BELL LABORATORIES RECORD

OCT. 1946 VOL. XXIV NO. X

The SL Radar

By N. I. HALL
Commercial Products Development

IN THE spring of 1942 the Navy approached the Laboratories with an urgent request for a 10-cm search radar to help combat the submarine menace to our shipping in the Atlantic. The original request was for five hundred systems to be designated the SL Radar, for installation on merchant vessels and fleet auxiliaries. What the Navy needed was a radar powerful enough to detect submarine periscopes at a distance of two miles or so and yet simple enough to be operated and maintained by the average radio personnel found on merchant ships. The Laboratories and the Western Electric Company undertook this project, and before the war ended Western had delivered more than 1,300 SL systems to the Navy. These constituted more than fifty per cent of all shipborne search radar systems built by Western during the war.

Before production actually began, the advent of the destroyer escort along with other factors prompted the Navy to change its original plan of supplying SL's to merchant vessels. Instead it was decided to use the SL on destroyer escorts, which in turn would be used to guard convoys.

Many interesting war stories connected with the SL are told by Captain R. D. de Kay, a member of the Laboratories' Technical Staff, who was skipper of a destroyer escort in the Pacific theater of operations. Captain de Kay found his SL indispensable in connection with operations at night and in fog. It was a Navy policy in the Pacific,

The photograph at the top of the page shows a destroyer escort equipped with SL Radar.—U. S. Navy Photo.

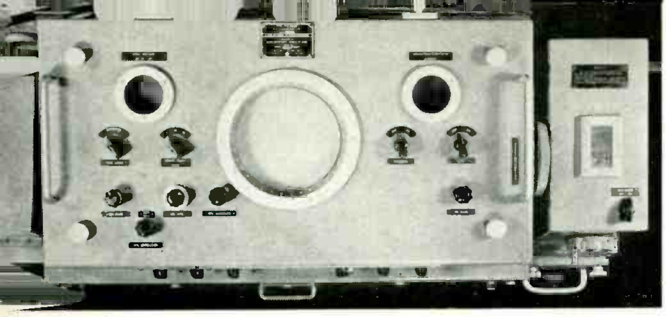
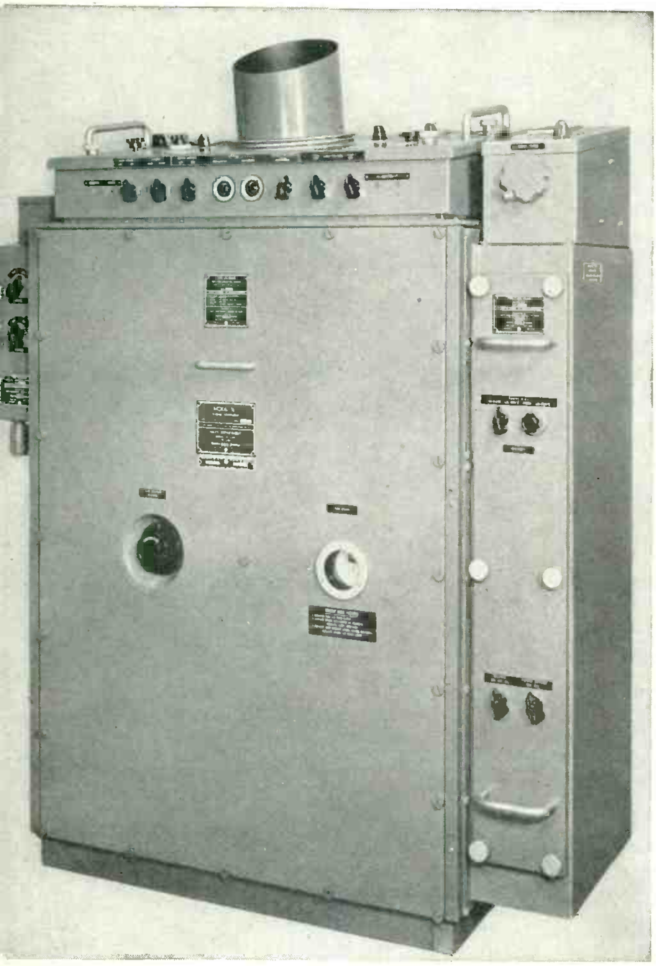


Fig. 1—Top view of the SL radar console showing the seven-inch cathode ray tube with a long-persistence screen and the various operating controls

Fig. 2—Console containing the indicator in the upper portion and the rotary spark gap in the lower portion. The automatic frequency control unit at extreme left and range unit at extreme right were not included in the original design



because of our radar superiority over the Japs, to schedule all operations at night, if possible. According to Captain de Kay, the SL made it possible to navigate in heavy fog and during pitch darkness through the enemy-infested waters near the Pacific coast of Asia, where they never would have ventured without radar.

The Pacific islands, with their characteristic steep-sloped, volcanic structure, made ideal radar targets. He says it was a common experience to detect these islands out to the extreme sixty-mile range provided in the SL indicator. In fact, they often increased the effective range of the system by peering around the curved edge of the cathode ray tube to gain a few extra miles.

When the SL project was undertaken by the Laboratories, radar was still an infant, and its growing pains were numerous. The magnetron, the heart of centimeter radar, was less efficient and stable than it now has become. Modulators for driving the magnetron were complicated and required more maintenance than the modulators of today. Crystal converters, now used universally in centimeter radar systems, were still in the early development stage.

The task of coördinating the SL project was assigned to E. L. Nelson and his group at Whippany, with H. T. Budenbom as the original project engineer. Important portions of the development, however, took place at almost every one of the many Laboratories locations in New York and New Jersey, and credit should go to the hundreds of Laboratories and Western Electric personnel who contributed to the success of the undertaking. Laboratories experts were available for solving many of the special problems, but for others, particularly those involving the microwave portions of the system, it was necessary to train the technical personnel hurriedly transferred to Whippany from unrelated peacetime jobs. Whippany mushroomed almost overnight from a few dozen persons to several hundred in order to handle the various Government radar contracts that were involved.

The SL radar utilizes the plan position indicator (PPI) method of displaying the received echoes. The indicator, which is located in the console shown in Figures 1 and 2, contains a seven-inch cathode ray tube with a long-persistence screen. A PPI indicator traces a polar type of map of the surrounding territory on the cathode ray screen with the position of the observer at the center of the tube. Bodies of water and smooth terrain show up as dark areas on the screen since they do not reflect the radar waves. Ships, aircraft and coastlines show up as bright dots or bright areas in their correct relative positions.

The indicator is provided with three range scales: 4, 20 and 60 miles. When using the four-mile range scale, the distance from the center of the cathode ray tube to its periphery represents four miles, and the angle at which the observed echo appears on the screen indicates its bearing with respect to the observer. When a destroyer escort is protecting a convoy, all of the ships in the convoy show up in their correct relative positions as bright dots upon the indicator screen. If one of the ships of the convoy gets out of position at night and endangers adjacent vessels, the destroyer escort may signal instructions to this ship and assist it in getting back into its correct position. The radar operator, knowing the position of each ship in the convoy, is able to detect the approach of enemy ships or submarine periscopes.

The SL is composed of three major units: the operating console, the transmitter-receiver unit and the antenna, which are shown in the accompanying illustrations. The transmitter-receiver unit, Figure 3, contains a 10-cm magnetron to generate a series of short, high-power microwave pulses that are fed through a wave guide to the antenna at the top of the mast. Figure 4 shows a view of the magnetron and its associated equipment. The magnetron is in the center, mounted between the poles of its permanent magnet. To the left is a portion of the wave guide leading to the antenna, and at the right rear of the illustration is the pulse transformer.

A rotary spark-gap modulator in the lower part of the console generates 4,500-volt, 80-ampere pulses at the rate of 800 per second. These are transmitted to the pulse transformer in the transmitter-receiver unit, which changes them to 18,000-volt, 18-ampere pulses which it feeds to the magnetron. The peak power output that the

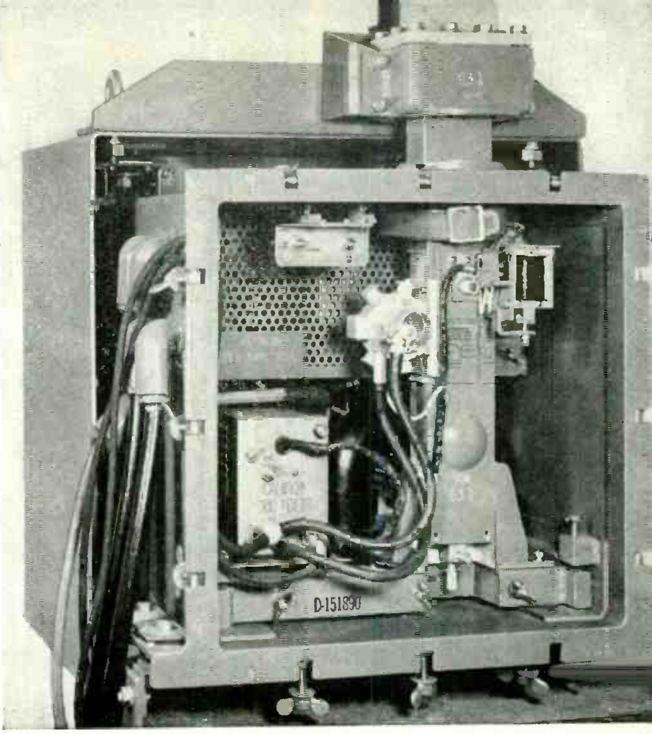
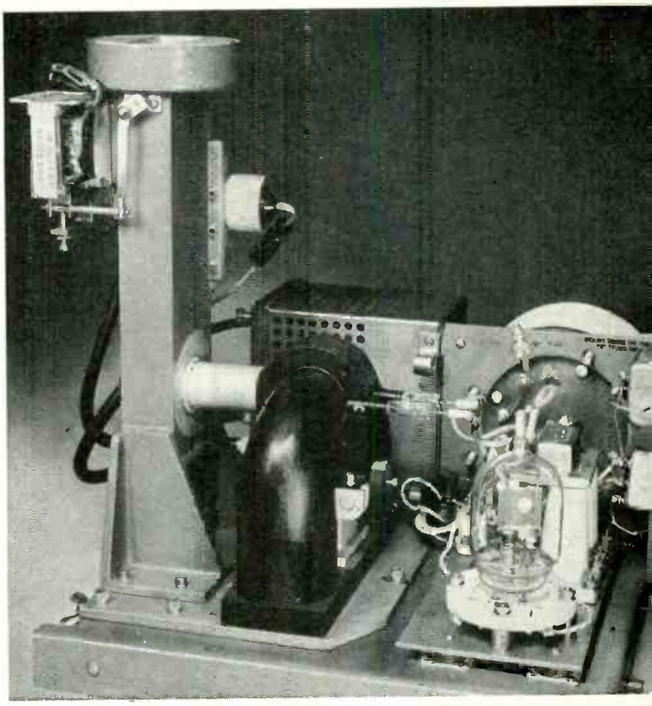


Fig. 3—Transmitter-receiver unit showing wave guide output section supporting the T-R cavity, crystal converter, and shutter solenoid. The beating oscillator and 60-mc I-F pre-amplifier are in the shielded unit at the lower left

Fig. 4—Transmitter-receiver chassis showing magnetron and associated apparatus



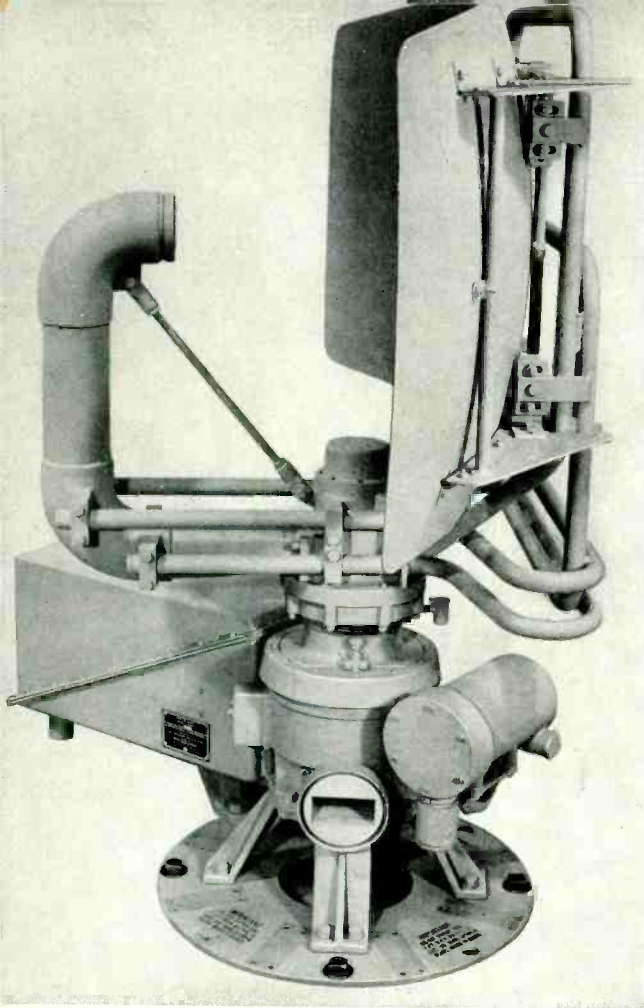


Fig. 5—Antenna assembly consisting of front-fed parabolic reflector, rotary joint, drive motor, and synchro generator

magnetron supplies to the antenna is about 150 kw, and the pulses are of 1¼ microsecond duration. The antenna, mounted on the mast, is used for both transmitting and receiving. It is shown in Figure 5 without its protective hood, which is a dome about four feet in diameter. Producing a beam six degrees wide in the horizontal plane and twelve degrees vertically, the antenna rotates continuously in the horizontal plane at eighteen revolutions per minute, which means that it takes about three seconds to scan through 360 degrees. As the antenna rotates, it "looks" at a small, distant target for about fifty milliseconds as determined by the beam width and rotational speed. During this interval, approximately forty pulses from the transmitter strike the target and are reflected back via the same antenna to the receiver. These forty pulses combine to produce a bright dot on the indicator screen. Due to the long-persistence character of the screen, this dot remains visible until the antenna again points at the target three seconds later to reinforce the image. The antenna is synchronized with the drive mechanism of the indicator-tube sweep coils, so that there is always a fixed relation between the direction in which the antenna is pointing and the position of the echoes upon the screen.

After Western Electric had delivered about eight hundred SL systems, the Navy requested that several new features such as a precision range unit, automatic frequency control unit, and remote indicators be provided on the next production series. The improved model, which is the one shown in the accompanying illustrations, was designated the SL-1 radar. Field modification kits were ordered, so that all of the systems already delivered could be modified in the field to provide these new features. All systems so modified in the field are designated the SL-a radar.

The console, which is the operating location, is generally placed below decks, in or near the radio room, since it is too large

---

THE AUTHOR: NATHAN I. HALL received his B.S. and M.S. degrees in 1934 from the University of West Virginia, where he remained as a member of the Faculty of the Department of Physics until 1936. He then entered Stanford University as Research Assistant to Professor F. E. Terman, where he developed apparatus for measuring the height of the ionosphere. He received his E.E. degree from Stanford in 1937, following which he joined the Research Department of the Laboratories. During World War II he developed rotary spark gap modulators and microwave components for a number of radar systems and was Project Engineer for the latter part of the development of the SL Radar. At present he is engaged in electronic telephone switching research.

to be placed on the crowded bridge of a destroyer escort. This requires that the information be relayed by telephone to the captain and to the other interested officers. The field modifications provided the necessary amplifiers and synchronizing facilities for attaching remote cathode ray indicators to the SL, and thus added substantially to the effectiveness of the system. Several remote indicators can be used simultaneously, and they are small enough to be placed on the bridge and at other strategic points where the ship's officers may keep them under direct observation.

The SL was designed primarily for detecting submarine periscopes and surface vessels. It has also been found very effective, however, for detecting aircraft as indicated by the following report taken from the log of a destroyer escort: "Picked up fleet of German planes at forty miles on our SL and permitted convoy to send out smoke screen. Result—no damage from bombs."

Employees' Stock Plan

THE Board of Directors of the American Telephone and Telegraph Company voted on August 21 to recommend to stockholders a new issue of convertible debentures in an amount not to exceed $351,000,000, an increase in the authorized capital stock of the company from 25 million to 35 million shares, and the adoption of an Employees' Stock Plan under which up to 2,800,000 shares may be issued and sold to employees of the company and its subsidiaries. A special meeting of stockholders to vote on the recommendations will be held October 16.

The Employees' Stock Plan would provide for the sale of stock to all regular employees of A T & T, and of most of the company's subsidiaries, who meet certain requirements as to length of service. Payment for shares would be on an installment basis, either through payroll allotments or by cash payments, and installment accounts would be credited with interest at the rate of 2 per cent. No employee could purchase more than 50 shares.

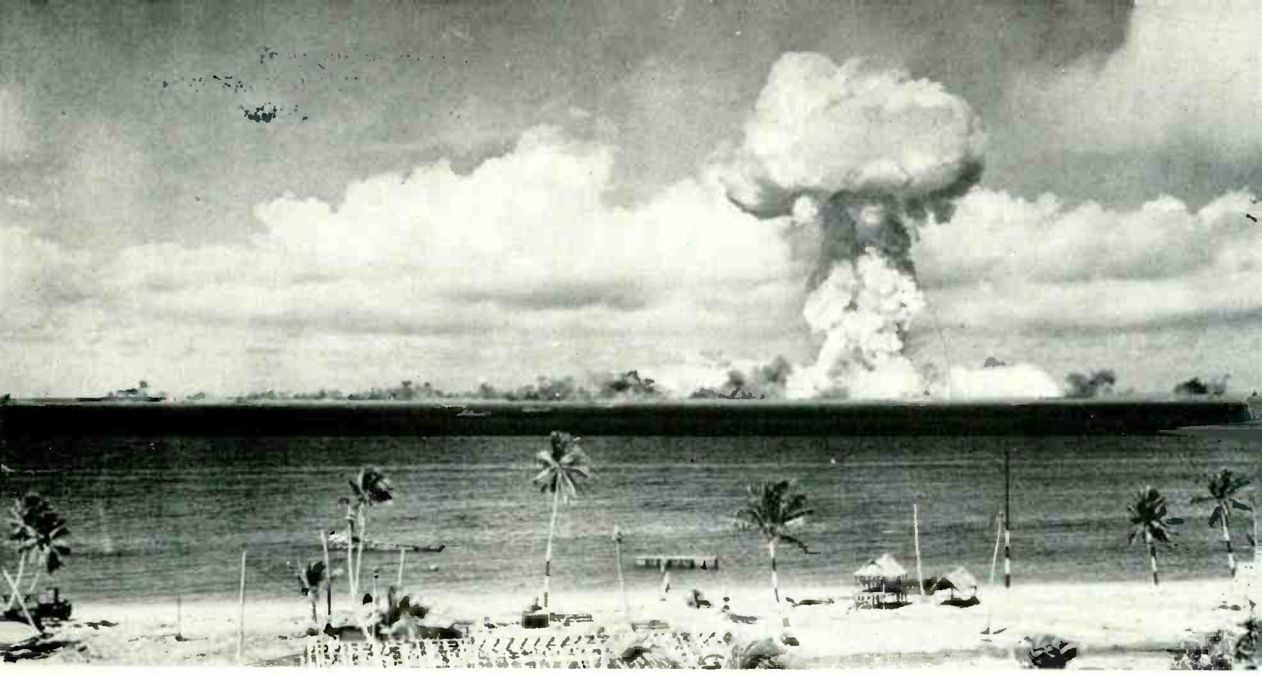
The price of the stock to employees would be $150 a share as long as the average market price is $170 or more. The employee price would be reduced if the average market price were less than $170 either in the month when the employee's payments were completed, or in the following month. In that event, the employee price would be $20 below the market in whichever of the two months the average market price was lower. The employee price would in no event be less than $100 per share.

For example, if the average market price were $168 in a month when the employee has accumulated $148, the employee price would be $148 a share, unless the market price the following month were lower—say $167—in which case the employee price would be $147.

Any employee participating in the Plan would be allowed to cancel all or part of his subscription at any time, with the option of receiving a refund of the full amount credited to his account, including interest, or of taking whatever number of shares that amount would purchase.

The initial offering would be made to regular employees having at least six months' service. Each would be entitled to purchase one share of stock for each full $500 of his or her annual basic rate of pay, subject to the maximum limit of 50 shares. Payment for the shares would be made at the rate of $5 per share per month.

Pending approval of the Plan by stockholders, no date has been established for the offering of stock to employees.



Fastax at Bikini

By JOHN H. WADDELL
Photographic Engineering

THE world learned of the atom bomb in August, 1945, when a B-29 dropped one on Hiroshima. At the same time, announcement was made of the first atom bomb explosion at Alamogordo, New Mexico, a short time before. With the dropping of one on Nagasaki, World War II ended.

For the Alamogordo test, the Los Alamos group of Manhattan District had contracted with the University of California, the University of Chicago, Johns Hopkins University, and Woods-Hole Oceanographic Institute to make certain studies of the phenomenon. Western Electric Fastax motion-picture cameras secured by these organizations were used to photograph the most dangerous and destructive bomb man has ever conceived. The cameras were placed at varying distances from the bomb site, some relatively close by and others at greater distances. All of them were placed in lead housings, and periscopic devices were used between the cameras and the outer housings. These precautions were necessary to prevent fogging of the film by the gamma radiation, which is extremely intense at the time of the explosion. Gamma rays are stopped by lead but, unlike visual light, penetrate the periscopic mirror and so are not reflected into the lens. The combination of the housings and the periscopes thus permits satisfactory photography without ill effects from the gamma radiation.

One camera was so close to the explosion that it was completely wrecked, and several others a little farther out were rendered inoperative due to the heat wave. Except in these cases, excellent photographic records were obtained, showing the size and brightness of the explosion in time intervals of a few millionths of a second. Both the 8 and 16-mm cameras* were used at Alamogordo, the 8 mm taking 8,000 pictures per second and the 16, 4,000 pictures per second. At full speed, a 100-foot roll passes through the camera in 1¼ seconds—about the time it takes one to say "One thousand and one."

The photograph at the top of the page shows the blast from the atom bomb dropped from the B-29 "Dave's Dream." The shock wave appears just below the target fleet. All photographs by Joint Task Force One.

*Record: *September*, 1943, *page* 1, *and April*, 1946, *page* 129.

In February, 1946, the Crossroads Project was announced by Joint Task Force One. Preliminary work had started on this project in December, and for the two months before the public announcement was made, the Army Air Forces, the Navy Department and the Manhattan District of the Engineer Corps had been coöperating to secure the necessary men and material for the tests, which would be held at Bikini, Marshall Islands. It was announced that there would be three phases to the test: for the first, an atom bomb would be dropped from a plane as at Hiroshima and Nagasaki; for the second, a bomb would be exploded when submerged a few feet below the surface of the water; and for the last, a bomb would be exploded in deep water. It was announced also that the first two tests would occur about the 15th of May or shortly thereafter, and that the fleet of target vessels assembled for the tests would consist of approximately 80 vessels. It was to be arrayed in such a manner as to show the effect of the blast on ordnance, airplanes, naval craft and living subjects. For the execution of this part of the program, also, cameras were to be used to study and record the results. The plan called for still cameras, aerial cameras, all types of ultra-high-speed motion-picture cameras, and special cameras that had been devised for recording oscilloscopic, radar, and spectrographic data.

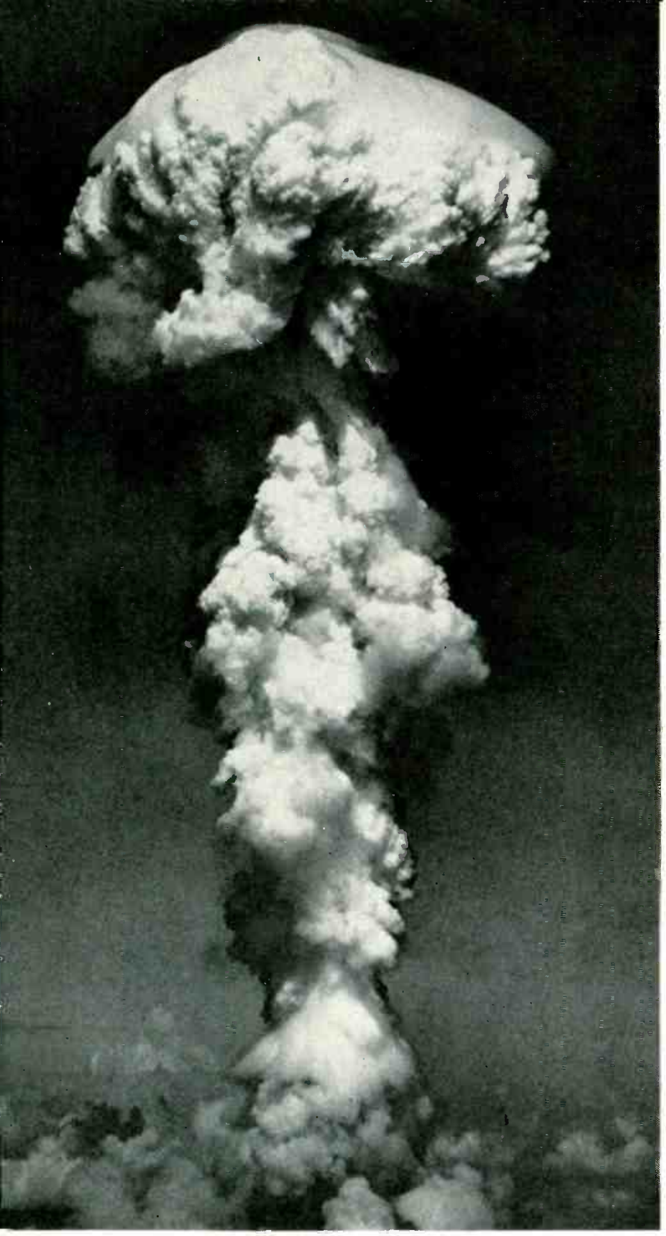
The photographic study was divided into three major groupings: the first, under Captain Robert Quackenbush of the Navy, was to record the event from ships and from towers on Bikini Island; the second, by the Air Force under Col. P. T. Cullen, was to record the event from the air with ultra-high-speed motion-picture cameras and motion-picture cameras operating from 16 to 120 frames per second, with aerial still cameras both manually and electrically operated, and with radar oscilloscopic and spectrographic cameras; and the third, by the Los Alamos group, was to record the event from towers on Bikini, primarily with ultra-high-speed motion-picture cameras.

It was learned that three times the number of Fastax cameras that had been used at Los Alamos were to be used on the Crossroads Project. The Air Force was to use approximately 17 Fastax cameras, and approximately 40 were required by the Los Alamos group. The Army Air Force Fastaxes were, of course, all airborne, and were to be operated at a speed of 1,000 pictures per second. The Los Alamos group used their Fastax cameras at speeds up to 8,000 per second.

The Los Alamos group set up an electronic system for controlling all of the cameras both in the air and on ground installations. This circuit was such that the airborne 1,000 PPS cameras were started two seconds previous to the blast, and higher speed cameras were started somewhat later. There would be a tone signal transmitted simultaneously with the operating signal, so that if the latter failed, the cameras could be manually operated.

The high-speed cameras mounted on the towers at Bikini were rigidly supported, and lenses of different focal lengths were used so that varying magnifications could be obtained of the blast, the fire ball, and

Dual high-speed camera mount in blister of an F-13 (modified B-29) photo plane. The Western Electric Fastax camera is mounted on top and was used to photograph the faster action first



Smoke cloud from atom bomb dropped from plane

the damage to the ships due to the shock wave. For the aerial test, getting the cameras on target was more difficult because of the uncertainty as to the exact location of the bomb at the instant of ignition. The cameras were equipped with lenses varying from 35 mm to 15 inches in focal lengths. Since the cameras are designed with bayonet mounts, it was very easy to change the lens set-up from one focal length* to another. The three types of Fastax cameras used in the tower set-up were the 8,000 per second 8 mm, 4,000 per second 16 mm, and the 3,500 per second 35 mm wide angle camera. All cameras were protected from excessive radiation by lead glass windows in lead housings. This set-up, relatively simple compared to that at Alamogordo, was entirely suitable because of the relatively greater distance from the source of the gamma radiation.

On Kwajalein, where the airborne cameras were fitted to the planes, more varied installations were required. Because of the mobility of the planes, the cameras were mounted on free-head tripods so that they could be quickly swung through a wide range, and the crewmen had to be trained to keep on the target. The planes used were F-13's, which were B-29's modified for photographic work on the Crossroads Project as well as for mapping purposes and reconnaissance work elsewhere. On location the planes were to fly in a counter-clockwise orbit, and hence the cameras were generally installed on the left-hand side. There were automatically controlled cameras mounted in the top turrets, in the lower turrets and in the tail turrets, all controlled with the automatic gun-sight mechanism. There were motion-picture cameras installed in the oblique mapping position, which is in the lower quadrant of the plane facing diagonally downward. The high-speed cameras were mounted in the blisters of the planes and in the nose. The blister is roughly three feet in diameter, and because of its spherical shape the cameras had to be mounted well back from the Plexiglas to prevent distortion. Even so, it was noted that on some of the 16-mm color shots the Plexiglas did affect the over-all color value somewhat. In all cases, the cameras were mounted on tripods for reasons of mobility. They were mounted in pairs, a Fastax camera on top of a slower speed camera on one tripod. The automatic control circuit started the Fastax first to photograph the action at the instant of detonation, the resulting fire ball, and the shock wave. The other camera started as the last part of the film was passing through the Fastax camera, and photographed the shock wave and the damage to the ships. Both of the cameras of the

*The lenses used were all standard photographic objectives and not of the telephoto type, and thus rendered greater resolution than could be expected from the telephoto lens.

pair were equipped with universal motors, which meant that they could operate from standard 28 volts d-c power supply in the plane. As in the other camera installations described, all the cameras were equipped with lenses of various focal length, depending on the scene to be photographed.

For the underwater test, it was planned to have a plane fly directly over the bomb at the instant of detonation. In this plane four wide-angle Fastax cameras were used mounted in pairs and pointed vertically downward with the major axes of the fields of view of the two pairs at right angles so as to cover as large a field as possible. One camera of each pair would be started as the others were finishing, thus covering as long a period of time as possible. As in the other airborne Fastax cameras, the speed was to be 1,000 pictures per second.

As an additional feature, two of the blast gauge B-29 planes were fitted with oscilloscopic camera set-ups to study the effect of radiation accompanying detonation upon radio transmission. For this purpose a T34 cathode ray oscilloscope developed by Bell Telephone Laboratories and manufactured by the Western Electric for the Signal Corps was installed in the plane along with a 35-mm Fastax camera from which the prism had been removed. Radio circuits fed the oscilloscope, and the trace on the oscilloscope screen was photographed by the camera continuously. The tube as furnished with the oscilloscope originally was replaced with a tube having a short persistence coating, which had been found best for high-speed oscilloscopic recording. The camera was run at 25 feet per second, and frequencies up to 50 kc could be recorded under these conditions. This same set-up could be used very well to photograph blast pressures, sound intensity, and other short duration events occurring at the time of the blast.

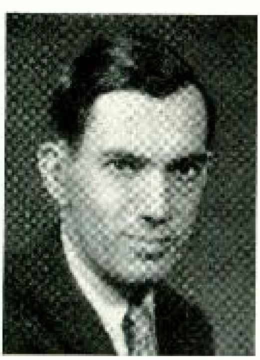
Because of the complex equipment and plans involved in the Crossroads Project, everything had to be ready at the appointed time, and must not fail to work. There would be no retakes. As is customary with the Armed Services in handling projects involving highly specialized knowledge and technique, civilian aid was requested in some fourteen different cases; one was a request for a technical photographic engineer from the Bell Telephone Laboratories. The utter reliance placed upon high-speed photography for quantitative and qualitative knowledge of what would occur in the few milliseconds after the bomb was detonated well warranted such a request, and the author was appointed to the job. Traveling by air from Roswell, N. M., our group arrived at Kwajalein, Marshall Islands, April 29. Kwajalein was the base for the B-29's, F-13's and C-54's, while the B-17 Mother Ships and Drones operated from Eniwetok. Bikini formed the other point of the triangle, being about 250 miles to the northwest of Kwajalein.

As soon as the cameras were unpacked and set up at Kwajalein, we began the preliminary work necessary to the success of the photographic venture. These included establishing suitable maintenance procedures to insure proper operation under the prevailing climatic conditions, and providing the photographic techniques for best performance and data gathering.

Exposure tests were made of the sun so that the filter factors necessary to get a sharp image of such a subject could be established. It was found, for example, that a neutral density of 3.0, which is one-tenth of 1 per cent transmission with the lens

---

THE AUTHOR: JOHN H. WADDELL joined Bell Telephone Laboratories in 1929 after having been with the duPont Film Manufacturing Corporation. He had studied chemistry at Pennsylvania State College, and during the period of our active work in sound pictures, he worked on the physics and chemistry of film developing systems in the sound picture laboratory. Since that time he has been engaged in photographic and optical engineering work, chiefly in designing cameras of both the recording and slow-motion-picture type, and in developing photographic techniques for special applications in the Bell System and Armed Forces.

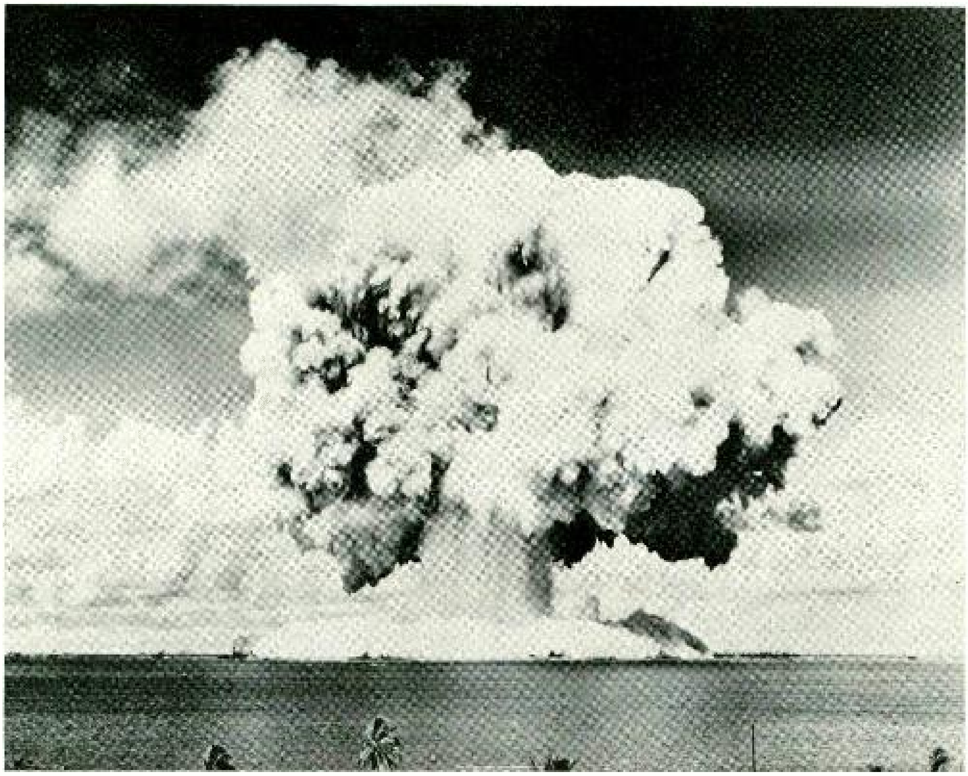


Kjeldsen-Hawthorne

stopped down to F/22, would give a sharp image of the sun. The maximum light of the flash was expected to be from ten to a hundred suns in brightness, and then would rapidly decay to less than the sun. From these basic data, the filter factors for various phases of the blast were established. Filter factors were also established for color photographs. The absolute fields of view were also computed for the various lenses and cameras that were used.

It was noticed shortly after the arrival of the cameras that the high humidity and high temperature would have a tendency to affect certain parts of the cameras, and immediate steps were taken to devise a maintenance procedure that would prevent trouble from occurring. Subsequent events proved these measures worth while, since the Fastax cameras all operated perfectly on every mission.

As to the Fastax pictures obtained through all this planning and effort, we never expect to see them, and don't know how they turned out, since they are rated "Top Secret." We do know, however, that everyone in authority felt that the results achieved were all that could be expected, and we have no doubts that they will prove to be worth while.



Underwater atom bomb blast showing column of water 2,000 feet in diameter

Testing Tank Set Crystals

By L. F. KOERNER
Transmission Apparatus Development

MONTHLY production at the Western Electric plant for one particular type of quartz crystal—used in large quantities for the tank radio set*—ran to nearly three-quarters of a million during the peak of war production. Besides having the proper frequency, these crystals must have an "activity," or output, above a specified minimum value. Activity, however, is not a constant of the crystal itself, but depends on the circuit with which the crystal is used. To provide for testing both frequency and activity in the proper circuit, therefore, a transmitter of each type with which crystals were to be used was maintained at the Western Electric plant. Although this method gave satisfactory results, it involved more equipment than necessary and generally lacked simplicity. As a result, the Laboratories developed a standard oscillator that could be used in place of the standard transmitters.

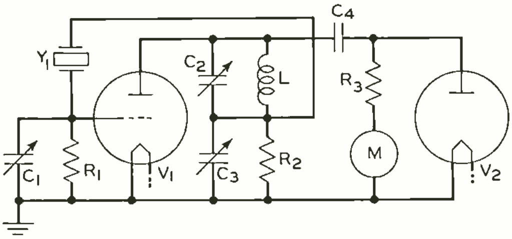


Fig. 1—Circuit of the basic oscillator used for testing tank set crystals

The basic oscillator circuit designed for this work is shown in Figure 1. It is essentially a Pierce resistance-capacity crystal oscillator circuit modified by a tuned plate circuit to obtain a relatively constant output over a range of frequency. The output level of the oscillator is adjusted by varying the feedback capacitance C_3, and the output is read on the meter M associated with the diode V_2. Standard coils are provided that when inserted in place of the crystal are the equivalent of a crystal with the minimum allowable activity. After one of these coils has been plugged into the circuit, the condenser C_3 is adjusted until the meter reads the voltage corresponding to minimum activity. The coil is then replaced by the crystal to be measured, and if the meter reads the same or a higher voltage, the crystal is satisfactory.

The crystals to be tested fall into four frequency ranges, and thus the equivalent of four oscillators is required. Tubes V_1 and V_2, the meter M, and resistance R_1 and condenser C_4 are used for all the frequency ranges, but the other circuit elements may differ. The circuit as provided includes the necessary circuit elements for all four ranges, and the set required for any one range is connected into the circuit by a single four-position dial switch.

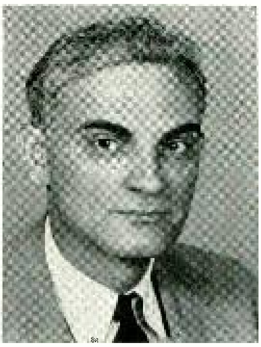
A complete oscillator, including a power supply operating on 110-volt, 60-cycle current is contained in a seven-inch standard rack-mounting panel and is shown in use in the photograph at the head of this article. At the upper left is the dial that selects the frequency range. Crystal units of the four ranges are finished in different colors to distinguish them, and the circles indicating the four positions of the switch are given similar colors. Below the frequency selecting switch is a socket into which the crystals and the test coils are plugged. To cover the four ranges, three test coils, shown in Figure 2, are provided. These coils have colored circles correspond-

*Record, *January*, 1945, *page* 1.

ing to the color of the switch positions.

At the lower middle of the panel is a rectangular plate with holes for screw-driver adjustment of the four condensers used in the C_3 position. Condensers C_1 and C_2 are adjusted at the time the set is first put into service and require further adjustment only at rare intervals. At the upper right of the panel is the meter M, and directly beneath it at the right is a jack into which an external meter may be plugged to replace M. Beneath this jack is a power switch which turns the set on. Directly beneath the meter at the left is a button to permit the meter to be used to measure the voltage supplied to the oscillator. A rheostat in the rear of the chassis permits this voltage to be adjusted when necessary. The pilot lamp below this button lights when the set is in use.

Ten of these oscillators have been manufactured and furnished to the Signal Corps. They have been coded the Standard Oscillator TS-221/TSM, and are part of the standard crystal set AN/TSM-2, which includes the oscillator and the test coils.



THE AUTHOR: LAWRENCE F. KOERNER received his B.S. degree from Colorado College in 1923, and his M.S. degree from Harvard University in 1924. He joined the Laboratories in the latter year, where his work was concerned primarily with electrical testing equipment involving electric and piezo-electric oscillators. During the war he was chiefly occupied in the production of quartz crystal units at the Hawthorne plant of the Western Electric Company. He is now engaged in the development of crystal oscillator circuits and associated crystal equipment.

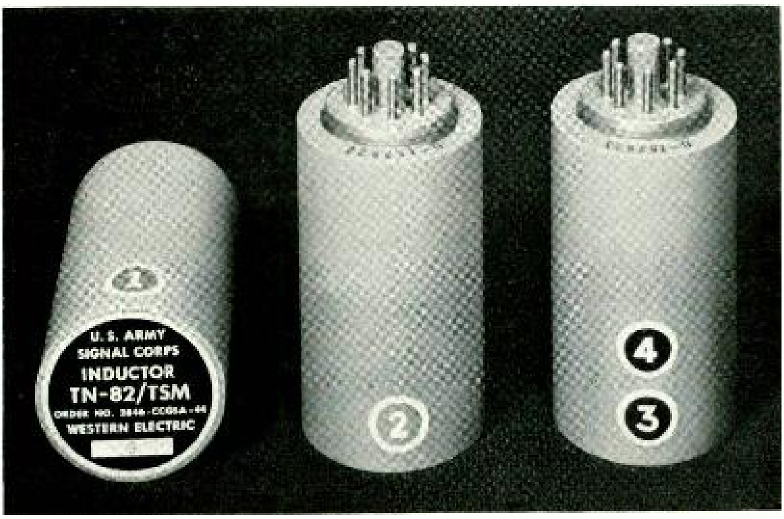


Fig. 2—Three test coils with differently colored markings are used for testing crystals over four ranges of frequency

Manufacturing Relations Speeds Production

By FRANCIS G. VARENHORST
Manufacturing Relations

SPEED and precision have been the watchwords for wartime development and manufacture, and they have had to be attained in the face of shortages both of materials and manufacturing facilities. New and often revolutionary methods have been required. A case in point is the procedure devised to reduce the normal gap between a completed design, as embodied in tracings and specifications, and the manufactured article. Under normal peacetime conditions, all drawings are very carefully checked to make sure that each component part is right, and that all the parts fit together to function properly as a whole. Models are usually made and tested before the drawings are turned over to the Western Electric Manufacturing Department, and then tool-made samples produced by the Western Electric Company are studied and tested. Difficulties that arise at the manufacturing plant are referred back to the Laboratories, and decisions are made by the engineers as to any changes to be incorporated. These are then sent to the Western Electric Company in the form of changed drawings or specifications.

Although these measures are effective in securing finished apparatus that meets all requirements, they require time and account for a substantial part of the interval between the completion of the original design and the availability of the finished product. Under peacetime conditions, however, the main requirements are a satisfactory product and a minimum cost. Time is usually subordinate to these two factors. With the beginning of the National Defense Program in 1941, however, a change in emphasis arose that rapidly became dominant in the following months. The necessity for high quality in the product was not lessened, but the factor of cost began to be overshadowed by that of time. The finished product was wanted in the shortest possible time after completion of the design, and thus emergency measures to reduce the time consumed in transmitting difficulties encountered in the Western Electric plants back to the Laboratories engineers, in studies and redesign at the Laboratories, and in making and transmitting to the Western

The photograph at the top of the page is an overall view of Department 987 at Hawthorne: Draftsmen on right side of room and engineers on left side.

A—Part of Department 984 drafting room at Kearny. Drafting control and stenographic forces in foreground, engineers' offices across the back, and blueprinting and distribution cage at the right rear

B—Part of the files of Department 987 in Hawthorne showing blueprint distribution group, tracing and Vandyke records, and correspondence files

C—The stenographic force and part of the drafting and engineering sections of Department 982 located in the Passaic plant

D—Drawing control and blueprint section of Department 988 at Point Breeze, Baltimore

E—Engineering section of Department 987 at Hawthorne

F—A corner of the laboratory of Department 987 in Hawthorne. Wiring samples are shown in this illustration being prepared for the Western Electric Company

El Company the corrected drawings and specifications were justified.

Conditions were aggravated by the urgent drive for war production. It had become necessary for the Western Electric as a prime contractor to sub-contract many of the components of the apparatus they were making, and these sub-contractors had varied facilities and different techniques, and they offered many suggestions for changes in design, materials and construction.

Many times components arriving at the Western Electric plants were found to depart from the drawing to such an extent that, under ordinary conditions, they would have been returned or scrapped. On war production, however, the loss of time that this would entail could not be accepted. Unless the parts were actually defective, it was preferable to use them and to change other parts to conform to them. This required prompt action and a considerable amount of engineering and drafting. To handle such situations promptly, Laboratories' engineers at the manufacturing plant seemed called for.

The first step in this expedited program was the arrival in Hawthorne in May, 1941, of A. K. Bohren. He was to act as the Laboratories' consultant at the Western Electric plant for the production of the tank radio set. His work was to investigate difficulties at once as they arose and to take the necessary corrective steps on the spot.

In the months following Mr. Bohren's arrival at Hawthorne, many other engineers of the Laboratories' Commercial Products Development Department went to Hawthorne to follow through the manufacture of additional projects such as the Navy command set, the Mark 3 and Mark 4 radars and others. At first, these men worked individually, or with small groups of assistants and draftsmen, on their respective projects. The advantage of increased efficiency and effectiveness of a single coördinated department, however, was early recognized, and arrangements were made with the Western Electric Company to allot the Laboratories the space and facilities required for a Manufacturing Relations Department, which was the name given this new organization. In February, 1942, the Laboratories' engineers at Hawthorne were

Part of Department 987 *Hawthorne files showing Vandyke and tracing cabinets*

moved to a fifth floor location which was enclosed with a wire mesh partition. From this enclosure the group also came to be known as the "cage" organization, and this name was used for similar organizations in the other plants. This group was assigned Western Electric Department No. 987, and W. J. Adams was put in charge as Manufacturing Relations Engineer.

These first radio communication and radar war projects were designed by the Commercial Products Department, and the engineers originally sent to Hawthorne to follow production were all from this group. As the number of this type of war projects increased, however, other Laboratories departments found it desirable to establish their representatives in the various manufacturing locations. Equipment Development, for example, which initially had a group at Hawthorne associated with Department 987, later established groups at a number of other locations, including Point Breeze and the New York area.

As project after project arrived, the demands on the cage organization grew rap-

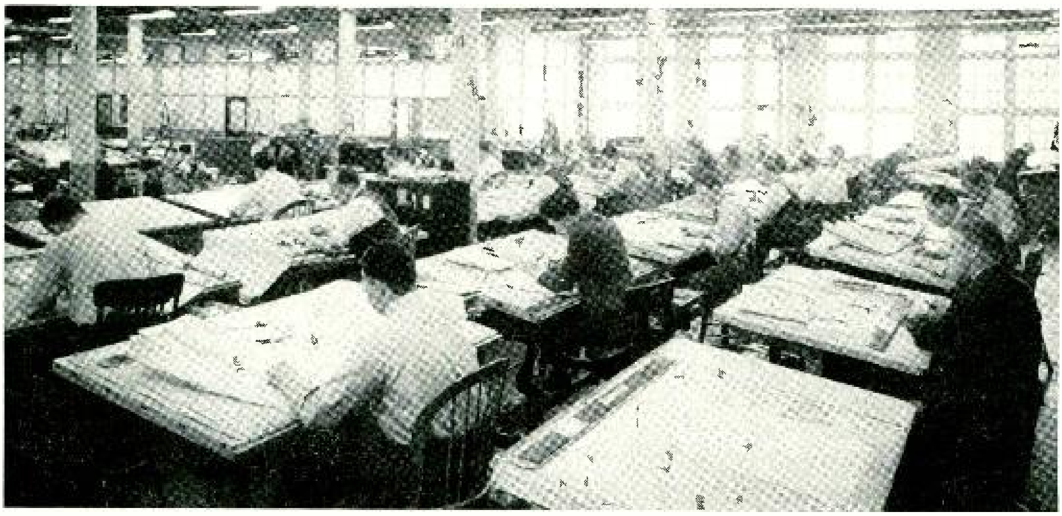
Department 988—*Engineers at Point Breeze*

idly. Since it was not possible to take the needed personnel from their design work at the Laboratories, the Western Electric Company assigned men of their Engineering, Drafting and Service Departments to Department 987, and quite a few of these men were temporarily sent to New York or Whippany to help the design engineers.

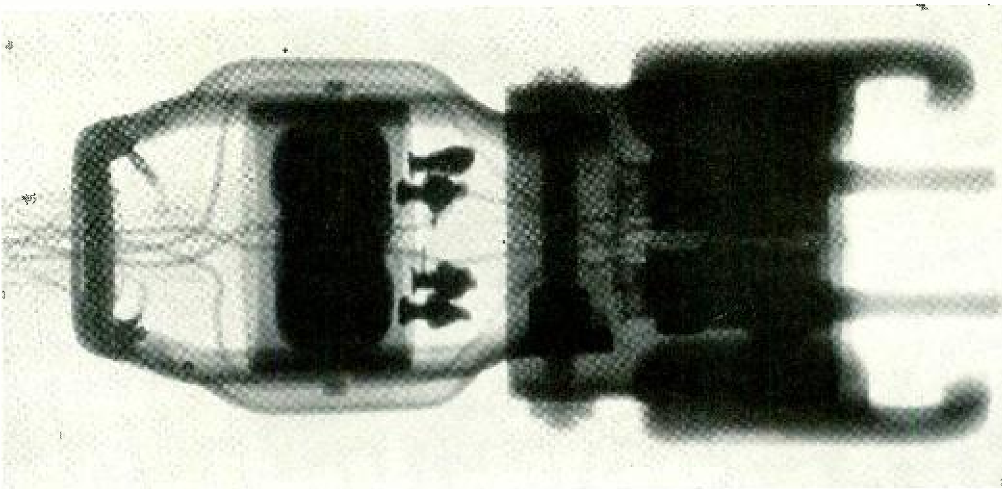
At the peak of war production, Manufacturing Relations organizations operated cage groups in some dozen Western Electric plants, and were furnishing expedited services to over 150 projects. The groups varied considerably in size and included total personnel in excess of 400. From its small beginning, these groups distributed more than 10,500,000 blueprints. An average monthly load involved originating about 1,600 change orders and instituting changes on 8,400 tracings.

Besides transmitting design changes to Western Electric, they made the necessary revisions in drawings and specifications, and issued the required change orders and blueprint reproductions to the Western Electric project engineers and other interested parties such as patent departments, radio sales, Laboratories instruction manual personnel, the proper Armed Services laboratories and others. They also interpreted and kept in touch with all electrical tests, kept spare parts lists up-to-date and co-operated with the Armed Services and other authorized agencies in providing and maintaining standardization. Their close contact with practically all war projects put them in a favorable position to appreciate the advantages of standardization, both in reducing and simplifying manufacturing stocks and in reducing the number of items carried as spares by the Armed Forces.

THE AUTHOR: FRANCIS G. VARENHORST joined the Illinois Bell Telephone Company in 1927 after receiving the Associate in Arts Certificate from Crane Junior College. He continued his college studies evenings while working, and received the B.S. in E.E. degree from the Illinois Institute of Technology in 1931. He continued working on all phases of inside and outside telephone maintenance work until 1943, when he was loaned to the Manufacturing Relations group of the Commercial Products Development Department for the duration. During 1942 and 1943, however, he was also in the employ of the State of Illinois Department of Labor doing vocational training work for war production workers, and was also on the War Training Staff of the Illinois Institute of Technology instructing Industrial Management. At present he is in the Switching Development Department of the Laboratories.



Part of drafting group of Department 982 *at Passaic*



Loading the Spiral-4 for War

By J. E. RANGES
Transmission Apparatus Development

SPIRAL-4 cable,* as designed for Army field communications, provides three voice channels and four full duplex telegraph channels over a four-conductor rubber-insulated cable. It comes in quarter-mile lengths with coupling units at each end to permit successive lengths to be rapidly and securely coupled together. Each of the coupling units incorporates one loading coil; one pair of conductors was loaded at one end and the other at the other end of the quarter-mile section. Each pair was thus loaded at quarter-mile intervals. Loading permits the portable carrier repeater stations to be located at least twice as far apart as would be feasible if the same type of cable were without loading. Also, it approximately doubles the talking range when the spiral-4 cable is used for voice telephony without repeaters. The loading coil is thus an important element of the spiral-4 carrier system, yet it is so small and so well concealed within the connector that its presence would hardly be suspected. This was the first American application of a magnetic core loading coil to a carrier cable transmission system.

Two of the connectors ready to be joined together, and then coupled as they appear every quarter mile along the line of communication, are shown in Figure 2. How the loading coil is located in the coupling unit may be seen in the X-ray photograph of one of the coupling units shown in the photograph at the head of this article. The paths of the Spiral-4 conductors are clearly evident. One pair is connected through the line windings of the loading coil to the re-

*Record, *April*, 1943, *page* 251; *December*, 1943, *page* 168.

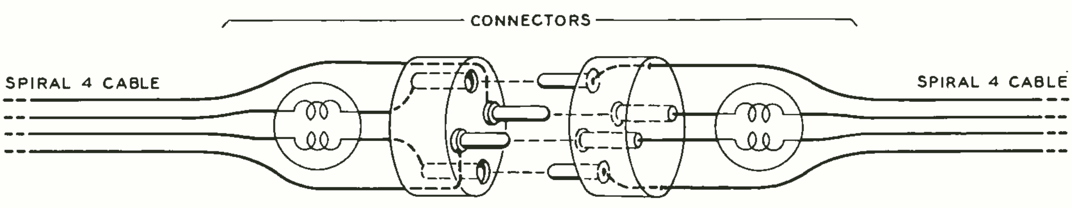


Fig. 1—Schematic of coupling unit showing internal connections

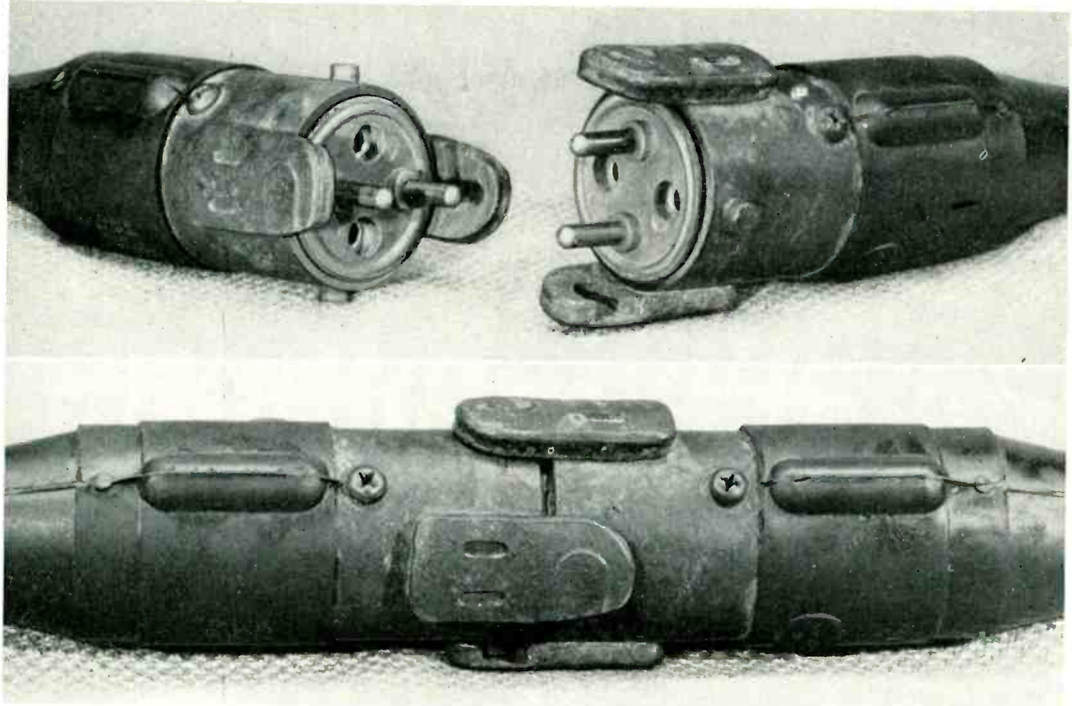


Fig. 2—Connectors for loading spiral-4 cable

cessed or jack terminals of the connector. The other pair separates as it enters the connector, going around the outside of the coil and connecting to the two projecting or plug terminals as shown in Figure 1. With this arrangement, no distinction need be made between the two ends of a quarter-mile section of cable. At each junction there will always be one loading coil in each pair.

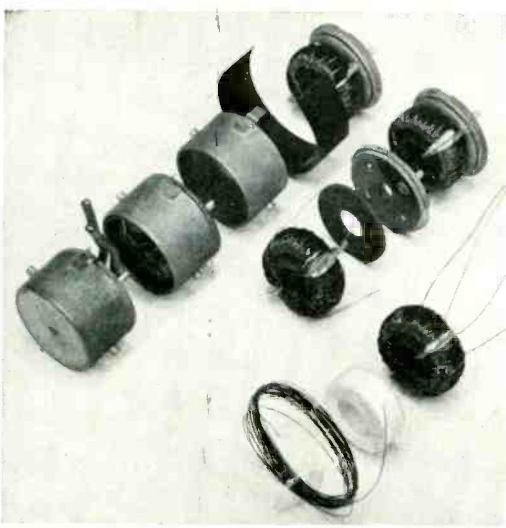


Fig. 3—Components of a coupling unit: wire, core, and wound core in lower row; steps in fastening coil to terminal plate in middle row; final assembly operations in upper row

The loading coil assembly is held in the connector by a steel yoke with two small holes in it to receive two projecting pins on the coil assembly, as shown in the X-ray photograph. The yoke in turn is secured by a through bolt to a steel collar carrying the lugs that lock the two connectors together. It also has two raised flanges, visible in photograph, to protect the two conductors that pass outside the loading coil. Another function of the yoke is to anchor the steel braid of the cable, thus taking the strain off the copper conductors and connections. A tough rubber jacket is molded around the assembly, in order to make the parts impervious to water.

Throughout the design of the connectors, considerable emphasis was placed on ruggedness. In modern mobile warfare, communication lines must be quickly established without too much regard to permanency. The cables may be laid on the ground, strung along fences, or hung from poles or trees. Such conditions require that the cable and connector be designed to withstand large tensile and compressive stresses.

The parts of the loading coil assembly, and the sequence of assembly operations, are shown in Figure 3. At the lower left is the copper wire with its heavy enamel coating. Immediately to the right is the toroidal core of compressed powdered molybdenum permalloy, also heavily enamelled for insulating purposes, on which the wire is wound. Two separate windings, each occupying half of the core, are applied by a high speed machine, resulting in the coil shown at the lower right. Immediately above it is the same coil with the lead wires trimmed and tinned ready for assembly to the phenol-fiber terminal plate. A soft synthetic washer is interposed between the coil and terminal plate as a cushion against damage to the wire during subsequent operations of sealing the coil in a rubber compound. The coil fastened to the terminal plate is shown in the illustration at the right of the middle row.

The final assembly operations are shown in the upper row from right to left. A strip of hard rubber lines the steel shell to insulate the windings. This shell is brass plated to insure good bonding with the rubber sheath with which the assembly is finally surrounded. The two diametrically opposite projections on the shell are those previously mentioned that engage the holes in the steel yoke. An important function of the steel shell is to reinforce the coil so that it will withstand the compressive stresses to which it would be inevitably subjected in service. After all parts are assembled, the shell is filled with a rubber compound under pressure, which completely surrounds the coil and seals it against water.

The extent to which the Spiral-4 system was used in World War II can be judged from the fact that over one and three-quarter million coils were manufactured by the Western Electric Company.

THE AUTHOR: J. E. RANGES entered the Physical Laboratory of the Western Electric Company as a technical assistant in 1913, and in the course of a few years became associated with the development of telephone cords, switchboard wire, and cable. During World War I he served in France with the Research and Inspection Division of the Signal Corps for some two years. In 1919 he again took up his work on telephone cords and wires, but two years later transferred to the design of loading coil cases and condensers. During World War II, in addition to developing loading coils such as those for the spiral-4 cable, he undertook the mechanical design of pulsing networks for radar systems.

Coaxial Cable in Regular Use by Television Broadcasters

The A T & T's coaxial cable between New York and Washington, which was made available for the experimental transmission of television last February, had been used on some sixty separate occasions as of August 15.

Now in service on an experimental basis in either direction, the cable is available to any persons equipped with suitable facilities for the transmission and reception of television. At present, those participating in such activities are the Columbia Broadcasting System, Inc., Allen B. DuMont Laboratories, Inc., and the National Broadcasting Company, Inc. Du Mont has a regularly scheduled program from New York on three evenings a week, and NBC also has a regular program on two evenings during the week and every third Sunday.

The New York-Washington cable is the first step toward nation-wide Bell System television network service which ultimately may be provided over coaxial cable, radio relay, or a combination of both.

Electrical and Mechanical Analogies

By E. B. FERRELL
Switching Research

DURING the early war years, engineers of Bell Laboratories were faced with a set of new problems whose quick and satisfactory solution was most important. Normally, as communications engineers, they had dealt with current and inductance and band width and distortion. Suddenly they found themselves worrying about velocity and mass and lag and error. Instead of the problems of speech transmission, they had the problems of gun-pointing and bomb-sighting. Different quantities, different units, different equations, different methods of analysis and investigation. Or are they?

An engineer with a tendency to personify the things he works with may think of a voltage as a man with a ramrod trying to stuff charge into a condenser or to push current through a wire. The wire, particularly if it is wrapped on an iron core to form an inductance, opposes any change in the current through it. The rate of change of current in the wire is proportional to the voltage applied and inversely proportional to the opposing inductance.

In exactly the same way, a mechanical force can be thought of as a man pushing on things and trying to change their position or velocity. A massive object opposes any change in its velocity. The change in velocity that does occur, that is the acceleration, is proportional to the force and inversely proportional to the opposing mass. These are the same relationships as for voltage, inductance, and change in current. The picture of a driver and an opposer are the same. The mechanical equations which say that the immediate result is proportional to the driver and inversely proportional to the opposition have exactly the same form. Since such analogies are found to exist between all the electrical and mechanical properties, the communications engineer can solve these mechanical problems by his old familiar methods if he just has a word list or dictionary of the new terms he must use.

Such a word list is given below. It shows some of the quantities the communications engineer works with and the analogous quantities of mechanical engineering arranged to indicate the relations among them.

		1 *Net Accomplishment*	2 *Drivers*	3 *Results*	4 *Opposers*	5 *Giver-uppers*
STATIC	*Elect.*	Pot. Energy	E.M.F.	Charge	Elastance	Capacitance
	Mech.	Pot. Energy	Force	Distance	Stiffness	Compliance
	Rot.	Pot. Energy	Torque	Angular Displacement	Torsional Stiffness	Torsional Compliance
DYNAMIC	*Elect.*	Power	E.M.F.	Current	Resistance	Conductance
	Mech.	Power	Force	Velocity	Viscous Friction	——
	Rot.	Power	Torque	Angular Velocity	——	——
KINETIC	*Elect.*	Kin. Energy	Magnetic Flux	Current	Inductance Permeance	Reluctance
	Mech.	Kin. Energy	Momentum Impulse	Velocity	Mass	——
	Rot.	Kin. Energy	Angular Momentum	Angular Velocity	Moment of Inertia	——

There are three main divisions: static, dynamic, and kinetic. Within each division is a line for electrical quantities, another for linear mechanical quantities, and a third for rotational mechanical quantities. For further clarification, the quantities are divided into five vertical columns. The relations among the five quantities in any one line are exactly the same as those among the five quantities that are given in any of the other eight lines.

In each line, the things we visualize as drivers are in the second column. The immediate results are in the third column. The opposers are in the fourth column. The giver-uppers, or conformers, are in the fifth. The ultimate net accomplishments are in the first. From the mathematical point of view, the first column divided by the second gives the third. The second column divided by the third gives the fourth. Unity divided by the fourth gives the fifth.

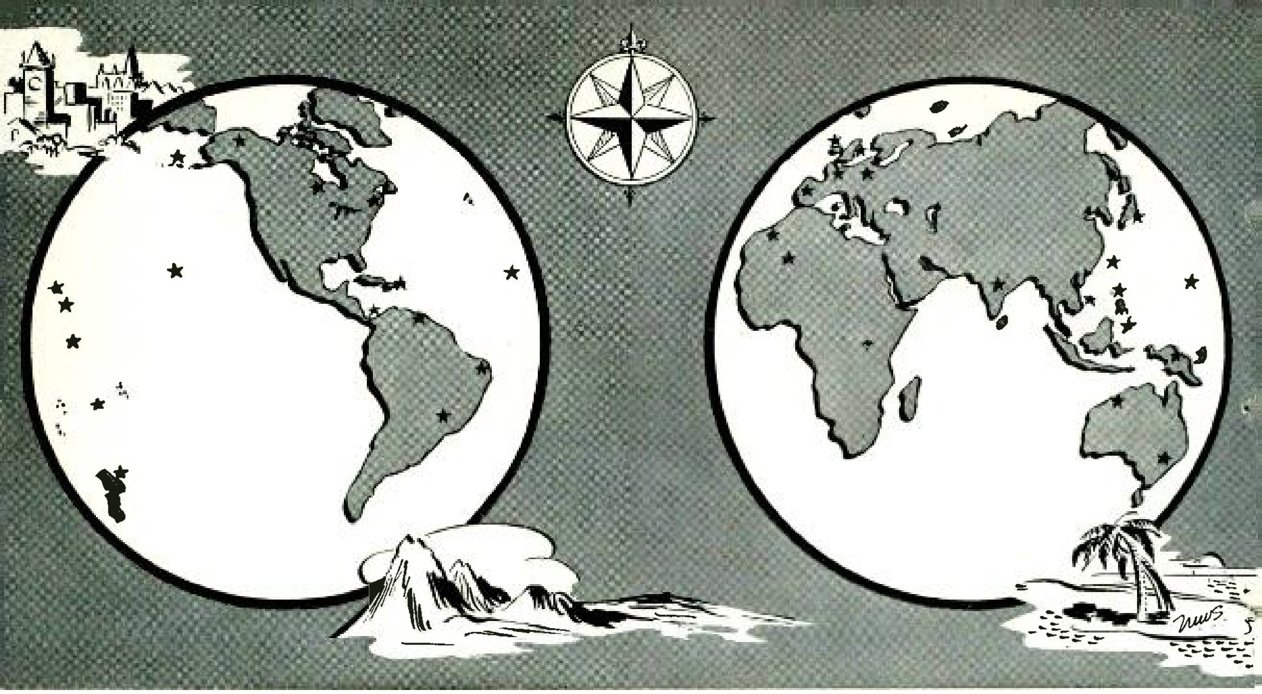
The relations among the electrical quantities on one column are the same as the relations among the mechanical quantities in the same column. Current, for example, is charge divided by time; and velocity is distance divided by time. Again, momentum or impulse is the product of force and time; and magnetic flux is the product of voltage and time. Some positions in the chart are left blank because there is at present no common name for those particular quantities.

This method of analysis by analogy has a very broad field of application. It has been used with success in the design of recording and loud-speaking systems, in the design of relays, and in the attack on other problems. Perhaps the most striking example is the wartime use of this method by the communications engineer to solve problems involving servo-mechanisms. With these devices, the actual position or velocity of a turret radar antenna is compared with the desired position or velocity, and the difference between them, or the error, is amplified and used to correct the actual position or velocity. The communications engineer sees in this the perfect analog of a negative feedback amplifier. The position of a hand wheel is the input. The position of the antenna that it controls is the output. The mechanical engineer calls any failure of the antenna to reproduce the motion of the hand wheel an error. The communications engineer recognizes it as distortion. If the antenna will not respond to changes fast enough, the mechanical engineer calls it lag, while the communications engineer considers it a failure to respond to high frequencies, and attributes it to insufficient band width.

By using the concepts, relations and methods of analysis that had been developed by the Laboratories for use in the design of feedback amplifiers, its engineers very quickly designed the servos needed in gun directors, radars and sonars, and achieved servo performance rarely achieved before.

THE AUTHOR: E. B. FERRELL received the B.A. degree in 1920, and the following year, the B.S. degree in Electrical Engineering from Oklahoma University. After three years as instructor in Mathematics there, he received the M.A. degree. He then joined the Research Department of the Laboratories, where, until 1937, he was concerned in short-

wave radio investigation. Since then, in the Switching Development Department, he has been engaged in the development of glass-sealed relays. During World War II he was intimately connected with the Laboratories' work on servo-mechanisms and automatic radar tracking systems.



Representing the Laboratories at the Front*

By C. B. BARNARD, JR.

Publication Department

SOME wartime projects are still so secret that Laboratories men don't mention them to each other. Jobs for the Navy in this category took Laboratories men across a couple of oceans. Since no other information has been released, this has to be a straight chronicle of names, places, and dates. H. C. Rubly and F. R. Dennis took part in an operation based in Trinidad between January and March, 1943. Dennis then crossed the Atlantic to England in May, 1943, returning in August, and in February and March, 1944, he crossed the Atlantic again on the escort carrier *Guadalcanal.* A. F. Bennett also visited England in July and August, 1943. W. H. Scheer toured England, Scotland, Ireland, and Iceland during the same months. C. F. Wiebusch was in Newfoundland in July, 1943, and in Hawaii in July and August, 1944, with P. W. Wadsworth, and again in Hawaii but without Wadsworth from January to May, 1945. H. J. Michael joined him in March, returning home in May also. M. S. Richardson and T. C. Henneberger spent the months of June to August, 1945, in this same bright land of poi and beach boys. H. N. Wagar journeyed to Nova Scotia in September, 1944. Wagar was conducting experiments for the Naval Ordnance Laboratory, and Wadsworth and Wiebusch, during their Hawaiian trip together, were attached to Comsubpac.

ANOTHER Navy project still obscured by security regulations was a very high-frequency communications program which took C. C. Munro to Hawaii, where he stayed from November, 1942, until August, 1943, to direct installation of the equipment and to train operators. He also engineered an addition to the large-scale station already planned. In September, 1942, S. B. Wright went to Panama as a confidential advisor to the Navy for surveys aimed at setting up a similar installation there, and in November he continued on to Trinidad on the same job, returning to the States in December. L. E. Melhuish worked in Panama from October, 1943, to April, 1944, supervising installation of some of the equipment.

WHILE on the subject of somewhat confidential matters, trips taken by two Laboratories men to the Pacific might well be mentioned. The NDRC had or-

*Concluded from September RECORD.

ganized a group of field engineers to assist the Navy in the use of anti-submarine warfare devices and underwater sound devices on American submarines. J. W. Kennard, on leave from the Laboratories as director of this group, visited a number of naval bases in the Pacific from April to June, 1944. He spent a month at Pearl Harbor, went on to Perth and Brisbane in Australia, New Guinea, and the Marshall Islands. Purpose of the trip was to determine at what locations field engineers would be useful. V. H. Baillard was in Hawaii from August, 1944, to March, 1945, assigned to Comsubpac as a representative in the Pearl Harbor subdivision of the Underwater Sound Laboratory. He worked with underwater sound systems primarily to insure their operation on submarines at sea, and trained submarine crews in their use.

AMERICAN scientific missions, liberally sprinkled with members of the Laboratories, visited Europe and Japan close behind the victorious troops to examine enemy technical developments. First Laboratories man to jump off in pursuit of our Germany-bound armies was Dr. Clarence N. Hickman, noted rocket researcher, who landed at Normandy on D-Day-plus-a-few-more and jeeped with the liberation into Paris, which he used as his headquarters for an investigation of German V-weapons. A trip to the launching sites on the Channel Coast a few weeks later netted a report which both American and British military authorities hailed as the complete and definitive study on the subject of V-1 launching.

THREE members of the Laboratories, R. B. Klyce, Pierre Mertz, and J. R. Townsend, toured Germany itself, studying factories, installations, and laboratories, and quizzing German scientists. Klyce was in Germany from May to August, 1945, at the behest of the U. S. Strategic Air Forces on the trail of radar developments which might be useful in the war against Japan. But, he reports, the Germans were generally some three or four years behind Allied developments in this field, and aside from a few odds and ends of structural arrangement, their studies were of no importance.

Mertz and Townsend visited Germany from June to August, 1945, as representatives of the Technical Industrial Intelligence Committee of the Foreign Economic Administration. Mertz studied techniques in German communications developed during and before the war, giving particular attention to broad-band communications. Townsend investigated new materials and processes, covering a variety of such things as selenium and silicon rectifiers, methods of activating screens for television and infrared work, thermistor and varistor developments, vacuum tubes, insulation for wire and cable, die-casting methods, magnetic materials and manufacture of telephone apparatus. The two sent home equipment and information which may be of outstanding importance to developments in this country, including machinery for making vacuum tubes and for die-casting, and methods for vapor-phase deposition of zinc on paper to be used in building capacitors.

JAPAN also was the target for scientific investigation by three men from the Laboratories, R. I. Wilkinson, G. W. Elmen, and R. M. Bozorth. Wilkinson's arrival in Japan was something of a personal triumph. He had been attached to our Air Forces in the Pacific as an operations analyst since the almost forgotten days of the Solomons campaign.

Wilkinson arrived in the New Hebrides as a member of the 13th Air Force Staff in October, 1943. A few months later he moved to Guadalcanal, commuting between that famous base and Munda in the Central Solomons while working on the air attack that reduced Rabaul to charred rubbish. Eventually he was sent to Emirau at the northern tip of the New Britain archipelago and in June, 1944, to Nadzab, New Guinea, where he joined the staff of the 5th Air Force. His successive jumps from there sound like a record of the advance in the Southwest Pacific. He went first to Owe and Biak with the 5th, rejoined the 13th at Noemfoor as head of its operational analysis section, then on to Morotai, and Leyte. During all this period his special problems included radar bombing, IFF, and ground-controlled interception by our night fighters of Japanese bombers. He joined the Far Eastern Air Force staff in Manila to work on radar plans for the invasion of Kyushu, and at the end of the war set out for Japan with the advanced echelon of the Far Eastern Air Force. He arrived in Tokyo in September, 1945, heading a group which surveyed all Japanese army and navy radar. When he returned to the States in November, 1945, he had completed a continuous 26-month tour of duty overseas.

MAGNETIC materials were the particular concern of Elmen and Bozorth on a mission sent to Japan by the Naval Ordnance Laboratory. Elmen, who invented permalloy while at Bell Laboratories, joined the NOL upon his retirement in 1942. Bozorth accompanied the mission as a representative of Bell Laboratories. The mission spent the months of November and December, 1945, in Japan, making its headquarters in Tokyo and visiting manufacturing plants, research institutions and university research centers throughout the islands. Of special interest was the Japanese attempt to substitute aluminum and silicon for scarce nickel and cobalt in magnetic alloys. Very little of the data obtained has been made public.

NOTHING has yet been said of the Laboratories men through whose work in overseas areas Bell System radar equipments were steered successfully into combat. John Mallett and E. H. Sharkey were the first off the starting blocks. In July, 1943, Mallett went to the Alaskan theater of operations, where he worked with a new, now-famous airborne search radar, the SCR 717. Mallett returned to the States in November.

V. H. Baillard

A month before Mallett departed for the Northland, Sharkey had begun the long journey to Guadalcanal with a very hush-hush organization, generally referred to as "Colonel Wright's mission." Col. Stuart P. Wright's mission was to take into action against the enemy the first squadron of Air Force bombers equipped with radar bombsights. The sight itself was an anti-shipping sight, used in conjunction with the SCR 717 mentioned above. Sharkey served as a technical representative, conducting maintenance and operations training, making field modifications, and sending information back to the States for use in factory modifications.

Sharkey returned home in December, 1943, but he was out in the Pacific again from June to August, 1945, this time on Guam as an expert consultant from the Air Force's Office of Air Communications assigned to headquarters of the 315th Wing of B-29's. His particular problem on this mission was one of the last and best radar sights developed by the Laboratories, and he was concerned with operations matters such as operator training, briefing, intelligence, and photo-analysis.

THERE were so many Laboratories people on Guam at one time or another that they might have opened a western Pacific branch. K. E. Gould, who had been project engineer on the sight that played the major rôle in B-29 radar bombing of Japan, was called to the Marianas in February, 1945, as an expert consultant for the Office of the Secretary of War. He served as radar advisor on the staff of General LeMay's Japan-smashing Twenty-first Bomber Command, returning to the States in June, 1945, to take another assignment involving B-29 radar training.

J. W. Geils and D. S. Barlow arrived in Guam in July, 1945, as consultants to advise and instruct on installation, maintenance, and use of an important modification of the B-29 set which made it an even more precise and effective instrument. The two assisted in mission planning and target selection, and gave instructional lectures to operators and installation and maintenance workers.

The war ended while L. W. Morrison was en route to Guam to take over direction of all radar activities of the by now exclusively radar-aimed strategic bombing of Japan by the 20th Air Force. His job would have been to coördinate all radar bombing by the Air Force's five wings, to train personnel in radar operational techniques and the philosophy of this kind of bombing, and to advise on methods of attack from the radar standpoint. He stayed in Guam for a while devising a training program that would hold B-29 groups in shape during the first uneasy months after the Japanese surrender.

THE B-29 saga should include the record of William Shockley's round-the-world trip. Shockley had already visited San Juan, Puerto Rico, in July, 1942, England and Scotland from November, 1942, to March, 1943, and Cuba later in the year as Director of Research of the Anti-Submarine Warfare Operations Research Group. In January, 1944, he took a new position with the War Department in which he was concerned principally with problems relating to the use of radar by B-29's. Starting in September of that year he began a tour of B-29 bases overseas, going by way of England and Italy, and visiting American and British radar bombing establishments en route. After six weeks at the B-29 base in India, he proceeded via Australia to 21st Bomber Command headquarters in the Marianas, then across the Pacific to the United States, where he arrived in January, 1945.

Also in the Marianas, among other places, was W. F. Miller, who was on loan to Western Electric as a field engineer for a searchlight control radar, and a portable early-warning radar on which he had worked in the Laboratories. Miller began his hitch at Pearl Harbor in February, 1945, toured through Saipan, Tinian, and Guam, and wound up with the end of the war on Okinawa.

J. W. Geils

THE European theater, too, saw its radar experts from the Laboratories. W. L. Cowperthwait visited England from May to July, 1944, at the request of the British Air Commission in Washington, D. C., to engineer changes in the night-fighter radar which was used by both the RAF and our own Air Forces. It was necessary to modify this set so that the Royal Air Force could use it for night intruder work in enemy territory and also for night interception.

Three more Laboratories men went to the European theater in connection with specific radar equipments. J. P. Radcliff served with the Ninth Air Force Service Command from July to October, 1944, in southern England and France, where he condensed the maintenance book and trained service teams in maintaining the portable, early-warning radar mentioned in connection with Miller. F. C. Willis spent from October to December, 1944, in England to advise the British on installation, maintenance, and operation of a Navy model airborne radar which was to be used by carrier-based planes for search, and by RAF Mosquitoes for intruder work. R. J. Shank was in England from March through May, 1945. Through a rather involved chain of transfers and attachments which included Western Electric, the Radiation Laboratories, and the radar division of the operations staff of the Eighth Air Force, Shank acted as technical advisor on tactical use of one of the late model radar bombsights mentioned above, and assisted in the training program.

THERE seems no end to the varieties of jobs that could be found for the special talents of Laboratories men. L. A. Yost, as a member of an NDRC survey group, was present on the shakedown cruise of the heavy cruiser U.S.S. *Canberra,* which lasted from December 4 to December 28, 1944, and was conducted at Trinidad. The survey made during this cruise served as the basis for a report to the Commander in Chief, United States Fleet, regarding communications facilities and equipment of Navy Combat Information Centers. L. B. Cook also voyaged to Trinidad aboard the aircraft carrier *Antietam* in July, 1945, to study the effectiveness in actual service of the battle-announcing system which the Laboratories had designed.

S. Darlington, on leave from the Laboratories to the Office of Field Service of the OSRD, as a theoretician, went overseas to General MacArthur's command in New Guinea and the Philippines, leaving the States in August, 1944, and returning in April, 1945. During his stay in the Southwest Pacific, he prepared statistical reports and analyzed problems involving tactical use of anti-aircraft artillery.

Also with General MacArthur's command, W. C. Babcock was in Australia and New Guinea from April to September, 1944, where he was attached to the NDRC as an advisor on propagation of radio waves.

On the cold-weather side was the experience of A. C. Peterson, Jr., who served as a technical consultant for the NDRC attached to the Radiation Laboratories. Peterson took a trip to the Aleutians and the Bering Sea, visiting St. Mathews Island in the Pribilofs among other places as a member of a committee to select transmitter sites for Loran, the new, long-range, radio-navigation equipment. Loran networks now cover both Pacific and Atlantic Oceans.

PROBABLY the longest and most complicated overseas address was that of M. E. Campbell and W. E. Evans, Jr., who has already been mentioned in connection with the communications men. Campbell worked from July to December, 1943, in radio counter-measures with the Telecommunications Research Establishment of the RAF in England. In December, Evans came over to take his place and stayed until V-E Day. Campbell returned in March, 1944, and stayed until June. By the time Evans arrived, the American part of the project was operating under a new organization whose identity and location can be succinctly described as the American-British Laboratory, a field branch of Harvard University's Radio Research Laboratory, using some of the facilities of the Telecommunications Research Establishment with headquarters in England.

Radio counter-measure work had its uses in more theaters of war than the Western European. Between May, 1944, when he left the States, and September, 1944, when he returned, R. L. Robbins jeeped 2,500 miles over most of the Italian boot in counter-measure activities. His motor trips included Taranto and Brindizi in the heel of the boot, took him up the Via Casilina to Rome and the Via Appia almost to the fighting front near Leghorn, then down the coastline through Rome again, Anzio, the Pontine marshes, Naples, and Caserta.

Several more Laboratories people were engaged in counter-measure work in the Pacific. H. H. Benning shuttled between Australia and New Guinea from December, 1943, to March, 1944, as an observer for the Office of Air Communications. He returned to the Pacific war again in May, 1945, stopping first at Pearl Harbor, then on to Guam and finally to Manila.

M. C. Francis also visited Pearl Harbor and Guam in counter-measure activities as a technical observer for the Office of Field Services of the NDRC. He was overseas from April to September, 1945.

AS EVERY story must sooner or later in these times, this one now gets around to mention of the atomic bomb project. J. B. Fisk visited North Africa and Italy from December, 1943, to February, 1944, on a special mission for the Office of Scientific Research and Development in behalf of the Manhattan District Project, the exact nature of which has not been disclosed.

Mr. Barnard, a former newspaperman, was a member of the Laboratories from August 6, 1945, to July 28, 1946, when he resigned to explore his capabilities as a fiction writer.

Left—The Fastax camera is demonstrated to General Eisenhower by Major Thomas. Right—J. H. Waddell explains the camera to General Ramey (center) and Lt. Col. Cunningham

Waddell at Bikini

JUST as the atom bomb was ready to drop over Bikini, J. H. Waddell* of the Laboratories was standing on the top deck of the U.S.S. *Haven* with his back to the blast and goggles on, as ordered. Over the PA system the seconds were being clocked off. Finally the order "Bombs away" resounded over the ship.

"The longest forty seconds of my life began then," Waddell relates. "There was the awful fear of not knowing what to expect. My pulse must have jumped to 200. Then a flash of heat struck my back—the bomb had landed. I reeled around to see an infinitesimal red cloud emerge from a great commotion on the water and start on its angry path to the sky. Black clouds of smoke arose from the target ships just over the horizon."

As the cloud changed from purplish pink to creamy yellow, Waddell kept an eye on the C-54 and F-13 photo planes, circling in their orbits, and he wondered how the Fastax cameras were making out. The great cream puff was nearly a mile in diameter and had risen 30,000 feet into the air before a south wind cleared the center of the column and carried it to sea.

Meanwhile the *Haven*, a hospital ship, prepared to sail for Bikini and was the first large ship to enter the harbor that afternoon. Her passengers, excepting Waddell, were radiologists who had been sketching the cloud formations and dispersals during the three hours in which the show lasted. They were now preparing to study the effects of atomic energy on water, fish, plant life and ships.

The only technical representative with the AAF to witness either drop, Waddell had been directed to inspect camera installations, and in this connection landed on Bikini on the afternoon of "A" day. For the following two days Waddell acted as "communications officer" and armed with a walkie-talkie led a party on the inspection tour of the ships, eleven in all, including a battleship, cruiser, destroyer, submarine and merchantmen. The report on his findings and of tests made are, of course, secret.

Once back on Kwajalein he began to prepare the reports of findings. Two and a half months had elapsed since he had arrived there on April 29 by air from Roswell, N. M., where he had been processed for shipment overseas and given time to study the plans of operation of photographic planes. During his stay on Kwajalein he had shared a quonset hut with Howard Mangan, Western Electric representative and the advisor to the AAF on radar.

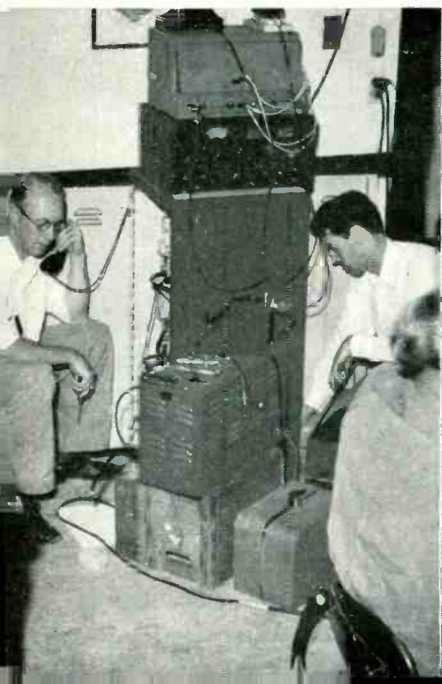
In addition to his duties as advisor on the Fastax, Waddell had ample opportunity to make humidity observations not only as to the behavior of the Fastax, but

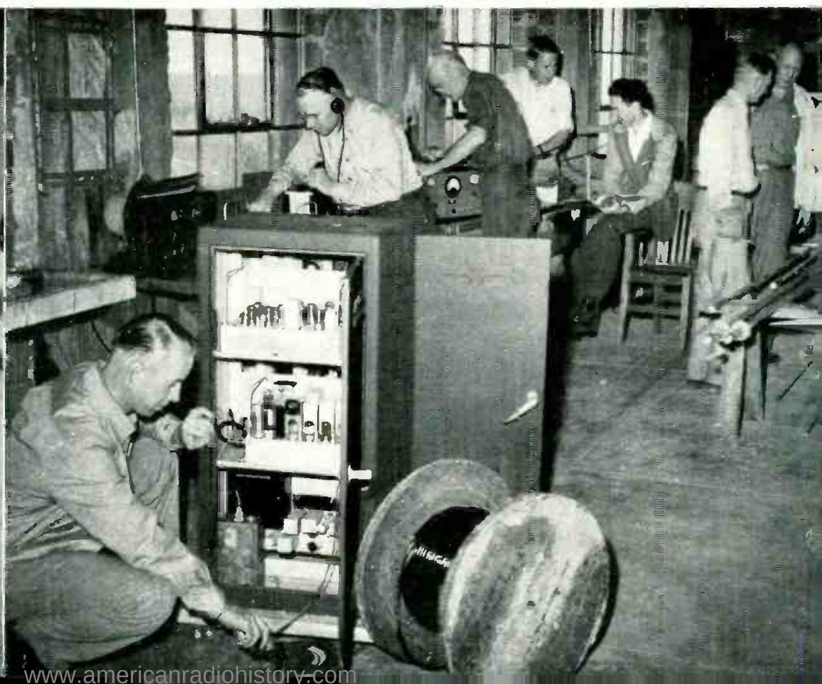
***Fastax at Bikini* on page 358 of this issue. Photos at top of page by Joint Task Force One.

Rural Radio for Isolated Ranch in Colorado

The antennas of the radio-telephone link at the home of L. E. Beck are shown at the upper left, and the equipment cabinet, installed in the basement of the house, is shown at the right with S. Duma

At the lower left, H. W. Nylund (left) and G. V. Lago are shown testing the equipment in the central office at Cheyenne Wells. In a manual training shop of the high school, lower right, engineers of the Mountain States Company and the Laboratories assembled the radio equipment. Laboratories men shown are H. W. Nylund, left; G. V. Lago, third from right; and S. B. Wright, project engineer, right





also as to the effect of corrosion and weathering on cameras of other manufacture. On "Baker Day plus 3" Waddell flew to San Francisco, arriving there on July 29. A diploma presented to him certifies to his having been at Bikini and to his being a member of the AAF organization, the *Exclusive Order of Guinea Pigs*. An ardent member of the Laboratories Stamp Club, he brought home the only two complete sets of Bikini covers in existence, having acquired them because it was at his suggestion that mail was carried on the bomber. The covers were on display in the Club Store.

Members of the Laboratories who wish to see his Kodachromes will have the opportunity when they are shown at the Laboratories Camera Club meeting in the West Street Auditorium at 6:00 p.m. on October 16 and at Murray Hill on October 23.

"The Telephone Hour"

NBC, Monday Nights, 9:00 p.m.

October 7	*Fritz Kreisler*
October 14	*Torsten Ralf*
October 21	*Helen Traubel*
October 28	*Myra Hess*
November 4	*Nelson Eddy*

Radio Links Eight Isolated Ranch Homes to Telephone Network

Rural radio-telephone service has become a reality for eight ranch families in a sparsely settled region of Eastern Colorado. On August 20, near the sun-baked ranch town of Cheyenne Wells, this service went into effect for the first time in world history.

The new service enables the eight families to reach any other telephone in the Bell System or in territory served by connecting companies. The inaugural followed several weeks of tests by engineers of The Mountain States Telephone and Telegraph Company and Bell Telephone Laboratories.* Service is being provided on an experimental basis but under regular commercial conditions.

The eight ranch families participating in the experiments live in widely separated locations, 11 to 21 miles from the Cheyenne Wells telephone central office that serves them. Out of reach of either telephone or power lines, the ranch families obtain the current needed to operate the radio-telephone equipment from their home electric plants.

Definition of Pulsing Terms

The Nomenclature Committee of the Laboratories has recommended the following terms for use on drawings and elsewhere:

Multifrequency Pulsing—A system of pulsing where the identity of digits is determined by two frequencies out of five. A combination of a sixth frequency is used to represent characters other than numerical digits.

Dial Pulsing—A system of d-c pulsing in which the digits are transmitted by the interruption of the d-c circuit a number of times, 1 to 10 corresponding to the digits 1 to 0.

The committee also recommended that the term "A-C Key Pulsing" be dropped.

*RECORD, *July*, 1946, *page* 269.

October Service Anniversaries of Members of the Laboratories

40 years
Claude Deyo
C. J. Kuhn

35 years
W. A. Boyd
J. W. Farrell
E. J. Johnson
S. B. Kent

30 years
C. C. Barber

25 years
M. L. Almquist
A. H. Falk
L. E. Gaige
H. A. Hay
W. H. T. Holden
Claude Kreisher
B. A. Nelsen
Norman Scribner

20 years
H. J. Camp
R. R. Cordell
L. R. Cox
C. C. Fleming
F. W. Horn
L. S. Inskip
W. T. Jervey
D. G. Neuman
Angel Roces
Edna Ruckner
C. W. Schramm
W. C. Toole

10 years
Steve Bodnovich
R. W. Bruckmann
J. M. Cullen
R. H. Griest
W. S. Irvine
John Rabbitt
Patrick Ronan
D. L. Viemeister

G. W. Atkins at the transmitter of a TE-1 radio television transmission system

Radio Television Demonstration in California

On August 21 and 22 models of the TE-1 radio television transmission equipment were demonstrated in Hollywood by G. W. Atkins, K. D. Smith, and J. J. Strodt to members of the telephone company and the I.R.E. on a circuit extending from Paramount Studios to the Hollywood central office by video wire circuits, thence to Mt. Wilson. On August 25, Mr. Atkins and G. R. Frantz set up a TE-1 circuit for a broadcast from Paramount's transmitter on the top of Mt. Wilson of the rodeo at the Hollywood Coliseum. A second broadcast from Paramount Studios was made by the same two engineers on August 30. Engineers from the Southern California Telephone Company assisted in setting up the equipment, shown in the three accompanying illustrations, and conducting the demonstrations. Mr. Smith and Mr. Strodt have returned to New York after extensive transmission tests of this equipment from Hollywood to Mt. Wilson, where permanent terminal equipment will be installed for connection to television broadcasting stations.

Birthday Greetings

Congratulations to our "esteemed contemporary," *Long Lines*, which in July celebrated its twenty-fifth anniversary. In the issue for that month, the Editors appropriately identify the magazine with the Long Lines organization by sketching briefly the growth of each department during the quarter century. The story on Plant brings in the names of many technical contributions by the Laboratories—TWX, Telephoto, Radio, No. 4 Toll System, Radio Relay, Cable Carrier, Coaxial. We quote:

Cable carrier systems are the order of the day, providing more than half of the ten million miles of telephone circuits. The number of telephone message circuits has grown from 4,000 in 1921, with an average length of 120 miles, to over 19,500, with an average length of some 500 miles. Central office equipment has changed in type as well as in quantity. Twenty-five years ago there were about 1,600 telephone repeaters, three telephone carrier systems and six telegraph carrier systems. Now we have 75,000 telephone repeaters, some 3,700 carrier telephone systems, including about 2,100 "EB" systems, and 400 carrier telegraph systems. . . .

Program transmission service, introduced in the early 1920's, consisted of one or two networks furnishing service to fifteen or twenty broadcasting stations. Today there are approximately five or six major networks, using about 100,000 miles of high-grade facilities, which have frequency connections to overseas points. A single network may connect as many as 200 broadcasting stations.

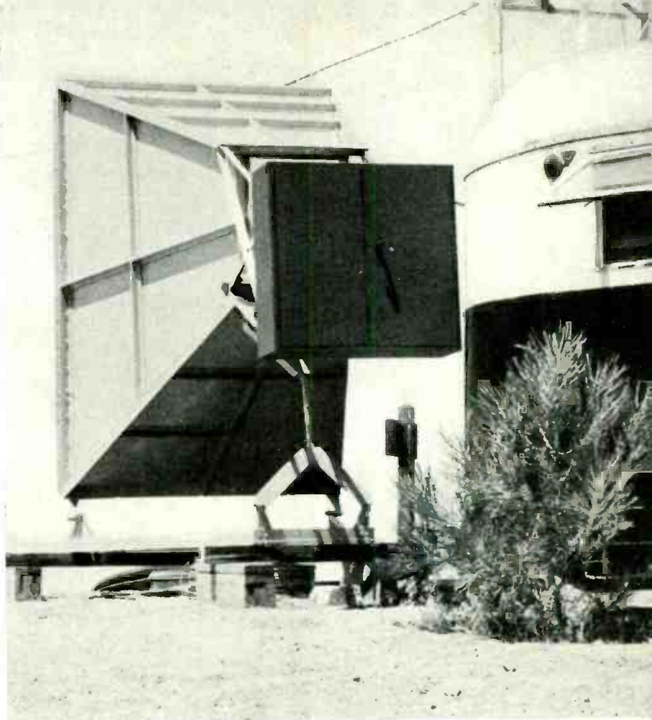
The transmission of pictures started in 1925; it now requires 20,000 miles of specially equipped telephotograph circuits. TWX service started in 1931; it now comprises 1,200,000 miles of TWX circuits. Private line telegraph service has increased from 500,000 miles to 1,500,000 circuit miles. Over 50 different countries or areas can now be reached by overseas or long-distance telephone.

Increasing complexity of the telephone plant is reflected in the company's investment per employee—$1,070 in 1921 and $2,380 in 1946.

Telephone Center for Armed Forces Closed

The public telephone center for the Armed Forces at Times Square and Forty-third Street, Manhattan, closed on August 31 at midnight. Largest of some six hundred attended telephone centers for servicemen and women throughout the country, the center had been visited by more than a million service personnel and had handled 565,000 calls to out-of-town points.

Radio lens receiving antenna on Mount Wilson used in radio television demonstrations between that point and Hollywood



Telephone Service to Belgium

Radio-telephone service between Belgium and this country was established on a direct basis on September 3, according to an announcement of the A T & T. Talks between government and telephone officials in Brussels, Washington, and New York marked the occasion.

This overseas service was resumed via London for public calling last July. Recently equipment shipped from this country was installed, enabling the service to be established from Brussels.

Recorded Voice Aids Customers

A magnetic wire recorder was employed in Philadelphia recently to intercept incorrectly dialed calls in connection with a change to a new system of dialing.

On the first day after the cutover, this 3A Announcing System handled 246,000 calls dialed in error, amounting to 9.9 per cent of the day's total of two and a half million. After two weeks, the number of incorrectly dialed calls dropped to 2.2 per cent.

In planning for the change from dialing codes consisting of three letters to the new codes made up of two letters and a figure, the Bell of Pennsylvania people knew that there were not enough operators nor positions to intercept the incorrectly dialed calls, so they turned to the announcing system, which proved to be ideal.

Two hundred trunk lines, connected to every dial office in Philadelphia, were routed to one centrally located machine. Within nine seconds after making an error in dialing, the customer heard this message: "Will you please hang up and dial the first two letters and five figures as shown in the directory? Thank you. This is a recorded message."

Bell System TWX Service

A review of the trends in TWX service over the past few years shows that Long Lines messages were averaging just over 400,000 a month in November, 1941. During the war, there was a period when the messages were double this November figure, and in the biggest month—March, 1944—messages totaled 890,000. Since the first of this year, TWX messages have been averaging about 536,000 a month.

Last month, the number of TWX stations was at an all-time high of approximately 17,260 stations.

In private line teletypewriter service, Long Lines' circuit mileage rose steadily from 548,000 miles in November, 1941, to a high of 1,334,000 miles in August, 1945. At the end of June the mileage had dropped to 1,226,000 miles.

K. D. Smith checks the radio television equipment on Mount Wilson

C. D. Hocker Goes to Union College

Testimonial dinner to C. D. Hocker, who has accepted an invitation to teach chemistry at Union College. Funmaking centered around a skit, "Heaven Helps Those ———," written by R. J. Nossaman which showed preparation of a pre-natal spec. for Dr. Hocker's life, and the latter realization, under the watchful eyes of "St. Peter" and "Gabriel." After-dinner speakers were O. E. Buckley, G. Q. Lumsden, S. C. Miller, R. A. Haislip and Dr. Hocker, with F. F. Farnsworth as Toastmaster.

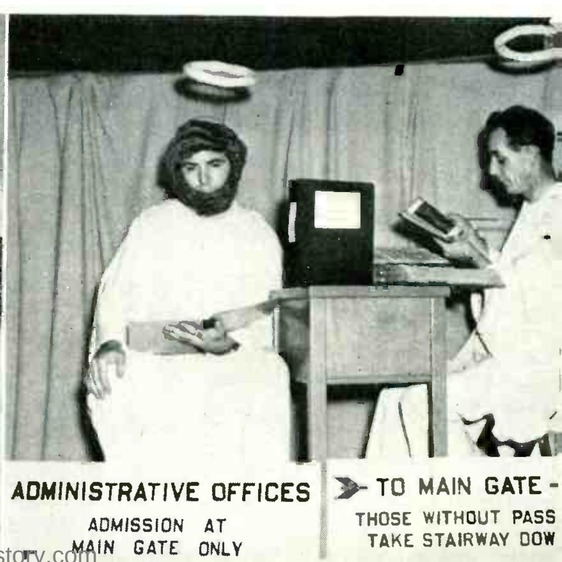
A—George Lumsden reviews Dr. Hocker's telephone career while the victim (extreme right) listens with incredulity. Others pictured are D. A. Quarles, O. E. Buckley and F. F. Farnsworth

B—Melody poured at intervals from Roy Jones, Obie Cook, Frank Livingston, Tom Durkin and Al Leyden

C—As a disc-jockey, Joe Harley was really a one-man orchestra for everyone's enjoyment

D—His first Outside Plant problem: "Dr. Hocker," played by Joe Brearley; "Stooge," by Obie Cook

E—Writing the spec. for Dr. Hocker's career: Jim Hays as "St. Pete"; Art Akehurst as "Gabe"



Pioneers' Fall Party

On Friday evening, November 1, Frank B. Jewett Chapter of the Telephone Pioneers will hold its biggest affair of the season—a dinner party at the Hotel Commodore. Before dinner there will be a reception, starting at about six-thirty; and after dinner there will be entertainment by a list of top-flight professional entertainers. Plans for the evening are being worked out by Chairman P. W. Spence and his fellow-members of the Pioneers' Entertainment Committee.

Full details of the evening's activities will be sent to all members of the chapter very shortly. In the meantime, set aside the date for the Pioneers!

Insurance by Payroll Deduction

The future—and by that we mean five, ten, twenty years from now—always gets a lot of thought in the Laboratories, for we expect Bell System apparatus to be in service for a long time. And the telephone companies, as soon as something is installed in their plant, begin to think about the day when it will have lived its life, and start to lay money away to retire it.

How smart, then, it is to think the same way about ourselves! Here is a young man who started to work for the Laboratories just before the war. He is now twenty-five years old. What shall he do to provide for the future?

Of course, there are certain things that are obvious. He will apply all his energy and skill to his work; he will get all the training he can; he will marry the right girl; live in a house he can afford. And he will make as much financial provision as he can against the certainties of old age and death, the hazards of sickness and disability. He will make these provisions for his wife, his children, his parents or other dependents—not forgetting himself. For a breadwinner can become disabled, and yet live for many years; and after the Benefit Fund and Social Security have done all they can for him, he will still have much less than he was earning.

Money is all that most of us can lay away for these emergencies. And while having money in the savings bank or in War Bonds is fine, after all, it is just the same number of dollars we put in, plus a little interest. But an insurance company will pay out the face value of a policy, even though only a single premium has been paid in.

So important is life insurance in nearly everyone's financial plans that the Laboratories long ago set up a payroll deduction plan for premiums, and arranged to have an expert regularly located here. Lloyd Bunting, our counsellor, with 18 years' experience in the Laboratories, is available to consult with you on your own insurance problems. His telephone numbers are at West Street, Ext. 264; at Graybar-Varick Bldg., Ext. 1426; and at Murray Hill, MH-347.

K. E. Gould Directs Research in Japan

K. E. Gould of the Transmission Development Department has been granted a military leave of absence to join the staff of the Supreme Commander for the Allied Powers in Japan. As Chief of the Research Branch, Dr. Gould is assistant to the Deputy Chief in charge of the Telegraph and Telephone Division. The objectives of the Research group he defined in a recent letter as twofold; first—to render assistance in raising the performance of the Japanese communications to a point where the Army of Occupation will be served satisfactorily; and second—to keep surveillance on Japanese research.

Early in 1941, when the Defense Program was getting under way at the Laboratories, Dr. Gould began research on the development of radar fire-control apparatus first for surface ships and later for airplanes. He was project engineer for a number of these systems until the middle of 1943, when he transferred his attention to radar bombing equipment for B-29's. In December, 1944, he was loaned to the Office of the Secretary of War, where he acted as expert consultant to the 20th Air Force. In this capacity he served as advisor on radar to General LeMay, Commanding General of the 21st Bomber Command, during much of the heavy bombing of Japan. From February through June, 1945, Dr. Gould was stationed in the Marianas, and then returned to this country for reassignment. He was preparing to return to the Pacific in a similar capacity with Gen-

Summit's "B" League Softball Champions was this team from Bell Telephone Laboratories at Murray Hill. Front row, left to right: J. Oestreicher, J. Pecca, C. Garcia, H. Bone, B. Gaughran and J. Takacs. Rear row: N. Pape, Manager; D. Scheiderman, D. Maccia, A. Koenig, M. Nielson and W. Whinn. Not present when the picture was taken were L. Osborn, G. Galbavy, M. Konash, J. Leutritz and W. L. Hawkins

eral Doolittle and the 8th Air Force at the time that Japan surrendered.

Earnings Questionnaire Being Sent to 125,000 Engineers

The earnings and economic status of professional engineers before, during and after the war is the subject of a survey being made coöperatively by six professional societies and the U. S. Department of Labor.

This is the first major survey of the economic status of engineers since 1935, when, at the request of the American Engineering Council, the Bureau of Labor Statistics reported for the years 1929 to 1934. The new survey will supply information for the years 1939, 1943 and 1946. The data are to be collected by means of mail questionnaires, which will be completely anonymous.

Questionnaires are being sent by the Bureau of Labor Statistics in coöperation with the National Roster of Scientific and Specialized Personnel of the U. S. Employment Service to a representative sample of the 200,000 engineers registered with the National Roster.

At the same time, to provide information for the professional societies on the economic status of their members, an identical questionnaire will be sent by the Bureau of Labor Statistics, in coöperation with the Engineer Survey Committee, a Sub-committee of the Committee on the Economic Status of the Engineer, Engineers' Joint Council, to approximately 90,000 members of A.S.C.E., A.I.M.M.E., A.S.M.E., A.I.E.E., A.I.C.E., and the National Society of Professional Engineers.

Thus, members of the Laboratories whose names appear on the National Roster and also on the membership lists of one or more of the engineering societies referred to above may receive two copies of the questionnaire.

Part-Time Post-Graduate Study Plan

Sixteen members of the Laboratories have availed themselves of the opportunity of doing post-graduate work under the Part-Time Post-Graduate Study Plan. Requirements under the Plan are that the candidates be members of the Laboratories for at least a year and hold a bachelor's degree in arts, science or engineering. It is also required that they discuss their enrollment with their immediate supervisors before submitting formal application and that they give consideration to the equivalent instruction available outside of working hours.

News Notes

Donald A. Quarles, director of apparatus development of Bell Telephone Laboratories, has accepted the invitation of Dr. Vannevar Bush, chairman of the Joint Research Board, to become a member of the Board's Committee on Electronics. Other civilian members of the Committee are Dr. J. A. Stratton of Massachusetts Institute of Technology and Professor W. B.

Everitt of University of Illinois. Three officers each from Army and Navy complete the Committee, whose mission is "the continuing study, evaluation, improvement and allocation of electronic research and development programs leading to the formulation of an integrated program in this field."

W. E. Campbell opened the Gibson Island Conference on High Temperature Corrosion, July 14-19, with a talk on *The Electrolytic Theory of Oxidation and Tarnish of Metals.* Mr. Campbell has also been elected chairman of the membership committee of the American Society for Lubrication Engineers.

A. C. Walker conferred at Framingham, Mass., on the raw material supply for the Western Electric synthetic crystal shop at Allentown, Pa.

H. Peters was elected chairman of the section of Sub-committee XI, D-11 of the A.S.T.M., on *Methods of Analysis Pertaining to the Determination of Sulfur in Rubber and Rubber-like Materials.*

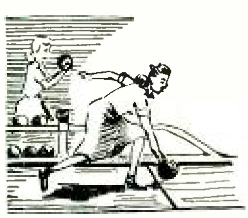
C. V. Lundberg discussed the manufacture of sponge-rubber ear caps at the B. F. Goodrich Co., Akron.

C. R. Steiner, S. H. Anderson and H. H. Cowen of Western Electric attended a Quality Survey conference on August 12 and 13 at Sprague Electric Company, North Adams, Mass. They attended a similar conference on August 18 and 19 at the P. R. Mallory Company, Indianapolis.

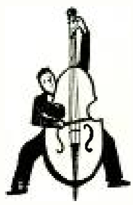
D. E. Cavenaugh conferred on power coils for microwave radio relay systems at the Power Equipment Company, Detroit.

H. H. Glenn, C. A. Webber and E. B. Wood conferred on cord manufacturing at Point Breeze.

Under the auspices of Bell Laboratories Club, the Women's Bowling League started off a new season with forty regular and fifteen substitute bowlers. The group meets at the West Fourteenth Street Alleys on Friday evenings from 6:00 to 8:30 p.m. The fee is ninety cents for the evening. New members will still be accepted as substitute bowlers. Annette Richter of 1217 Graybar-Varick, Ext. 1704, is Chairman of League.



Bell Laboratories Orchestra will open their musical season on Tuesday evening, October 15, at 6 o'clock, in the West Street Auditorium. Men and women who play orchestral instruments are invited to join the group for an evening of music enjoyment each week from 6:00 to 7:30 p.m. Bell Laboratories Club will supply such heavy instruments as the bass fiddle, 'cello and drums, as well as such unusual instruments as mellophones and "A" clarinets, which are available for use at rehearsals. W. A. Krueger on Extension 798, Room K-32, is now chairman of the executive committee and will welcome any inquiries you may have about the orchestra. L. E. Melhuish and J. C. Gabriel continue as conductor and concert master, respectively.



Papers presented by Laboratories members at the 31st meeting of the Acoustical Society of America have been published in the July, 1946, *Journal of the Acoustical Society of America.* R. K. Potter's *Introduction to Technical Discussions of Sound Portrayal,* the first paper in the issue, is followed by *Portrayal of Visible Speech* by J. C. Steinberg and N. R. French; *Sound Spectrograph,* by W. Koenig, H. K. Dunn and L. Y. Lacy; *Visible Speech Cathode-Ray Translator* by R. R. Riesz and L. Schott; *Visible Speech Translators With External Phosphors,* by Homer Dudley and O. O. Gruenz, Jr., and *Basic Phonetic Principles of Visible Speech* by G. A. Kopp and Harriet C. Green.

J. R. Weeks and H. G. Wehe, at Hawthorne, discussed condenser problems and the problem of setting up a German machine designed for making zinc-coated condenser paper.

W. J. King visited the H. H. Buggie Co., Toledo, on high-voltage cable connectors.

W. V. Thompson was at Burlington, N. C., on engineering problems associated with the production of cords for Western Electric hearing aids.

H. W. Holmlin, H. F. Hopkins, E. C. McDermott and G. A. Sander went to Burlington, N. C., in connection with problems relative to the design and production of the 728-B loud-speaker for use in sound reproduction systems.

COL. ENGELBERG LT. COL. LYON J. J. YOSTPILLE F. G. SCUDNER J. A. WHITAKER LT. COL. COL

Recently Returned Veterans

Colonel Albert J. Engelberg has returned to the Laboratories after five and one-half years' service in the Army. Col. Engelberg was called to active duty as a Major in February, 1941, reporting to Maxwell Field, Ala., where he activated the Air Base Group that comprised the station complement for the first pre-war air field established in the Southeastern Air Corps Training Center area. He was transferred to the Office of the Chief Signal Officer in Washington in May, 1942, where he served as Chief of the Aircraft Radio Division and later as Chief of the Procurement-Liaison Division, respectively. He was promoted to Lt. Colonel in June, 1942, and transferred to Army Air Forces in October, 1943, to serve as Communications Inspector and later as Air Communications Officer at San Bernardino, Calif., and at Oklahoma Air Technical Service Command. He was promoted to the rank of Colonel in November, 1944. From January to May, 1945, he worked on a special assignment from Headquarters, Wright Field, during which period he visited and surveyed all phases of communications activities at the fourteen area Air Technical Service Commands located within the geographical limits of the United States.

Lieut. Col. William R. Lyon recently returned to the Laboratories at West Street after a military leave of five and a half years. Col. Lyon spent about half of that time as AAF Resident Representative in a number of very large manufacturing plants in Ohio and Indiana. For over two years he was successively Instructor in Electrical Engineering at the AAF Engineering School and Professor of Engineering at the AAF Institute of Technology, Wright Field. He has been furloughed to the Officers' Reserve Corps, of which he has been a member for twenty-eight years, having served in World War I.

John J. Yostpille enlisted in the Naval Air Corps and had completed the V-12A training at Dartmouth and eight months in electrical engineering at M.I.T. when he was assigned to the Radio Technical Training Program, where he studied until his return to civilian life.

Frank G. Scudner in forty months of Army service fought with the 4025th Signal Service Group in New Guinea and the Philippines, installing and operating radio teletype relay stations.

John A. Whitaker maintained and repaired planes on an escort carrier in Pacific waters for over a year; then returning to this country, was stationed at Key West, awaiting the commissioning of the carrier *Kearsarge*, to which he was assigned.

Lieut. Col. Francis A. Coles held a reserve commission as a Captain in the Coast Artillery when called to active duty early in 1942 with the Signal Corps. Col. Coles returned to the Bell Laboratories on temporary duty for several months to complete a war job and was then assigned to the Signal Corps Radar Laboratory at Belmar. He served at the Signal Corps Laboratories in various capacities until relieved in March, 1946, the last two years as Technical Executive Officer at Evans Signal Laboratory, where he was responsible to the Director for conducting the planning, coördination and carrying out of technical objectives in its program.

Dietrich K. Wagner fought with the 13th Armored Division in France and Germany and was assigned to occupational duty in Austria for a time. When his division returned to this country, Mr. Wagner went to Fort MacArthur, where he worked in the separation center.

John E. Cronin saw action as a radio operator in the ETO with the 37th Field Artillery Battalion through Belgium, Germany and Czechoslovakia. He was returned to the States for redeployment to

D. K. WAGNER J. E. CRONIN R. C. RYAN R. T. DUFFEY P. M. CROUCH E. F. LUNDGRE






. A. Hopper W. F. Blazure Rudolph Droppa Lt. Schoen L. A. Bergdahl S. M. Wojtaszek

the Pacific, but instead was assigned to Fort Leavenworth until he was separated from service.

Richard C. Ryan attended Herzl Junior College and various ETM schools throughout the country. He sailed on the *Indianapolis* to Guam, where he was land based and assigned to meter repair work until released from service.

Robert T. Duffey in three and a half years of Army duty spent nineteen months overseas, most of it at Orly Airfield in Paris, where he was a radio mechanic. He was married in Paris to a Wac whom he met abroad.

Philbrick M. Crouch went overseas with 1265th Engineers in a Water Purification group, preparing drinking water for the troops from France through the low countries to Germany. Later he went to Switzerland and Italy.

The Laboratories has employed 1,142 veterans of World War II

Ernest F. Lundgren served in Germany for sixteen months, with the 407th Infantry Regiment of the 102nd Division with whom he fought along the Roer River. Crossing into Germany they advanced to the Elbe River.

LeRoy A. Hopper, of Whippany, received training at various service schools before he was assigned to the Army Airways Communication System as Communications Officer at Antigua and Trinidad. Later he became a technical supply officer at Puerto Rico.

William F. Blazure has returned to the Murray Hill Laboratory after approximately twenty-six months' service in the Navy, thirteen months of which were spent overseas in the Pacific aboard the aircraft carrier *Gilbert Islands*.

Rudolph Droppa, of Commercial Products Drafting Department, Graybar-Varick, served in the Navy as an engineering draftsman at the Bayonne Naval Supply Officers' Training Center, where he organized the drafting and art section of which he was later in charge.

Lieut. Donald R. Schoen studied radar at Harvard and M.I.T. and was then assigned to Camp Murphy, Florida, Fort Monroe, Va., and finally to Holabird Signal Depot, where he was in charge of Signal Corps radio and radar photographic equipment.

Louis A. Bergdahl was assigned to Norfolk to the Commander of the Operational Training Command of the Atlantic Fleet as part of a trouble-shooting team working on fire control problems.

Stanley M. Wojtaszek engaged in front-line traffic work with an MP platoon at Bougainville, Luzon, Manila and Boguio. Transferring to the Division's Artillery Hq., he worked in its intelligence section until the war ended. Prior to his return he was a chief personnel clerk.

Glenmore M. Bloss has returned to the Whippany Laboratory. He was stationed with the Army in Manila for approximately eight months, serving at various times as a mechanic, vehicle driver and supply clerk.

John Huntley has been discharged from the Army and has returned to work in Department 1140 at Murray Hill. He spent approximately ten months overseas in the 805th Signal Service Company in Paris and later in Berlin.

John H. Anderson, who does New York State Income Tax work in the Payroll Department, spent thirty-one months in the Army. He fought in the ETO and later during the occupation became a Personnel Sergeant in Stuttgart.

Arthur Henricks went to the ETO as a radio

G. M. Bloss John Huntley J. H. Anderson Arthur Henricks C. A. Haas L. B. Jones







DAVID WEBSTER


F. C. ROECKL


M. F. DEVLIN


A. LEONHARDT


H. A. LAMPERTY


WESLEY BENI

repairman with the 672nd Field Artillery and fought from France to Czechoslovakia. After V-E Day he became an airplane mechanic.

Charles A. Haas, like many other Laboratories men, trained in the School for War Training at the Davis Building for work on secret Army equipment. Sgt. Haas maintained and operated that equipment successively at the Pentagon Building, Oakland Army Base, Paris and Frankfort.

Lawrence B. Jones studied with the A.S.T.P. for three months and then joined the regular Army, where he became a remote-control turret mechanic. He maintained B-29's at Alamogordo Field, N. M.

David Webster transferred from the Medical Corps to the Air Corps early in the war and served in the Pacific at Manila, Leyte, Mindora, Okinawa and Tokyo, doing clerical work in connection with Intelligence S-2 of the 5th Forces.

Francis C. Roeckl has returned to do schematics drafting at West Street after two years of Army duty. He engaged in fire control work at Fort Bliss, but did clerical work at Fort Sheridan.

Michael F. Devlin, of 4A Files, was assigned to the light cruiser *Oklahoma City* of the 5th Fleet, which participated in the Okinawa campaign and in the bombardments of Japan. Later he served off Japan, the Marshalls and the Philippines.

Arthur Leonhardt was on duty with the Navy for about fifteen months. While in the service he was primarily engaged in the maintenance of aircraft at Pensacola, Florida.

Henry A. Lamperty was assigned to the 11th Engineers after the A.S.T.P. was discontinued. A rifleman and bridge builder, he fought in Germany and Austria, where he later managed a PX.

Wesley Bender, an aviation radioman, received amphibious training and served on the *AKA*-50 and on an auxiliary carrier in the Caribbean.

Robert Granger taught a radio electricians' course at Fort Knox before he saw action in Europe with the 16th Armored Division. He also served as communications chief in the 8th Tank Battalion of the 4th Armored Division.

Charles A. Liscum has returned to the Whippany Laboratory after serving two years in the Navy. After intensive training in radio matériel schools, he was assigned to airborne radio and radar equipment at Norfolk.

William P. Brander served in the Army a little over two years. He was trained in electrical gun director repair at Aberdeen, Maryland, following which he was assigned to several Army posts.

Albert H. Diegler has returned to the Whippany Laboratory following approximately twenty-six months in the Signal Corps. After specialized training, he went overseas with the 5th Army and served in the Mediterranean theater of operations.

Herbert K. Meyer went overseas in March of 1945 after completing his infantry training at Camp Robinson, Arkansas, and was assigned to the 10th Armored Division of the 3rd Army at the Rhine. When they shipped home, he was transferred to the 9th Infantry Division.

Joseph P. Reddington, of the Marine Corps, fought at Guadalcanal and Okinawa and participated in occupational landings in China while attached to the 3rd Amphibious Corps of the 155th Howitzer Battalion.

Leaves of Absence

As of August 31, there had been 1,052 military leaves of absence granted to members of the Laboratories. Of these, 859 have been completed. The 193 active leaves were divided as follows:

Army 89 **Navy 71** **Marines 7**

Women's Services 26

There were also 10 members on merchant marine leaves and 1 on personal leave for war work.

OBERT GRANGER

C. A. LISCUM

W. P. BRANDER

A. H. DIEGLER

H. K. MEYER

J. P. REDDINGT

News Notes

E. T. Ball visited the Dahlstrom Metal Company, Jamestown, N. Y., to discuss manufacturing problems pertaining to No. 5 crossbar frames.

R. R. Stevens and I. H. Baker, at Hawthorne, assisted the shop with the production of coin collectors.

J. H. Shuhart witnessed field tests at Huntington, West Virginia, of various transposition systems.

C. S. Gordon and C. C. Lawson discussed insulation wire problems on August 14 at Point Breeze.

During the months of July, the United States Patent Office issued patents on applications previously filed by the following members of the Laboratories:

H. M. Bascom	B. F. Lewis
L. G. Bostwick (4)	C. A. Lovell
W. K. Caughey	R. F. Mallina
C. I. Cronburg	W. H. Martin
M. Fritts	W. P. Mason (2)
W. D. Goodale, Jr.	T. A. McCann
R. E. Graham	D. B. Parkinson
L. N. Hampton	R. K. Potter (2)
J. H. King	J. E. Ranges
E. D. Knab	F. W. Reynolds
W. Koenig, Jr. (4)	F. F. Romanow (2)
L. Y. Lacy	V. L. Ronci
J. P. Laico (2)	A. E. Ruppel
L. K. Swart	

A. H. Hearn studied the copper naphthenate petroleum creosote treatment of Douglas fir poles at the wood preserving plant of Koppers Company at Nashua, New Hampshire.

G. Q. Lumsden has been appointed chairman of Committee 5-5-1 Poles Pressure Treatment, and a member of Committee 5-7 Miscellaneous Species—Ties and Lumber, Poles and Piles—Pressure Treatment, in the American Wood-Preservers' Association for the ensuing year.

H. J. Kostkos assisted the Michigan Bell Telephone Company in planning the Bell Laboratories features of their open house and family night exhibit at Detroit and with their exhibits in the Edison Institute at Dearborn, Michigan.

Four members of the Laboratories, all active in the Morristown Little Theater Group, took part in a pageant entitled "Peace Triumphant," which was staged at the Morris County Fair from August 21 to 24. "Father Time" was portrayed by C. C. Lawson and "George Washington" by A. R. Kall; R. C. Smith, Jr., appeared as a gladiator and Elizabeth Jentzen as an Indian in a scalping scene. J. J. Harley provided sound effects and recorded incidental music.

H. C. Curl, with D. W. Kinsinger and W. C. Moore of Western Electric, at the request of the Navy Department observed the Western Electric battle-announcing systems on the aircraft carrier *Franklin D. Roosevelt* during a cruise in southern Atlantic waters. Mr. Curl went as far as Cuba, and then flew back to New York.

J. A. Potter discussed first production of high-current rectifiers for central office battery charging at the Power Equipment Company in Detroit.

A. J. Wier, with A T & T engineers, recently discussed problems pertaining to a new K2 carrier route from Boston to Franklin with engineers of the New England Telephone and Telegraph Company.

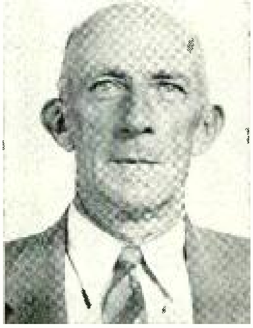
H. W. Hermance, C. F. Hefft and D. F. Seacord, accompanied by V. F. Headapohl and T. J. Talley of O & E, investigated contact noise problems in panel central offices in Cincinnati.

The Laboratories were represented in patent interference proceedings at the United States Patent Office during August by N. S. Ewing before the Primary Examiner, and by H. C. Hart before the Examiner of Interferences.

J. E. Cassidy went to the Patent Office in Washington on patent matters.

Harry Hulick, 1879-1946

Harry Hulick of the Plant Operation Department at Deal, who retired in 1944 after seventeen years of service, died on August 6. His work at Deal was on general building services and the maintenance of the grounds. For many years he was secretary of the Board of Tax Assessors of West Long Branch.



B. S. WOODMANSEE, C. T. GRANT, F. R. BIES and W. J. CARROLL explained the operation of a new crystal test oscillator at the Long Branch Laboratory, Fort Monmouth, N. J.

G. H. LOVELL, R. I. GAME and H. C. FLEMING were at the Harrisburg and Allentown repeater stations of the Long Lines during a trial installation of experimental filters.

T. H. CRABTREE attended conferences at the Raytheon Manufacturing Company at Newton, Mass., where problems concerning the use of subminiature vacuum tubes in hearing aid amplifiers were taken up.

G. J. V. FALEY's trip to the Western Electric plant in Burlington, N. C., concerned hearing aid problems.

R. H. KREIDER reviewed the installation of the "NACA" computer system at Langley Field, Virginia, with Mr. Sullivan and Mr. Loeffler, Division and District Superintendents of Installation. S. C. DEL VECCHIO, E. F. KETCHAM and W. H. BENDERNAGEL supervised the installation of this computer equipment.

E. F. WATSON, G. A. LOCKE and A. A. BURGESS were in Washington in connection with the No. 1 crossbar office.

A. S. KING spent several days at the North Electric Manufacturing Company, Galion, Ohio, discussing unattended dial office equipment.

L. C. ROBERTS has been making lightning tests on carrier telegraph for several weeks in Kansas City.

L. R. COX was in Washington and Richmond in connection with installation tests of terminal equipment for coaxial cables in those cities.

W. D. MISCHLER investigated transmission difficulties in the L1 carrier terminals at Minneapolis.

A. R. D'HEEDENE, E. I. GREEN, A. D. KNOWLTON, A. L. ROBINSON, J. R. TOWNSEND, J. R. WILSON and M. N. YARBOROUGH attended an Electronics Symposium given by the Technical Intelligence Service of the Air Matériel Command at Wright Field, where information concerning captured equipment and documents was presented.

C. L. DOLPH is author of a paper published in the June, 1946, *Proceedings of the I.R.E.*, entitled *A Current Distribution for Broadside Arrays Which Optimizes the Relationship Between Beam Width and Side-Lobe Level.*

AN ARTICLE by J. T. SCHOTT on *The Lookator* which was published in the RECORD of October, 1945, was abstracted in *Nature* (London), June 8, 1946.

R. W. HAMMING, B. MCMILLAN and J. W. TUKEY attended meetings of the American Mathematical Society at Ithaca.

C. C. TAYLOR and K. BULLINGTON spent August 8 in Philadelphia, where they discussed plans for the New York-Washington highway mobile radio-telephone system.

K. K. DARROW lectured on *Nuclear Energy* on August 16 and *Foundations of Wave Mechanics* on August 31 at the University of Mexico.

H. H. SPENCER witnessed the installation and testing of power plant equipment for the ⅜-inch coaxial trial at Dallas. He also visited a coaxial station between Dallas and Shreveport on power problems and the K-Carrier Station at Davenport, Iowa.

Inside-Back-Cover Girl

When Advertising needed a model for "The hat that became a headset" on the opposite page, they needed not to look beyond their own group. Shown in both pictures is JANE CONLON of Publication who joined the Laboratories on June 26, 1944, immediately after graduation from Our Lady Queen of Peace High School in North Arlington, N. J.

In reviewing R. A. Heising's recent book on Quartz Crystals for Electrical Circuits *in the Proceedings of the I.R.E., Professor W. G. Cady says: "The book offers the most complete and authoritative account of modern methods in quartz technique that has yet appeared."*