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,

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

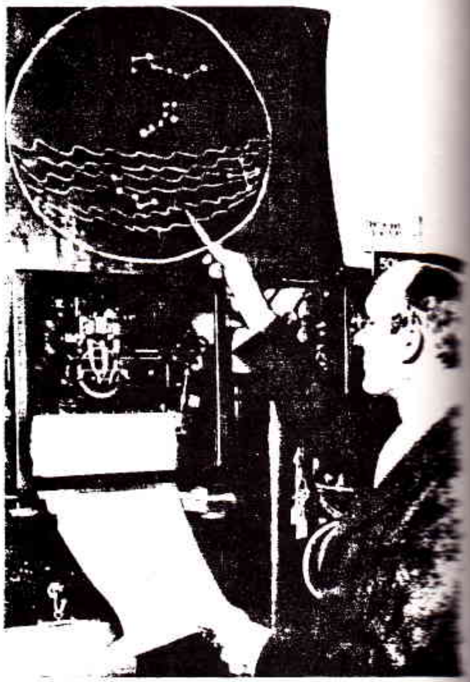
** "Radio Astronomy's 50th Year" Bell Laboratories Record, April 83 expanded his work to study how transatlantic radio waves arrived at receiver stations; he became, in fact, an expert in selecting favorable receiver sites. But as Dr. Friis also recalls, five years after Jansky had reported his findings 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.

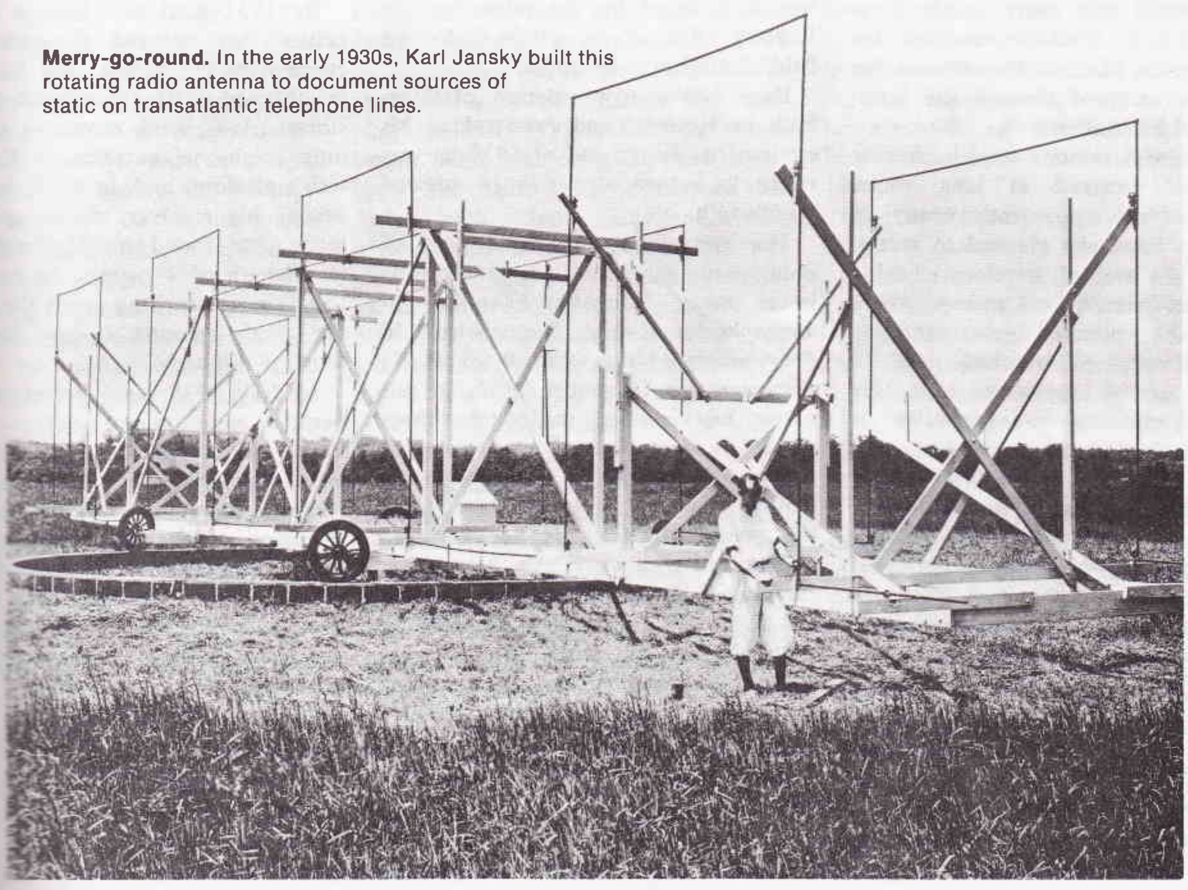
could be used outdoors."

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 this 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 side-line, 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 his epochal discovery, and not a word of encouragement to continue this work had appeared from scientists or astronomers. They evidently did not understand its significance. Besides, 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.

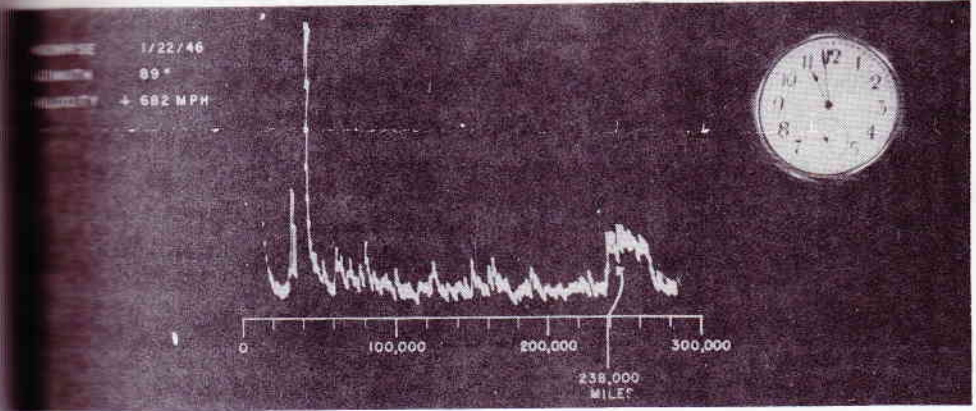
DIANA CAKE CUTTING -- Specialists, engineers and military men who took part in the original successful Diana experiment, when a radar signal was first bounced off the moon and received back on earth on Jan. 10, 1946, take part in a cake-cutting ceremony at the Evans Area of Fort Monmouth marking the 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 [illegible] 1946. The successful project established the feasibility of space communications.

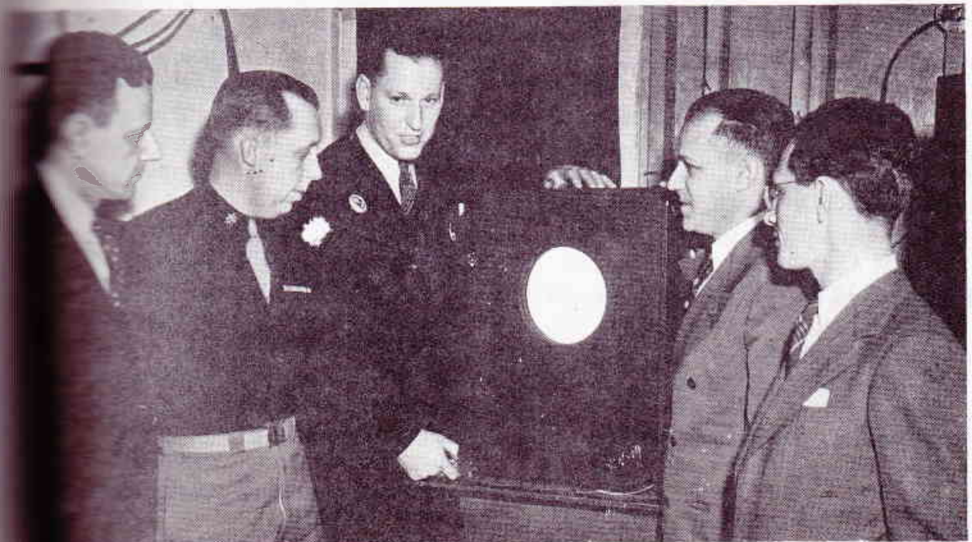
Sylvanians who helped design and develop the history-making equipment were Dr. Robert M. Bowie (seated) and (left to right) Francis Collins, Joseph Ryan, Norman L. Harvey and Willis Snyder. Not shown are Robert H. Brown and James Iske.

Dr. Harold D. Webb, Signal Corps scientist, adjusts controls on the power supply for the equipment.



This "radar scope" shows impulse (left) and echo from moon at 238,000 miles. Peak at left is outgoing impulse; at right, returning echo.

Signal Corps scientists who successfully contacted the moon: (left to right) Dr. Harold D. Webb, Lt. Col. John H. DeWitt, Jacob Mofsenson, Herbert Kaufman and E. King Stodola.



Major Edwin H. Armstrong, nationally famous radio inventor and professor of Engineering at Columbia University, and Dr. Frederick B. Llewellyn, President of the Institute of Radio Engineers, are revealed by Army officials to have played important roles in the orginal design of some of the equipment used in the moon experiment.

From the standpoint of Sylvania, this is merely additional testimony to the fact that the Company is one of the leading electronic concerns in the nation. With the Company's advance in size since 1940, there has been an even more rapid growth in the importance of its research activities. Sylvania's engineering performance in the war placed it in a position of scientific and technical production leadership. And the moon radar experiment, outstanding peacetime scientific feat, demonstrates that progress continues.

A Signal Corps space odyssey

Part II-

SCORE and beyond

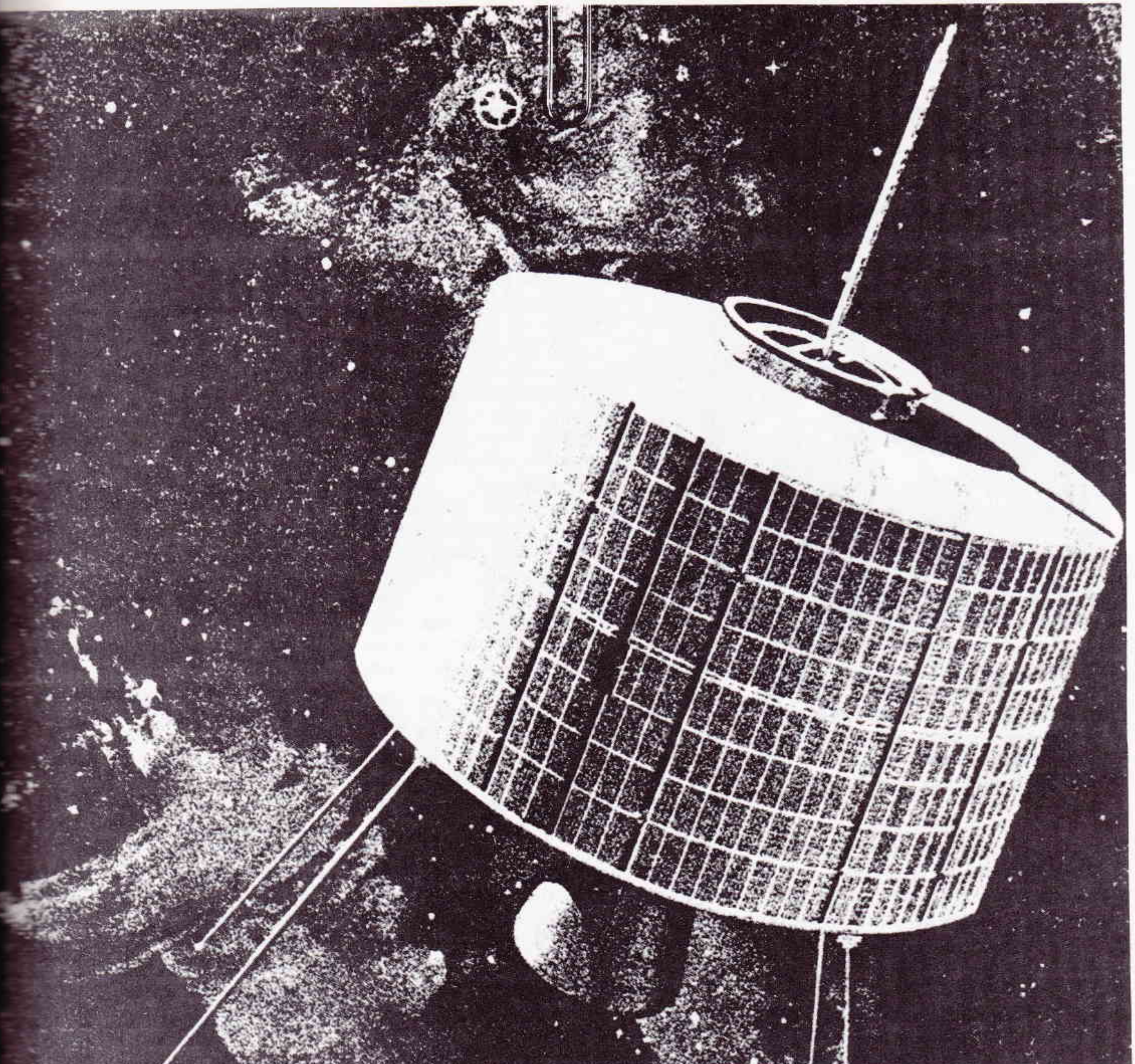
by Brig. Gen. H. Mc D. Brown (retired)

"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 S… world's first communi… and the final phase of o… contributions of the Si… early space age. The… particularly SCORE, re… the Signal Corps' most … achievements. It has … "success has a thous… failure is an orphan." … COURIER and TIR… remarkable successes!

As a major parti… projects, I would like … Army communicators, … my recollections of … happened without …



gritty technical details which have been published widely in the open literature.

In 1958 I was a colonel assigned to the Army Electronics Proving Ground (AEPG) at Fort Huachuca, Arizona. I was nearing the end of a tour of duty as chief of the Electronic Warfare Department when I received a telephone call from Maj. Gen. Emil Lenzner in the Pentagon. Lenzner had been Commanding General of the AEPG but had recently gone on to the Pentagon where he had become the Deputy Chief Signal Officer.

Lenzner's call was to set in motion events which brought me to the most exciting, most satisfying and best tour of duty of my entire thirty year military career. He told me that the Chief Signal Officer, Gen. O'Connell, wished 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. E. F. 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 aspects from any other regular military command duty. First, a laboratory of a predominantly civilian workforce of scientists and engineers, including a scattering of professionally prominent prima donnas, cannot be managed like a troop command. More freedom of action and a relaxed military discipline must be granted to keep them motivated and productive.

Second, whereas a commander of regular military activities can observe the effects of his decisions mostly on a day by day basis, in a laboratory the results may not come to light for a long time, often not before his departure to other duty since the complex process of

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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.

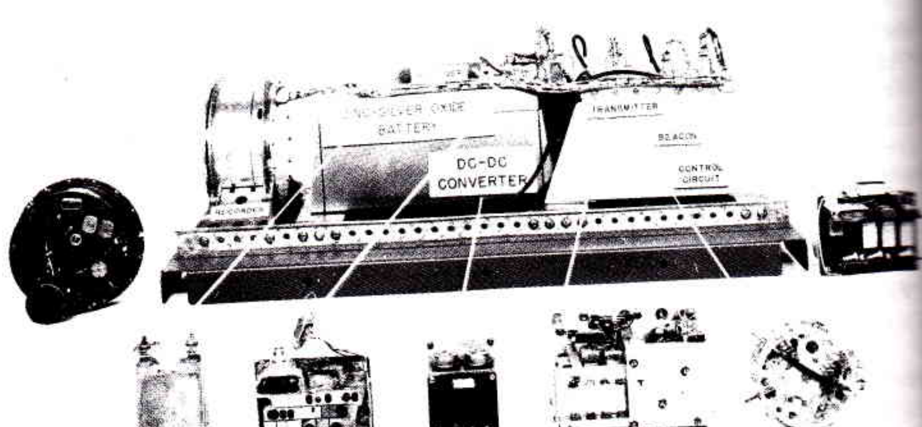
Nevertheless, we were promised a piggy-back ride for communications equipment when extra weight on another main payload should become available. But, assisted by the chief signal officer, we kept our eyes wide open for other and earlier opportunities which, fortunately, would soon develop.

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 results. 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.

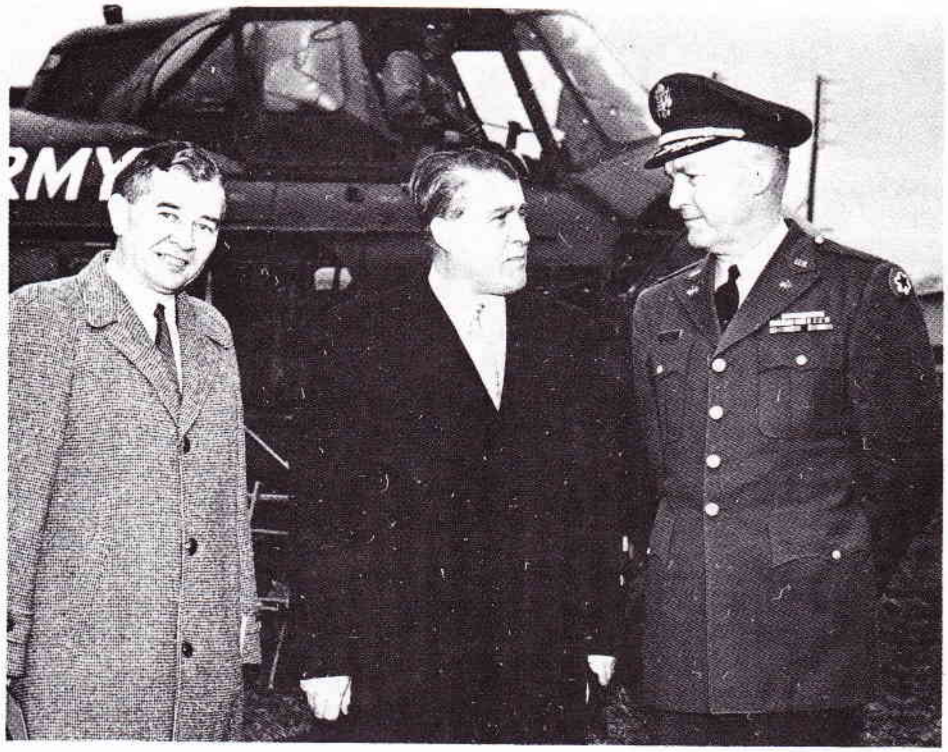
could be demonstrated. Considering the risk of a communications package which included electromechanical devices, such as a tape recorder, it was decided to provide redundancy by installing two independent copies of the equipment. The capacity of the system was one voice channel or seven 60 wpm teletype 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 as) 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 AEPG 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

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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.

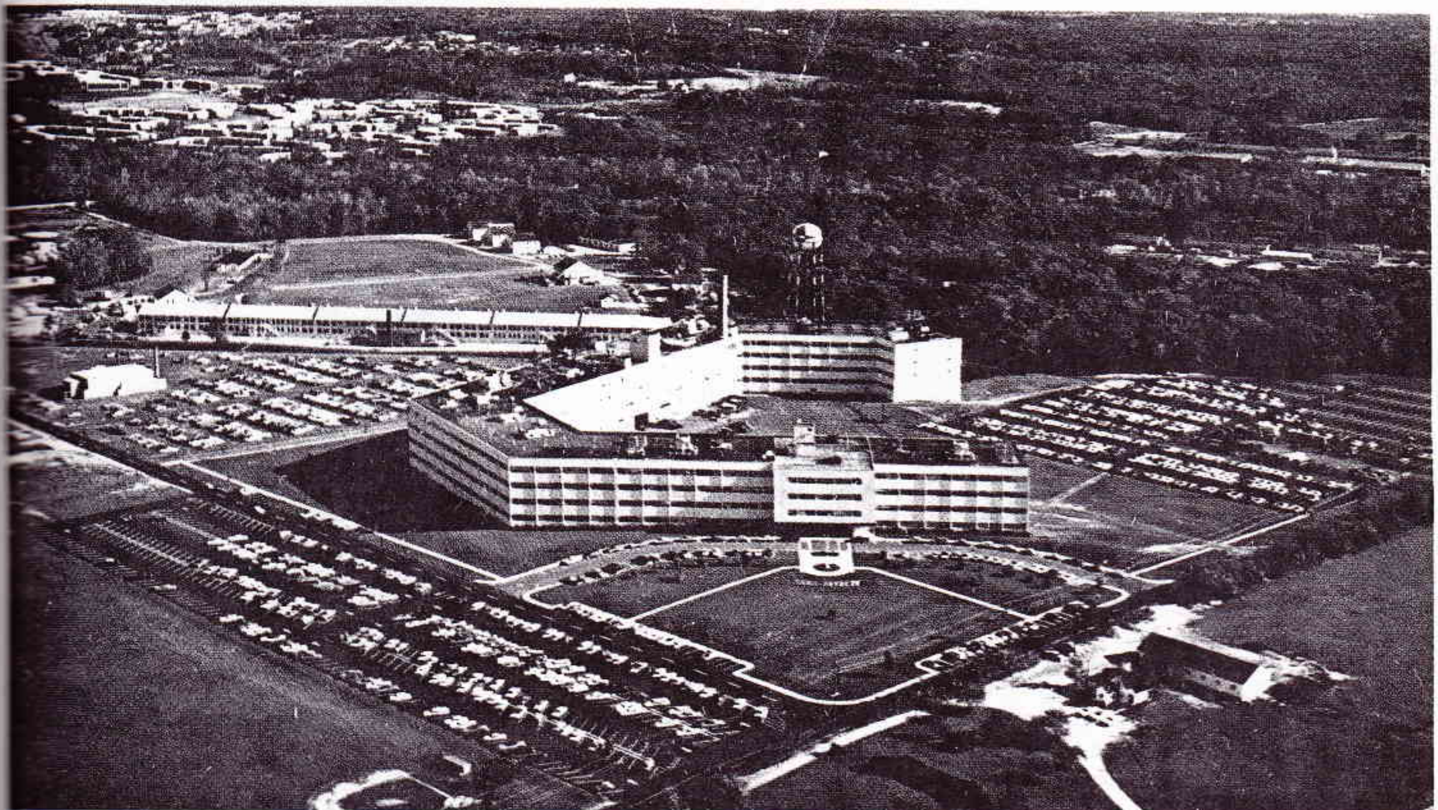
Actually, as Gen. O'Connell revealed at a later date, this is what happened: Secretary Brucker was on the list of the "Club 88" and a member of his immediate staff was supposed to keep him posted. But in the last phases of the project this was overlooked somehow. He became aware of the completion of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

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

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

Let me digress for a

Dr. Ziegler, like Dr.
had been transplanted to
after WWII as one of the
German scientists and
brought with him broad
many fields, but during the
of the war he had attained
in electronic fuse and
concepts. When he
assignment to the Signal
Monmouth there was



The Signal Research and De velopment 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 to join their faculty. Now, Georgia Tech accused the Army of having gotten wise to their negotiation through the still existing mail censorship and having had him snatched away. Clay, an alumnus and loyal supporter of his alma mater, wrote a letter to the chief signal officer requesting Dr. Ziegler's immediate dispatch to Atlanta. But the commanding officer of the labs at Fort Monmouth (Col. P. L. 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 in 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.

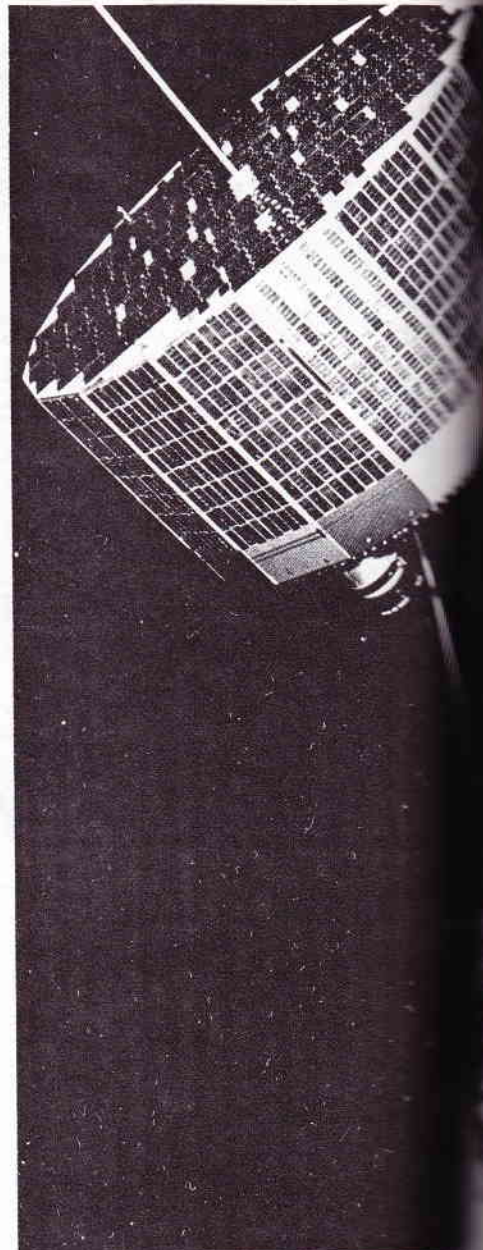
Shortly before the completion of SCORE, I disclosed to Dr. Ziegler my plan to concentrate all SRDL space activities into a new Astro Electronics Division, comprised of appropriate elements which would be extracted from the overall SRDL manpower and equipment resources and in which he would be offered 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 launch day of SCORE. When I had permission to let him finally 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.

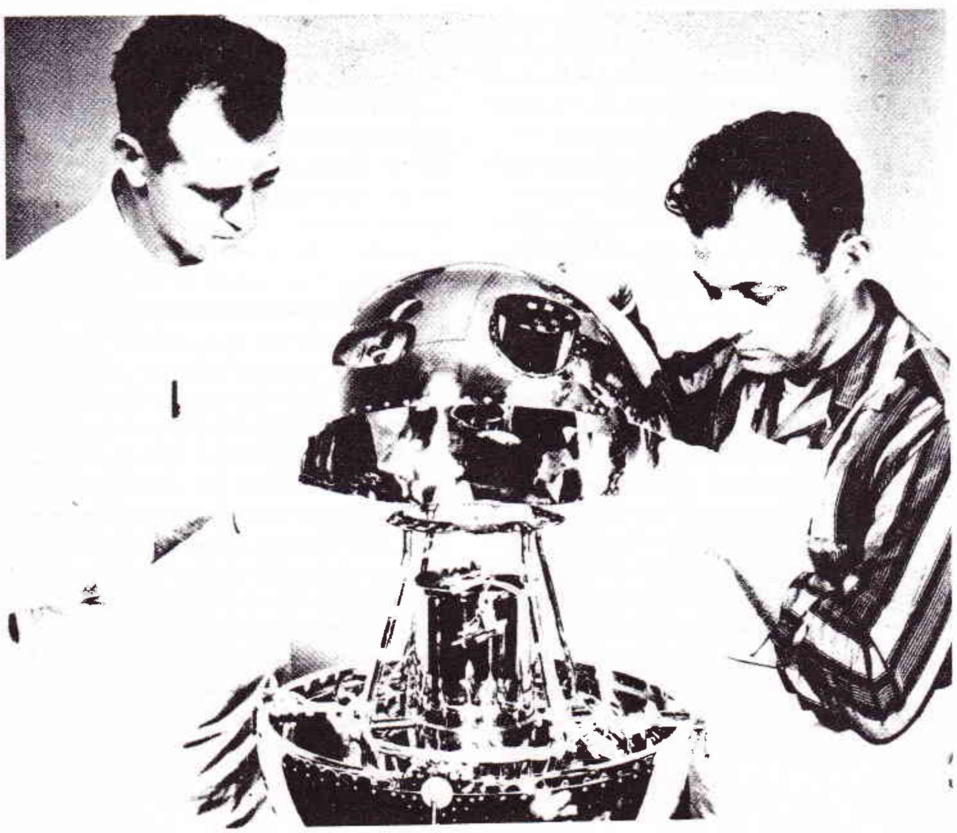
Just then, in the first days of January 1959, he received that attractive offer from Johnson. But he did not take it. After his own thorough analysis of the responsibilities he was to take at ARPA at that time and of the future outlook of the role of ARPA and after explaining these viewpoints to the 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 sc of the entire newly created US A Electronics Command (ECOM), w he successfully served for many y greatly enjoyed working with H he was of great help to me du tour of duty.

Since I am talking about who were of great help to me, I w greatly remiss not to mention deputy commander, Col. J Watters, who was always a to strength. With unfailing





Vanguard II was successfully l 17 Febraury 1959. But a misha the final orbit insertion made th cover payload virtually u Ironically, the payload's ele performed perfectly for the 18 battery life.

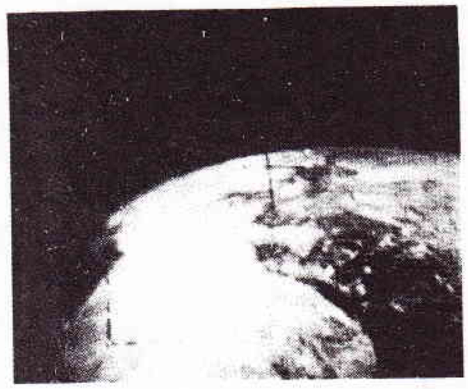
judgement and a firm, experienced hand. Watters handled literally every type of problem imaginable every day and he did it with great insight and good humor. His many talents were fully tested in this challenging assignment, which some of us likened to being a chaplain in an insane asylum. It must thereby 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 tele vision 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

A Signal Corps space odyssey

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.

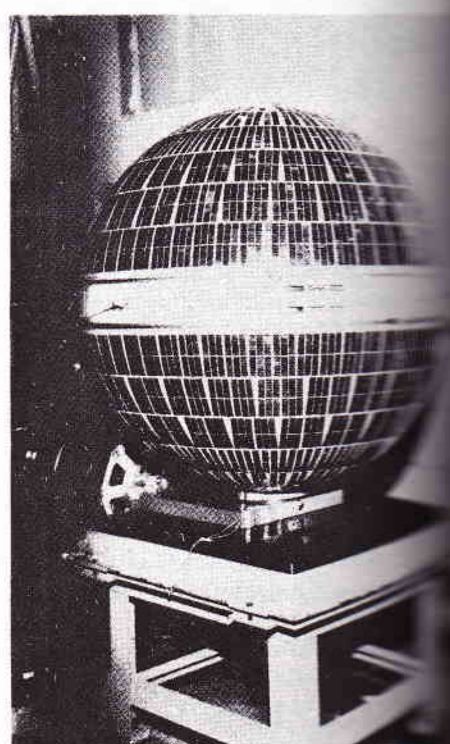
Nevertheless it was our gut feeling that we had made significant contributions to the meteorological satellite development both in the concept of our first cloud-cover instrumentation and our technical directorship of the TIROS payload.

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.

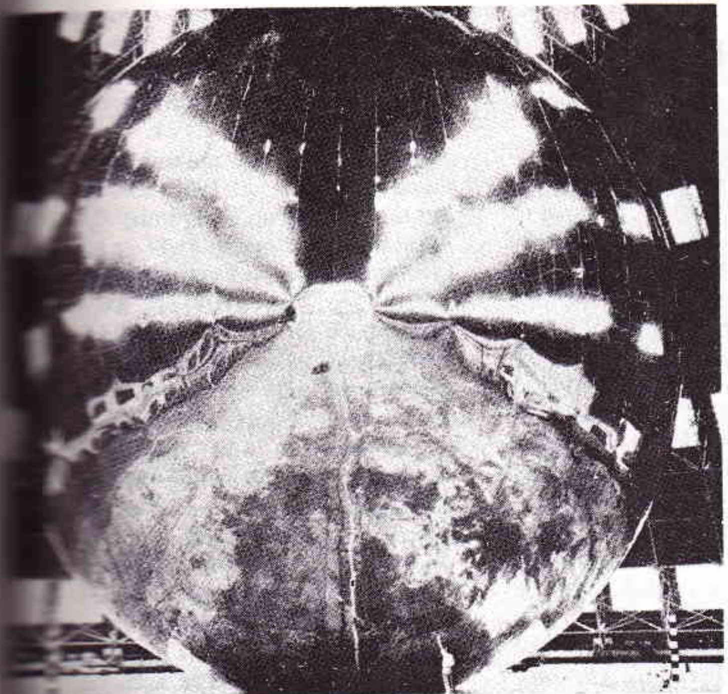
This concept did not please Gen. Medaris. Unfortunately, however, top government decisions had not favored Army space vehicle developments in spite of their pioneering role and demonstrations of capabilities.

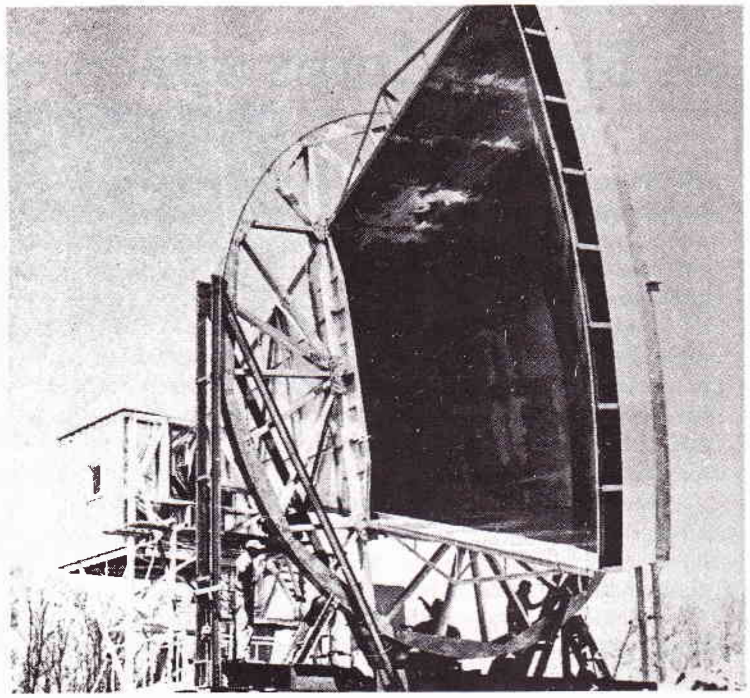
The COURIER 1 B satellite, which provided basically the same communications modes as SCORE, plus facsimile, but with an immensely larger capacity, was successfully launched from Cape Canaveral on 4 October 1960. An earlier launch attempt in August had resulted in vehicle failure. The tremendous communications 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 broadcasts



COURIER IB 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 earned 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

A Signal Corps space odyssey

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 missi[le] 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 electronics and communications field 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 recently one of the major ... activities at Fort Monmouth has been recognized as the top laboratory ... entire Army and has been presented with the Secretary of the Army Laboratory of the Year Award.

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

Brig. Gen. Brown retired from active ... 1967 after thirty years of ... service. A 1937 West Point gradua... successfully completed the US Army ... School (1940), Command and General ... School (1944), Armed Forces Staff ... (1951) and the Army War College ... Among his many key assignments ... two years as commanding general ... Army Signal Center and School ... and his final assignment as Deputy ... C&E, Department of Army ... Brown, who played a central ... initial Signal Corps space effort, ... 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. Acknowledgment 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 the 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 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.

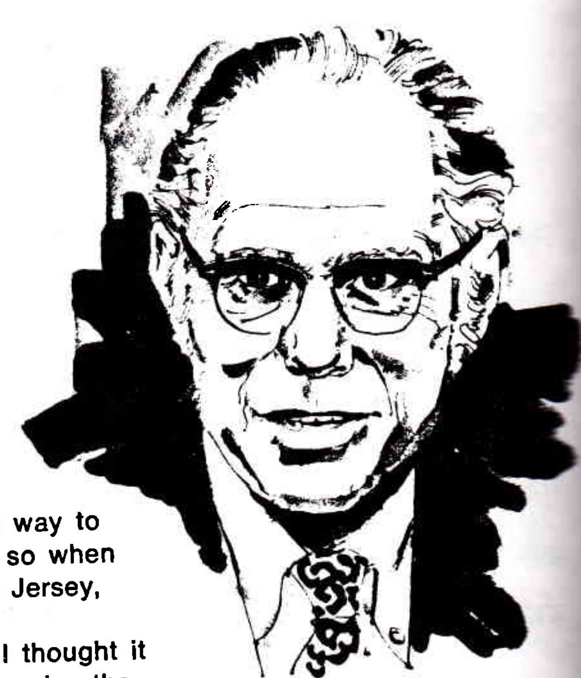
An NSPE committee cited the following advances as the most outstanding since 1934: nylon; the first controlled self-sustaining nuclear chain reaction; the Electronic Numerical Integrator and Calculator (Eniac); the transistor; the inertial navigational guidance system; the Boeing 707 jet airliner; the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

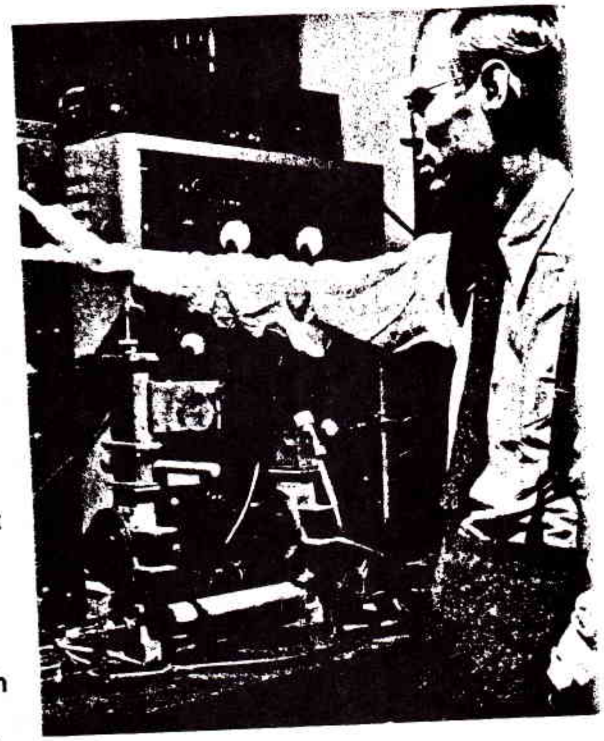
This "passive" Echo satellite—so described because it did not actively retransmit the signals but merely reflected them—was followed in 1962 by AT&T's Telstar satellite, which had an amplifier-transmitter to relay the signals, and soon afterward by other active satellites.

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.

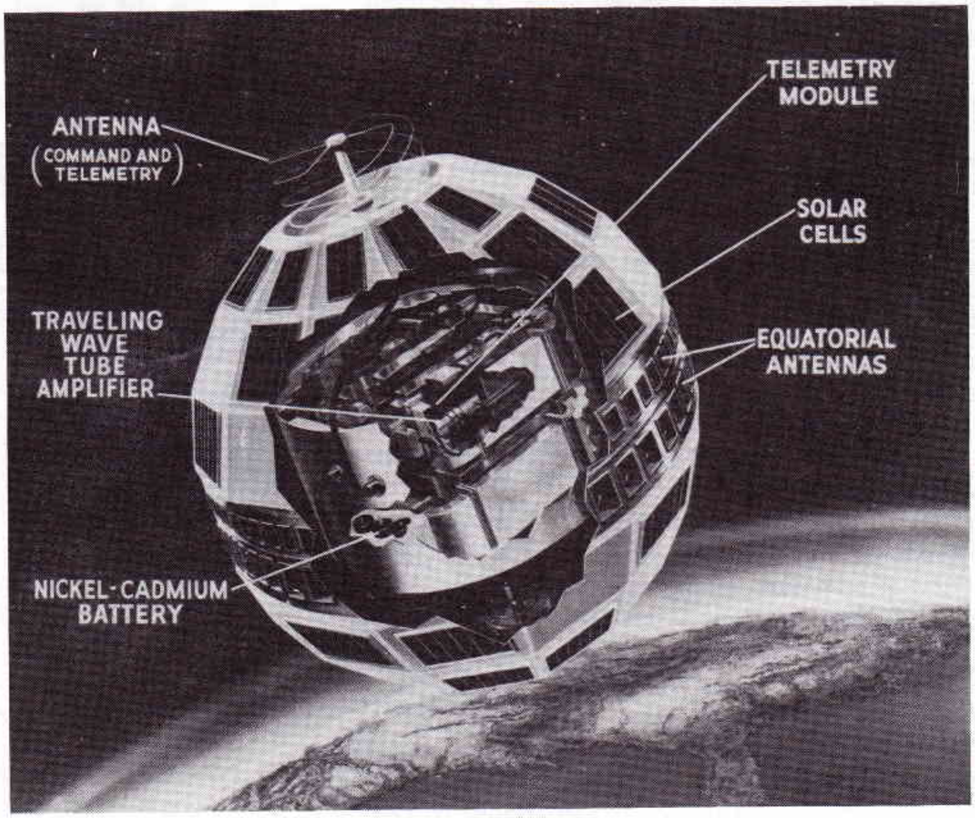
Pierce made many other contributions during 35 years at Bell Laboratories. Important among them were ideas and designs for a device called the traveling-wave tube, which had been invented by Rudolf Kompfner in England in 1943. Years of work by Pierce, Kompfner and their associates at Bell Laboratories (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.

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 38 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.



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



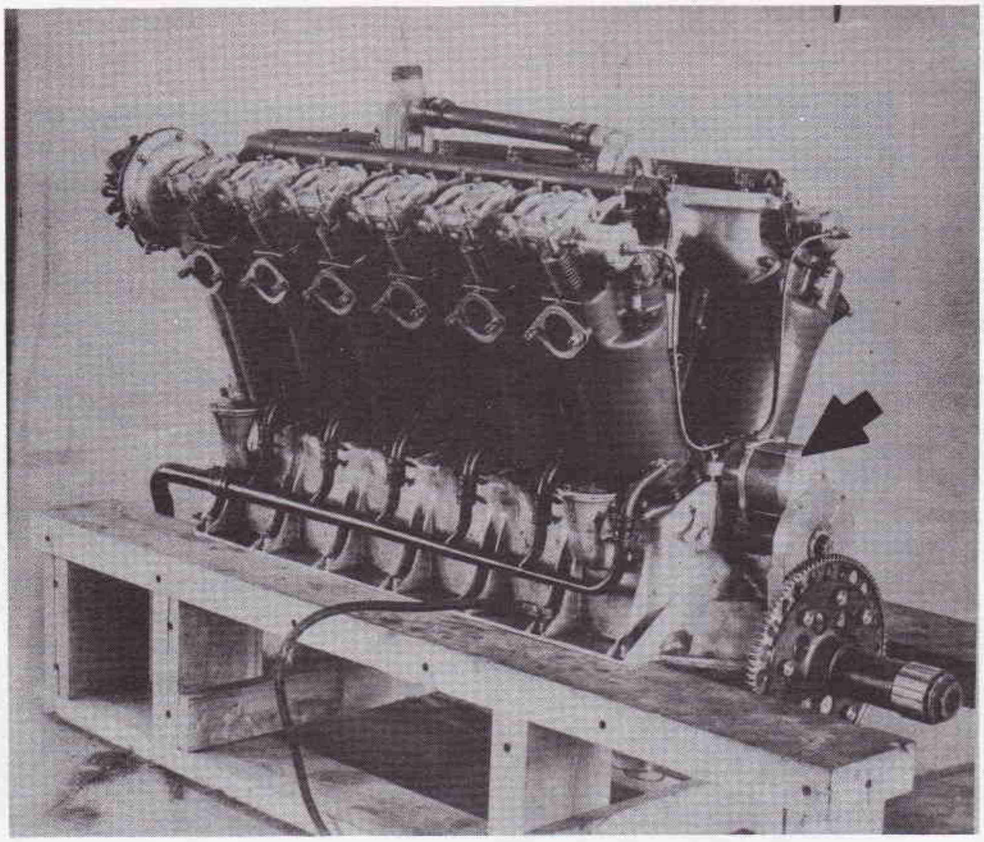
TELSTAR I

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

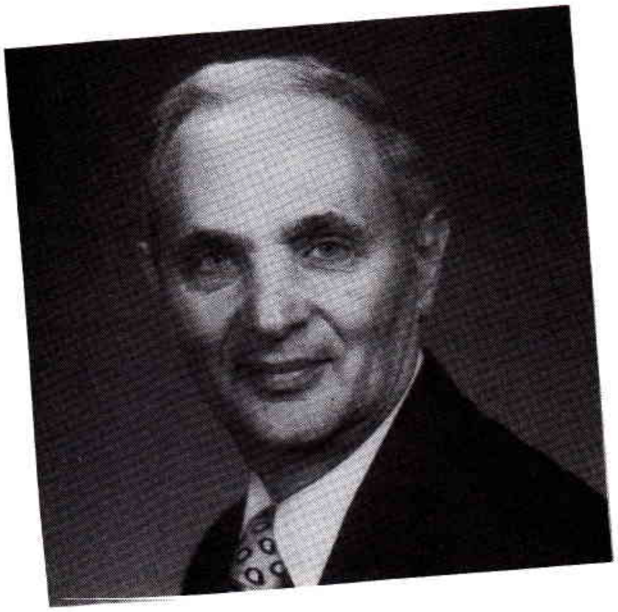
MR. IRVING REINGOLD

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.

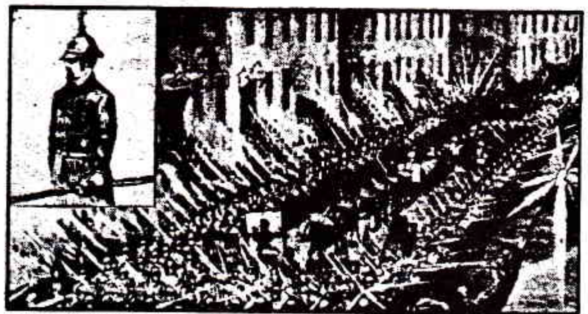
The rank of Fellow is created in the AIEE, which is the largest engineering society in the United States, with more than 7300 members. In addition, the Code of Principles of Conduct for the society is approved.

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 special space issue of IRE magazine; Centennial project officer's 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; map showing ACAN network; information booklets on Fort Gordon, Ga and 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 Monmouth 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 October 1937.

Tales of Yesteryear . . .

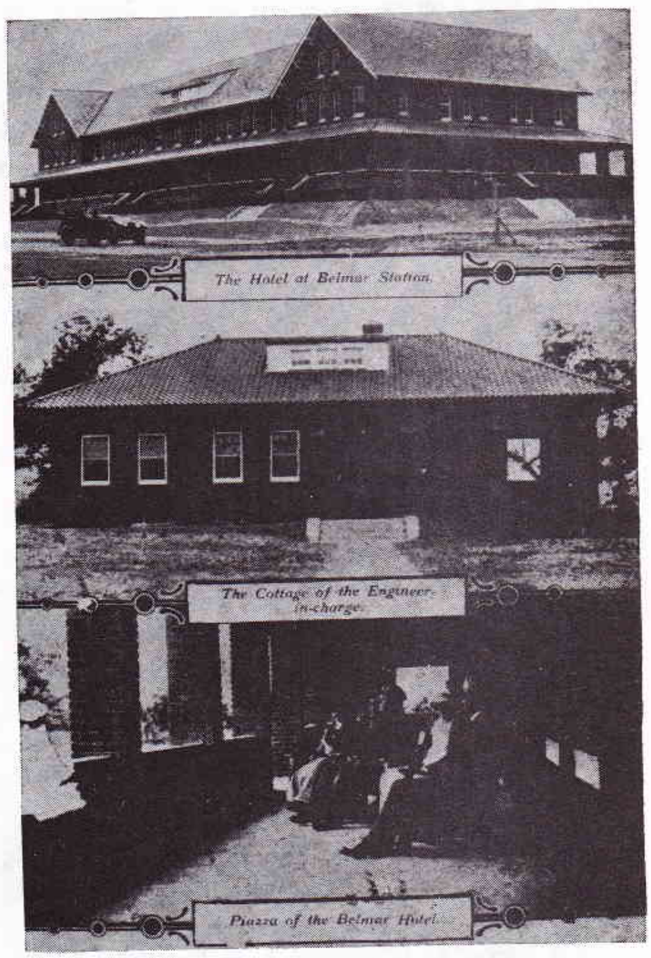
In Case You Have Forgotten

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*) 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 stations, one being on the Jersey coast situated at the Highlands 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

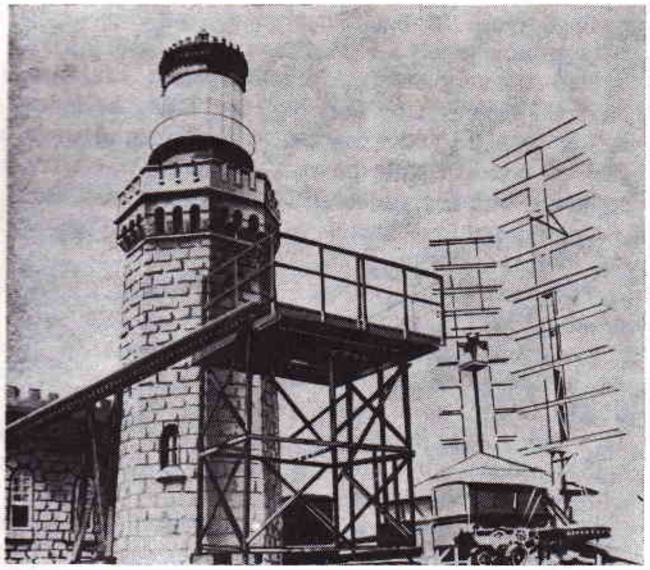
Returning now to the 1899 race and Marconi's radio triumph in its coverage, it is of historical interest to note that an ever-alert Signal Corps was also on the scene. Special Orders No. 213, Headquarters of the Army, dated September 12, 1899, directed Sergeant Walter R. Taylor to temporary duty at the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

• • • — • —

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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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 peacetime 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 a building blocks upon which to construct the new civilia operation.

It was signal research which gave the first govern ment support to aviation when it bought an airplan from the Wright brothers in 1908 and quickly expande this interest to include surveillance techniques, machi guns, bombs, and bombsights. With people like t late General G. O. Squier and Nobel Prize-winni physicist, R. A. Millikan (also a World War I Sig Officer), aviation interest expanded, growing into m turity so rapidly that near the end of World War the Army Air Corps was formed and "crossed-fla 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 re-

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 head-first 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

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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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Proceedings of the IRE®

continued

continued

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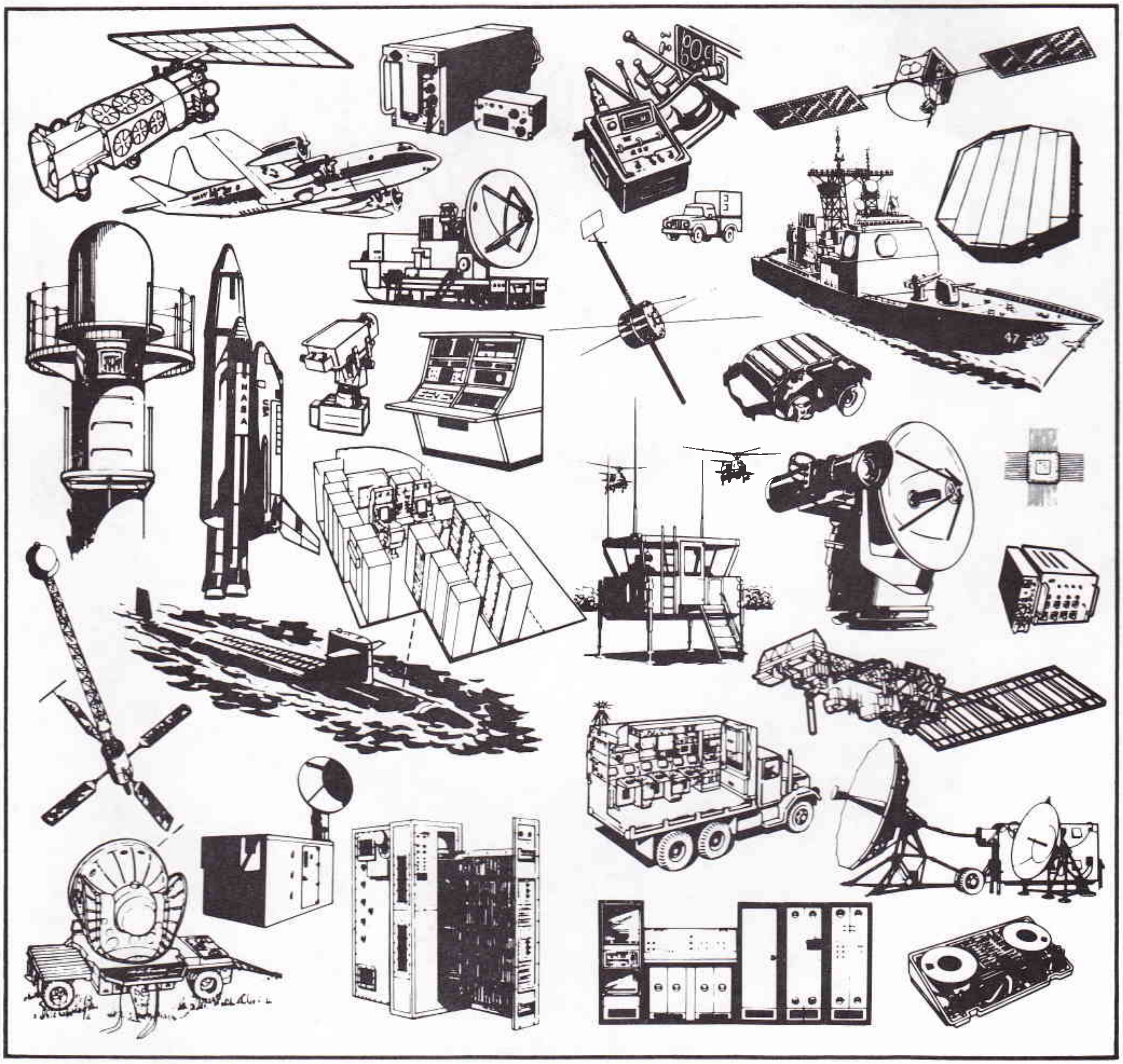

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