination: a man both human in his reactions and humane in his instincts. Without the broad understanding and generosity of these men, our Institute might never have come into being.

The original builders of the IRE were certainly no example of squatting on their hunkers.

They were strong exponents of a much more logical creed that work conquers all. And work they did, over the passing years, and in the face of many obstacles.

Yet they were fortunate as the years went on in encountering an ever more favorable and respected environment. There were numerous fortuitous helpful events, and there were also many planned and logical campaigns. The founders and their many associates were able to function partly because of three major factors. One factor was the dependable and increasing devotion and effort of the membership. It would be impossible to exaggerate the sacrifices and labor which the membership readily gave the succession of officers of the Institute over the years. The second factor was the continued and friendly cooperation of the communications and electronics industry. Industry fully understood the work of the Institute and enthusiastically backed its efforts and expansion. And the third factor was the truly explosive growth of electronics, which provided an opportunity and a challenge which were gladly accepted and turned to the advantage of the Institute. And the Institute in turn contributed greatly to that expansion over the years. Thus the membership, industry, and the expansion of the electronics field offered the Institute its opportunities. Nor should it be forgotten that governments showed a clear understanding of the worth of the activities of the Institute and encouraged their officials, scientists, and engineers to affiliate with the Institute and to aid in its upbuilding. To all of these forces recognition must be given and gratitude expressed.

Yet growth itself, from a numerical viewpoint, is not enough to ensure the basic success of any professional organization or learned society. It must retain its personality. It must maintain its ideas and ideals. It must display continuing vitality. It must avoid entangling alliances or deviations from its true purpose. Accordingly it became necessary for the IRE carefully to plan its growth along statesmanlike lines to the end that it would remain as youthful and vigorous as in its earliest days. It would be too lengthy a recital to go into the details of the appropriate measures adopted by the Institute to accomplish its aims. Some of these measures have become classic and have blazed the trail for other engineering organizations which have wisely seen fit to adopt them. The IRE established its Sections to meet the needs of members in a city and its environs. It established subsections to fulfill the needs of smaller numbers of members in suburban sections or in smaller population centers. It coordinated the activities of Sections and subsections over large territories through the formation of Regional administrations. It coordinated Regional activities through National divisions or their equivalent.

And, in addition to these "horizontal organizations," the Institute established vertical organizations of all persons among its membership interested in a particular specialty. This led to the formation of Professional Groups and of their local Chapters. Undoubtedly the end is not yet. Additional organizations or administrations, and new forms of publication may in time be needed to meet the ever-increasing desires of the membership. And, if the past is any index to the future, the necessary statesmanship will be found to meet any current needs.

The IRE has carefully avoided such measures as would lead to its grounding on the shoals of disaster which often lie in the path of learned societies as they expand toward maturity. These pitfalls include insufficient interest in the organization by the individual member, of local geographic groups of members, of larger or regional groups of members, and of members imbued with a sense of the national dignity of their compatriot members. Also avoided was the development of insufficient interest resulting from the diverse activities of individual members of the Institute—a situation which was well met by the Professional Groups. More broadly, the Institute has also avoided the dangers of involvement with political, sectional, partisan, commercial, or personal viewpoints and activities which were not of a definitely engineering and scientific nature. It is easy for a learned society to forget its basic purpose of a search for truth, or for an engineering institute to forget that the practice of its profession for the benefit of humanity is its basic aim. The membership of the IRE may be proud in reviewing the past of the Institute and noting its complete detachment from purposes alien to its basic aims.

However, the Institute has not established itself in a guarded ivory tower and without contact or collaboration with others. One of its aims is continued cooperation and even coordinated activity or a suitable degree of integration with other engineering and scientific organizations. Wherever the IRE could help in the organization, operation, or publication activities of conventions, conferences, or symposia in collaboration with other engineering societies of standing, it has done so unhesitatingly and, at times, with considerable sacrifice. Since the establishment of the IRE Professional Groups, this type of cooperation has been greatly broadened. In fact, the roster of joint meetings or the like in which the IRE is engaged is almost startling in its dimensions.

One very important aspect of The Institute of Radio Engineers is its international nature, prescribed by its charter and consistently carried out in its activities. It has been said that science knows no country and that truth is universal. Such fields as communications and electronics are peculiarly adapted to the application of such doctrines, to the utmost practical limits.

Speaking more lightly, the techniques of communications and electronics might even make it logical that the scope of the IRE should ultimately become cosmic. We might look forward to the establishment of lunar and planetary Regions and Sections of the Institute in due course. And after that, who knows? But who would dare place finite limitations on the activities and studies which reach outward with the speed of light toward the infinite?

It may not be amiss also to emphasize that The Institute of Radio Engineers has sought and achieved a unique form of leadership in its dedicated field. In the world there are indeed many types of leadership. Some men, political parties, or nations maintain important positions of power or influence by brute force and iron discipline. Some organizations hold their eminence through guile, subtle persuasion, empty promises, or deceptive practices. But The Institute of Radio Engineers, the mental child and professional expression of its membership, holds its leadership only by service and accomplishment. Its sole aim is ever to give more to humanity and to its members. Its accomplishments require little recital or egotistical praise. They speak for themselves, and win hearty approval of all candid observers.

Thus the Institute will remain as a symbol of an epoch—the age of the approaching welfare, comfort, and health of every man on earth, and of man's conquest of space. And so, in the spirit of selfless aspirations to serve the interests of the people of the world and to express the best professional aims and accomplishments of its membership, The Institute of Radio Engineers looks forward through the decades and centuries toward ever wider, more useful, and more enlightening accomplishments.

Centennial perspective

by Ian M. Ross

The IEEE celebrates its Centennial in a world that has become much smaller in the last 100 years. But the technological revolution responsible for this change has only begun.

Advances in telecommunications have altered society's notions of time and space forever. In 1884, those without service from the fledgling telephone company were quite willing to accept overnight delivery of a telegram, while today we drum our fingers impatiently when faced with a brief delay in getting a dial tone. In 1884, a New Yorker could telephone Boston but could not yet call Philadelphia, whereas today we can dial directly from New York to Tokyo as easily as from Manhattan to Brooklyn.

This remarkable progress has been driven by technology, by the work of dedicated scientists and engineers. Much credit accrues to the contributions of electrical and electronics engineers. They, probably more than any other group, have been the creators and architects of a worldwide system of instantaneous telecommunications.

In the last 100 years, we have come very close to realizing a dream that AT&T's founders had of connecting every city and town in the United States with the rest of the "known world." Given the state of electrical communications technology then, that was a rather ambitious goal—some might say a brazen one. But the goal setters had faith that the intelligence, competence, and drive of the professional engineer would overcome the obstacles.

Now that universal telephone service has been achieved in this and many other nations, we must set our goals even higher. We must plan and work toward those capabilities that will make data and video communication as available and usable as telephone communication.

In doing so, we will redefine the communications industry and its requirements. We must not only transmit enormous amounts of information rapidly, but process and present it in a manner that makes it most useful for people. Also, we must devise the hardware and software to make computers more responsive to humans. We must, for example, develop computers that understand oral instructions with tolerance for individual differences in pronunciation, syntax, and organization. We must use them to free human intelligence and talents to work at optimum levels.

Once again, it will be the product of the engineer and the scientist that will make these goals achievable. Continuing advances in microelectronics and photonics are beginning to make such Information Age goals economically and technically feasible. Today we can put more than a half-million components on a fingernail-size chip. And the equivalent cost of a transistor is less than one-hundredth of a cent—a thousandfold cheaper than the cost of a quality transistor 20 years ago. There is no question that we will soon surpass a million components on a chip and ultimately reach 100 million. Even a billion-component chip may be a physical possibility within a few decades.

These advances, coupled with the enormous transmission power of lightwave communications, promise to add a new dimension to human communications and the expansion and transfer of knowledge. Both the rate at which information can be sent through light-guide fibers and the distance the information can travel without amplification have increased dramatically. In fact, the product of rate and distance is doubling yearly—and probably will continue for the rest of the decade.

As a result of such advances, the benefits to education, medicine, business, and science of a world girded by the most up-to-date, rapid, and sophisticated communications and information-management systems are innumerable. Certainly they will have a profound influence on political, economic, and social activity. They will just as certainly change society in ways that cannot be foreseen. To some extent we will enter this era on faith, not sure where it will lead, but ready to control it, change it, or adapt it so that the outcome is favorable.

Bringing a new dimension to international communications will be vital to this era. It will also present a new challenge to the engineering profession, perhaps the greatest ever confronted—that of designing an international system of fully compatible networks. To accomplish this, global standards must be set. Unfortunately, standards can be used as barriers, perhaps providing some initial advantages but inhibiting real technological and economic progress. All nations should take an enlightened and positive approach toward achieving a balance between competition and cooperation in advancing telecommunications.

We must also work to maintain an open exchange of scientific and technological information. In view of the increasing convergence of communication and information management in a highly competitive and politically fragmented world, this is going to be a major challenge for us all.

Those of us in the electrical and electronics engineering profession are ultimately the stewards of the Information Age. We must use our understanding of the technological issues and our influence to ensure that the potential benefits of this era are fully realized. We have come too far in these 100 years and done too well to fall short of that objective now.

Ian M. Ross is president of AT&T Bell Laboratories and a member of the IEEE Honorary Centennial Committee.

One Hundred Years of Service

THIS issue of the IRE TRANSACTIONS ON MILITARY ELECTRONICS is devoted entirely to the U. S. Army Signal Corps in recognition of its centennial anniversary of service to the nation. Selected articles within these pages will give the reader an appreciation of some of the Corps' brilliant history as well as its approach to the solution of current scientific problems.

This centennial anniversary brackets a hundred-year segment of colorful and fast-moving military history. It has been a period of singular extensions of science as applied to the battlefield. Notable among them have been advances in all three essential elements of military operations: firepower, mobility, and communications.

The history of progress in military electronics has been a history of cooperative enterprise. In a series of instances, advances by industry have applied directly to the battlefield; in others, military need has sparked creative invention that led to wholly new products in industry. Throughout the century, the progress of one has extended the progress of the other. Today, such joint effort, spanning all aspects of technology, lies at the base of our national military strength.

While the Army Signal Corps' 100th anniversary marks a past period of progress, it also marks the entrance of the Corps into a future of far greater challenge. This future begins in an era when a single advance in technology is exerting more impact on military science than any other event in the history of warfare—the development and control of nuclear reactions that can readily be applied to battlefield weapons. Their impact on tactics, and in turn upon the sciences fitted to their support, is far-reaching, especially in communications-electronics. We see versatile nuclear weapons capable of dominating the battlefield of the future and introducing the greatest firepower increase in history, yet requiring a proportionate increase in mobility for ground combat. As a result of the advances in missile science, we have a new artillery capable of unprecedented destruction at great ranges, with both sides in combat being capable of massive blows delivered with great flexibility.

Preparedness in the nuclear field, however, does not necessarily forecast that all engagements of the future will see the use of these weapons. Indeed, many types of military operations may be conducted without them. The decisions as to these matters will be made at the highest levels and will be based on national objectives and national policy for the particular case in hand. The preparation for possible future combat, therefore, demands development of a state of readiness covering a wide variety of situations and circumstances.

Fitted to such varying tactical situations are the Army's new organizational concepts which are keyed to the application of graduated force, and have the dual *capability for conventional combat, or for hard-hitting* application of nuclear weapons. But their proper functioning in combat presents one of the greatest communications-electronics challenges in history. Consider the necessarily wide dispersal of troops of both sides on the battlefield. When a situation arises that can be exploited, commanders must not only get the facts quickly, and often from a distance, as the situation develops, but must be able to process and disseminate their decisions *to all elements in a timely fashion. A rapid and reliable* battlefield-information process, together with fast and precise command control over units widely dispersed across the combat area, are indispensable partners to future success in ground combat.

Among the key scientific systems needed for the modern army, therefore, is one of combat area surveillance for information on enemy movement and for the location of timely targets this movement presents. Its system concepts and indeed the development of many of its components are well under way, spanning an array of sensory means including radar, infrared, photographic, visual, acoustic, seismic, radiometric and meteorological devices.

Army communications systems serving the dual needs of conventional or nuclear combat emphasize three characteristics to a greater degree than in the past: they must provide a greatly increased communications capacity per military unit; they must span greater distances; and they must possess a high degree of systems interconnectivity.

To support these greater communications-electronics needs, all of us must probe into extended uses of the science, for example, into space vehicles for communications and combat surveillance purposes, messenger drones as ground-directed relay points, and even into the creation of artificial ionospheres as short-time conveyors of military intelligence. Added to these are perhaps a dozen more approaches toward an increase in communications capacity. As history repeats, their solution will come through the joint imagination and teamwork of industrial and service laboratories; and again this solution will both strengthen the national security, and pay substantial dividends through civilian application to the nation as a whole.

The Army Signal Corps joins with its colleagues of the IRE, industry, and the other military services in attacking the scientific problems of military electronics. It is the Corps' proud hope that its second century of existence will provide even greater opportunities for service to the nation.

COL. HAROLD McD. BROWN, *Guest Editor*

September 1976 *Vol. 64* *No. :*

PROCEEDINGS OF THE IEEE

Scanning the Issue

SPECIAL ISSUE ON TWO CENTURIES IN RETROSPECT

Matters in electrical science and engineering were not always as they are now. Our first sources, batteries and machines, had to be conceived, systems had to be developed in which the sources could operate efficiently, and the ac-dc controversy had to be resolved. The telephone was almost not invented, so eager were the entrepreneurs to expand the capabilities of the telegraph.

Steinmetz, Kennelly, and Pupin had to carry on a lengthy campaign of education in the pages of the *AIEE Transactions*, that the "electricians" of the early days might improve their abilities in mathematical understanding, in order to design and build the components of the advancing and enlarging systems. Analysis of the ac system did not arrive full-feathered–the sine wave was not a fortuitous result of the ac system, since Fourier analysis was not a common skill of the early members of the profession. The intricacies of inductance had to be explored–even the name "reactance" was debated–and the use of complex algebra and *j* was long fought for before the proponents of the useful but unwieldy vector diagram were overcome.

The hard work that went into the electrical field's early development should be a source of pride to those in the profession today. But to derive that sense of pride we must have knowledge of that early history. Thus we have the IEEE History Committee's mission to seek for and disseminate historical knowledge, exemplified by this Special Bicentennial-Year Issue, devoted to the general theme of the history of electrical science and engineering in the U.S.

However this Special Issue has not been executed in the traditional anniversary-issue style and format. The issue represents, in fact, an unusual–if not unprecedented–experiment by an engineering journal in that over half the papers are contributions from historians rather than from engineers. That this experiment in intercultural collaboration could be undertaken at all was the result of a singular conjunction of circumstances and personalities that itself might someday be studied by historians.

In planning the issue, the Guest Editors made a deliberate decision to avoid the chimerical goal of a comprehensive coverage of every facet of electrical history, even in the United States, over the past two hundred years. Instead, we adopted the strategy of inviting some leading electrical historians to write on topics that were in their field of special interest and competence. Somewhat surprisingly, we found that the resulting collection of papers revealed numerous linkages and a relatively broad coverage. From the editors' perspective, the papers in this issue provide a reasonably good summary of the current state of the field in electrical history, showing both its strengths and weaknesses. We believe it should not be surprising to find large gaps of knowledge when one considers the enormous disparity in the numbers of professionally trained historians and professional engineers, and the even greater disparity of support of research in the two fields. This Special Issue should, therefore, be viewed as more of a demonstration of needs and opportunities for historical research than as a definitive work.

The Editors are convinced that more effective communication between humanists and engineers is possible and should be encouraged. Too often historians of technology seem to have communicated mainly with other historians, and engineers with other engineers. Engineers traditionally have been taught to be forward-looking and agents of change rather than to be contemplative, with pride and knowledge of their professional heritage. Yet, as Lynn White pointed out in an essay entitled "Engineers and the Making of a New Humanism," one characteristic of a mature profession is a conscious appreciation of its history. That contemplative historian-engineers can contribute to the writing of engineering history as well as to its appreciation is demonstrated by a number of papers in this issue. These engineers who are authors of these papers have profited from their privileged perspective as participants in the activities described, and their accounts are enriched by personal reminiscences. The professional historians have demonstrated the value of seeking a variety of sources, including unpublished manuscripts and oral interviews. Their contributions in this issue also show that historical "facts" are often difficult to ascertain and do not speak for themselves but require informed interpretation.

Some recent events suggest that electrical history may be approaching the "invisible college" status that seems always to precede the emergence of a new scholarly discipline. Sessions on electrical history were held at the annual meetings of the Society for the History of Technology (SHOT) in 1970, 1972 and 1974. The "Jovians," a group of members of SHOT who share an interest and enthusiasm for electrical history, have held meetings during the SHOT convention each year since 1971. A number of the Jovians have contributed to this issue. An electrical history archive was established by the Smithsonian Institution in 1973, with some financial support by the IEEE Life Member Fund (LMF) arranged by the IEEE History Committee. An LMF grant also was instrumental in the compilation and publication of a guide to manuscripts relating to electrical history by the Smithsonian's Division of Electricity in 1974. This was compiled by David Hounshell, who is among the contributors to this issue. The LMF and IEEE History Committee have also sponsored development of several slide presentations on electrical history and a forthcoming directory of electrical museums and artifact collections. The artifact directory was compiled by Robert Belfield, also a contributor to this issue. Both the directory and slide collections will be distributed by the Smithsonian Division of Electricity. An archive documenting the growth of physics and electrical engineering in the western United States was established at the Bancroft Library of the University of California, Berkeley, in 1973. The project coordinator at the Bancroft Library is A. L. Norberg, who has written a paper for this issue in which he has drawn on the collections of this important project.

Perhaps the most significant development for the future increase and diffusion of knowledge in electrical history is a recently announced agreement between the IEEE History Committee and the Administrative Committee of the Education Group. This agreement provides for regular publication of electrical history papers in the *IEEE Transactions on Education* and appointment of an Associate Editor for History. All IEEE members who have or who would like to develop an interest in the history of their profession and its founders are encouraged to join the Education Group and to contribute manuscripts for consideration.

J. D. RYDER
J. E. BRITTAIN
Guest Editors

II

CENTENNIAL AWARD WINNERS

IEEE REGION 1 AWARD

JOHN G. NORDAHL

Electrical Engineer/Manager-Retired
40 Riverside Avenue
Red Bank, NJ

An outstanding career in engineering management which he has extended well into retirement by accepting voluntary and part-time assignments to solve local and national problems.

Nordahl holds a BS in EE from the University of Washington and did graduate work at Columbia University. He is a member of Tau Beta Pi, is a licensed Professional Engineer, and is a Senior Life Member of the IEEE.

Nordahl's career was with the Bell Telephone Laboratories from 1925 to 1968, where developed radio transmitters managed a production group at Western Electric, and directed aspects of the Nike Zeus anti-ICBM program. He was instrumental in selecting and setting up the Nike Zeus test range on Kwajalein Island. Later he managed the "Value Engineering" for this program, leading to outstanding cost savings.

Especially noteworthy have been his volunteer and part-time contributions,following his retirement. He served as manager for the Federal Emergency Management Agency in disaster areas and as a counselor for the Service Core of Retired Executives (SCORE) in Monmouth County.

IEEE REGION 1 CENTENNIAL AWARD
and
NJ COAST SECTION CENTENNIAL AWARD

MARTIN V. SCHNEIDER

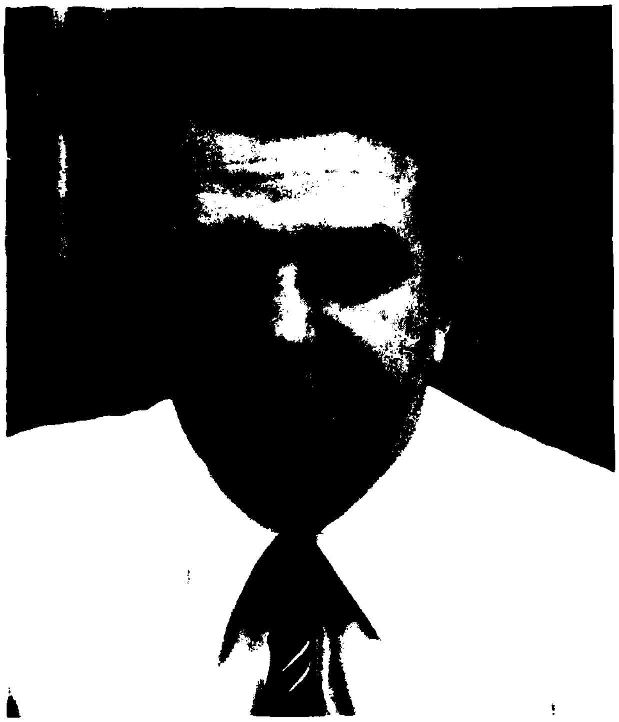
Research Supervisor
Radio Physics Research Department
Bell Laboratories, Holmdel, NJ

FOR

Outstanding record on contributions and related publications in the fields of semiconductor devices and thin film circuits at microwave millimeter-wave and optical frequencies.

Long service to the IEEE, including Joint Group Chapter Chairperson MTT, ED & QFA, NJ Coast Section IEEE, 1982/83. Initiator of tri-chapter meetings held jointly with North Jersey and Princeton MTT Group Chapters at Rutgers University. Initiated foundation of the Swiss and Scandinavian IEEE-MIT Group Chapters.

NJ COAST SECTION CENTENNIAL AWARD



ROBERT C. ECKENFELDER

Director of Engineering
Bendix Electric Power Division
Eatontown, NJ

A recognized authority in the application of solid-state circuit designs, Eckenfelder has contributed to the development of scores of electric power systems used in both military and commercial aircraft. He designed the first transistorized AC voltage regulator to be used in aircraft; and managed a number of important electric power system programs for such applications as the U.S. Air Force B52-G, Boeing 747, NASA's highly successful Orbiting Astronomical Observatory, and the recent Gulfstream Aerospace GIII. This latter system is the latest state-of-the-art Variable Speed Constant Frequency (VSCF) System, the first ever to be used in commercial/business jet aircraft.

Eckenfelder is a 1954 graduate of New York University, holding a B. S. in Engineering Physics, and has attended graduate school at City College of New York. He holds a number of patents in control systems and power conversion equipment. Of recent significance is a patent entitled "Polyphase Transformer for a Variable Speed, Constant Frequency System", co-invented with R. Kautz; and a patent entitled "DV/DT Circuit for Use in DC Link Converters", co-invented with L. Bourgeault and R. Kautz.

A member of the IEEE, U. S. Navy League and the American Defense Preparedness Association, Eckenfelder has served as a board member and engineering curricula advisor at Monmouth College.

NJ COAST CENTENNIAL AWARD

A. GARDNER FOX

Head, Radio Systems Research Department
Crawford Hill Laboratory
ATT-Bell Laboratories
Holmdel, NJ

FOR

Outstanding contributions to the Microwave Art including many microwave advancements and authoring chapters in noteworthy texts such as George Southworth's "Principles and Applications of Waveguide Transmission".

As head of the Radio System Research Department at the Crawford Hill Laboratory, he generated many publications for the IEEE and earned 53 patents. He has received the Microwave Career Award of the IEEE Quantum Electronics Society in 1978, the IEEE Fellow Award in 1956 as well as the David Sarnoff Award in 1979.

N[illegible]ENTENNIAL AWARD

BRUCE C. MILLER

Chief Electromagnetic Vulnerability and
Electronic Counter-Counter Measures (ECCM) Division
Electronic Warfare Laboratory
Fort Monmouth, NJ

FOR

Service to the Government as leader and engineer in the field of electronic defense. Numerous contributions in the areas of vulnerability/ECCM for avionics systems, electromagnetic compatibility, and electromagnetic interference control techniques.

NJ COAST SECTION CENTENNIAL AWARD

VASANT K. PRABHU

Distinguished Member of Technical Staff
Bell Laboratories
West Long Branch, NJ

FOR

Outstanding record on contributions and related publications in the fields of digital modulation, phase shift keying systems and error rate analysis.

Service to the IEEE as NJ Coast Section Chairperson 1974-75 and Associate Editor of the IEEE Transactions on Communications 1976-1979.

NJ COAST SECTION CENTENNIAL AWARD

LUKE G. SCHIMPF

Retired, 1984; ATT-Bell Laboratories
West Long Branch, NJ

Over a career at Bell Labs which has spanned 4-1/2 decades, Luke Schimpf has contributed significantly to a number of communication disciplines, notably radio paging, telephone transmission and mobile telephone. From the battlefields of Africa (World War II) to the radio research laboratory, Luke has never lost his inquisitiveness and his ability to take a job from the idea stage to the working system. In particular, Luke is recognized in the industry as a pioneer in the concept of radio paging which keeps millions of subscribers within reach of their secretaries while away from the office.

An indication of the scope of Luke's contributions are his 13 patents and many papers, principally in the field of mobile telephony.

As Luke nears 70 years of age, he continues to set an example for his younger colleagues in dedication to the cause of efficient, economical and ubiquitious communication.

NJ COAST SECTION CENTENNIAL AWARD

ROBERT W. WILSON

Head Radio Physics Research Department
Bell Laboratories
Holmdel, NJ

Discovered the microwave cosmic background radiation of 3K with the Echo/Telstar hornreflector antenna stationed at Crawford Hill in Holmdel, NJ.

Wilson is one of the few Laureates who has continued working at the bench after receiving the Nobel Prize in Physics in 1978. His experimental work has led to new discoveries in the fields of star formation and giant molecular clouds in our Galaxy.

NJ COAST SECTION CENTENNIAL AWARD

MARY N. YOUSSEF

Associate Professor, Department of Statistics
and Computer Information Systems
City University of New York, NY

1. Switching System Design - Youssef solved one of the most difficult and persistent problems in the area of switching. She defined and developed optimal design rules for interconnecting the outlets of a switching system to the serving trunks. These rules are now implemented throughout the Bell System.

2. Forecasting Methods - She developed an interactive computer system for model building and forecasting of telephone usage demand and formulated improved and useful methods for projecting telecommunication requirements.

3. Performance Evaluation of Systems and Networks - Mary devised and implemented numerous large scale simulators for evaluating system and network performance in the Bell System. Her simulators are widely used by AT&T and the Operating Companies. She also developed useful analytical methods for estimating the carrying capacities and blocking probabilities of systems.

4. Teaching in Academia - Professor Youssef is highly respected and admired as a first rate teacher and researcher by her faculty and students at the City University of New York. In addition to her teaching responsibilities she conducts master thesis seminars and supervises most of the graduate students in the Department.

5. Services to the IEEE - Dr. Youssef has served as a reviewer of technical papers for IEEE sponsored conferences (National Telecommunication Conference, NTC, and International Communication Conference, ITC). She gave a course on "Local Area Networks" for the NJ Coast Section IEEE and the Group Chapters on Computers, MTT, ED & QAE. This course was the best attended and presented lecture of the whole 1982-83 seminar series sponsored by the IEEE Section and its Group Chapters.

III

IEEE

MAJOR AWARD WINNERS

HARALD T. FRIIS

- Morris N. Liebmann Memorial Award - 1939
- IRE Medal of Honor - 1955
- Mervin J. Kelly Award - 1964

Moving Spirit of the "Old" Holmdel

Early in 1920, before Bell Laboratories was formed, a young man who had arrived in the United States a year earlier from Denmark was sent by his employer, Western Electric, to work in a small shack in Elberon, New Jersey. His desk consisted of a board over two packing cases and his job was to study and measure radio reception from ships.

From that day on, Harald Friis made a fair amount of history in radio research. He, and later a group that worked under his leadership, moved soon to a laboratory at nearby Cliffwood and later to Holmdel. There, at the "old" Holmdel lab, long before Bell Laboratories built a major installation in the same neighborhood, Friis and his associates set the course of major developments in radiotelephony, first in shortwave and later in microwave systems.

Friis had no sooner set foot in Elberon than he devised significant circuit improvements in the equipment he was to work with there. A couple of years later he produced, on hurry-up notice, the first superheterodyne broadcast radio receiver—the forerunner, actually, of present-day sets. Then followed, in succession, a receiver that would automatically compensate for fading signals, a more directional antenna, and methods for recording static and measuring shortwave signals as they faded. It was an antenna designed by Friis that Karl Jansky was using when he discovered the "star noise" that led to the science of radio astronomy (see page 107). In a memoir Friis wrote years later, after he had retired, he remarked, "Note that the inventions always originated because of a definite need."

The rhombic antenna, designed by Friis and Edmond Bruce, found worldwide use in shortwave radiotelephony, which could hardly have been the same without it. Another system called MUSA (Multiple Unit Steerable Antenna) was not practical for general use but made it possible, in Friis' words, to unravel the phenomena of shortwave transmission. As has also been pointed out, electronically steerable antennas have recently become important in ballistic missile defense systems.

Moving on from shortwaves to microwaves, Friis and another associate, A. C. Beck, created the horn-reflector antenna now seen everywhere on microwave relay towers; and the Holmdel group as a whole investigated all aspects of microwave systems. By the time World War II started, in fact, they were quite prepared to go ahead with microwave transmission, for which the major components were by that time available. So it was that in 1947, soon after the war ended, AT&T was able to place the first experimental microwave relay system in operation.

Friis himself has said that his formula for radio transmission in free space, evolved in the 1930's but first published after World War II,* is his most important contribution. "This formula," his memoir says, "is used in designing the microwave communication system that now covers all of the U.S.A. The adjective simple has been applied several times, but the problems were actually not so simple before they had been solved."

Others have emphasized other aspects of Friis' strength. Ralph Bown, who was vice president for research at Bell Laboratories for several years, once said that Friis' notes told more about the conduct of research than all the books printed on the subject. John Pierce had the notes privately published under the title, "The Wisdom of Harald Friis," and added some interpretive comments of his own based on discussion with Friis. There is room here for just a few of the many ideas Friis brought together.

While big research projects might have to start with "the boss," he said, it is much better on small jobs to have the initiative come from the research worker. The boss's function is to help a

*"A Note on a Simple Transmission Formula," *Proceedings of the IRE*, Vol 34 (May, 1946), pp. 254-6.

man do some clearly defined, worthwhile thing. The worker should be sure there is a real need and that the state of the art is ready for his effort. And if he is the right man for the job, it should haunt him day and night. If the importance of the job has decreased with time, or results are meager, it should be stopped.

One more thought, at the end of Friis' notes, can also end this sketch. The worker should remember, he said, that some credit belongs to the laboratory employing him; and in discussion with Pierce he modestly added, "The fact that I was planted in the Labs, and all the background, that was everything, John."

Friis (second from left) discusses an experimental circular waveguide with Bell Laboratories executives Ralph Bown (left) and Mervin J. Kelly in 1948

R. Kompfner

David Sarnoff Award - 1960
IEEE Medal of Honor - 1973

RUDOLF KOMPFNER

Inventor of the Traveling Wave Tube
IEEE Medal of Honor 1973
David Sarnoff Award 1960

Rudolf Kompfner has been awarded the 1973 IEEE Medal of Honor, the highest honor awarded to an individual by IEEE "for a major contribution to world-wide communication through the conception of the traveling wave tube embodying a new principle of amplification." A native of Vienna, Austria, Dr. Kompfner received the degree of Diplom-Ingenieur in 1933. He practiced architecture in London, England, till 1941 pursuing physics and radio engineering as a hobby. Physics and radio engineering became his main profession when the British Admiralty offered him a position in 1941 under Professor M. L. Oliphant at Birmingham University. It was at Birmingham University that Dr. Kompfner invented the traveling wave tube (1943). From 1944 he worked for the various British government institutions, including University of Oxford, where he received the D.Phil degree in 1951. Projects "Echo" and TELSTAR were carried out under his general direction at Bell Laboratories. He was named Director of Electronics Research in 1955, Director of Electronics and Radio Research in 1957 and assumed his present position of Associate Executive Director, Research, Communication Sciences Division in 1962. He is the recipient of the 1955 Duddell Medal of the Physical Society of England. Also he was awarded the David Sarnoff Award by the American Institute of Electrical Engineers in 1960 for creative achievements and leadership in the field of Research and Development. Also in 1960 he received the Stuart Ballantine Medal of the Franklin Institute. Dr. Kompfner is a Fellow of the IEEE and a member of the National Academy of Engineering and the National Academy of Sciences.

ALEXANDER GRAHAM BELL MEDAL

The principal award for exceptional contributions to the advancement of telecommunications.

AMOS E. JOEL, JR.

1976

Mr. Joel was co-recipient in 1976 of the IEEE Alexander Graham Bell Medal for "the conception and development of electronic switching systems and their effective introduction into a nationwide telephone system." He shares the medal with W. Keister and R. W. Ketchledge.

He is a switching consultant at Bell Labs in Holmdel, NJ. His work currently centers on surveys and evaluations of new telephone switching systems developments in the United States and abroad.

Mr. Joel joined Bell Labs in 1940. He worked initially on fundamental development studies of telephone switching systems. During World War II, he designed circuits for early general-purpose digital computers and was instrumental in developing secret-message coding and decoding machines for military and diplomatic use. Following the war, he proposed, prepared, and taught a Bell System course on switching system and circuit design. Later, he was involved in the design of automatic message accounting equipment to automate telephone billing, and in fundamental engineering studies of electronic switching systems.

A pioneer in ESS development work, from 1952 to 1961 Mr. Joel supervised development planning for the Bell System's first electronic telephone switching systems and helped prove the concept of electronic switching for use in the nationwide network. From 1961 to 1967, he was responsible for the development of the Traffic Service Position System, used to automate the work of telephone operators, and the Automatic Intercept System, used to automatically handle calls to nonworking numbers. Both systems are in service throughout the nation.

Mr. Joel received bachelor's and master's degrees in electrical engineering from the Massachusetts Institute of Technology.

ALEXANDER GRAHAM BELL MEDAL

The principal award for exceptional contributions to the advancement of telecommunications.

John Mayo M. Robert Aaron Eric Sumner

1978

Mr. Robert Aaron has been elected as a co-recipient of the 1978 Alexander Graham Bell Medal for personal contributions to, and leadership in, the practical realization of high-speed digital communications. He shares the medal with J. S. Mayo and E. E. Summer.

Mr. Aaron joined Bell Laboratories in 1951 after receiving the BS (1949) and MS (1951) in Electrical Engineering from the University of Pennsylvania. He is head of the Digital Techniques Department working on exploratory development of digital signal processing terminals and techniques. Since joining Bell Laboratories, he made numerous contributions to various areas, such as computer aided design, submarine cable system, and the TI carrier system.

He is a Fellow of IEEE and the American Association for the Advancement of Science.

EDISON MEDAL

For a career of meritorious achievement in the electrical sciences

C. CHAPIN CUTLER

1981

JOHN R. PIERCE

1963

(See TELSTAR)

HARRY DIAMOND MEMORIAL AWARD

For outstanding technical contributions in the field of government service.

MARCEL J. E. GOLAY

1951

HAROLD ZAHL

1954

GEORG J. E. GOUBAU

1957

HELMUT L. BRUECKMANN

1961

JOHN J. EGLI

1966

HAROLD JACOBS

1973

HARRY DIAMOND AWARD

HAROLD A. ZAHL

1954

Received the B.S. degree from North Central College, Naperville, IL, in 1927, the M.S. degree in 1929 and the Ph. D. degree in physics in 1931 from the State University of Iowa, Iowa City.

From 1927 to 1931 he was a research assistant at Iowa. In 1931 he became a research physicist at the U.S. Army Signal Research and Development Laboratory in Fort Monmouth, NJ, where he was director of research until 1948. From 1942 to 1946, he was an officer in the Signal Corps, and as a Lieutenant Colonel was involved in the work with the Bikini Atomic Tests in 1946. In the same year, he received the Legion of Merit. He authored 50 technical publications in the fields of molecular and atomic physics, xrays, acoustics, thermodynamics, and astroelectronics. He had patents issued for work in radar, communications, electron tubes, infrared and aircraft instruments.

Dr. Zahl was a Fellow of the American Physical Society and in 1971, received the National Honor Award of the Armed Forces Communications and Electronics Association.

HARRY DIAMOND AWARD

HAROLD JACOBS

1973

Harold Jacobs received the 1973 Harry Diamond Award "for identification of new bulk semiconductor effects at millimeter waves, with application to the fields of imaging and surveillance." Dr. Jacobs passed away on December 24, 1983 and is sorely missed.

A native of Portchester, NY, Dr. Jacobs was a senior research scientist in the Electronics Technology and Devices laboratory of the U.S. Army Electronics Command, Fort Monmouth, NJ. He joined the USAEC in 1949 after serving as a physicist at RCA Manufacturing Company and Sylvania Electric Corporation. He was also active in engineering education having served part time on the faculty of Polytechnic Institute of Brooklyn and was chairman and professor in the Electronic Engineering Department of Monmouth College. He has worked in the fields of electron tubes, solid state devices, quantum electronics, millimeter waves devices and systems, and submillimeter wave lasers. He received the B.A. degree from Johns Hopkins University and the Ph. D. degree from New York University in 1945. Dr. Jacobs was elected a Fellow of the IEEE in 1967. He was given the Decoration for Exceptional Civilian Service by the Department of the Army in April of 1969 for his work on advancing the field of semiconductor millimeter wave devices and opening new research horizons involving submillimeter wave concepts. He was program chairman for the 4th Department of Defense Conference on Laser Technology in San Diego, CA, in January 1970. He was the Army member of the Special Group on Optical Lasers sponsored by the Department of Defense. He was also Chairman of the Group IV Materials Committee of the IEEE.

MORRIS N. LIEBMANN MEMORIAL AWARD

For important contributions to emerging technologies

STEWART E. MILLER

1972

Stewart E. Miller received the 1972 Morris N. Liebmann Award "for pioneering research in guided millimeter wave and optical transmission systems." Mr. Miller is Director of the Guided Wave Research Laboratory, Bell Laboratories, Holmdel, NJ, where he is concerned with the exploration of the use of lasers and associated devices in transmission. He is an MIT graduate and a Fellow of IEEE.

WILLARD S. BOYLE

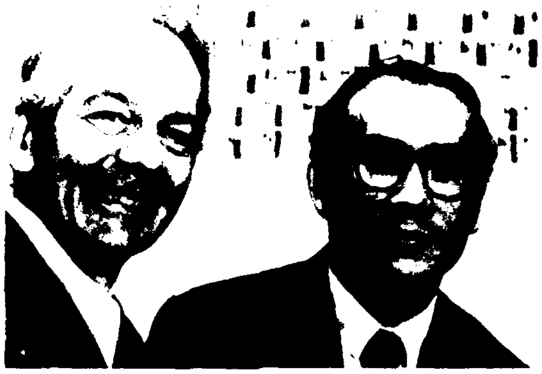
1974

(See TELSTAR) JOHN A. PIERCE - 1953

(See Medal of Honor) HARALD T. FRIIS - 1939

DAVID SARNOFF AWARD

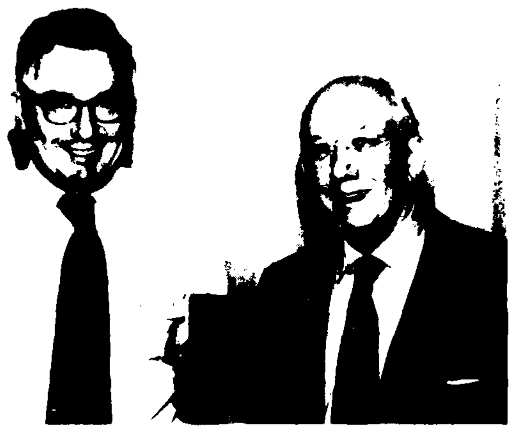
In recognition of outstanding contributions in the field of electronics



1979

A. GARDNER FOX
TINGYE LI

Distinguished Innovators and Authors



1977

HARRISON E. ROWE
J. M. MANLEY

For "work on the properties of nonlinear devices resulting in the well-known Manley-Rowe Relations."

1975

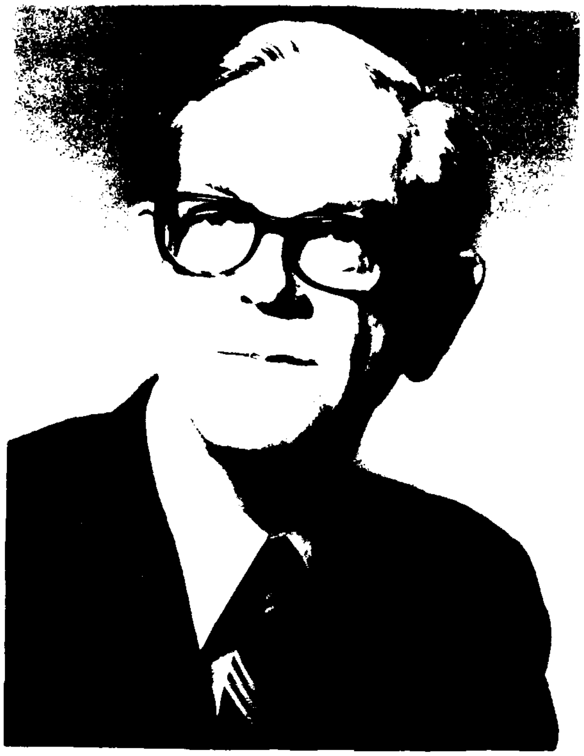
B. C. DeLOACH

Inventor of the IMPATT Diode

W. R. G. BAKER PRIZE AWARD

For the most outstanding papers reporting original work.

1975



STEWART E. MILLER

TINGYE LI

E. A. J. MARCATELLI

BROWDER J. THOMPSON MEMORIAL PRIZE AWARD

For the most outstanding paper in any IEEE publication
between 1 January and 31 December by any author
or joint authors under thirty years of age

1950

ARTHUR W. RANDALS

Arthur W. Randals received the 1950 Browder J. Thompson Memorial Prize Award jointly with Joseph F. Hull for the paper titled "High-Power Interdigital Magnetrons" in the November 1948 Proceedings of the IRE. This paper records the theory and practice of cavity mode interdigital magnetrons operating at high efficiency and wide tuning ranges for the first time.

Mr. Randals received his B.S. in Physics from Lincoln University in 1941 and held the position of Research Physicist in the Thermionics Branch of the Signal Corps Engineering Laboratory, at Camp Evans in Belmar, NJ. Currently Mr. Randals is an Electronics Engineer in Radar Systems Division of Combat Surveillance and Target Acquisition Laboratory of the ERADCOM, at Evans Area, Belmar, NJ.

Browder J. Thompson, associate research director of the RCA Laboratories was killed in action overseas in 1944 while serving as a consultant to the Secretary of War. He was awarded the President's Certificate of Merit post humously. The memorial prize award was established in 1945 in his honor.

LAMME MEDAL

For meritorious achievement in the development of electrical or electronic apparatus or systems

C. KUMAR N. PATEL

1976

Mr. Patel was born in India where he received his B.E. in Telecommunicaions. After earning an M.S. and Ph. D. from Stanford, he joined Bell Laboratories where in 1970 he became Director of the Electronics Research Laboratory. Dr. Patel was elected a Fellow in the IEEE last year and is also a Fellow in the American Physical Society.

INTERNATIONAL COMMUNICATIONS IN HONOR OF HERNAND
AND SOSTHENES BEHN

For outstanding contributions in the field of
international communications.

EUGENE F. O'NEILL

1971

Eugene F. O'Neill has received the 1971 IEEE Award in International Communication "for outstanding technical innovations and management in the development of many key technologies underlying the present day international communication art, especially TELSTAR, the first operational telecommunications satellite, as well as his earlier contributions to transoceanic cable telephony." Mr. O'Neill is Executive Director of the Toll Transmission Division, Bell Laboratories, Holmdel, NJ where he is responsible for all long haul transmission development for the Bell System. His early work was in the development of radar, coaxial cable, radio relay and submarine cable systems. Groups under his direction developed the TELSTAR satellites and the satellite ground terminal at Andover, Maine. He is a Columbia graduate, and a Fellow of IEEE.

IV

NJ COAST SECTION

FELLOWS

1984-1928

YU-SHUAN YEH was born in Wu-Kiang, Kiang-Su, China on September 9, 1939. He received the B.S. degree in electrical engineering from the National Taiwan University, Taiwan in 1961; and the M.S and Ph.D. degrees in electrical engineering from the University of California, Berkeley, California in 1964 and 1966, respectively.

From 1961 to 1962, he was an electronic officer in the Chinese Navy. He was a research assistant at the University of California from 1963 to 1966. From 1966 to 1967, he was a Research Fellow at Harvard University, Cambridge, Massachusetts, doing antenna research. Since September, 1967, he has been a member of the Technical Staff at AT&T Bell Laboratories, Holmdel, New Jersey. His research interests include Digital Modulations, Radio Propagations, Adaptive Antennas and Communication Systems. He is currently a supervisor in the Radio Systems Research Department.

Dr. Yeh published extensively on subjects related to Mobile Radio, Satellite Communication and Digital Radio. He holds 17 patents and is the recipient of two best paper awards from IEEE Transactions.

Newly Elected Fellows — 1984

For contributions to advanced communications satellites and high-capacity mobile radio systems

TIEN-PEI LEE was born in Nanking, [illegible] 1933. He received the B.S. degree in electrical engineering [illegible] [Nation]al Taiwan University, Taiwan, China, in 1957; the M.S. degree [illegible] Ohio State University, Columbus, Ohio, in 1959, and the Ph.D. [deg]ree from Stanford University, Stanford, California, in 1963.

He joined Bell Laboratories, Reading Pennsylvania, in 1963, where he engaged in the development of microwave semiconductor devices. In October 1966, he was transferred to the Guided Wave Research Laboratory at Crawford Hill, Bell Laboratories, Holmdel, New Jersey. From 1966 to 1968 he had engaged in the research on millimeter wave repeater systems. Since 1968 his interest has been in fast optical detector diodes, semiconductor injection lasers, light emitting diodes, and optical repeater systems. Recently, his work has been in light sources and photodetectors for applications in the optical fiber communication systems in the 1.0 to 1.6 um wavelength region. He has published over 75 technical papers and several book chapters, and holds five patents on optical semiconductor devices.

Dr. Lee is a member of Sigma Xi, Chinese Institute of Engineers, U.S., and Optical Society of America.

He and his wife Josephine, children Charlottee, Sherry and Daren reside at 5 Marion Drive, Holmdel, New Jersey. They enjoy tennis, swimming, jogging, camping and traveling.

For contributions to semiconductor elements for lightwave communications.

NJ COAST SECTION FELLOWS

1984-1976

Tien-Pei Lee — 1984
For contributions to semiconductor elements for lightwave communications.

Yu-Shuan Yeh
For contributions to advanced communication satellites and high capacity mobile radio systems.

Noach Amitay — 1983
For contributions to design and application of satellite phased arrays

Warren Kesselman
For contributions to EMC and EMI measurement techniques

L. A. Coldren — 1982
For contributions to SAW devices.

V. G. Gelnovatch
For contributions to microwave circuit design

Morton I. Schwarz
For leadership and contributions in fiber optics.

Bruce A. Wooley
For contributions to design of ICs and communications systems.

Arthur Ballato — 1981
For contributions to the theory of piezoelectric crystals and frequency control.

Ira Jacobs
For contributions and leadership in lightwave systems.

Douglas O. Reudink
For contributions to satellite communications and microwave mobile radio systems.

NJ COAST SECTION FELLOWS

1980

John Creedon
For leadership and contributions to high energy pulse power engineering.

Joel S. Engel
For contributions to the concept and to the implementation of spectrally efficient, cellular mobile telephone systems.

Jacob Katzenelson
For contributions to simulation and computer-aided design.

Lee S. Tuomenoksa
For contributions to the development of telephone electronic switching systems.

1979

Dietrich A. Alsberg
For contributions to the development of low loss millimeter waveguides.

Francis T. Boesch
For contributions to the application of network theory to invulnerable communications networks.

Donald C. Cox
For contributions to the understanding of radio propagation effects in mobile telephone and satellite communications systems.

Irwin Dorros
For leadership in the management of engineering projects associated with integrated nationwide telecommunications.

Alistair E. Ritchie
For contributions to telephone networks and signaling equipment.

Ta-Shing Chu 1978

For contributions to dual polarization radio transmission and to propagation of radio and light waves in precipitation.

Erich Hafner

For contributions to the improvement of piezoelectric crystals and frequency control devices.

John O. Limb

For contributions to efficient coding of color and monochrome video signals.

Peter W. Smith

For contributions to tuneable gas lasers

Clyde N. Hardin 1977

For contributions to, and leadership in, the development of radar and ordinance electronics.

E. R. Kretzmer

For contributions to understanding of video transmission, and for leadership in the development of data communication systems.

D. G. Thomas

For contributions to the understanding of luminescence in semiconductors and to the development of light emitting diodes.

F. D. Waldhauer

For contributions to the development of pulse code modulation systems and design techniques for feedback amplifiers.

Arthur Ashkin 1976

For contributions to microwaves and lasers.

Gary D. Boyd

For contributions to the field of ultrasonics.

James C. Candy

For contributions on digital coding devices.

Detlef Gloge

For contributions to optical fiber transmission systems.

FELLOW AWARDS

1975 AND PRIOR YEARS

Frederick E. Bond	1974
Frank A. Brand	1967
Charles A. Burrus, Jr.	1974
Roger B. Colton, MG (RET) USA	1946
Arthur B. Crawford	1952
C. Chapin Cutler	1955
George C. Dacey	1964
Fred B. Daniels	1965
Stanley F. Danko	1966
James R. Davey	1966
Edward E. David, Jr.	1962
Owen E. De Lange	1966
Stephen Doba, Jr.	1960
Willie L. Doxey	1964
John J. Egli	1967
Hayden W. Evans	1970
Michael Ference, Jr.	1961
William O. Fleckenstein	1971
A. Gardner Fox	1956
Harald T. Friis	1929
Fritz E. Froehlich	1975
Kenton Garoff	1968
Edward A. Gerber	1958
Marcel J. E. Golay	1960
William M. Goodall	1951
Georg J. E. Goubau	1957
Richard Guenther	1965
Paul G. Hansel	1957
David C. Hogg	1965
Harold Jacobs	1968
William C. Jakes, Jr.	1962
Amos E. Joel, Jr.	1962
Ivan P. Kaminow	1974
John E. Karlin	1965
Herwig Kogelnik	1973
Rudolf Kompfner	1950
Tingye Li	1972
Walter E. Lotz, Jr. LTG (RET) USA	1968

Robert W. Lucky	1972
William A. Malthaner	1962
Enrique A. J. Marcatili	1967
Dietrich Marcuse	1973
William S. Marks	1952
James D. Meindl	1968
Harold F. Meyer	1964
Stewart E. Miller	1958
James D. O'Connell	1957
Eugene F. O'Neill	1969
Arthur A. Oswald	1928
Salvatore E. Petrillo	1956
John R. Pierce	1948
Bernard Reich	1973
Irving Reingold	1975
Douglas H. Ring	1966
Aldred W. Rogers	1960
Ian M. Ross	1966
Harrison E. Rowe	1971
Clyde L. Ruthroff	1974
John C. Schelleng	1928
Sol Schneider	1973
Herbert A. Schulke, Jr., MG (RET) USA	1973
Gustave Shapiro	1961
William M. Sharpless	1958
Jack M. Sipress	1975
Rudolf A. Stampfl	1971
Clarence G. Thornton	1966
Frank S. Vigilante	1975
Herbert B. Voelcker	1973
Roger I. Wilkinson	1968
Carl R. Wischmeyer	1951
Robert S. Wiseman	1970
John M. Wozencraft	1965
William Ray Young	1964
Hans K. Ziegler	1961

Henry H. Abbott	1967
J. A. Baird	1969
Wallace A. Depp	1969
Daniel F. Hoth	1969
John S. Mayo	1967
Martin V. Schneider	1976
William D. Warters	1976
Harold A. Zahl	1950

ECOM's IEEE Fellows Now Number 13

STANISLAUS F. DANKO

DR. HAROLD JACOBS

Westinghouse Research

IEEE FELLOW CITATION —

JOHN J. EGLI

V

OUTSTANDING ACHIEVEMENTS

NEW JERSEY COAST SECTION

Karl G Jansky

The Father of Radio Astronomy

A young father he was, too—for Karl Jansky was only 22 when he started work at Bell Laboratories to record and measure radio static. This was in 1928. Overseas radiotelephone service had started only a year or so earlier and knowing more about noise was important. Four years later, in 1932, Jansky published a paper in which he classified three kinds of static: that from local thunderstorms, that from distant thunderstorms, and "a steady hiss static, the origin of which is not known."

Let Dr. Harald Friis, in whose group Jansky was working, continue the story. "The hiss-type static, or hiss noise, fascinated Karl," Friis wrote years later. "Having collected thousands of records, he discussed the data with his colleague A. M. Skellet, who was familiar with astronomy. The conclusion was that the hiss noise came from the Milky Way."* This conclusion, reported by Jansky in papers published in 1933, was supported by the fact that the noise, which sounded like the fluctuating "thermal" noise in electrical circuits, was strongest when Jansky pointed the antenna he was using at the Milky Way's center.

This discovery was one of the epochal events in the history of science.** For centuries astronomers had studied the heavens using optical techniques alone. Now, for the first time, the mysteries of heavenly bodies, and of space itself, were manifesting themselves through the radio spectrum as well.

Yet strangely, scientists were slow to grasp the meaning of this revelation. Jansky himself, continuing at Bell Laboratories,

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*"Karl Jansky, His Career at Bell Telephone Laboratories," *Science*, Vol. 149, No. 3686 (August 20, 1965), p. 841.

** "Radio Astronomy's 50th Year" Bell Laboratories Record, April 83 expanded his work to study how transatlantic radio waves arrived at receiver stations; he became, in fact, an expert in selecting favorable receiver sites. But as Dr. Friis also recalls, five years after Jansky had reported his findings and conclusions, the term "radio astronomy" still did not exist and no word of encouragement to continue work on "star noise," as he later called it, had come from scientists or astronomers.

In 1941, however, studies by Grote Reber, an enthusiastic radio amateur, confirmed Jansky's work; and after World War II radio astronomy started in earnest. Already its results have been profound. Since radio waves can penetrate the dust of space and planetary clouds that may limit optical observations, the new science has greatly increased understanding of solar phenomena and the physical processes that occur in interstellar space. Using huge radio telescopes, ultrasensitive amplifiers, and computers, radio astronomers have organized new knowledge transmitted from the sun, from our galaxy, and from nebulae beyond. The most dramatic discovery has been that of the existence of quasars, those "quasi-stellar" bodies that generate continuous power at many frequencies and constitute sources of energy never guessed at before.

Karl Jansky, always frail in health, died in 1950, before he could see the full significance of his discovery. An important aspect of his work, be it added, lies directly within the field of communications and has been powerfully demonstrated by other Bell Laboratories scientists within the last few years.

Using advanced techniques of millimeter-wave spectroscopy, which is in effect a form of radio astronomy, they have discovered and studied "more molecules in outer space," to quote President W. O. Baker of Bell Laboratories, "than have been discovered in all the history of astronomy before." This knowledge, Dr. Baker says, has been invaluable in conjunction with efforts to exploit the bountiful spectrum of millimeter waves for radio communications.

"We have adopted the knowledge and challenge of radio astronomy," he comments, "to help establish our competence with millimeter waves. Today we can generate and control these waves economically—and can do so because we had this theoretical/practical testing system in space. If we had not had such insights from outer space, with the excitement and stimulus they provided . . . well, nobody ever imagined millimeter-wave radio could be made practical, nobody ever thought those waves

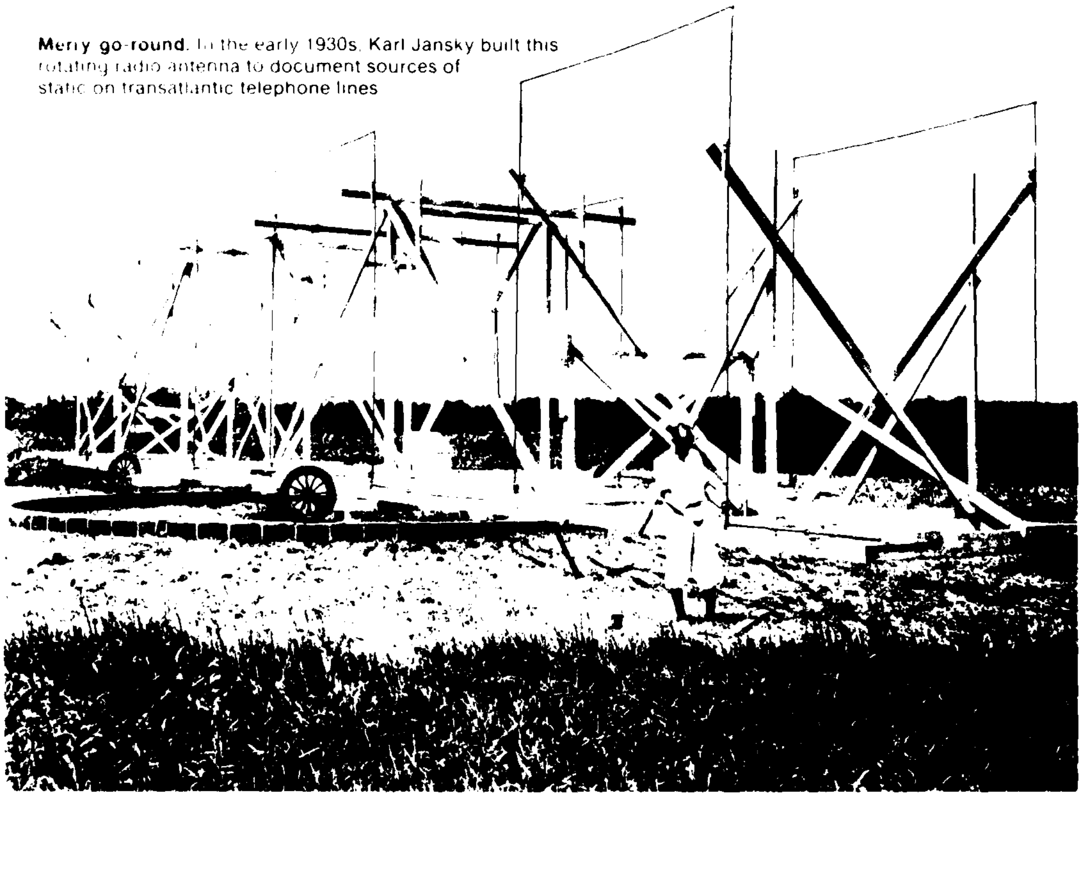
Jansky indicates the spot in the heavens from which radio noises from space were first heard.

could be used outdoors."

Further, Baker sees the opportunity to observe the behavior of molecules in space as affording what he calls "a new test tube for science. In these vast spatial reactors, molecular collisions are occurring orders of magnitude slower than they have ever been observed on earth—they are meters apart. So you have a model, magic situation where pair collisions take long times, you can observe the individual orientation of the molecules in space; and these are just the things we want to know in studying the stability of the hardware of the Bell System, in studying ways to make new components, in studying the interaction of charges and molecules in the electronics and circuitry of the System. So here is a whole new game."

A whole new game some 40 or more years after Karl Jansky's discovery; the frail young man's legacy to Bell Laboratories, to science, and to the world was large indeed.

Jansky with the rotatable antenna he used in studies of atmospheric noises that interfered with overseas radio telephone service. Among the noises, in 1933, he discovered a mysterious one coming from the center of the Milky Way. His discovery led to the new science of radio astronomy.



Merry go-round. In the early 1930s, Karl Jansky built this rotating radio antenna to document sources of static on transatlantic telephone lines

Karl Jansky: His Career at Bell Telephone Laboratories

Harald T. Friis

In 1928, 22-year-old Karl Jansky joined my group in our Cliffwood field laboratory and, because he had a chronic kidney ailment, it was requested that he be assigned to work which would not exert undue pressure on him. (Jansky was first rejected by the Medical Department but later was accepted through the intervention of his brother.)

Karl agreed to start work recording the static received at long wavelengths, using equipment already in existence. Later, he planned to record static at 14 meters' wavelength, using a 100-foot-long "Bruce" antenna which was to be mounted on a rotating platform such as we had used in 1924 to study long-wave static. He built an ultrasensitive shortwave receiver similar to the one I had used in 1928 to show that Johnson noise limits the sensitivity of radio receivers. He also modified Mutch's static recorder, which was an improved version of the one that had been used earlier to record long-wave static.

After working with his colleagues, especially Beck, Mutch, and Sharpless, to become thoroughly familiar with the then-existing techniques for accurate measurement, Karl began to assemble the equipment, but his work was interrupted by the relocation, in January 1930, of the whole Cliffwood field laboratory to Holmdel.

Karl had a new rotating platform built at Holmdel and reassembled his equipment. By the end of 1930 he was ready to record static at 14 meters' wavelength.

His recordings gave him lots of data, and he published the results in a paper, "Directional studies of atmospherics at high frequencies," in *Proceedings of the Institute of Radio Engineers* for December 1932. In this paper he classified static into three types: (i) that due to local thunderstorms, (ii) that due to distant thunderstorms, and (iii) "a steady hiss static, the origin of which is not known."

The hiss-type static, or hiss noise, fascinated Karl. The angle of arrival did not seem to check with anything pertaining to the earth or the solar system. Having collected thousands of records, he discussed the data with his colleague A. M. Skellet, who was familiar with astronomy. The conclusion was that the hiss noise came from the Milky Way.

Karl presented the findings before the International Scientific Radio Union (URSI) in April 1933, in Washington, and published a paper, "Electrical disturbances of extraterrestrial origin," in *Proceedings of the I.R.E.* for October 1933. He also published a short paper, "Radio waves from outside the solar system," in *Nature*. The Bell Telephone Laboratories publications department issued a press release, and the New York *Times* carried the story as front-page news.

As a result of this astounding and, to most people, unbelievable discovery, Karl was now a famous man. Karl was modest, and this adulation did not affect him. He wanted to continue his work and thought that it would be worth while to look for hiss noise at a shorter wavelength.

By 1931 Karl had built a new receiver that covered the wavelength range 4 to 20 meters, and he used it to observe static from local thunderstorms. A. C. Beck erected a 100-foot-long comb-type antenna on Karl's rotating platform and, in 1934, Karl connected his receiver to the comb antenna, but found no hiss noise at a wavelength of 4 meters. In retrospect, this is not surprising since the gain of the comb antenna is low (its directivity gain is high).

In July 1935 Karl presented a paper, "A note on the source of interstellar interference" (*Proceedings of the I.R.E.*, October 1935), in which he pointed out that the hiss noise was strongest when the antenna beam pointed toward the center of the Milky Way, and that the hiss noise sounded like thermal agitation noise. Karl had, in the meantime, made many measurements of the noise output of large fixed rhombic antennas; he always found hiss noise appearing at that time of the day when the antenna pointed

Dr. Friis, prior to his retirement from Bell Telephone Laboratories in 1958, was director of the radio laboratory at Holmdel, New Jersey, for many years. He resides at 30 River Road, Rumson, New Jersey.

toward the center of the Milky Way. These observations confirmed his earlier results, and he stopped making them at the end of 1936.

Karl had been an instructor at the University of Wisconsin for a year before he came to Bell, and he liked teaching. A. C. Beck had the same background at Rensselaer Polytechnic Institute, and he also liked teaching. Both he and Karl accepted gladly the additional job of teaching courses to our technical assistants and often talked about taking teaching jobs. Beck recalls discussing an opening at Iowa State College in 1936, but they both agreed that, in spite of the curtailment in research activity and their low pay due to the depression, they were better off at Bell Telephone Laboratories.

Karl consolidated his findings on hiss static, or what he was then calling "star noise," in a paper, "Minimum noise levels obtained on short wave receiving systems," which he presented before the April 1937 URSI meeting in Washington (*Proceedings of the I.R.E.*, December 1937). This paper also included a study of man-made diathermy interference. Karl had by now, as a sideline, become an expert on receiver sites; for example, he recommended the Manahawkin site for reception of transatlantic short waves.

Karl, being a good research man, then became interested in the characteristics of the several different kinds of noise, thermal noise included. He did some excellent experimental work and presented his results in a paper, "An experimental investigation of the characteristics of certain types of noise," at the April 1939 URSI meeting in Washington (*Proceedings of the I.R.E.*, December 1939).

In 1938, Karl dropped the study of star noise and, some 17 years later, I was criticized by people who thought that I had stopped him. This was not true. Karl was free to continue work on star noise if he had wanted to, but more than 5 years had passed since he made his epochal discovery, and not a word of encouragement to continue his work had appeared from scientists or astronomers. They evidently did not understand its significance. Also, Karl would have needed a large steerable antenna to continue his work, and such antennas were unknown to us at that time. Radio astronomy, as such, did not then exist, and neither Karl nor I had the foresight to see it coming some 10 years later.

What actually happened was that Karl, who had worked for 10 years on the angle of arrival of noise and interference, now expanded his work to measurement of the angles of arrival of transatlantic radio waves. He and a colleague, C. F. Edwards, studied the angle of arrival of 16-meter waves in 1938, and then began a special radio propagation experiment in January 1939, which resulted in a paper, "Measurements of the delay and direction of arrival of echoes from near-by short-wave transmitters," published in the *Proceedings of the I.R.E.* for June 1941. They also compared reception at the Manahawkin and Netcong receiving sites in 1940.

It was an outsider, Grote Reber, an ardent radio amateur, who took up studies of star noise after having read Jansky's original papers, and in 1941 he succeeded, with improved equipment and a 30-foot "mirror," in mapping the Milky Way at 3 meters' wavelength. Karl was delighted that somebody else had finally confirmed his early work. John Schelleng, who headed the Deal Laboratory, was greatly impressed by Reber's single-handed and successful effort. He recalls that he told Karl that it was too bad that he was not himself working in this field. To this Karl replied cheerfully that after all he had "skimmed the cream."

The United States was then getting into war, and all Holmdel personnel worked 50 percent overtime on war jobs (radars). Later, sensitive receivers and large paraboloids became available, but nobody in my group, Jansky included, could take time off from war work to study star noise. During the war, Karl made several valuable contributions in classified areas and received an Army-Navy citation for his work.

My group turned back to communication research after the war and, since microwave radio had looked promising even before the war, everyone concentrated his research on microwave transmission and microwave repeaters. Being familiar with the importance of minimum noise levels in receivers, Karl selected this phase of microwave repeater research and worked on intermediate frequency amplifiers in 1946 and 1947. Our work resulted in an important paper, "Microwave repeater research," by H. T. Friis in the *Bell System Technical Journal* for April 1948. Karl contributed the section on intermediate frequency amplifiers, edited the whole paper, and presented it before the Monmouth subsection of the Institute of Radio Engineers.

A chore that Karl did not mind was visiting his old alma mater, the University of Wisconsin, in 1947 and 1948, to recruit new employees.

I was made director of radio research in 1946. As a result of the reorganization this entailed, I asked Karl to join G. C. Southworth's group in January 1948. The era of transistors was just emerging, and Karl included them in his experiments with amplifiers. Karl, naturally, also showed interest in the new field of radio astronomy. He wrote, for example, a detailed report on a conference that he attended on this subject at the Naval Research Laboratory in May 1948.

Karl's health had in the meantime declined somewhat. He was out on extended sick leave in 1945 and 1946. He spent 4 days in the spring of 1948 at Durham, North Carolina, for medical tests, and went back in the fall for medical treatments. By the end of 1949 he was really sick. He died 14 February 1950, and I lost a close friend.

After the war, radio astronomy started throughout the world, especially in Australia, England, and Holland. Ewen and Purcell made their important contribution of the 1420-magacycle hydrogen line in 1951. After a conference in Washington in 1954, large-scale work started in the United States.

It is unfortunate that Karl did not live long enough to see the unbelievably important results of his early discovery. He is now recognized as the father of radio astronomy, and I am proud of having been associated with the man who deserved, but never got, the Nobel prize for his discovery.

PROJECT DIANA

It was on January 10, 1946 that a small group of Army Signal Corps officers and civilians carefully aimed their 40-foot-square "bedspring" antenna and fired quarter-second radar pulses at the rising moon. Soon they had a return signal, audible over their receiver's loud speaker and visible as a peak on their nine-inch cathode-ray tube.

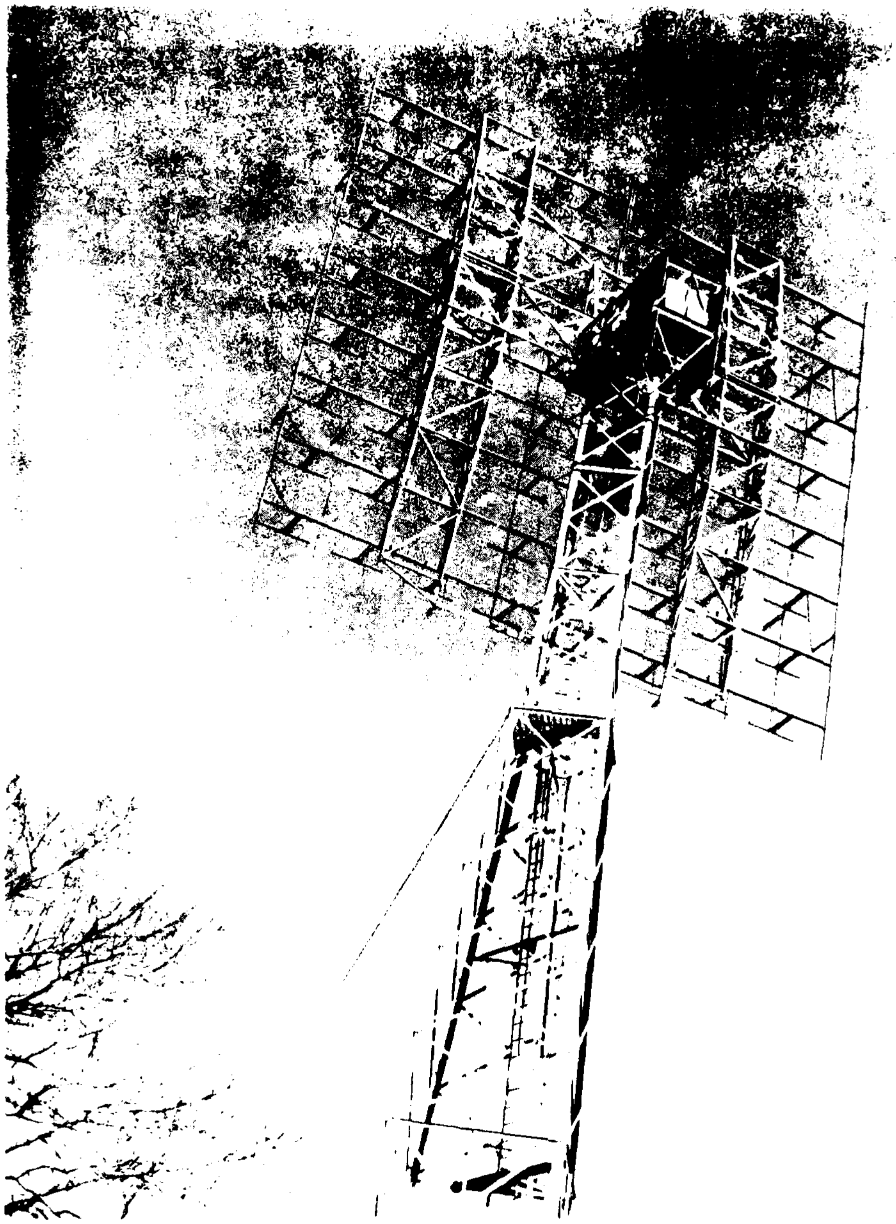
Man had established contact with the moon. The pulses had traveled from the antenna near what is now the Evans area of the Army Electronics Command in Wall Township the quarter-million odd miles to the moon and bounced back with enough energy to reach the earth in approximately two and a half seconds.

The experiment was called "Project Diana", after the mythical moon goddess, but the results were far from mythical. They proved that radio signals could travel through space - and back again. Radio communication through space, the essential forerunner of all subsequent space achievements, was a proven fact.

But the Fort Monmouth experimenters, led by LT COL John H. DeWitt, Jr., Evans Commander, shared true scientific detachment and caution. They continued their experiments until they were certain of the results without a shadow of doubt. Not until two weeks later, January 24, did they announce their momentous achievement, and then they did it through the Army's Office of the Chief Signal Officer in Washington.

Working closely with COL DeWitt were Dr. Harold D. Webb, Eugene D. Jarema, Herbert P. Kaufman, E. King Stodola, Jacob Mofsenson, Peter Devreotes, Gilbert Cantor, and Dr. Walter S. McAfee.

DIANA CAKE CUTTING -- Specialists, engineers and military men who took part in the original successful Diana experiment, when a radar signal was first bounced off the moon and received back on earth on Jan. 10, 1946, take part in a cake-cutting ceremony at the Evans Area of Fort Monmouth marking the 25th anniversary of the event. Left to right: Gilbert Cantor, Bradley Beach, Eugene D. Jarema, Belmar, Maj. Gen. George L. Van Deusen, (U.S.A.-Ret.) Monmouth Beach, Dr. Harold A. Zahl, Holmdel, Dr. Walter S. McAfee, South Belmar, and Peter Devreotes, West Long Branch. Cantor, Jarema, Dr. McAfee and Devreotes actually worked on the original Project Diana. Dr. Zahl approved the project, and Gen. Van Deusen announced it two weeks later, from the Office of the Chief Signal Officer in Washington. The knife used in the cutting was made from a replica of one of the original dipoles of the Diana antenna.

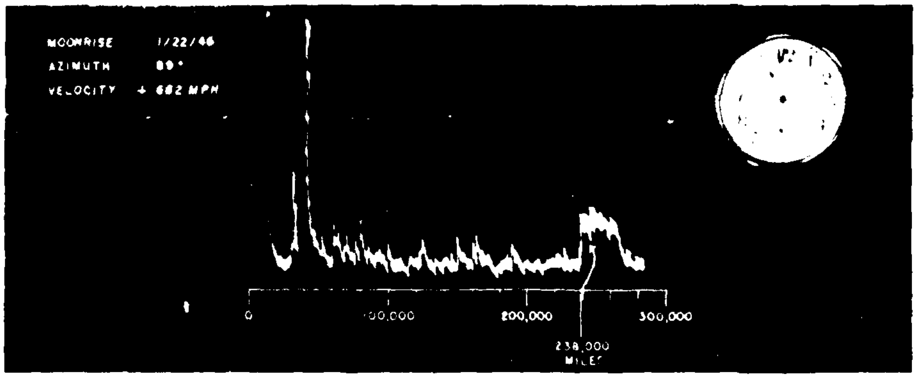


HISTORY MAKING ANTENNA

The 40-foot-square "bedspring" antenna, replaced many years ago, used in the initial Diana experiment, when the first radar signal was bounced off the moon on January 10, 1946. The successful project established the feasibility of space communications.

[illegible] design and [illegible] the [illegible] equipment were Dr. [illegible] (left to right) [illegible] Joseph Ryan, N[illegible]man L. [illegible] Snyder. Not shown are R[illegible] B[illegible] and James Iske.

Dr. Harold D. Webb, Signal Corps [illegible] trols on the power supply [illegible] the equipment.



[illegible] impulse (left) and [illegible] at 238,000 miles. [illegible] outgoing [illegible]

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From the [illegible] Sylvania [illegible] is merely [illegible] fact that the Co[illegible] leading electronic [illegible] tion. With the Company [illegible] size since [illegible] has been [illegible] more rapid [illegible] of its research [illegible] Sylvania [illegible] engineering [illegible] placed [illegible] techni[illegible] the moon [illegible] proved [illegible] progress [illegible]

A Signal Corps space odyssey

Part II-

SCORE and beyond

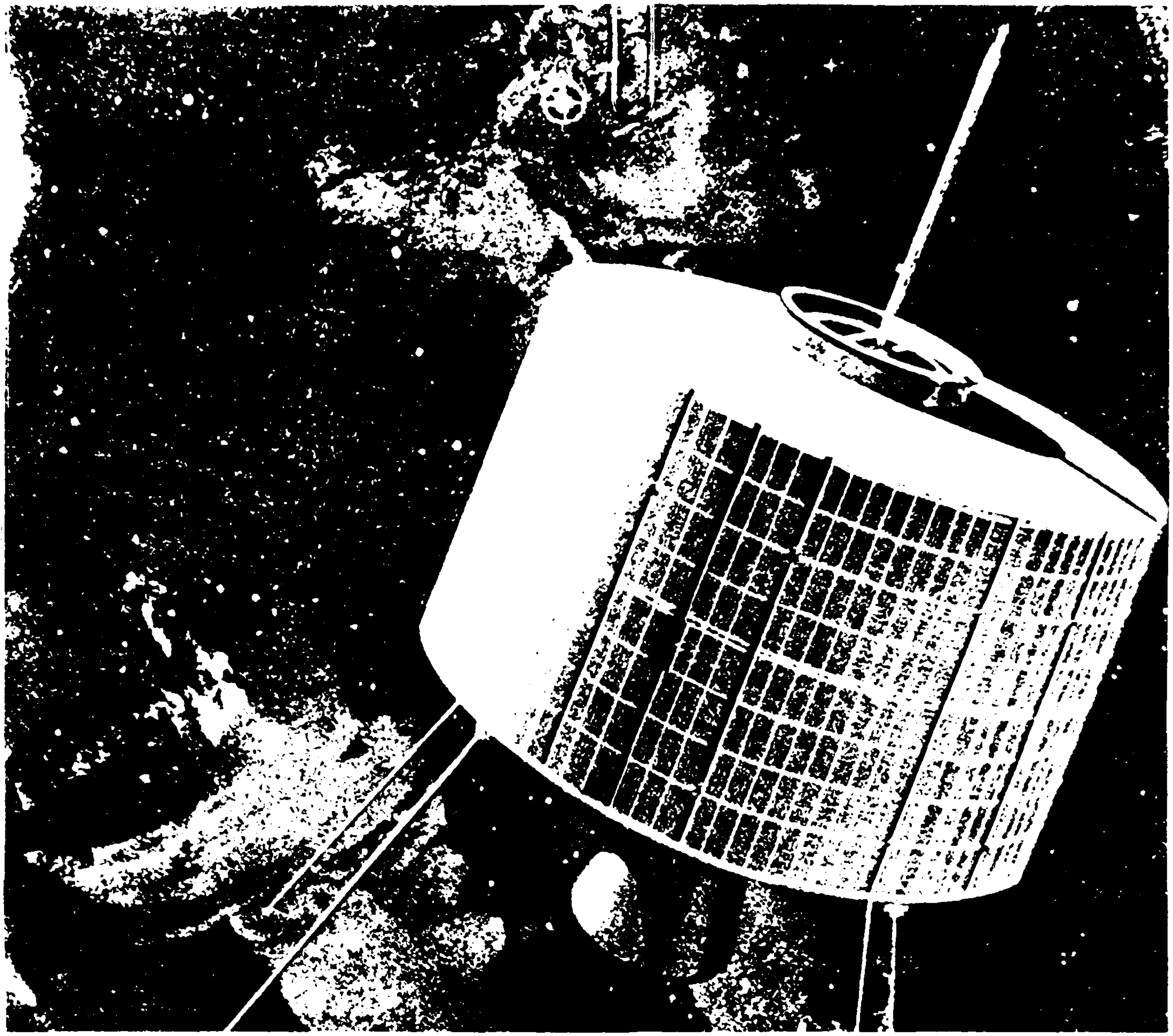
by Brig. Gen. H. Mc D. Brown (retired)

"This is the President of the United States speaking. Through the marvels of scientific advance, my voice is coming to you from a satellite traveling in outer space. My message is a simple one: Through this unique means I convey to you and all mankind, America's wish for peace on earth and good will toward men everywhere."

— President Dwight David Eisenhower, December 19, 1958

This is the story of SCORE, the world's first communications satellite and the final phase of other pioneering contributions of the Signal Corps to the early space age. They all, and particularly SCORE, represent some of the Signal Corps' most memorable achievements. It has been said that "success has a thousand fathers but failure is an orphan," and SCORE, COURIER and TIROS were all *remarkable* successes!

As a major participant in these projects, I would like to share with all Army communicators, young or old, my recollections of what really happened without going into nitty-



[illegible] ... Military Affiliate [illegible] ... W[illegible] ... Maj. Gen. [illegible] ... Fort [illegible] had [illegible] ... Oct[illegible] ...

of duty of my entire twenty years [illegible] career. He told me that the Chief Signal Officer, Gen. O'Connell, wanted to know if I would like to be assigned as the commanding officer of the Signal Research and Development Laboratory (SRDL) at Fort Monmouth, N.J. I had been assigned to Fort Monmouth before and although I was surprised at being considered for such an assignment, a friend, Brig. Gen. [illegible] Cook, had commanded the laboratory for the previous three years and I knew he had enjoyed the assignment. So I told General Lenzner I would like to accept.

Command assignment to an R&D laboratory is uniquely different in two respects from [illegible] ... [illegible] projects [illegible] ... costs and [illegible] ... gathering [illegible] ... promising [illegible] ... action, and [illegible] ... and productive.

Second, [illegible] regular military [illegible] the effects of his [illegible] day-by-day basis [illegible] results may not [illegible] time, often not [illegible] other duty since [illegible]

A Signal Corps space odyssey

R&D takes a long time from initiation to completion which leaves a lot of room for arguments of fathership for both good and bad ideas. At any rate, the commander of an R&D activity faces some rather unique peculiarities, which call for unorthodox management approaches and sometimes seem to create odd sentiments in command transfer and succession not prevalent in other military assignments.

But let me come to the main subject: SCORE. Right from the start of the satellite program in 1955, the Signal Corps and particularly SRDL had been crusading through proposals, presentations and recommendations for the early utilization of satellites for its communications needs. The basic idea was by no means new. In science fiction stories, satellites had long been loaded with communications gear and realistic and detailed theoretical studies existed in the open literature since 1952. But something practical had to be done about it now.

The IGY program strictly ruled out any applications tests and consequently our sights had to be focused on the military satellite programs which were expected to follow. In this respect, we hoped that our close relationship with the Army Ordnance Corps and the ABMA, for which we provided significant support in electronics, would secure us priority consideration in their planned programs. But that was not so. Gen. J. B. Medaris as well as Dr. Wernher von Braun were not too keenly interested in communications satellites. Although they appeared fully confident of the soundness of the principal and of their future importance, they felt they had, at that time, not enough appeal to impress the nation and Congress sufficiently to give urgently wanted greater support to space programs. After all, the general public probably couldn't care less whether a telephone connection was provided by cable, ground based radio, or satellite relay until satellites would make possible real-time global TV transmission which low altitude satellite orbits could not yet offer. Medaris felt that highest priority belonged to an eye in the sky surveillance satellite which would stun the nation and the world by furnishing detailed pictures globally.

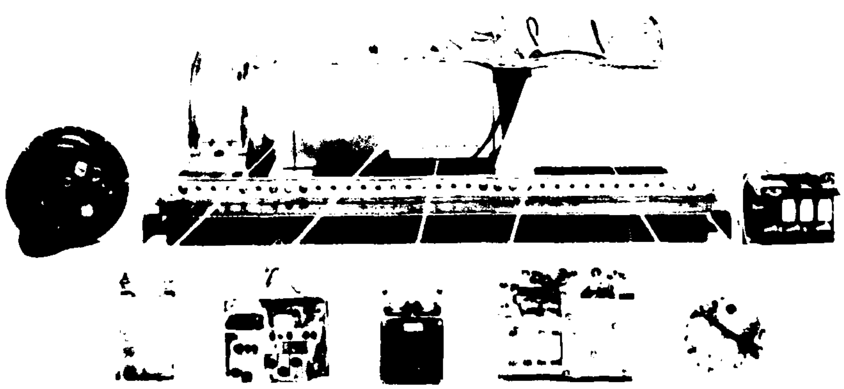
Nevertheless, we were promised a piggy-back ride for communications equipment when extra weight on another main payload should become available. But, assisted by the chief signal officer, we kept our eyes wide open for other and earlier opportunities which, fortunately, would soon develop.

On 29 May 1958, we had a visit from the Secretary of the Army, Wilbur Brucker, who was accompanied by Gen. O'Connell and in our briefings we made a strong pitch for communications satellites, which seemed to impress Brucker.

As a consequence, Gen. O'Connell came back for another visit on 23 June. This time he brought with him the director of ARPA, Roy Johnson. Fully aware of Johnson's sweeping power in the satellite field, we made an all out effort to convince him of the urgency of communications satellites as a matter of national emergency. We did not have to wait long for the gratifying result. Within a few days, we received an urgent telephone call from the office of the chief signal officer, prompted by ARPA. It requested a quick answer to what kind of satellite communications equipment we could put together in 60 days if we were allowed a weight of 150 pounds on a rocket which would be sent into orbit. The SRDL workforce, well-prepared for such an opportunity, responded promptly with design plans and presentations, and in early July we received ARPA authorization to proceed. Thus project SCORE was born.

The project provided for an Air Force Atlas ICBM to be launched from Cape Canaveral, Florida. Since the entire one-stage rocket of some 9000 pounds was to be placed into orbit, no separate satellite payload configuration was planned and the communications equipment was to be properly integrated into the fairing pods of the missile. A relatively low orbit and a correspondingly short life expectancy of this satellite of some 2 to 3 weeks, called for the use of battery power rather than a long-life solar power supply.

In view of the relatively low orbit expectation and the related limited opportunities for simultaneous access to the satellite from various ground stations, the SRDL-designed communications equipment included a store-and-forward mode through a tape recorder subsystem in addition to a real-time radio relay capability. Thus, even for the low orbit, worldwide delayed message delivery or "courier service"



The world's first satellite to relay the human voice through space was placed in orbit on 18 December 1958 through Project SCORE. President Eisenhower's Christmas message proved that voice and code could successfully be relayed or stored and forwarded by satellites over tremendous distances.

could be demonstrated. Considering the risk of a communications package which included electromechanical devices, such as a tape recorder, it was decided to provide redundancy by orbiting two independent copies of the equipment. The capacity of the system was one voice channel or seven 60 wpm teletype channels, frequency division multiplexed. The tape recorder had a four-minute capacity for either recording or playback.

To accomodate the 30 south inclination of the projected orbit, special ground stations for satellite interrogation and communications had to be located at Fort McArthur, California; Fort Huachuca, Arizona; Fort Sam Houston, Texas; Fort Stewart, Georgia; and Cape Canaveral, Florida.

As this project sponsored and funded by ARPA with the Air Force having vehicle responsibility and the Army Signal Corps in charge of the payload proceeded in deep secrecy, the 60 day deadline was soon extended to 90 days as the Atlas schedule slipped. The timely completion of our own part was aided by contractual industry assistance by RCA and others. The integration of missile and payload required close cooperation between Air Force and Signal Corps.

But in September 1958 (incredibly to us) we received word from ARPA that the project had been cancelled. The cancellation was followed by a directive to continue the work with no change in deadlines as an important exercise for the purpose of using the equipment for communications tests in helicopters, airplanes and other flying devices short of satellites.

Actually the "cancellation" was only a ploy to shroud the project into super secrecy. When it happened, we could not understand the underlying reasons. It was later explained that President Eisenhower, angered by security leaks on other space vehicle launches and associated embarass-ments, had threatened ARPA with actual project cancellation should any information leak out before the launch of the Atlas. As a result, only those individuals at ARPA, the Air Force and the Army qualified for a "need to know" since failure to inform them could have directly endangered the timely completion of SCORE. The 88 people who were selected to know became the now famous "Club 88."

Dr. Hans K. Ziegler (left) and then Col. H. McD. Brown (right) talk with Dr. Werner Von Braun after one of his visits to USASRDL, Fort Monmouth, New Jersey, 13 November 1959.

Maintaining the super secrecy over almost three months was quite difficult and caused much confusion, especially in the preparation of the ground stations. At one point I was told that Maj. Gen. F. Moorman, the CG of the AFPG at Fort Huachuca, threatened to have our people evicted from his post by the MPs unless he got some explanation of our clandestine activities.

Finally, the Atlas with its SCORE payload was standing on the launching pad at Cape Canaveral, ready to go.

But then one more unexpected problem developed. To start off the SCORE operations, we had prerecorded a message into the tape recorder. It was a paragraph from a nonpolitical, patriotic document of US history and nobody seems to recall any longer what it actually was. The late Herbert Hawkins, a member of the SRDL-SCORE team, who had a very pleasant voice, had recorded it and it was also contained in teletype mode.

Now, just hours before the takeoff, another tape recording was hurriedly brought to Cape Canaveral, which was to replace the one already in the recorder. Roy Johnson, who had kept President Eisenhower well informed on progress, had in a last minute effort succeeded in convincing the President that SCORE would be a splendid opportunity to broadcast a Christmas peace message to the world and here it was. Since there was no longer any physical access to the SCORE equipment at the pad, the substitution of the prerecorded messages had to be done by radio interrogation and transmission with the risk that the ever alert news media might intercept it and prematurely publish it. But in the wee hours of Thursday, 18 December 1958, the Signal Corps team succeeded in this tricky task.

At 1802 hours, the long awaited launch took place with everyone full of anxiety over the outcome. How great was the joy when the tracking data confirmed within minutes of rocket burnout that orbiting had been successful. The Air Force had convincingly proven the capability of its Atlas ICBM. But, we wondered, would our communications equipment be equally successful?

The operational plan called for interrogation on the first orbit by the California ground station to receive and record the President's message and at once transmit it by telephone via the Pentagon to the White House for public

A Signal Corps space odyssey

release. But interrogation of the first of the two SCORE packages was responded to only by a transmission of an unmodulated carrier and the quick switch to interrogate the second package obviously was too late to produce conclusive results during the first orbit. Though we were not fully discouraged by this result, we nevertheless spent a sleepless night and anxiously waited for the twelfth orbit which would be suitable for another chance of interrogating the second SCORE package. This occurred at 1515 hours on 19 December and was accomplished by our SRDL team at Cape Canaveral. The message came down loud and clear from the satellite:

This is the President of the United States speaking. Through the marvels of scientific advance, my voice is coming to you from a satellite traveling in outer space. My message is a simple one: Through this unique means I convey to you and all mankind, America's wish for peace on earth and good will toward men everywhere.

During the next two weeks, the second SCORE package continued to work perfectly in 78 interrogations in all modes of communications — real-time relay over long distances and store-and-forward on a global basis, both in voice and teletype. The first package failure was later diagnosed as a malfunctioning of the tape recorder, probably by the jamming of a take-up reel. How fortunate that we had worried along these lines and provided equipment redundancy.

The Army Signal Corps had really done it again! Almost one hundred years after it had given our country its first primitive network of telegraph communications, it had pioneered the nation's and the world's first communications satellite, demonstrating almost unlimited potential.

Needless to say, we at SRDL were immensely proud and naturally we were also looking forward to credits and recognition for the dedicated efforts and the untiring crusade which had led to this achievement.

The President had shown great interest in the project and the newspapers reported that he was in high spirits when he joined reporters in the office of the White House Press Secretary to listen to his tape message as retransmitted from space. Of course, the event represented two different significant milestones in our national progress: The Atlas ICBM had placed into orbit the largest satellite ever launched, which at almost 9000 pounds was just about three times as heavy as the heaviest Russian Sputnik III and which renewed our confidence that we were well on our way, both for space and defense goals. And then, of course, there was the world's first *communications satellite*.

The President, in general terms, congratulated all involved in both milestone achievements and there were many who had to share the credit in ARPA, the Air Force, the Army and its Signal Corps and in the US industry. We did not necessarily expect nor did we receive any specific congratulatory reaction from the White House.

Most gratifying, however, the news media gave the Army Signal Corps' contributions excellent coverage, which should have been properly reflected later in the records of space history, but obviously was not. Moreover we received numerous congratulatory telephone calls and letters from both military and civilian professionals.

But what we most expected was some official recognition from our own bosses: the Army and the Signal Corps, which had not yet materialized. Then we heard some rumors of a Pentagon snafu which could have been the reason. There were several versions of how Secretary Brucker in the confusion of the project's super secrecy had unfortunately been left uninformed and had heard of its completion only afterwards through the news media, which made him very unhappy, if not angry with his Signal Corps.

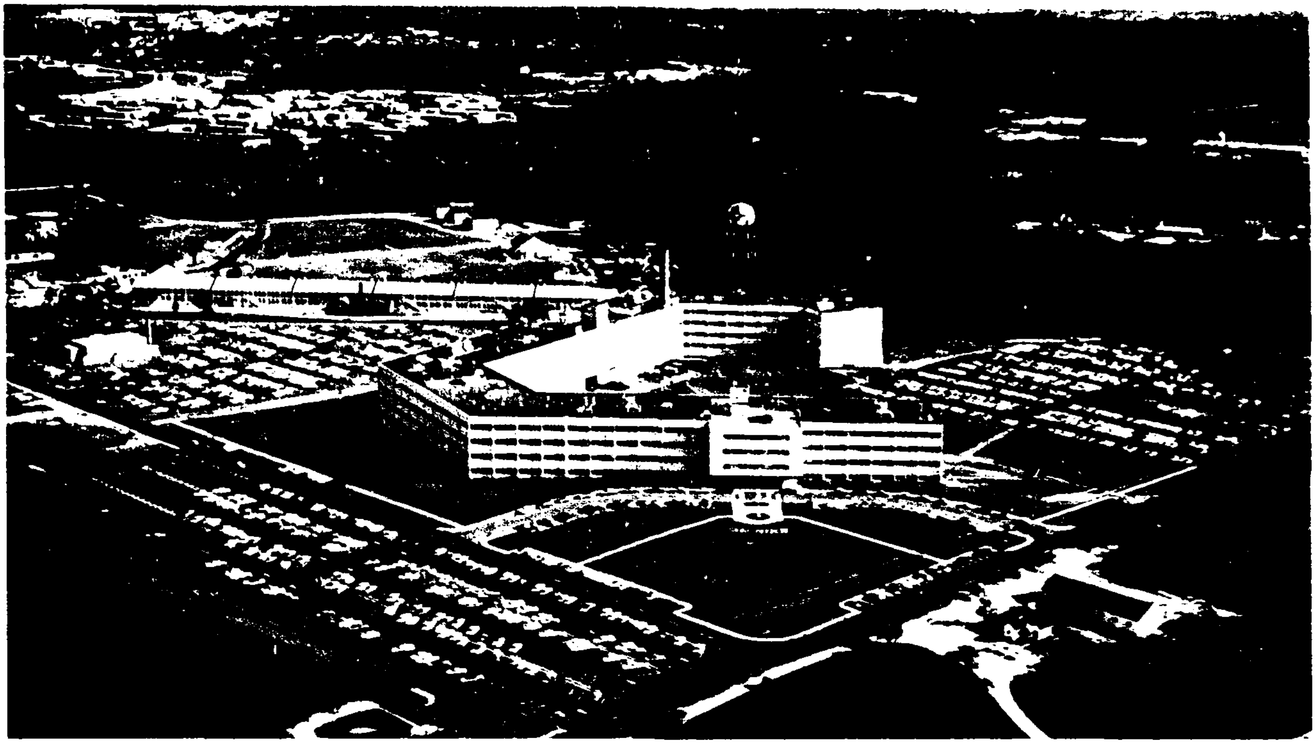
Actually, as Gen. O'Connell revealed at a later date, this is what happened: Secretary Brucker was on the list of the "Club 88" and a member of his immediate staff was supposed to keep him posted. But in the last phases of the project this was overlooked somehow. He became aware of the completion of the project on the evening of 18 December only when a news reporter, who had somehow picked up some information on our failure to successfully negotiate SCORE on the first orbit, called up the Secretary at his residence and tried to get an explanation. The Secretary was indeed angry and immediately summoned O'Connell for an explanation.

But our assumption that this was why we had gotten no reaction from our bosses during the 1958 holiday season was dead wrong. It turned out that on Monday, 22 December — the first working day after the SCORE announcement on Friday, 19 December — Secretary Brucker had written a most complimentary letter of congratulations to the chief signal officer to be conveyed to all participants of SCORE. O'Connell immediately endorsed the letter, added his own specific additional congratulations and dispatched it through channels to me. And there, in the channels, was where it got stuck until it reached me (quite antichmatically) on 5 January 1959.

ARPA recognized all our members of the "Club 88" with an appropriate scroll and, although I do not clearly remember the details, we were congratulated by Roy Johnson through other means. ARPA further initiated an action which could be interpreted as a significant recognition of our professional competence at SRDL. Right after the holidays, Johnson approached Gen. O'Connell for his consent to invite Dr. Hans Ziegler, our key civilian in all our space activities, to join ARPA and to become the prestigious director of its Communications Satellite Division. Although he realized the loss for the Signal Corps, O'Connell felt that filling such a position with an individual of proven competence and an understanding of the Army and Signal Corps capabilities, would be desirable and he gave Johnson the go ahead.

Let me digress for a moment.

Dr. Ziegler, like Dr. von Braun, had been transplanted to our country after WWII as one of the prominent German scientists and engineers. He brought with him broad experience in many fields, but during the last phases of the war he had attained prominence in electronic fuse and proximity fuse concepts. When he arrived on assignment to the Signal Corps at Fort Monmouth there was not sufficient



The Signal Research and Development Laboratory (SRDL) was based at Fort Monmouth and housed in this huge hexagon in the Charles Wood area of the post. (US Army photograph)

activity in this special field, but the laboratories had other important tasks in mind for him and he was assigned as Scientific Consultant to the Power Sources organization.

Not long after Ziegler's arrival, the Signal Corps got into a hassle over his assignment with Gen. Lucius D. Clay, who was Commander in Chief of US Forces in Europe. Before receiving the Army offer, Ziegler had been contacted by the Georgia Institute of Technology [illegible] faculty. Now, Georgia Tech [illegible] Army of having gotten wise [illegible] ation through the still [illegible] censorship and having had [illegible] d away. Clay, an alumnus [illegible] pporter of his alma mater, [illegible] to the chief signal officer [illegible] Dr. Ziegler's immediate [illegible] Atlanta. But the commanding [illegible] officer of the labs at Fort Monmouth (Col. P. E. Neal) felt this was an appropriate point to demonstrate our American principle of freedom of decisions and he left it up to Dr. Ziegler to stay or to leave. Since he was already deeply involved in solving Signal Corps problems, he preferred to stay and for 8 years he successfully conducted research in power sources areas. During this period he had often expressed to the laboratory's director of research, Dr. H. A. Zahl, his sincere desire to get into greater technological challenges, should opportunities arise. The opportunity arose in June 1955 when the labs got involved in space activities and Dr. Zahl drafted him immediately as a special assistant for this new mission. Shortly thereafter, he was named assistant director of research. When, during the following three years, the Signal Corps space efforts took on momentum, he became the key civilian in charge of all these programs and he represented the Army and the Signal Corps at related high level national and international conferences. He was, in fact, appointed by the National Academy of Science as a US delegate to the IGY conference at Moscow.

When I arrived on the scene, he enjoyed under the title USASRDL Coordinator for Space Age Activities unusual broad authority to cut across existing organizational lines to get all projects — most of them requiring services from a variety of laboratory elements — accomplished on a crash basis. Although I was well-impressed by the skill and effectiveness with which all this was accomplished, I felt that on the long run, this modus operandi was not the proper way to cope with an obviously emerging new long term Signal Corps and SRDL mission. I felt the new responsibilities had to be reflected in the creation of a new operational element in the laboratory's organization. I soon had some firm ideas about how to do this, but did not want to interfere while SCORE was in progress.

Shortly before the completion of SCORE, I disclosed to Dr. Ziegler my plan to concentrate all SRDL space activities into a new Astro Electronics Division, comprised of appropriate elements which would be extracted from the overall SRDL manpower and equipment resources and in which he would be offered the directorship. He did not seem to like it too much since he felt quite happy in his present role. But when I frankly told him that after establishment of the new division, no one on my staff would have much to say in space matters, he joined my plan. There was one more crisis on the morning of the la[st] day of SCORE. When I had permission to let him finally

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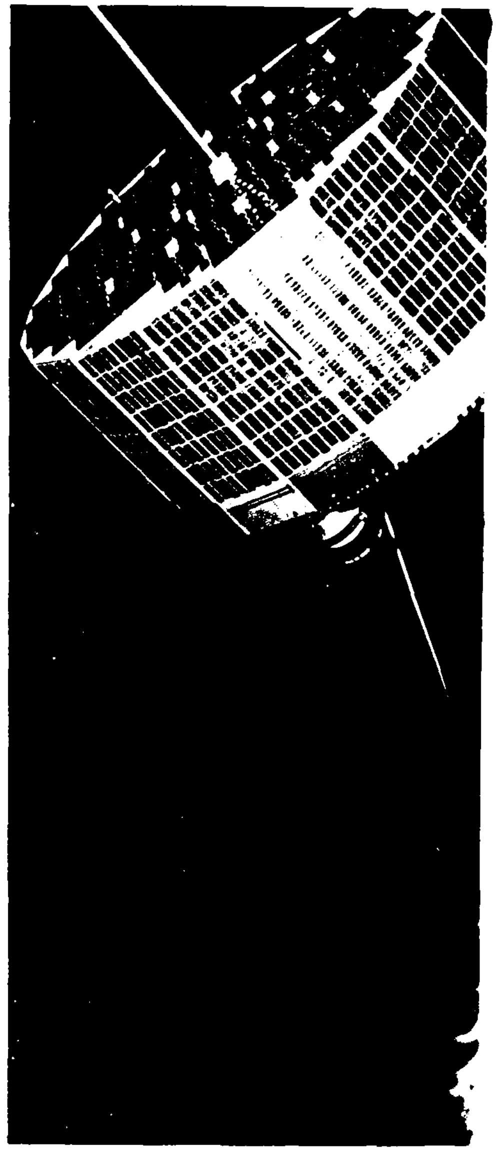
know about the secret — in spite of his key role, he had not qualified originally for need-to-know since the project had already reached the point where it no longer depended on his involvement — he was very disturbed and felt he had to interpret the whole thing as an expression of lack of trust in his integrity by top government echelons and that he should promptly resign. But eventually I succeeded in explaining the situation to his satisfaction and he was ready to assume the directorship of our new division.

Just then, in the first days of January 1959, he received that attractive offer from Johnson. But he did not take it. After his own thorough analysis of the responsibilities he was to take at ARPA at that time and of the future outlook of the role of ARPA and after explaining these viewpoints to the chief signal officer, he declined. In February 1959, he was appointed as director of SRDL's new Astro Electronics Division.

The ARPA offer and my own dim appraisal regarding the longevity of our SRDL space involvement in the light of increasing three service competition and the emerging role of NASA, prompted me to take steps to secure Dr. Ziegler's valuable service for SRDL on a longer range basis. SRDL had on its approved organization table a position of a chief scientist, who was the top civilian directly reporting to the commander. This position had never been filled and I immediately pursued necessary efforts at the Pentagon to have it filled by Dr. Ziegler. It took nine months to accomplish that goal and on 7 August 1959, I had the satisfaction of installing Dr. Ziegler as the first and only chief scientist the laboratories at Fort Monmouth ever had.

I should add here that his appointment was without any campaign or political Pentagon crusade from his side; it was strictly on the basis of his proven competence and performance. I only assured myself of his willingness to accept and conducted the Pentagon battle on my own. Later on, after the Army's reorganization in 1962-63, he was asked to take over the greater responsibility of chief scientist of the entire newly created U.S. Army Electronics C[illegible] and (ECOM), where he successfully served for many years. I greatly enjoyed working with Hans and he was of great help to me during my tour of duty.

Since I am talking about people who were of great help to me, I would be greatly remiss not to mention my deputy commander, Col. John F. Watters, who was always a tower of strength. With unfailing good



Vanguard II was successfully launched 17 Febraury 1959. But a mishap during the final orbit insertion made the cloud-cover payload virtually useless. Ironically, the payload's electronics performed perfectly for the 18 days of battery life.

judgement and a firm, experienced hand. Watters handled literally every type of problem imaginable every day and he did it with great insight and good humor. His many talents were fully tested in this challenging assignment, which some of us likened to being a chaplain in an insane asylum. It must thereby be realized that the chapter of space activities, singled out for special discussion in this article, represented but a small fraction of the overall mission effort conducted by the 3500 personnel at the laboratory complex.

As we entered 1959, our space contributions continued.

After four failures since April 1958 to place a full size instrumented payload into orbit, the last of them containing the SRDL conceived and developed "cloud cover" instrumentation, Vanguard was ready on 17 February 1959 to make another try. It was successful and the Vanguard program had finally delivered the first of the long overdue originally planned IGY satellites. It was designated Vanguard 2 and carried the backup model of our cloud-cover instrumentation.

But while successful physical orbiting of the 22-pound payload was demonstrated, a mishap during the final orbit insertion made the payload virtually useless. The satellite had already been separated from the burnt out last stage rocket and was perfectly on its way when residual fuel in the rocket reignited and propelled it forward, kicking the satellite in the back *and sending it tumbling erratically.* The cloud-cover imaging concept was based on scanning the earth in circular sweeps with photoelectric sensors as the rotating satellite moved along its orbit. Therefore, the now *irregular tumbling* motion made image computation impractical. Ironically, the payload's electronics performed perfectly for the 18 days of battery life, but in spite of desperate attempts to derive *images from* the data, through simulation and computer programs, the effort had to be given up finally.

But a much more sophisticated cloud-cover and meteorological satellite was already coming along: TIROS (Television and Infrared Observation Satellite). This satellite included two television cameras, one with a wide angle and one with a narrow angle view. The picture taking periods of these cameras could be preprogrammed from ground stations for each orbit to coincide with proper sunlight conditions and to achieve coverage of desired parts of the globe. The pictures were stored on magnetic tape and transmitted to ground terminals upon interrogation, but also a real-time TV capability was provided.

In 1960 TIROS I (far left) took these two photographs among many others, from several hundred miles east of the Atlantic coast from an altitude of about 450 statute miles. The photos were sent by television to Ft. Monmouth and then transmitted to NASA, which conducted the TIROS project.

In addition to the TV feature, the system included infrared sensors for various wavelengths to obtain overall heat balance measurements and coarse IR images using a scanning concept similar to our cloud-cover instrumentation.

Actually the TIROS did not originate at SRDL, nor was it an SRDL design, although we were involved in many planning phases and in the final design stages, especially in the IR subsystems.

The project had come a long way from ABMA, where it was derived from Gen. Medaris' ambitious "Eye in the Sky" surveillance satellite concept and had resulted in a contract with the RCA, Princeton. In July 1958, ARPA placed the technical direction of the *development and production* of the TIROS payload by RCA into the responsibility of SRDL.

ARPA's sponsorship was later transferred to NASA and when TIROS I was successfully launched *on 1 April* 1960, it was under the auspices of NASA. All systems operated perfectly and flooded the meteorological community with a total of 22,952 cloud-cover pictures.

The final management of the TIROS project represented a rather complex picture. The Air Force Ballistic Missile Division was in charge of the launching vehicle and the

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operation of a ground terminal at Hawaii; the Signal Corps was responsible for the payload and the operation of a ground terminal at Fort Monmouth. The overall operational phase was directed from the Space Operations Control Center of NASA, with the NASA Computing Center and a Weather Bureau Meteorology Satellite Center, both in Washington, D.C., playing a major role.

The results of the TIROS were most gratifying and fascinating. Besides the cloud formation, the first set of pictures depicting a sweep along the east coast clearly showed the contours of the coast and the St. Lawrence River.

These first pictures were immediately flown to Washington where the head of NASA presented them to President Eisenhower for public release. Later, even more impressive images were obtained from many parts of the globe, among them pictures of the Baja California Peninsula and the Suez-Canal-Red Sea area which are still vividly in my memory.

We received fair credit for our contributions through the news media and some official channels, but were muzzled by NASA in the release of any information or results from our ground terminal at Fort Monmouth. We ended up as mere messengers to deliver the goods for further analysis to the various centers.

My contacts with NASA officials at that time were not particularly pleasant. On the very first day of TIROS operation, after some congratulatory pleasantries in a telephone call, the head of NASA accused us of having leaked information on Signal Corps participation to the UPI without his specific authorization. It was quite obvious that the Signal Corps' role in the project was to be subdued. Other conversations with NASA people led me to the strong belief that a determined trend was in the making to reduce and erase the credits of the military services on their pioneering space accomplishments. I even came to the sad conclusion that this was done with the knowledge or consent of the White House to ascertain quickly a prominent role for NASA as the newly established civilian space agency.

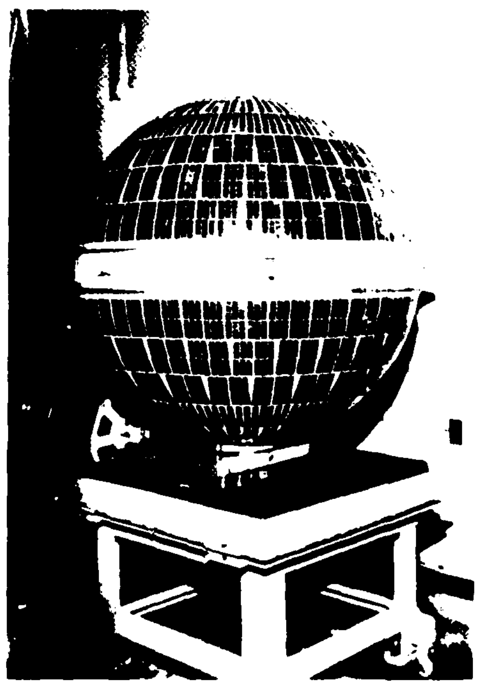
Nevertheless it was our gut feeling that we had made significant contributions to the meteorological satellite development both in the concept of our first cloud-cover instrumentation and our technical directorship of the TIROS payload.

Before we had to experience some more frustrations, we were fortunate to further advance the communications satellite development. Already in September 1958, while the SCORE project was in progress, SRDL submitted to ARPA a technical proposal of a similar but greatly expanded and much more sophisticated store-and-forward, or delayed repeater, system named COURIER, which called for a 500-pound satellite. ARPA operated, and through their authority covering all three services, they were in a position to select one favorable subsystem from one service and marry it to a timely available favorable subsystem of another service. This is what had happened in SCORE, and for COURIER, the Army Signal Corps payload was again scheduled for an Air Force vehicle.

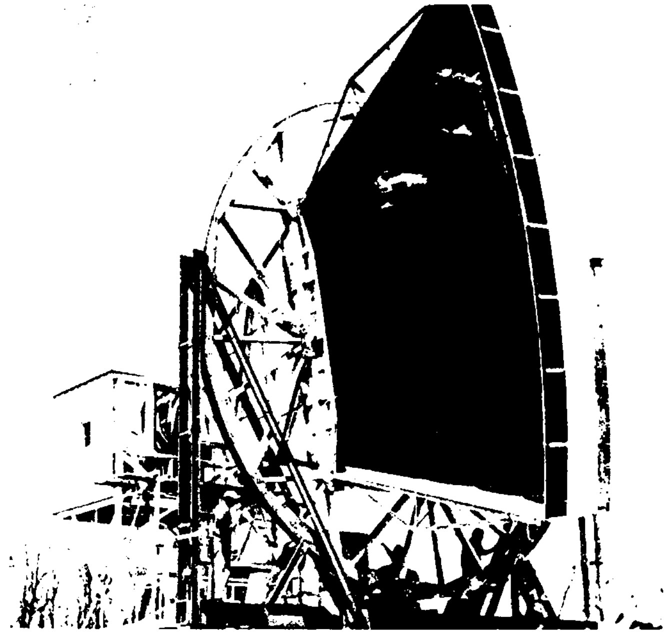
This concept did not please Gen. Medaris. Unfortunately, however, top government decisions had not favored Army space vehicle developments in spite of their pioneering role and demonstrations of capabilities.

The COURIER 1B satellite, which provided basically the same communications modes as SCORE, plus facsimile, but with an immensely larger capacity, was successfully launched from Cape Canaveral on 4 October 1960. An earlier launch attempt in August had resulted in vehicle failure. The tremendous communications capacity can probably be best dramatized by the fact that it could carry the text of the entire Bible and communicate with ground terminals at an effective message transmission rate of 55,000 bits sec. It was also the world's first communications satellite equipped with a complete long life solar power supply, using approximately 19,000 solar cells and associated nickel cadmium storage batteries. As had SCORE, the satellite carried a patriotic message by President Eisenhower, which in view of the large satellite capacity was accordingly longer. The Philco Corporation was the prime contractor on the project.

The COURIER system operated perfectly in all modes and practical Signal Corps use was envisioned particularly for the large volume logistic overseas traffic. But after 228 orbits in 17 days, somehow we were no longer able to interrogate, although the electronics seemed to be in working order. No conclusive failure diagnosis was ever achieved, but we speculated that we had lost the access code. Because of a disturbing experience with SCORE, which had a simple access code and obviously could be triggered accidentally by FM broadcast



COURIER 1B was an advanced communications satellite for its time (1960). It could see, it could speak and it could remember. But after 228 orbits in 17 days, technicians were no longer able to communicate — although the *electronics seemed to be in working order.*



transmissions. COURIER was endowed with a highly sophisticated interrogation system, including a continuous code change by an advancing clock. Therefore, it is not impossible that the ground stations got out of step with the satellite subsystem and were never able to find the way back. But nevertheless, data and lessons learned with COURIER would greatly benefit further advances in communications satellites.

In 1960, the Army Signal Corps had its Centennial Anniversary and its recent contributions to the space age had further enriched its proud history of technological progress.

Many celebrations were being planned. Within their framework, we felt that it would be entirely appropriate to request the Post Office Department to issue a commemorative stamp. Other organizations had been honored in the past at their centennials such as the American Institute of Architects in 1957, the American Chemical Society in 1951 and the American Poultry Industry in 1948. The Signal Corps pursued this goal through every possible official and unofficial channel, at every possible level, including the White House and was even able to offer excellent designs from our outstanding Signal Corps artist Harold Christenson. But we were denied the honor. The only explanation given was that too many stamps had already been scheduled for the year 1960! (I am alleged to have said "They can go to Hell in a wicker basket," but I can't remember if I did!)

Dismayed as they were by the Post Office decision, the faith of the SRDL people in their government's fairness to recognize accomplishments was completely shattered when (in spite of an "overcrowded" stamp schedule) a commemorative stamp honoring the NASA ECHO satellite was issued 15 December 1960. To add insult to injury, the ECHO satellite was credited in the Post Office publications as the World's First Communications Satellite, entirely ignoring the Signal Corps' and SRDL's first which had been firmly established two years earlier.

The issue of the ECHO stamp caused an uproar of protests by our dedicated people at SRDL. When we started preparation for a strong complaint, we soon found out that no government agency complains to another without moving through miles of red tape. Dr. Ziegler decided, therefore, to launch the complaint to the Postmaster General in his capacity as a private US citizen. An assistant of the Postmaster General replied that the matter has been referred to NASA, which was the last we ever heard of it.

In the meantime, reputable publications, like the *Life Science Library* books picked up the erroneous Post Office information. Based on another private effort by Dr. Ziegler, however, the editors took prompt steps to make corrections.

The 100-ft. aluminum-coated sphere (above, left) of Project Echo orbited at 1,000 miles altitude. It had two tracking beacons, and the aluminum coat provided radio wave reflectivity of 98 percent up to frequencies of 20,000 mc. Scientists armed the 50-ft. long horn reflector receiving antenna (above) directly at the orbiting sphere.

The case with the Post Office was reopened in 1964. Dr. Ziegler had the opportunity to appear before the President's Science Advisory Committee and he included in his prepared statements a reference to the stamp controversy as a typical example of the mishandling of accomplishment credits of government personnel. He again privately complained to both the Postmaster General and the administrator of NASA. This time success was at hand. The NASA reply pointed out that they had never claimed that ECHO was the first communications satellite but only the first man-made passive communications satellite and that it was all the Post Office's fault that the error was spread. On the same day, the Post Office thanked Dr. Ziegler for bringing the error to their attention and proposed to identify ECHO I in future publications "as the world's first passive communications satellite." Finally the case was settled, but the damage had been done. The erroneous

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identification had crept into many publications of space history. Corrections are slow in coming. In fact, some Post Office publications still contained the error in 1978!

Unfortunately, the Signal Corps missed a great opportunity in 1960 to get its success story to many millions of readers in the US and all over the world and to have it prominently recorded for history.

Dr. von Braun, with whom we had a fine working relationship and whom I have always admired as a perfect gentleman, had referred to us Cornelius Ryan, the famous author of *The Longest Day* and other WWII best sellers. Ryan had been asked by *Reader's Digest* to write a feature story on communications satellites. Consequently, he made several visits to us and spent many hours with Dr. Ziegler and others. He felt he should also go to the Pentagon to collect firsthand background material. At that time many details on satellite work were still safeguarded under security classification and he returned rather frustrated from his Washington trip, since he had not received all the desired answers. He was also told that any publication covering ongoing military R&D was by government regulation subject to prior review and editing. When he finally submitted his manuscript to Dr. Ziegler, it turned out that, based on the gaps in information withheld from him and his attempt to bridge them with his own vivid imagination, the manuscript required considerable revision. When Ryan was told about this, he was so upset that he could not get all the information he had desired and that he would be told what he could, and could not, write, that he cancelled the project. Thus, unfortunately, no *Reader's Digest* article on the evolution of communications satellites was published and a great opportunity for the Signal Corps was lost.

The future of satellite communications, we recognized, lay with satellites in stationary synchronous equatorial orbits, with fixed relationships to their ground terminals. Since launching vehicle developments quickly approached required capabilities, ARPA decided to combine the related efforts of the three military services into project Advent and assigned overall project management to the Army in a newly created US Army Advent Management Agency located at Fort Monmouth and reporting through the chief of R&D of the Army. Although this Army responsibility was already established by September 1960, the new agency was not officially activated until 27 March 1961. For us at SRDL this had a serious impact. Although we continued to be responsible for some R&D in communications satellites, the immediate need for staffing the new agency with competent similar talents required the transfer of some forty key people from our recently initiated Astro Electronics Division. In the Advent project, the Army had major responsibility for the payload and ground terminal systems, the Navy for shipboard terminals and the Air Force for the launching vehicles and related operations.

But this lasted hardly more than a year. Under the pressure of the Air Force to include the satellites into their mission, the Army's responsibility was reduced to ground terminals and ground support. In May 1962, the Army agency was renamed the US Army Satellite Communications Agency (SATCOM). With this change, the R&D mission of SRDL was also reduced accordingly and the Signal Corps no longer had any direct stake in satellite payloads, thus bringing to an end a most memorable chapter of Signal Corps pioneering efforts and achievements.

The SATCOM agency has survived all subsequent reorganizations and is still continuing to perfect satellite ground terminals for Army use, including tactical applications for the Signal Corps communicator in the field, the ultimate gratifying purpose of any successful Signal Corps technological endeavor.

NASA, originally absorbing the NACA, major parts of the Navy's Vanguard group at NRL, some parts of SRDL and, above all, the Dr. von Braun team and related Army missile elements, gradually came into its own.

Meanwhile I had gone to Seventh Army in Europe in 1961 and from there to USAREUR, back to Fort Monmouth as Commandant of the Signal School in 1964 and to the Pentagon in 1966 as Deputy Chief of Army Communications and Electronics, where I retired in 1967.

The laboratories at Fort Monmouth are still there, but after the reorganization of the Army in 1962, they are no longer an integral part of the Signal Corps and have changed their parentage in one more drastic reorganization. Some of the missions have been modified or eliminated, others have been added.

A new generation of scientists and engineers has replaced the many who have retired or passed away since I departed. Although they are no longer part of a Signal Corps activity, they represent — together with industry — the backbone of the Army R&D in the electronics and communications fields and their continued achievements will benefit the Army communicator. The memorable phase of the early Space Age has passed and the labs are now successfully penetrating the frontiers of the Computer Age.

It is gratifying to note, that just recently one of the major R&D activities at Fort Monmouth has been recognized as the top laboratory in the entire Army and has been presented with the Secretary of the Army's Laboratory of the Year Award.

Thus, while we hope the pioneering achievements of the previous institution will remain deeply embedded in the minds and hearts of Signal people everywhere, we also wish Godspeed to its successors for the continued benefit of our Army and its communicators.

AC

Brig. Gen. Brown retired from active duty in 1967 after thirty years of distinguished service. A 1937 West Point graduate, he also successfully completed the US Army Signal School (1940), Command and General Staff School (1944), Armed Forces Staff College (1951) and the Army War College (1955). Among his many key assignments are his two years as commanding general of the US Army Signal Center and School (1964-66) and his final assignment as Deputy Chief, C&E, Department of Army (1966-67). Brown, who played a central role in the initial Signal Corps space effort, resides in Edinburg, Texas.

Hans K. Ziegler

Hans K. Ziegler (SM'56) was born on March 1, 1911, in Munich, Germany. He received the following degrees from the Technical University of Munich: the German equivalents of B.S. in 1932, M.S. in 1934, and the Ph.D. in 1936, all in electrical engineering.

Between 1934 and 1936 Dr. Ziegler was the German equivalent of an Assistant Professor in Electrical Engineering at the Technical University, Munich, pursuing research in dielectrics and in the theory of nonlinear circuits. In 1936 he accepted a research position with the Rosenthal Isolatoren G.M.B.H. in Selb, Germany, a subsidiary of the AEG, where he spent the first three years in research of dielectrics, high-voltage phenomena, lightning, high-current arcs, and energy transmission. Soon after the beginning of World War II, he was appointed Chief of the Research and Development Department of the company and his work shifted to military electronics for the German Army and Air Force. Electronic fuze systems for bombs, shells, and mines, proximity fuze systems and many other aspects of military electronics and communications, and associated components, were his major assignment.

After the war he was invited by the U. S. Government to come to this country and in March, 1947, he joined the Army Signal Corps Laboratory at Fort Monmouth, N.J., where he has been for the past thirteen years.

In 1954 he became a United States citizen.

For eight years he was a Scientific Consultant to what is now the Electronic Components Research Department of the Army Signal Corps Laboratory, and has made major research contributions to the field of energy generation and conversion, and to the electronic components field. In 1955 he was assigned to the Office of the Director of Research to guide the Laboratory's Space Electronics and Geophysical Programs. In 1956 he was appointed Assistant Director of Research, with research in meteorology and electronic components added to his assignments.

In late 1958 he became Director of the newly established Astro-Electronics Division. Under his leadership, since 1955, the Army Signal Corps has produced major contributions to space electronics, among which are the first solar power supply for Satellite 1958 Beta, the SCORE communications electronics for Satellite 1958 Zeta, and the Vanguard cloud cover electronics for Satellite 1959 Alpha. It has technically supervised further the TIROS electronics for Satellite 1960 Beta and presently is developing various advanced satellite communication systems.

During the IGY, he was a Defense Department Delegate to the Technical Panel on the Earth Satellite Program of the NAS and a U. S. Delegate at the 5th CSAGI conference at Moscow, 1958.

In August, 1959, the Signal Corps appointed Dr. Ziegler to the position of Chief Scientist of the U. S. Army Signal Research and Development Laboratory at Fort Monmouth.

He has published numerous scientific and technical papers, holds a number of patents, and is a frequent speaker, lecturer, and moderator to the scientific community throughout this country and abroad.

Dr. Ziegler is the 1960-61 President of the Armed Forces Communications and Electronics Association Fort Monmouth Chapter, and also serves on various military and civilian committees and panels.

Guest Editorial

HANS K. ZIEGLER

OVER the past 100 years the United States Army has established a proud record of pioneering on many scientific and technological frontiers. The experience of each war in retrospect has generated an energetic and imaginative drive for progress which has allowed it to set many outstandingly significant milestones of success, to make this country safer, improve our mode of living, and enhance the Nation's prestige in the world. These accomplishments not only cover many aspects of electronics, but also very much include the physical, chemical, engineering, biological and medical sciences. In some instances the results of the progressive undertakings grew to such magnitude and importance that the Nation decided to establish organizations devoted completely to the newly-created disciplines or potentials.

The U. S. Weather Bureau's transfer in 1890 to the Department of the Interior after origination by the Army in 1870; the establishment of the U. S. Air Force as an independent third military service in 1947 as the result of the Army's forward-looking initiation of an Aeronautical Division of the Signal Corps in 1907, and its 40 years aggressive effort in the aviation field; the foundation for the activities of the Atomic Energy Commission as an outgrowth of the Manhattan Project (for which the Army had an important responsibility)—these are only a few examples of the Nation's trend to utilize the Army as a trail blazer into new areas of science and technology.

The advent of the Space Age found the Army well prepared. Its own capabilities gained in years of endeavor in the scientific and engineering fields—supplemented by the Free World's most experienced rocket and missile team under Dr. Wernher von Braun—enabling it to establish an unsurpassed record of achievements in many aspects of our military and civilian space effort.

The Army's first successful electronic contact with the moon in 1946 from the Diana Radar at Fort Monmouth, N.J., extended man's information beyond the earth's environment and paved the way for later space age electronics.

In 1949 a V2 rocket with WAC Corporal second stage, fired at White Sands, New Mexico, reached up 250 miles and provided the first physical penetration into outer space.

In 1956 a Jupiter C test firing exhibited a performance which obviously had the inherent capabilities of launching an earth satellite.

In 1957 another Jupiter C test firing furnished the first solution to the re-entry problem—the nose cone which President Eisenhower proudly displayed in his talk to the Nation.

In January, 1958, the Army launched Explorer I, the first satellite of the United States and the Free World.

In March, 1959, the Army placed the first U. S. satellite, PIONEER IV, into orbit around the sun.

In addition to these and other launching successes, it has contributed many firsts to the payload electronics of various satellites. The first solar power supply was provided for the small IGY satellite Vanguard I in 1958. The first satellite communications system, Project SCORE, transmitting the President's 1958 Christmas message to the world, was an Army project. So was the first cloud cover electronics carried by the IGY satellite Vanguard II in 1959.

In the biological field, after a journey into outer space, the first recovery of live premates, Able and Baker, was an Army achievement.

These are only a few of the outstanding milestones associated with a wealth of new scientific information found along the long road of Army space activities. The accompanying papers are an attempt to give the reader a cross section through the past and some of the future contemplated work, much of which has been and will be conducted in close cooperation with other military and civilian agencies and industry. All of this work is closely related to the field of electronics.

This issue is arranged in four parts to tell the story of JUNO I and II satellites and space probes, of the Communications Satellites, of the many other space endeavors, and the story of the satellite tracking effort. Acknowledgement is due to all who have contributed and helped to make this publication possible.

The Army has its own important role in space—as other military services have. The utilization of space technology in the future fulfillment of its assigned missions in the areas of communications; air defense, reconnaissance (including meteorology) and mapping, will be an indispensable requirement, for which proper implementation is on the way.

The Army is indeed proud of its major part in launching the United States space effort and will continue in this field consistent with its roles and missions. But perhaps more important, the imagination which has led to so many of our Nation's "firsts" is now aggressively at work, and, inevitably, new concepts or potentials of great importance and significance will come out of its laboratories—concepts vital to superior defense, and as history has so often demonstrated, concepts which also lead to better living.

TELSTAR

The top communications engineering achievement in the past 50 years

The National Society of Professional Engineers (NSPE) has just announced its 10 top engineering achievements over the past 50 years during a ceremony of the NSPE in San Francisco, as reported in the IEEE "Institute" for March 1984.

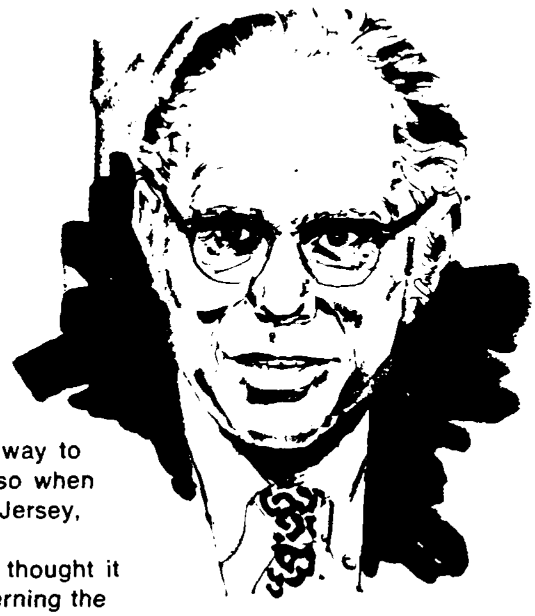
An NSPE committee cited the following advances as the most outstanding since 1934: nylon; the first controlled self-sustaining nuclear chain reaction; the Electronic Numerical Integrator and Calculator (Eniac); the transistor; the inertial navigational guidance system; the Boeing 707 jet airliner; the cardiac pacemaker; lasers; the TELSTAR satellite; and Project Apollo.

The 10 outstanding engineering achievements were selected in a two-stage process. First, the 80,000 NSPE members were asked to choose 10 award categories. (The ones selected were synthetic fabrics, nuclear energy, electronic computers, solid-state electronics, automation and control systems, jet aircraft, biomedical lasers, communications, and the space program.)

Next, an ad hoc NSPE committee chose the most significant achievement in each category. A chronological list of the achievements and their award categories followed.

The launching of the TELSTAR I by AT&T Bell Laboratories on July 10, 1962, heralded a new era of communications for data transmission, television and radio signals, and telephone messages. The TELSTAR and its succeeding communications satellites have provided the links to move information around the world almost simultaneously.

For the latest on TELSTAR III see the Bell Laboratories Record for May/June 1983.



John R. Pierce

Leader in Satellite Communications

John R. Pierce, the many-sided man who led the way to satellite communications, was initially moved to do so when preparing a talk for a meeting of the Princeton, New Jersey, section of the Institute of Radio Engineers in 1954.

"My topic was space," Pierce recalled later, "so I thought it would be interesting to make some calculations concerning the possibilities of communications satellites. I was astounded at the way things looked when I actually made the calculations."

This was three years before Russia launched the first Sputnik. With the subsequent rapid development of rocket power in the United States, Pierce pushed the idea of using a big plastic balloon, then being planned by the National Aeronautics and Space Administration to measure the density of the atmosphere at high altitudes, to reflect voice signals between transmitting and receiving stations in New Jersey and California. In 1960 the scheme was tried, with complete success.

This "passive" Echo satellite—so described because it did not actively retransmit the signals but merely reflected them—was followed in 1962 by AT&T's Telstar satellite, which had an amplifier-transmitter to relay the signals, and soon afterward by other active satellites.

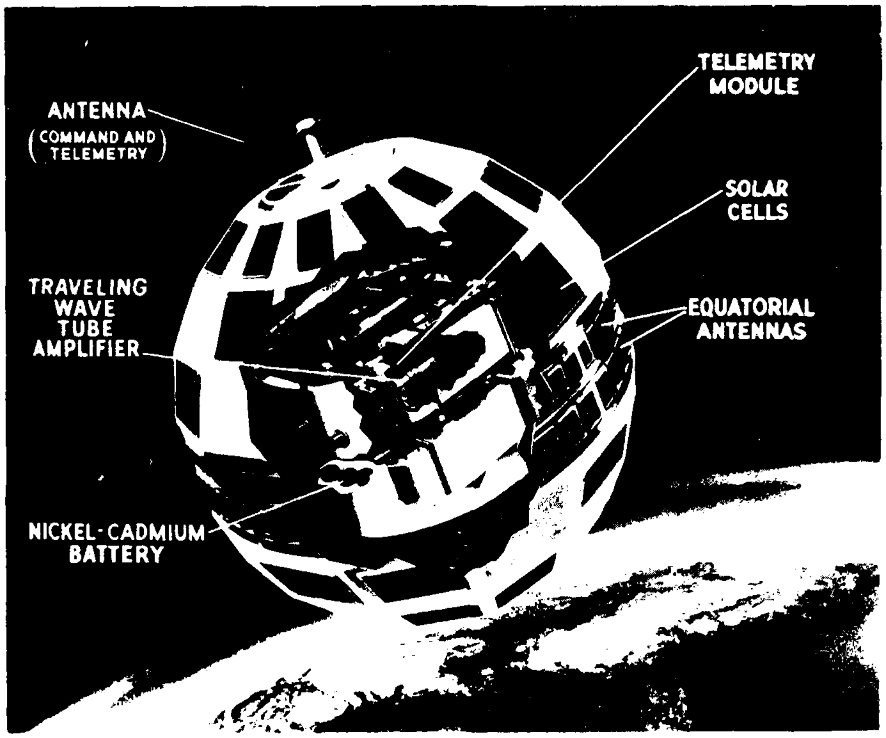
Today satellite communication systems are vastly important in transoceanic service (more than 50 per cent of all the voice channels between the United States and other continents are obtained in this way) and domestic communication via satellite is both technically and economically practicable. A domestic satellite system should be in operation by 1976. The system will add 28,800 circuits to the long-distance network using satellites to be leased from the Communications Satellite Corporation.

Pierce made many other contributions during 35 years at Bell Laboratories. Important among them were ideas and designs for a device called the traveling-wave tube, which had been invented by Rudolf Kompfner in England in 1943. Years of work by Pierce, Kompfner and their associates at Bell Laboratories (which Kompfner joined in 1947) eventually made the tube into a powerful amplifier for microwave radio systems. It has also become a rugged, reliable component for communications satellites, which are, in effect, microwave relay stations in space. And here it should be said that Pierce's ideas about satellite communications went far beyond the Echo experiment, which he promoted simply as a practical, relatively inexpensive way to explore the possibilities. A technical paper he wrote in 1955, expanding his Princeton talk, covered all aspects of the subject and by the time of Echo he and others at Bell Laboratories had already carefully studied the resources developed there that might make active satellites economically useful. These included, beside the traveling-wave tube, the transistor; the solar battery; the horn-reflector antenna; an FM circuit invented at Bell Laboratories many years earlier; and an extremely low-noise amplifier, the maser, that introduced only about one one-hundredth as much noise as previous amplifiers.

In 1949, Pierce tests a model of a traveling wave tube, one of several Bell Laboratories developments that made satellite communications possible.

Pierce also invented the helical structure for the inner wall of the circular waveguide. For years he directed research programs in electronics and in communications systems and principles, including studies in mathematics, acoustics, vision, economic analysis and psychology. Numerous other inventions resulted in 88 patents. Pierce was also a writer (13 books and a lot of science fiction while he was at Bell Laboratories), a wit ("Nature," he once said, "abhors a vacuum tube") and above all a stimulator of other people. When he retired from the Bell System in 1971 to teach at California Institute of Technology, President Baker of Bell Laboratories (at that time vice president for research) said, "John Pierce has unwaveringly looked for the most challenging ideas that science and engineering could contain. He often personally phrased these in forms which excited the best energies and enthusiasm of whole generations of collaborators."

It was this capability that made Pierce, more than any other man, responsible for bringing satellite communications from dream to reality.



TELSTAR I

Cutaway view of Bell System's experimental communications satellite, TELSTAR I.

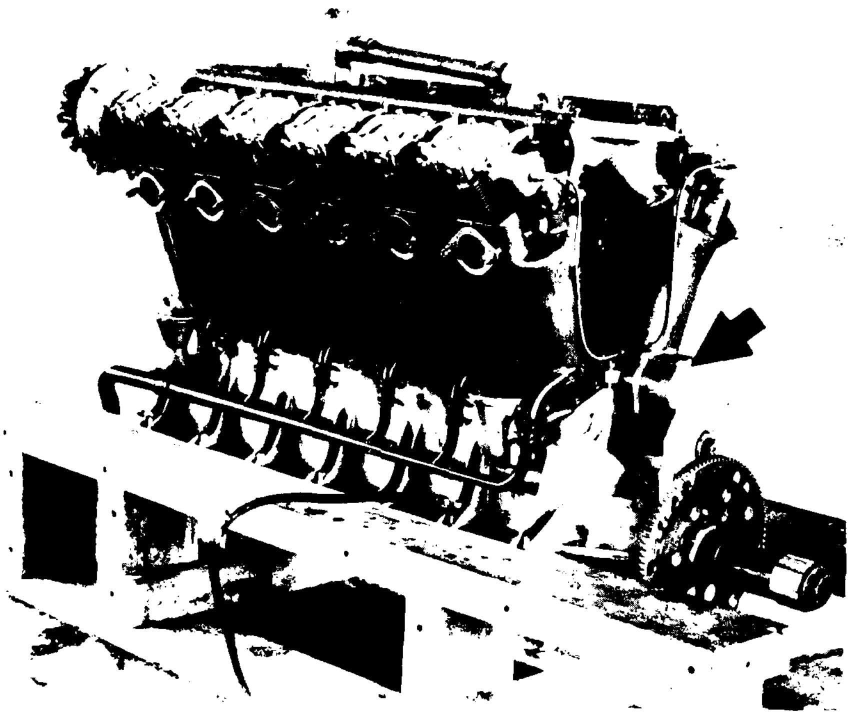
Cannister containing TELSTAR's electronics is laced to inside of satellite frame for shock resistance. TWT (Traveling-Wave Tube) amplifier, boosted strength of one-billionth of a watt signal reaching TELSTAR from ground to about 2 1/4 watts for retransmission to earth station. Solar cells converted sunlight into electrical energy that was stored in 20 rechargeable nickel-cadmium batteries. Equatorial antennas transmitted and received signals to and from ground stations.

HISTORICAL CONTRIBUTIONS

OF BENDIX (AIEE/IEEE MEMBERS)

TO AEROSPACE INDUSTRY

First Aircraft Generator - Hispano - Suiza Engine	1914
First Electric Starter - Liberty Engine	1916
First AC Generating System for Aircraft (XB15 Experimental Acft.)	1936
Complete Line of AC and DC Brush - Type Generating Systems	1950
Development of Family of High - Temperature, Brushless Generating Systems	1956
First Transistorized Voltage Regulator	1957
Introduction of Oil - Cooling Techniques to Brushless Aircraft Generators	1963
Introduction of 3/4 Design with Spray - Mist, Oil Cooling for Generators	1968
Introduction of DC Brushless Generators	1973
First No Break AC Electric Power System for Aircraft	1977
First Commercial VSCF System	1982



LIBERTY ENGINE 1916

WITH

BENDIX ELECTRIC STARTER

FIRST EVER USED IN AIRCRAFT

U.S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT COMMAND

ELECTRONICS TECHNOLOGY

AND

DEVICES LABORATORY

U.S. ARMY "LABORATORY OF THE YEAR"

16 JANUARY 1981

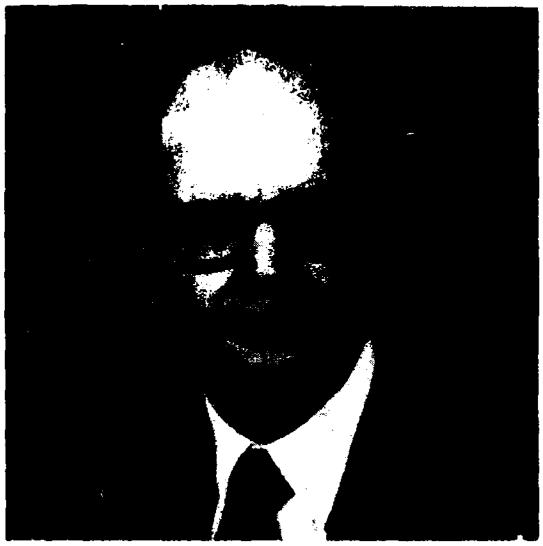
23 JANUARY 1984

DIRECTOR

DR. CLARENCE G. THORNTON

DEPUTY DIRECTOR

MR. IRVING REINGOLD



DR. CLARENCE G. THORNTON

Fellow 1966
AFCEA Gold Medal 1983

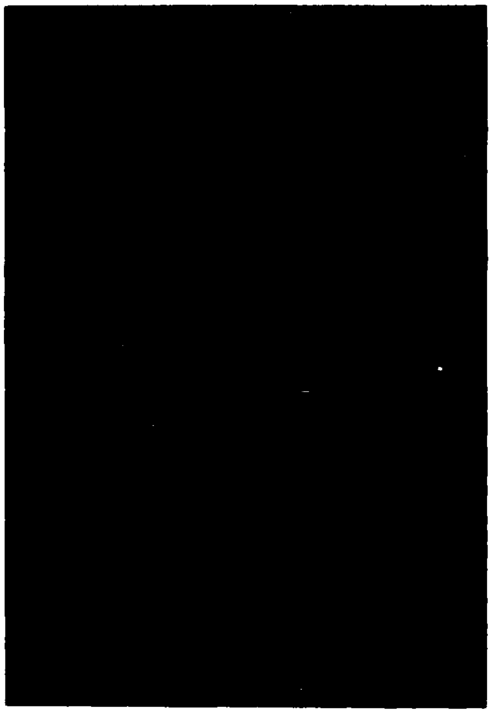
Dr. Thornton is currently Director of the U.S. Army Electronics Technology and Devices Laboratory, ERADCOM, Fort Monmouth, New Jersey and is responsible for planning, managing, coordinating, and implementing a $30-40 million dollar research and development program which forms the nucleus of the entire electronics field and provides the basic media for the development of all types of electronics equipments and systems for use within the military.

Laboratory programs encompass the full range of R&D from basic research through engineering development of semiconductor devices, integrated electronics, elecronic tubes and plasma devices, displays, power sources (including primary, secondary and reserve batteries), and supporting areas of electronic materials research. He is responsible for determining Army subsystem and component needs in terms of end-use application in communications, data processing, surveillance target acquisition, electronic warfare missiles and ordnance, and for planned coordinated integration of known and anticipated requirements for all DARCOM equipment and systems responsibilities.

IRVING REINGOLD

Fellow 1975
Fellow Society of Information Display 1973

Mr. Reingold is Deputy Director of the Electronics Technology and Device Laboratory, after previously serving as Director of the Beam, Plasma and Display Division of the Electronics Technology and Devices Laboratory, U.S. Army Electronics Research and Development Command, Fort Monmouth, NJ. Since joining the Fort Monmouth laboratory complex in 1945 his work has covered a wide spectrum of technologies, including radar systems, microwave tubes and associated transmitter devices, display related device development, techniques, and applications, and high energy pulsers for directed energy weapons. He has published extensively, and is the holder or co-holder of a dozen patents.



VLADIMIR G. GELNOVATCH

IEEE Fellow 1982, for contributions to microwave circuits design

Vladimir G. ("Walt")Gelnovatch is current Director of the Microwave and Signal Processing Devices Division, Electronics Technology and Devices Laboratory, Fort Monmouth, NJ. He is nationally known in the microwave community for his innovative contributions in the fields of microwave integrated circuits and computer aided design. He pioneered development of the highly effective "DEMON" computer program, widely used in the U.S. and Europe for automatic design of microwave integrated circuits. His expertise also includes: microwave solid state devices, microwave circuit design, optimization, measurement and synthesis, microwave transistor amplifiers, and reflectometer modeling, that has given him international exposure.

DR. ARTHUR BALLATO

IEEE Fellow 1981 for contributions to the theory of piezoelectric crystals and frequency control

In 1958, Dr. Ballato joined what is now the U.S. Army Electronics Technology and Devices Laboratory, U.S. Army Electronics R&D Command, Fort Monmouth, New Jersey. Since that time he has worked on analytical and experimental aspects of classical frequency control and selection. Specific areas of interest include evaluation of piezoelectric substances, development of SAW resonators, filter crystal and crystal filter design, development of crystal parameter measurement equipment, and growth of high-purity quartz. Most recently, he has investigated the properties of stress- and thermal-transient-compensated plate vibrators for high precision application, and has developed acceleration-compensated resonators. These results have been presented at the Frequency Control, Ultrasonics, Microwave, Circuits and Systems, and other symposia.

VI

HISTORICAL CAPSULES

100 year history capsule of IEEE

1884 The American Institute of Electrical Engineers (AIEE) is formed by a number of "electricians and capitalists" at a meeting on May 13 in order to properly host the foreign delegations expected to attend the International Electrical Exhibition, planned for that fall at the Franklin Institute in Philadelphia. The first technical paper presented at the conference deals with the Edison effect, a harbinger of electronics.

This exhibit at the Franklin Institute in 1884 spurred the formation of the IEEE's first predecessor, the American Institute of Electrical Engineers.

1886 Several members prod the AIEE to hold local monthly meetings in New York. The first meeting starts shakily when "a complication of business" prevents the scheduled speaker of the newly formed Westinghouse Electric Co. from reading his paper on "Incandescent Lighting from Central Stations."

1889 Committees on units and nomenclature are established within the AIEE.

1893 The Chicago section is formed, marking the first AIEE base outside New York City. The AIEE is also instrumental in getting the "henry" approved at an international conference in Chicago as the worldwide unit of inductance, thereby honoring Joseph Henry, one of the founders of electrical science in the United States.

1900 The AIEE creates an *ad hoc* committee to join in a general drive to get the U.S. Congress to form a "standardizing laboratory." Hearings are held, culminating in the creation of the National Bureau of Standards in March 1901.

1902 Charles F. Scott, the AIEE president, forms student chapters at colleges and universities to support industrial courses that prepare students for "the plunge from theory to practice on graduation."

1903 Andrew Carnegie's grant of $1.5 million helps launch an effort to establish an engineering headquarters in New York for the AIEE and the equivalent mechanical and mining engineer groups. In addition, the first AIEE technical committee, the High Voltage Transmission Committee, is formed. Sections are established in Cincinnati, Denver, Philadelphia, Pittsburgh, and St. Louis.

1912 The Institute of Radio Engineers (IRE) is founded during a meeting in New York at Columbia University on May 13 of the Society of Wireless Telegraph Engineers in Boston and the Wireless Institute of New York. By explicitly excluding the word "American" in the title of the new institute the radio engineers support the proposition that radio is not bounded by national boundaries.

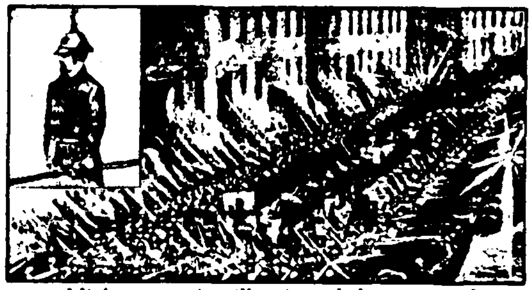
The rank of Fellow is created in the AIEE, which is the largest engineering society in the United States, with more than 7300 members. In addition, the Code of Principles of Conduct for the society is approved.

1914 The rank of Fellow is created in the IRE. The first IRE Fellow selected is a German citizen, Jonathan Zenneck, well known in the magnetics field.

1917 At the request of U.S. President Woodrow Wilson, the AIEE appoints two of its members, Benjamin Lamm and Frank J. Sprague, to serve on a Navy wartime research and development committee.

1927 The AIEE and the IRE sponsor the sectional committee on radio of the American Standards Association. Already the societies have shared two presidents, Arthur E. Kennelly and Michael I. Pupin.

1930 The IRE initiates the custom of always electing a non-U.S. vice president.



A torchlight procession illuminated the streets of New York on Oct. 31, 1884, demonstrating the effects of about 300 incandescent 16-candlepower lamps.

1939 The first IRE section outside North America is founded in Buenos Aires, Argentina.

1947 The IRE forms its first student branches at the College of the City of New York and New York University.

1948 Professional Technical Groups are created by the IRE, further organizing members into specialties. These groups are the forerunners of the IEEE Societies. The first IRE technical group, on audio engineering, is now the IEEE's Society on Acoustics, Speech, and Signal Processing.

1954 The IRE begins publishing the *IRE Student Quarterly*.

1957 The expanding IRE surpasses the AIEE in terms of total membership. (In 1947, the AIEE membership totaled 26 500, compared with 18 000 for the IRE. By 1962, membership in the IRE topped 96 000, compared to 57 000 in the AIEE.)

1961 A Merger Committee is formed between the IRE and AIEE.

1963 The IEEE is created on Jan. 1, when the AIEE and the IRE merge. The merger is favored by 87 percent of the voting members of each organization.

1973 By an amendment to the IEEE Constitution, the U.S. Activities Committee is formed, predecessor of the current U.S. Activities Board. This entity expands the IEEE's role into professional as well as technical issues.

1984 The IEEE celebrates its Centennial with the theme "A Century of Electrical Progress."

Sources: *Engineers and Electrons* and *The Making of a Profession: A Century of Electrical Engineering in America* (IEEE Press); and the *IEEE Centennial Activities Guide*, Chapter 6 (IEEE Center for the History of Electrical Engineering).

Time Capsule Sealed To Be Opened 21 June 2060

FORT MONMOUTH — A time capsule, with Army Signal Corps electronic equipment, documents and papers in a copper cylinder was installed in a four-ton concrete vault on the top landing to the entrance of this post's headquarters building — Russel Hall last Friday.

Army officials, government employees and guests saw Maj Gen. William D Hamlin, commanding general of Fort Monmouth lead the ceremony in the sealing of this relic which is to be opened on 21 June 2060, the two-hundredth anniversary of the Signal Corps.

The ceremony marked another step in the celebration of the Signal Corps Centennial being feted this year.

The items included in the capsule should prove of great historical value on the 200th birthday. They will provide not only a complete and representative picture of the Signal Corps in 1960, but also historical information dealing with the origin of the Corps and of major developments during the first 100 years.

Made of one-eighth inch copper, the capsule measures 46 inches in height and 24 inches in diameter. The contents weigh approximately 350 pounds.

In the final sealing of the capsule, all air was evacuated and the cylinder was filled with an inert gas. The contents are individually sealed in polyethylene envelopes, and the capsule itself was placed in a polyethylene container.

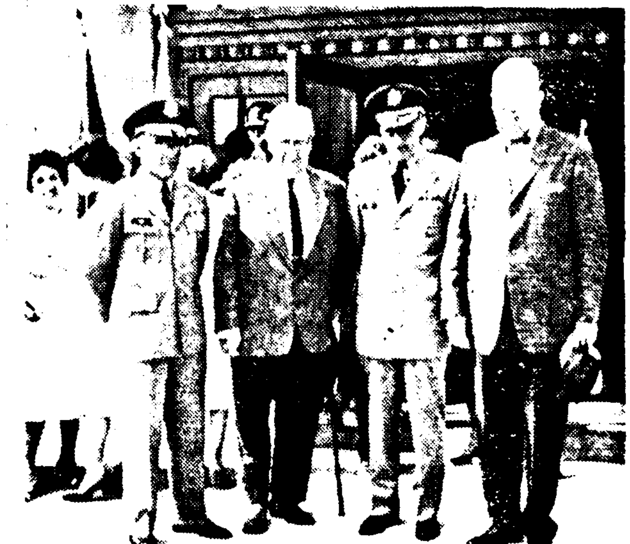
The inscription on the bronze plaque covering the vault is:

CENTENNIAL TIME CAPSULE

Beneath this plaque lies a time capsule installed 16 September 1960 to commemorate the first Centennial of the United States Army Signal Corps. The time capsule is to be opened in the year 2060 on 21 June, the birthday of the Corps.

This time capsule contains items depicting the status of military communications in 1960, as ell as historical material showing origins of the Corps and progress during the first hundred years.

Contents of the time capsule are: photos of CG Staff and Major Activity Commanders; composite photo of all Chief Signal Officers; photos of Fort Monmouth; missions and functions manuals; organization charts telephone directories; general orders; microfilm of handbook - *Electronic Communication* Equipment; microfilm of General Albert J. Myers' (first Chief Signal Officer) papers, Army regulations on uniforms insignia and decorations; Centennial brochurch; Centennial issue of MONMOUTH MESSAGE [illegible] space issue of IRE magazine, Centennial [illegible] report; Centennial flags; film — 'This is Fort Monmouth' and 'A Century of US Army Signals' helmet radio; radiosonde representative electronic components solar cells, booklets and materials covering training at the U S Army Signal Corps' School tape of Army Secretary Wilber M Brucker's and General Ralph Nelson's (present Chief Signal Officer) addresses at Fort Myer Washington, D C on 21 June 60 encomium to Signal Corps by Gen Douglas MacArthur insignia imbedded in lucite; quarterly management report; copies of current newspapers and magazines; book on 'Traditions of the Signal Corps'; information on local communities [illegible] ACAN network information [illegible] on Fort Gordon Ga [illegible] Fort Huachuca Ariz two major Signal Corps installations copy of printed program for time capsule installation ceremony and a list of contents in the time capsule.



VIEW CENTENNIAL PROGRAM — Among the honored guests at yesterday's installation ceremony of an Army Signal Corps Time Capsule at Fort Monmonth were Congressman James C. Auchincloss (second from left), Rumson and Maj. Gen. (Ret) Joseph O. Mauborgne (right), of Little Silver. The Post visitors, with Maj. Gen. William D Hamlin (third from left), Fort Monmouth commanding general and Brig Gen. Charles M Baer, Army Signal School Commandant, view bronze plaque which has just been placed over cylinder just outside of Post headquarters building. General Mauborgne is a former Army Chief Signal Officer, serving a four year tour which started in Octobee 1937.

Tales of Yesteryear . . .

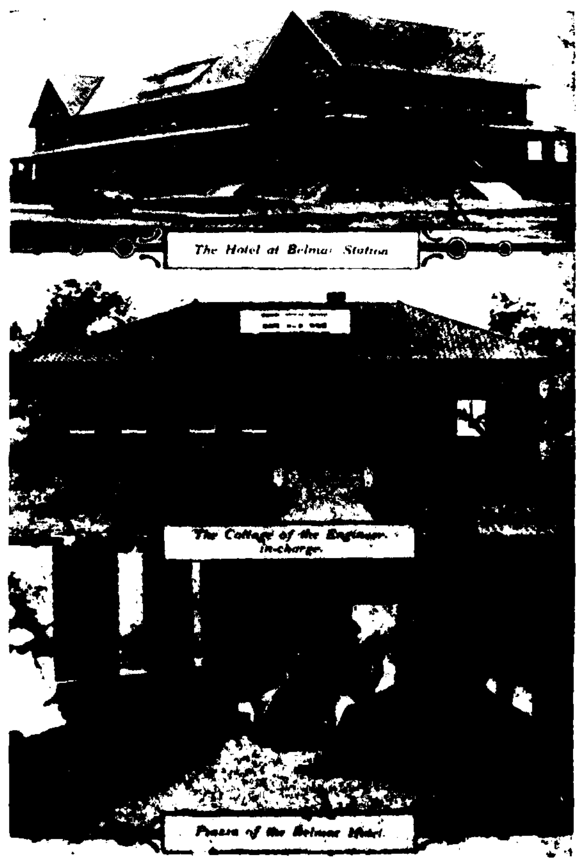
In Case You Have Forgotten

by Dr. HAROLD A. ZAHL

At the turn of the century, the newly formed Marconi Wireless Telegraph Company of America, with its home office in England, purchased a 93-acre farm from a New Jersey resident by the name of Mr. Woolley. The farm, located in Belmar, New Jersey, was to be the site of their receiver equipment for commercial transatlantic radio operation. Advance publicity of this new enterprise appeared in Volume I of the new magazine, *The Wireless World*, April, 1913-March, 1914. Under the title of "New Jersey Station," the article concludes, "At Belmar, a large force is required to handle the operating work, and much will be done to make the residential quarters attractive to live in. Summer boating on Shark River is a pastime which is looked forward to with pleasure, while tennis and outdoor sport will be encouraged; in fact, a happy little community will soon be thriving in this neighborhood."

Since that memorable time, the old Woolley farm has hosted a number of "communities," the present one being a part of the U. S. Army Electronics Command of Fort Monmouth, New Jersey—the Evans Area. The war-time home of U. S. Army radar, this area is known to tens of thousands of soldiers, civil-

This is another in a series of short historical reminiscences by Dr. Zahl. The tale is similar to those appearing in the author's book, ELECTRONS AWAY . . . Or Tales of a Government Scientist (Vantage Press, New York, N.Y.)



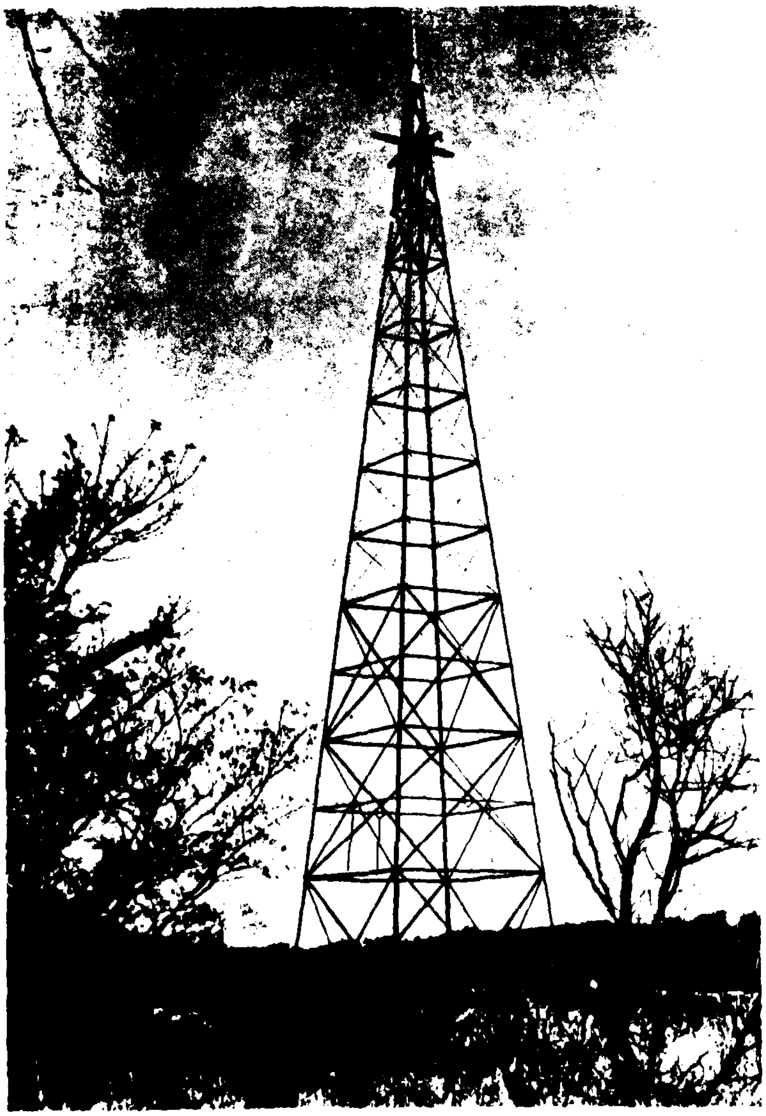
Upper and lower photos: now Headquarters site of the Evans Area and also of the Electronic Warfare and Combat Surveillance laboratories. (Photo credit: Volume II, *The Wireless World*) ians, industrial representatives, the academic world and foreign visitors. The first part of my story involves turning back some calendar pages and recording some history made before the Army moved in.

An Era of Yesteryear

The Headquarters building of the present Evans Area was completed and dedicated by the Marconi Company in 1914. Of dark red ornamental brick with a lighter tile roof, it was intended to be a 45-room hotel for unmarried employees, complete with dining room, smoking room and a spacious lounge overlooking the wide, sweeping shore line of the Shark River and the Atlantic Ocean. A French chef was in charge of the kitchen and was assisted by cold storage facilities having a generating capacity of 600 pounds of ice per day. Outside, a twelve-acre vegetable garden served to supply fresh produce. Quoting now from Volume II of *The Wireless World*, April, 1914-March, 1915, "The bedrooms are charming—that is the only word that can describe them—while the private sitting rooms will be a delight to all who can afford this added luxury."

And I quote further, "Already Belmar has become a 'sight' for touring motorists, who avail themselves of the opportunity to spend a quiet hour also at the hotel, or to wander through the beautiful country with its hills covered by thick woods of laurel, birch, oak, maple and pine trees; or again to wander through the undergrowth in search of spoils from the wild grape vines, huckleberries, mulberries and blackberries.

"Spinney and coppice, wood and open meadow-land offer of their abundance, and the countryside teams with wild life. To anyone with a bent for natural history there is an unending source of amusement, while to those whom sport claims for devotees, there is an equally wide range of interest. Fishing and shooting and, what is perhaps the most sportsmanlike of sport, long tramps over the miles of open country with a chance of bringing home a mixed bag at the end of the day.



This staunch pygmy is the last standing tower of some 30 towers which were erected by the Marconi Wireless Telegraph Company of America for their commercial transatlantic radio receiving site at Belmar, New Jersey. Almost half of these towers were over 400 feet high. Although it has stood alone for more than half a century, this little dwarf was present at Armstrong's demonstration of his regenerative circuit in 1914, DeWitt's reception of radar signals from the moon in 1946, and the receipt of cloud-cover pictures from Tiros I in 1960, the first pictures being developed only a few feet from where the tower stands. History has been witnessed many times at Belmar.

"The earth has many pleasant places, and Belmar is one of them."

Antenna Construction at Belmar

Now leaving the pleasantries of Belmar ecology, let me go on and say that the initial antenna construction there was six masts, each 300 feet high, crossing the road at right angles and stretching westward for almost one mile. Later construction added other antennas, some wood and some steel. Old-timers in the neighborhood tell me some were as high as 400 feet.

A total of six permanent antennas were constructed on buildings—the hotel, two houses across the street for top Marconi officials and three buildings which housed apparatus. The site of the transmitting station was New Brunswick, some 40 miles away, but keyed from the Belmar central headquarters.

With this new Marconi Company, there was an office boy very much interested in the new technology of radio. His name was David Sarnoff, a popular hero of the day for his reception of ship-to-shore radio signals during the Titanic disaster in April, 1912. Young Sarnoff and another radio enthusiast by the name of Edward H. Armstrong became close friends. During 1913 at Columbia University, Armstrong worked toward an invention which he hoped would improve the sensitivity of radio receivers. He was quite secretive and kept his new circuit concealed in a "black box." On the night of January 6, 1914, at Columbia, he demonstrated his new circuit. The results were sensational. As a next step, it seemed very important to use the huge antenna complex of the Marconi Company in Belmar.

An Historic Experiment

On a bitterly cold night, the 30th of January, 1914, the stage was set for the Belmar experiment. The team of experimentors was made up of Armstrong, Sarnoff and Weagant. The normal receiving equipment was having its usual trouble in getting good signals. Finally adjusted, the Armstrong circuit was given its test; it was both historic and dramatic. Throughout the drafty shack, signals filled the air with unprecedented volume. They came from Clifden, Ireland; Poldhu, Cornwall; Neuen, Germany; numerous arc stations from the West Coast; and finally Honolulu coming in strong during the early morning hours. It was Armstrong's *regenerative circuit,* his first major invention, which was followed by the court-contested superregeneration and later by his grand climax, *frequency modulation.*

During U. S. involvement in World War I, the U. S. Navy took over control of American Marconi. At the war's end, U. S. industry at government urging exchanged American dollars for the British interests. It started with $3,000,000 from the General Electric Company, with Westinghouse and AT&T soon also developing interest in this lusty new baby infant called radio. On December 1, 1919, a new corporation called RCA came from this technological incubator.

As all this was going on, new transatlantic receiver stations farther north were showing great advantages over the Belmar site. During 1924, the Belmar site was abandoned.

It is interesting to note that while the site was electronically deserted, there came in its place another type of man-made interest. For some years, the main Marconi building served as state headquarters for a clandestine group known as the Ku Klux Klan. The Grand Wizard of this group was a man by the name of Evans, and the area became locally known as "The Evans Encampment."

Commemoration Confusion

Jumping ahead a bit in my story, the Army purchased the site in November, 1941. The area was given its official name commemorating Colonel Paul Wesley Evans, a famed World War I signal officer, but many of the old-timers living in the general vicinity, lacking facts, assumed that the Army had named the site to honor the memory of the Grand Wizard.

The years of the KKK encampment were limited, as the forces of government moved toward their eviction. From one extreme end of occupancy by the KKK, the pendulum swung the other way, this time towards the spiritual. In 1937, Reverend Percy Crawford, a protestant evangelist from Philadelphia, purchased the tract for a school which he called King's College. It was to be protestant, interdenominational, liberal arts and co-educational. The first class began in the fall of 1938, and by 1941 the school had an enrollment of 100 students.

With an ever-growing student body, it was apparent to Reverend Crawford that he needed more building space, even as it became apparent to the Signal Corps at Fort Monmouth that they needed both more building space and acreage as war clouds darkened. The Reverend's solution was to move first to Delaware for a few years and then on to a spacious campus near Tarrytown, New York. The Army's solution was to buy the college and plan for more buildings.

Accordingly, it was during November, 1941, that the Signal Corps announced the purchase of King's College, including the six original American-Marconi buildings and the surrounding 93 acres as a start. The plan was to close the temporary Fort Hancock radar laboratory and to expand substantially in Belmar.

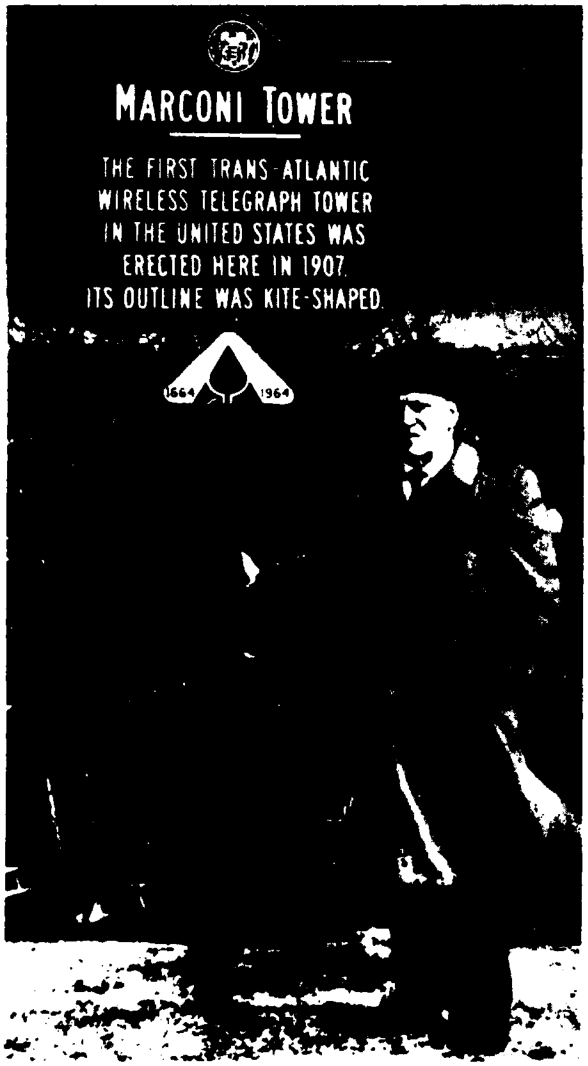
Peculiar Architecture

Seeking cheap and rapid construction, drawings were prepared for a single-story brick structure 900 feet long and 60 feet wide, to be located in the rear of the main Marconi-American brick building, which would be headquarters. Lt. V. L. Friedrich, in charge of "Buildings and Grounds," showed me these plans one morning while the two of us were at Fort Hancock. His orders were to bring the completed drawings to the Commanding Officer, Colonel R. V. D. Corput, by 1100 hours that morning for routine approval and then to be sent out for construction bids. Such a long and narrow building looked very peculiar to me. The two ends were just too far apart and would require long hikes. Vic and I looked at a map showing the Belmar site topography, and gradually our pencils started marking out shorter lengths of the same type of construction, but shaping it up as an "H"-building instead of a single length. Within an hour, we had every draftsman at our Fort Hancock site working feverishly on our new brain-child.

Birth of the "H"-Building

At precisely 1100 hours, Lt. Friedrich reported to Colonel Corput in his Squier Laboratory office. He carried with him the requested drawings and a set of those which had just been finished. Using as much tact as possible, he persuaded the Colonel to look also at the new drawings. As Colonel Corput looked at the "H"-building drawings, a broad smile crept across his soldierly face, and the drawings for the 900-foot building quickly found a resting place in his wastepaper basket. And so the present "H"-building was born.

And speaking of buildings, there is also a story about those many cubical wooden structures spread throughout the Evans Area. The form factor for these buildings originated at Fort Hancock as shelters for test models of the SCR-268, one radar per building. I seem to recall that about 20 of these buildings were erected at Fort Hancock, neatly lined up with military precision.



The author at the museum of the Twin Lights Historical Society, Highlands, New Jersey.

The argument for the plan was: first, we must be able to work on many sets at once and under cover; second, we wanted to spread our resources so that in the event of German bombing or fire all would not be lost in one raid; and third, a standardized construction design could produce many buildings cheaply and rapidly. Looking over our construction one day, a visiting Air Corps officer impishly said that the alignment and spacing of our buildings was just right for a bomber dropping 100-pound demolition bombs. One bomb would fall on the first building, the second on the next, the third on the following and so forth, all down the entire street, leaving areas between buildings unscathed. Fortunately, the bombers never came. When we moved to Evans, this same type of building construction came easily and in mass production. I seem to recall a figure of $40,000 per building, with only a few weeks required for delivery. So Evans was soon crowded with these SCR-268 shelters, all of which have been under continuous modification since 1942.

Conspicuous Lettering

Occupancy of the Belmar site started during the 1941-42 winter under the name of Signal Corps Radar Laboratory, a name conspicuously posed in large lettering for all to see from the public road passing by the headquarters building. The Fort Monmouth laboratory counterpart was called the Signal Corps General Development Laboratory. But the word "Radar" in the marquee did not stay up for many months, for winging its way up from Washington came the message that the word "radar" was classified, and great were the bonfires as tens of thousands of envelopes and letterhead stationery became a part of the atmosphere.

On March 31, 1942, the new site was designated as the Camp Evans Signal Laboratory, commemorating the late Paul Wesley Evans. On April 16, 1945, the name was shortened to Evans Signal Laboratory. And so concludes my prologue.

Reporting a Race

The topography of my story now shifts some fifteen miles north of Belmar to a place called Twin Lights, Highlands, New Jersey, the highest point of land on the Atlantic seaboard. Again, my story will be of Marconi first and the U. S. Army second.

It was the fall of 1899. On both sides of the Atlantic, excitement ran high as Sir Thomas Lipton, with his British *Shamrock*, challenged the U. S. yacht *Columbia*, in what later became known as the America's Cup Race. It was to be their first meeting of many more races to come. Young Marconi, working for the *New York Herald* newspaper, hoped to bring ship-to-shore radio coverage of a race in which British seamanship challenged that of a former colony. The Highlands at Navesink overlooking Fort Hancock, New Jersey, was selected as the site for the receiving station. Marconi's friend, W. W. Bradfield, was to man the receiving station while Marconi would be at sea transmitting signals on the race as it progressed. Antennas over 100 feet high were installed on both the shore and ship stations—at sea it was the *Ponce* of the Puerto Rico Line and the *Grande Duchesse*, an ocean-going steamer, both chartered.

As the *Columbia* finally won the long drawn out contest, Marconi became somewhat of a national hero. He had sent out 1,200 messages, and the *Herald* made the most of them in a tremendous news scoop!

Two years later came another challenge from the indomitable Sir Thomas Lipton. Radio coverage of the race was now to be undertaken by a newly formed company called The Marconi Wireless Telegraph Company, Ltd., of London, England. But unlike 1899, there was competition, for radio in 1901 was starting to blossom. There were DeForest interests, as well as a new organization called the New England Wireless Telegraph Company. I am indebted to Mrs. B. Hance, Assistant Historian of the Marconi Company Limited, for a copy of the following letter which covered the radio aspects of the second race:

About the Race:

"*re Yacht Races.*

Hotel Marlborough, Oct. 31st, 1901.

The Manager,
M. W. T. Co. Ltd.,
18, Finch Lane,
London, E. C.
Dear Sir,

I have waited until my return to New York before replying to your letter of the 9th instant as I wished to procure a chart of the Yacht Race course so as to be able to give you as precise particulars of distances as possible. I enclose with this a sketch to make matters as clear as I can.

As you are aware I established the land station one being on the Jersey coast situated at the Highlan. of Navesink and the other on the Long Island shore at Long Beach, the distance between them being twenty nautical miles. The New England Wireless Tel. Co. erected a station at Galilee, distant about three miles from our Jersey station and twenty two from Long Beach.

The land station of the Deforest Interests was situated at Sandy Hook about four miles from Navesink and nearly twenty miles from Long Beach.

I naturally made long Beach the principal receiving station and took charge of it myself.

The heights of aerials were approximately the same at all these stations namely about 120 feet.

The various ship stations were as follows:

1. The Marconi Co. on board the "Mindora" with a total available height of 115 ft.

2. The New England Co. on board the schooner "Maid of the Mist" in tow of a tugboat. Height over 100 ft.

3. The Deforest Co. on board the tug "Edna Crewe." Height about 100 ft.

We were supplied with apparatus for working with a comparatively short wave length, the receiving jigger being No. 306 which has a secondary 60 ft. long. This would probably be the most efficient arrangement having regard to the fact that our available heights were approximately 120 ft.

Unfortunately the opposition appear to have regulated their heights by our own, and using as far as I can learn plain aerial, omitted a fundamental wave of 240 ft. in length with the various shorter waves corresponding with the various harmonics.

It was therefore difficult to cut them out either with condensers or chokers.

The real difficulty came however not from the opposing land stations so much as from their ships.

On many occasions they were right alongside Gray in the "Mindora" and by sheer force of energy (the "Edna Crewe" used a powerful alternater as transmitter, and the schooner a large induction coil) made quite useless any arrangement of condensers and chokers as a tuning device.

The three ships were practically close together throughout the races and thus at about equal distances from Long Beach. The available energy however, on the opposition ships being apparently much greater than that on the "Mindora" even when Gray used the biggest spark obtainable, it became—to me—an impossibility to cut out interfering signals from them.

We made transmitting and receiving jiggers for using a much longer wave but without success, not the necessary time to experiment fully.

In my opinion a very long wave system should have been sent for the work, when we could possibly have obviated to some extent the interference by the insertion of much self-induction: with the short wave system we were practically powerless.

If it had not been for the very great pains taken by Mr. Gray and our other assistants engaged in the work, and the patience that they displayed under very trying circumstance, we could not possibly have got through the quite considerable amount of work that we did.

Yours faithfully,
(sd.) W. W. BRADFIELD."

Signal Corps Interest

Returning now to the 1899 race and Marconi's radio triumph in its coverage, it is of historical interest to note that an ever-alert Signal Corps was also on the scene. Special Orders No. 213, Headquarters of the Army, dated September 12, 1899, directed Sergeant Walter R. Taylor to temporary duty at the Highlands of Navesink during the yacht races "for the purpose of carrying out special instructions of the Chief Signal Officer of the Army."

Apparatus Test

On September 26, 1899, a Mr. Carl Kinsley wrote to Sergeant Taylor, "I find that Marconi won't be in condition to make any tests until Monday. All his apparatus has not yet arrived. It seems necessary to make another attempt to reach the light ship and to try our apparatus.

"I will come down to Babylon Wednesday evening. Please see Southard and have him on hand at 5:30 Thursday morning.

"Please call for my mail at the Babylon P. O. and return Capt. Wildman's mail to Governors Island.

Early models of both the SCR-270 and SCR-271 installed at Twin Lights, New Jersey, about 1940.

"I enclose $5.00. Get 10 panes cheap 8 x 10 in. of window glass to make condenser.

Yours truly,
(S) Carl Kinsley"

Proving a Claim

I do *not* know who Carl Kinsley was, but since Sergeant Taylor's orders also included a short trip to Schenectady, New York, there is room for the reader to guess, if he wants to. How the experiment went, I do not know.

More than three decades later, the life lines of Marconi and the U. S. Army Signal Corps again intersected, but this time it was your author who put to sea, not, however, to race Sir Thomas Lipton. In 1931, Marconi put forward claims that he had detected his 550 megacycle signals at a distance of five to nine times the optical line-of-sight. Many people doubted these claims. To prove or disprove these claims, the Signal Corps set up a 400 megacycle radio transmitter within feet of the commemorative Marconi plaque at Twin Lights. On Tugboat L-40, your author was able to hear these signals to almost 100 miles. The date was August 13, 1933. Again Marconi was proven correct.

The ground hallowed by the early Marconi work was also the scene of other experiments by personnel from the nearby Fort Monmouth laboratories. Twin Lights, July 30, 1935. Set up within a few feet of the Marconi antenna site, a heat detector was demonstrated having a clear weather sensitivity capable of following a ship from its own thermal radiation until it had passed well beyond the horizon. A spectacular searchlight display associated with the tests resulted in a high level of international publicity with the press dubbing our *secret* project "The Mystery Ray." It was this equipment, demonstrated a few months later at Fort Monroe, Virginia, which led to a major General Staff decision giving the Signal Corps the entire Army responsibility for research and development using radio techniques for the detection of aircraft and marine targets (radar).

Radar Demonstration

Quite appropriately, a very important radar demonstration was also made from this Marconi site some years later. It was during November, 1939. The demonstration was for the Secretary of the Army, Harry A. Woodring, and Generals George C. Marshall and Henry H. "Hap" Arnold, together with Chief Signal Officer Joseph O. Mauborgne. The potential of early-warning radar was dramatically shown to this top "Army Brass." A flight of B-17 bombers was tracked to the end of Long Island and back. (The one-way distance covered 138 miles). The success of this test led to early and expedited production of this radar, the SCR 270's and 271's. The first sets of this type were operational in Panama by June, 1940, and a year later in Hawaii. It was an Hawaiian-based SCR-270 which heard the warning, albeit unheeded, of the Japanese approach to Pearl Harbor on December 7, 1941.

And so ends another chapter of "Tales of Yesteryear."

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References for first part of story:

References: My list could exceed the length of this story. Suffice it to say, it includes many official Army documents and historical files. I have studied books on the lives of Marconi, Sarnoff and Armstrong. Reference to back copies of the Asbury Park Press has also been helpful; also a short report by Col. Edward T. Hale and discussions with others who lived and worked in the time frame involved. Credit is due also to Monmouth County Historical Association (Freehold, N.J.) and the Twin Lights Historical Society. Finally, I should also mention my recent series of short historical tales called "Tales of Yesteryear," most of which have appeared in SIGNAL Magazine. And, as mentioned in the text, my references also include Volumes I and II of the British publication, *The Wireless World*.

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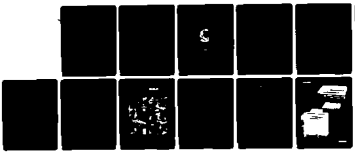

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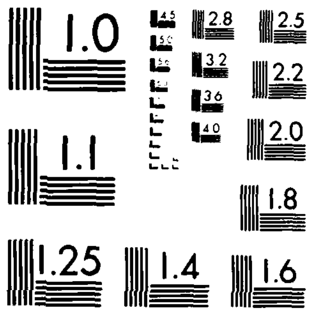

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

One Hundred Years of Research*

HAROLD A. ZAHL†, FELLOW, IRE

Summary—On June 21, 1960, the U. S. Army Signal Corps celebrated its 100th birthday—a century of service to the Army and the Nation.

In the narrative which follows, particular attention is directed toward a few selected items of research which characterize the scientific past and present of the Corps; it is concluded by a look toward the future.

Stressed are the facts that, over the years, signal research has had a profound effect on the nation's military posture, that this is of importance in periods of wartime stress, and finally, that the peace-time economy has also gained, both directly and indirectly, from much of this research. The article also includes a short summary of the Greely mission to the Arctic covering the period of 1881–1884—the tragedies of the expedition, and its scientific achievements.

Looking ahead, the narrative concludes with a brief description of signal research in several areas which today show great promise as the nation moves forward into the unknown of tomorrow.

At 4:00 A.M. on Sunday, December 7, 1941, two U. S. Army signalmen, Lockard and Elliott, switched on their radar for a routine 3-hour run at their station in Oahu. Their orders were to keep the equipment on the air until 7:00 A.M., when a truck was to pick them up and return them to barracks.

But a new chapter of history was in the making, and contributing to the introduction was the fact that their transportation was late in arriving. So, to gain more practice with their new aircraft detection equipment, they kept it running overtime. Suddenly at 7:02 their TV-like cathode-ray tube (on which small bright spots meant airplanes) developed a dim cloud, the like of which they had never seen before. The cloud grew brighter with time and, as the fateful seconds ticked off, seemed to be coming closer. Their first reaction was—equipment failure—and so they hurriedly made a check, but all was well, the meters read correctly, and the power unit outside droned on monotonously.

Now excited, they made some quick calculations and decided that this massive echo really represented a flight of unidentified airplanes 132 miles off Kahuku Point approaching at 180 miles per hour, a fact which they formally reported by telephone at 7:20 A.M.

The first bombs fell at 7:55 A.M. . . .

Though the bombing of Pearl Harbor is a dismal part of over-all U.S. history, a small group of scientists and engineers at Fort Monmouth, N. J., on learning that their equipment at least had functioned, felt tremendous personal relief coupled with a certain type of grim technical satisfaction. The responsibility for what was done with these historic data had not been theirs. However, had the radar been operating and ineffectual, no one in that small early-morning aspirin-chewing group on the following day doubted for one moment that part of the arrow of blame would have pointed in their direction, and with some justification, since the entire concept of early-warning radar was to prevent just such surprise attacks.

Almost 20 years later, and in peace, at Kaena Point, in our now fiftieth state, another historic observation was made, an observation which also was announced to the world by the President of the United States. This time it was not the belated news of an enemy invasion—it was TIROS, and the invaders were friendly clouds and weather fronts.

History again, for under Signal Corps technical direction, and as a part of the National Aeronautics and Space Administration program, the earth had acquired a new moon on April 1, 1960. Powered by the sun's rays, it radioed back TV-like pictures of the earth's weather. These pictures will also be long remembered, but this time for man's eternal glory and benefit—and not "in infamy" as President Roosevelt bitterly predicted in speaking of the 1941 holocaust.

These two events, so close together in geography, but widely separated in time, seem admirably suited to introduce the story of the Centennial Anniversary of the U. S. Army Signal Corps, serving its country in war and in peace. The combat aspects of this proud Corps shine brightly in the annals of our military history; but in research and development, not only is there a long record of militarily impressive contributions to our defense, but there also comes strong satisfaction in the realization that many of the by-products of this military-supported research, started by General A. J. Myer (Fig. 1) in 1860, serve to enrich everyone's living in peace.

It was signal research during and after the Civil War which provided this country with its first weather service, a service decades later recognized as being so indispensable that in 1890 Congress established the U. S. Weather Bureau under the Department of Agriculture, using the Army Weather Service nuclei as building blocks upon which to construct the new civilian operation.

It was signal research which gave the first government support to aviation when it bought an airplane from the Wright brothers in 1908 and quickly expanded this interest to include surveillance techniques, machine guns, bombs, and bombsights. With people like the late General G. O. Squier and Nobel Prize-winning physicist, R. A. Millikan (also a World War I Signal Officer), aviation interest expanded, growing into maturity so rapidly that near the end of World War I, the Army Air Corps was formed and "crossed-flags" were routinely exchanged for "wings."

* Received by the PGMIL, July 11, 1960.
† USASRDL, Fort Monmouth, N. J.

In electronics, research aimed at winning this same war brought about radio broadcasting as we have long enjoyed it, at least ten years before normal peacetime practices would have made it available to the public. In fact, radio was so new in World War I that when the Germans cut all his telephone wires, one U. S. commander doubtingly radioed back to his headquarters, "I am entirely out of communications."

It was radar, now indispensable to all aviation, which also did so much to make the cathode-ray tube commercially practical as the picture screen of present-day television, while the sensitivity of our present-day TV cameras can be traced back, in part, to the late war days when "shot-up" bombers, good only for one last flight, were loaded with high explosives and, unmanned, flown through heavy flak into choice enemy targets where they were deliberately crashed with tremendous devastation—TV eyes and research substituting for the dreaded kamikaze in which the pilot also flew a terminal mission.

Over the years, in much of its research, the Signal Corps has received generous support from American industry and educational institutions. Almost every electronic industry, its photographic and meteorological counterparts, parts of the aviation complex, and over 100 colleges and universities—all are a part of the story being told the force behind Signal research.

A poet might well see this force as an ethereal substance which hides behind every cloud and weather front . . . in daring men as they communicate with each other in combat . . . in an aviator who looks about wondering how he got where he is, what is his mission, how to do it, and if possible how to get home . . . in radar reaching out as far as the moon and beyond . . . in the confidence good communications instills in a commander and his troops . . . in the eyes and the ears of intelligence . . . in an artificial earth satellite seeing from afar and passing its electrical sensing back to earth. Through the microscope of a scientist, it may even be the atom waiting to give up its secrets to men wise enough to probe deeply and with understanding.

The many individuals and diversified groups involved naturally see this century-old drama differently (like the mixed reactions of an audience to a piece of modern art), for, in the fury of war, the immediate environment and one's emotions make broad perspective difficult to realize. But one aspect all see alike; a living vibrant force which erupts violently when our nation's security is threatened. And as millions who have fought for their country surely sensed, in war this force became military communications and combat surveillance, without which victory would have been impossible.

The present center of this research is at Fort Monmouth, N. J., where the USASRDL three thousand top-notch scientists, engineers, supporting personnel, and a carefully selected military cadre peer into the crystal ball of science—and as they see, the nation's defense continuously grows stronger. Much of their recent vi-

Fig. 1.

sion, understandably, must be kept in secrecy, but as the new becomes routine, the curtains of secrecy lift.

The early history of radar was particularly exciting. Everything thought of, everything done, was an important invention or demonstration thereof, for the field was new. Almost each test, too, brought in the unexpected; for example, in the 1938 experiments at Fort Monroe, Va., a bomber pilot assisting in tests was unknowingly blown to sea in the upper altitude torrent of the then unknown jet streams, and radar brought the crew back to safety. And on the west coast, early in radar's history, there was the case of the daring civilian pilot who took off in a small airplane from Nevada flying to California; when faced with landing, he found pea soup fog embracing his entire gasoline potential. With minutes of air time left and without a parachute, good luck stepped in, and he made radio contact with a scientist at an experimental Signal Corps blind-landing device, whose calm voice broke through the visually impenetrable fog and said, "Do exactly as I say and I'll bring you in." The pilot complied, his choice being rather limited! And soon there appeared a landing field a few feet below the airplane, and all was well. But the miracle-producing device was still secret, and so the lucky pilot, while extremely grateful, was denied the answer to his question as to how his stay on earth had been magically prolonged. But not so today, for all aviation now uses blind-landing techniques routinely.

In World War II, with the superb NDRC Laboratories in the vanguard, came microwave fire control radar which cleared the air of the dreaded buzz bomb; there came also blind bombing which accurately rained death through protective clouds, super navigation, the proximity fuze which contributed so greatly to the defeat of the kamikaze, electronic countermeasures, and myriads of inventions which wartime wrath and ingenuity devised.

With everyone helping now, much of the effort of Signal Corps Laboratories went toward coordination responsibilities, "crash developments," routine equipment testing, specifications, contracts, delivery, operability, and maintenance—often involving tests under grueling combat conditions. Purple Hearts were common to those whose ammunition was electrons instead of bullets. At Monmouth alone, a peak civilian personnel force of 14,800 was reached in 1943. At Wright Field, many additional thousands of Signal Corps personnel carried on similar tasks related to Army Air Corps activities.

But with all the assistance total mobilization brought, there were many problem areas where the most learned hesitated to travel, lest the war be over before the problem could be solved—if it could be solved at all. Riding high in this category was the location of enemy mortars, the deadly device which caused the majority of our ground casualties.

The problem was one of finding metal objects the size of a small tomato can, loaded with explosives and fired at our troops in bursts of hundreds, with nothing more complicated than an augmented shot-gun shell at the bottom of a piece of iron pipe. Finding these clouds of hell-created torpedo raindrops coming unannounced toward one from miles away was the first part of the problem; the next was to establish definitive trajectories, trace the various shell paths back to their points of origin, and by coincidence methods, to saturate these coordinates with overwhelming counterfire so that peace and quiet would again prevail in those particular areas—and many thousands like them!

With Major General R. B. Colton challenging his scientists and engineers, signal research took on this problem during the war when much talented advice said there was no quick solution. A field laboratory in Paris and scientists at Monmouth concurrently struck hard. At Monmouth, they even took advantage of the small size of the target and picked a radar wavelength which made these tiny lethal projectiles fairly glisten in the glow of the radar's illumination. Within six months the problem was solved, and to hurry the first equipments into emergency overseas air freight, a task force of 20 signal research men (and one woman) worked 96 consecutive hours; and a tired, sleepy, and bearded (one exception) crew of scientists and engineers on the verge of collapse cheered as the first equipments were loaded for flight into Pacific combat areas. They had done it—and had well earned the long sleep which soon engulfed them.

Immediately after the war, the country's most powerful radar, DIANA, was retuned for peaceful intercepts. In January, 1946, at Fort Monmouth, in return for eons of its own beautiful glow, the moon was caressed with earth-made radiation and seconds later the crown jewel of the sky responded with echoes which were detected at our transmitter site—in effect heralding the arrival of the Space Age.

And then came the day in 1958 when the Corps basked in pleasant and much-earned publicity, when early Laboratory Director Colonel W. R. Blair was granted the basic U. S. patent in radar for work done in the Signal Corps Laboratory prior to World War II.

Going back again in time, while radar men were excitingly opening up an entirely new field, pre-World War II communications people, with sabers now rattling in Europe, found themselves completely out of date, as U. S. tanks and airplanes were about to be expanded 100-fold in number, not to mention increased speed or mission complexity. In armor, for instance, all experience had been with AM (still the work-horse of our present civilian broadcasting system). But to produce a communications net using this system of voice modulation, and still to be superior against such noted fighters as General Rommel with his highly mobile and enormous striking power, was considered well-nigh impossible.

With a bold stroke of imagination and much-hurried research, a wise and brave decision was made to convert our system to FM, a much-neglected concept of a famed World War I Signal Officer, the late Major Armstrong. With this decision made, however, and with real dollars now backing the concept, communications soon became possible between all the many thousands of our tanks plus the supporting infantry and aircraft, which later made up General Patton's overwhelming force. And to allow for combat success, as one chased the enemy deep into Western Europe, the radio relay (now so common in our coast-to-coast TV) was quickly introduced, and U. S. armor defeated vaunted German steel with communications playing a decisive role.

In the nuclear environment, from Bikini in 1946, down the long road of atomic bomb tests to the present moratorium, we see Signal Corps scientists making experiments of civilian interest and military necessity, such as tracking atomic clouds loaded with death-dealing radioactive particles and producing dosimeters which tell how much radiation the wearer has received —whether he can be immediately returned to combat, whether he should be treated, or, more gruesomely, whether treatment would be of academic interest only.

In the same area of the atom, riding almost out of the world of fantasy, we see a strange unmanned radio-controlled weasel equipped with television eyes stalking around the deadly debris of Frenchman's Flat minutes after an atomic explosion, on command scooping up highly radioactive soil, and then rushing back to safe areas where scientists take the samples and hurriedly pass them through chemical analysis to learn more of man's assault on nature's age-old elemental stability.

For atmospheric research, our scientists set up Project Cirrus, and soon were pushing clouds around, making it rain, making it snow, causing it to clear, forming clouds—all these, of course, under selected and highly accommodating conditions, but still pointing to things to come in the future when man has applied enough patience, scientific brilliance, and hard work toward the conquest of the forces of nature. And as already mentioned, then came TIROS and its 270 pounds of sophisticated electronics thrown into orbit for us by the USAF. Tens of thousands of global cloud pictures are now available for the meteorologist to study and theorize upon, and when he is ready, to use such data in his weather predictions.

Closer to the earth, radar returns now are of immediate interest to the farmer, the Eastern Parade belle, and the millions who want to know how to plan for a sunny afternoon at the beach. Following years of research, new radar equipment was tested which observed a rainstorm 185 miles from Fort Monmouth, a storm which was tracked to range zero giving accurate precipitation forecasts for intervening areas down to the closest minute—then a bit unusual, but now commonplace. This equipment, or modifications thereof, is now in wide use in the military services and the U. S. Weather Bureau.

In recent years, one of the brightest parts of the Signal Corps unclassified research program came about when many of our scientists turned gypsy, packed their bags, and strolled down the Romany Road of the International Geophysical Year—to the Antarctic, the Arctic, the South Pacific, Western Europe, Australia, Japan, Canada, and you name it, including the USSR.

Rocket soundings producing new atmospheric data were made almost daily in various parts of the world; electromagnetic propagation data were obtained through fantastically pure ice formations in both polar regions; at Thule, a weasel equipped with an odd down-looking radar, while in rapid motion, measured ice thicknesses instantly, as compared to the weeks required by normal seismic techniques in obtaining ground contours hidden by miles of snow and ice accumulated over centuries.

Still part of the IGY: on the satellite front, our components first explored outer space with U. S. Army Ordnance Explorer I, while in Navy Vanguard I, a most exciting experiment using sun power was first tried. Launched March 17, 1958, the original solar cells still power the radio; the clear signals today give no indication of letting up, and the estimated orbit time is over 200 years. Our very first weather satellite was placed in orbit early in 1959; and while its orbital life will exceed 100 years, its electronic life is over. Its contributions, however, live on through TIROS and kindreds to come.

Viewing Signal Corps aspects of the recently completed and highly successful International Geophysical Year in retrospect, one cannot help recall the International Polar Year of 1882–1883. Congress had passed a resolution in 1879 approving this country's participation in the Arctic Project in cooperation with eleven other nations. The task of manning two U. S. stations fell to the Signal Corps with Lieutenant P. H. Ray named for Point Barrow and Lieutenant A. W. Greely assigned to Lady Franklin Bay, just 500 miles from the North Pole.

Ray's mission was outstandingly successful from all points of view and, with the country's cheers, he returned in October, 1883, showing tremendous research accomplishments; not one man of his expedition had suffered injury or been sick for even a day.

But not so with Greely . . .

Proudly marching in 1881, 1st Lt. Greely's carefully picked staff consisted of two Second Lieutenants of Infantry, one assistant surgeon, five sergeants of the Signal Corps, fourteen noncommissioned officers and men assigned from the combat arms—and two Eskimo guides.

Six came back!

Here are a few extracts from a draft copy of "Traditions of the Signal Corps," April, 1959:

On August 9, 1883, Greely broke camp . . . and with his whole party started south . . . over a drifting ice pack they labored through violent blizzards and sub-zero temperatures for twelve hours a day. Little by little they discarded everything they could except the instruments and the records . . .

Months of almost unbelievable hardships passed.

On 18 February 1884, Sgt. Cross died. He was an Infantry soldier, and the first of Greely's command to perish.

Others died.

Toward the close of April, Jens was drowned while pursuing the carcass of a shot-down bird. Nineteen men remained alive . . .
In the next five days, four men died. Fifteen were still alive . . .
On 5 June, Private Henry was executed for stealing food. Fourteen were left.
Agonizing days went on. The men were eating lichens and the oil-tanned seal-skins covers of their sleeping bags. Nobody noticed any longer who died or when. Roll-call on 21 June showed seven to be alive . . .
Above the storm one of the men thought he heard the blast of a steamship's whistle . . .
Reasoning slowly, groggily, Long decided it must be a ship. . . .
With a terrific effort he got to his feet and waved. He was too weak to shout. He started forward, collapsed and pitched headfirst down the rock, almost to the water's edge. He was picked up by sailors of the United States Navy rescue mission—
And so, of the twenty-five men who had formed the garrison of Fort Conger in the summer of 1881, six men were brought back alive in the summer of 1884! . . .
They brought back all their records. These were America's chief contribution to the international effort to discover the basic mystery of the weather. They were, in fact, among the best scientific records history had ever known. They formed an unbroken series of hourly meteorological, tidal, magnetic and pendulum observations covering a period of two full years . . .

And Researcher Lieutenant Greely lived on to become General Greely—Chief Signal Officer of the Corps which is now accepting accolades from the nation after one hundred years of service.

Before leaving Greely and his tragic experiences up north, one interestingly notes on a parallel vein that the Signal Corps' present polar veteran, Amory (Bud) Waite, in more modern times, has already made eight trips to the Antarctic, during the first of which he was one of an intrepid group of three who braved nature's most violent forces, and in the darkness of the long Antarctic night, pushed forward against great odds, and saved Admiral Byrd's life as he lay "ALONE," weak and helpless, after an all-winter vigil in the world's most desolate and isolated spot.

In closing this historic review, and in dedication to recent Chief Signal Officer, Lieutenant General J. D. O'Connell (Ret.) and present Chief, Major General R. T. Nelson, let us take a quick look at some futuristic communications. We see an experimental communication circuit between Monmouth, the moon, and the University of Illinois—a short thousand terrestrial miles also coupled magically for research through a path one-half million miles long. Or again, with tremendous electrical discharges, the environment of an exploding atomic bomb is created in the "test tube" of our laboratory in order to study possible effects that a nuclear war might have on present global radio communications. And in a related field experiment when actual atomic bombs, before the moratorium, were exploded at high altitudes in the South Atlantic, our scientists discovered two new duct-like mechanisms for propagation of waves called "hydromagnetic." These waves appeared to develop when the atomic blast completely annihilated the earth's magnetic field at that point and thus were generated as the magnetic balance re-established itself. They travel at several thousand miles per second in a layer of plasma about 1500 miles high, spreading around the earth like ripples in a magnetic pond.

In miniaturization, we see complete operating radios the size of a few lumps of sugar being assembled in the helmets of our soldiers for command control purposes. With miniaturization techniques, now far extended, also came delivery of Mobidic, the fighter-field computer which "talks faster, reacts faster," than any General (even with a Ph.D. entourage). Time alone will tell how MAN and MACHINE will divide the decision process. The machine suggests a vast area of untapped potential, but we must learn more of its language before we can even start to use efficiently the millions of small components now available leading toward ability almost to think—tomorrow, perhaps even to reason. As part of this scientific crescendo, a high-performance U. S. Army Signal Corps turbo-jet surveillance drone made its first flight in May, 1960, when, unmanned, it streaked high over Arizona terrain sending back information at the speed of light, following which it was directed to its recovery area and commanded to parachute to earth.

Finally, the Signal Corps envisages maximum use of satellites in extending its global communications. These satellites may be balloon type which spray incident radiation to any number of receivers on earth, or they may carry their own transmitter powered by solar energy and, with directional antennas, relay signals received from earth to preselected sites on this bit of cosmic dust called Earth—or perhaps elsewhere. Global communications could even be by reflections from a Saturn-like belt of chaff in orbit around the entire earth.

The first[1] demonstration of one of these concepts is already history, since on December 18, 1958, the Army Signal Corps operated a communications center in outer space, and from far beyond the earth the President of the United States broadcast Christmas greetings to the inhabitants of the world and beyond—in effect, opening the door to time's long unpredictable corridor of the Corps' second century of research, a century during which, be it peace, the marvels of science can lift man the world over to now undreamed heights of good living.

[1] The Nation's second active communications satellite, "Project Courier" was successfully launched on October 4, 1960. The communication-electronics portion of the system was developed under the technical direction of the U. S. Army Signal Corps.

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Proceedings of the IRE®

contents

COVER The men who founded the IRE May 13, 1912.

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PROCEEDINGS OF THE IEEE

TWO CENTURIES IN RETROSPECT

contents

COVER This painting by Elbon (Daniel E. Noble) shows Benjamin Franklin flying his kite in a thunderstorm to identify lightning as static electricity. Fortunately the gods loved Ben, and he survived to become the first American electrical engineer by inventing the lightning rod. It is thus fitting that he is featured on the cover and in the first paper of this issue devoted to the history of electrical engineering in the United States. (Photograph by L. Zbiegien.)

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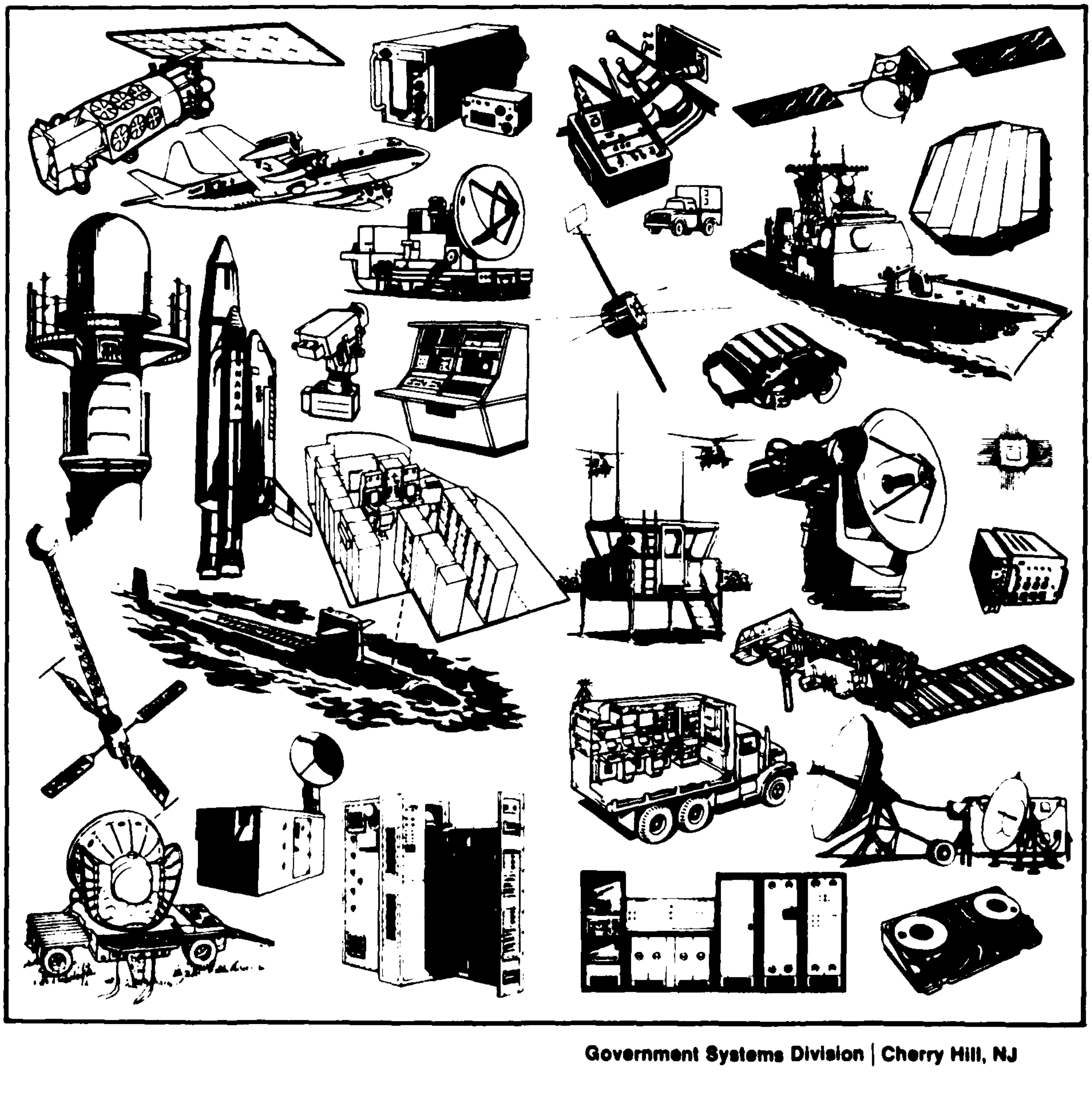

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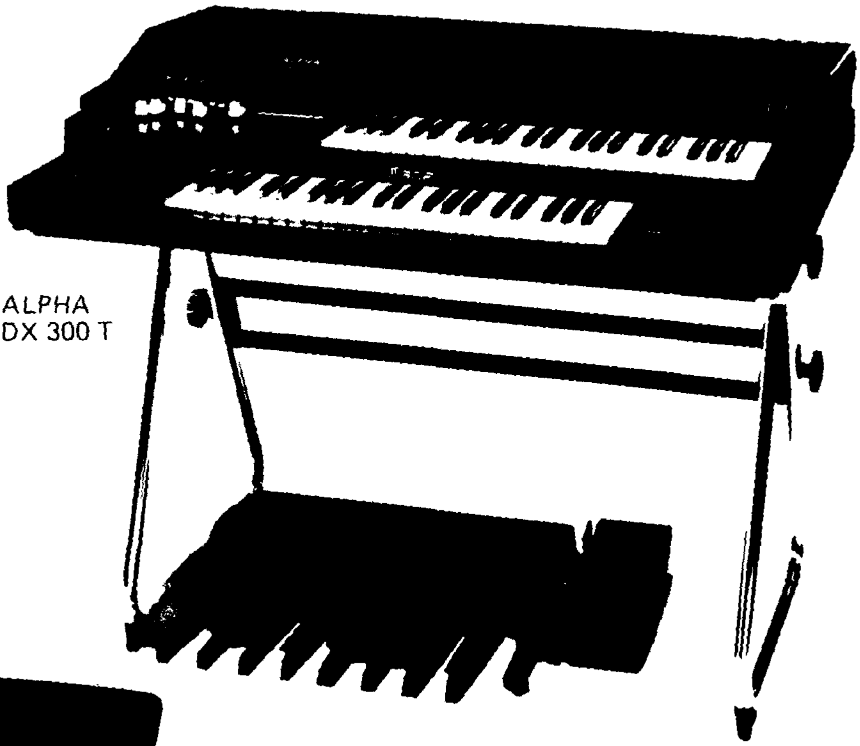
Several papers of historical significance to the history of Fort Monmouth, NJ and Bell Laboratories of Holmdel, NJ are given with the fellowship citations of the NJ Coast Section IEEE Fellows and major IEEE award winners with biographies and accomplishments.



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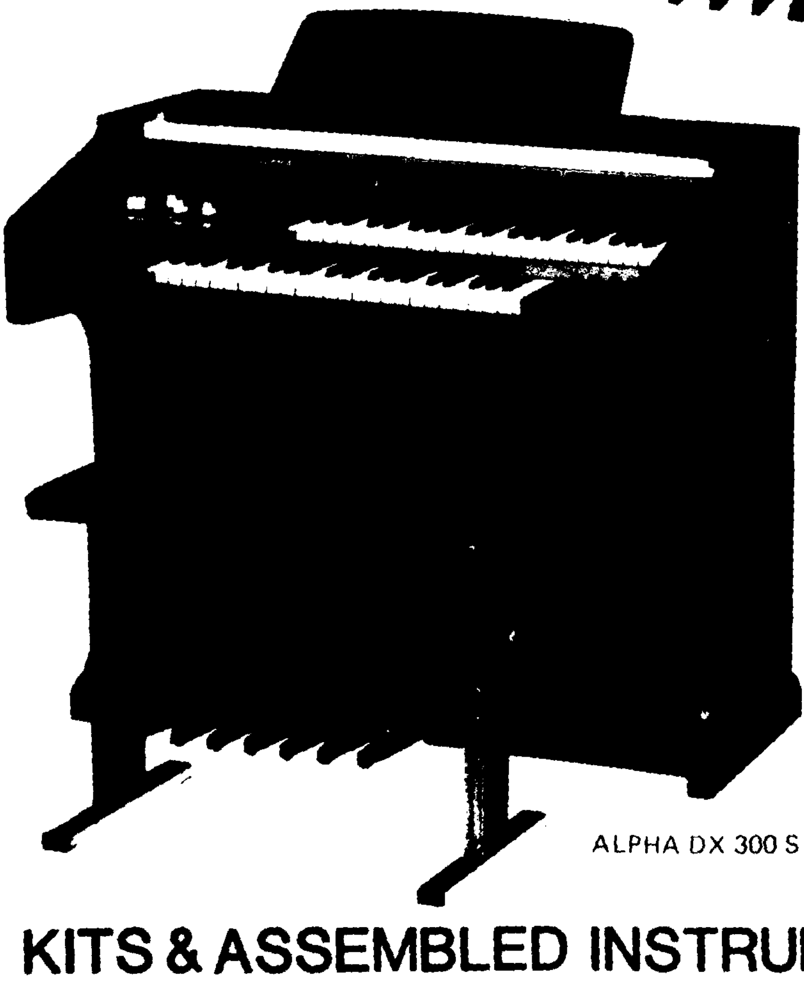

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