BELL LABORATORIES RECORD

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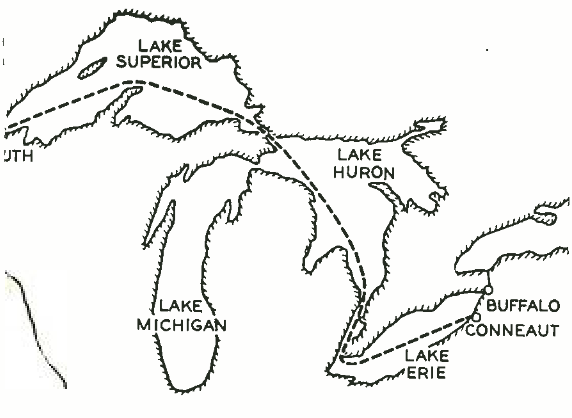
A VOYAGE BY RADAR

The Great Lakes are among the most heavily traveled waterways of the world, and through the narrow straits and rivers connecting them flows an almost continuous stream of shipping. Dominating the tonnage carried is iron ore and wheat from Duluth at the western end of Lake Superior, to the great steel and grain centers of Chicago and Gary, Ill., Detroit, and Cleveland, Conneaut, Buffalo, and other cities on Lake Erie. Coal is usually carried on the return voyage. The Lake Carriers Association, a group of ship operators controlling over 350 large vessels totaling two million gross capacity tons, was quick to perceive the possible advantages of radar as a navigational aid, and planned extensive trials during the summer of 1946 on several of their large ore ships. The Western Electric Company was one of several manufacturers asked to provide suitable equipment for one ship for the trial. In designing the apparatus, the Laboratories utilized as far as possible circuits and apparatus that had been developed for war applications, making modifications or new designs only when it seemed necessary. Since the apparatus was provided as a trial model, and time was very short, most of the manufacturing was also done by the Laboratories in its Development Shop.



In the spring of last year, the Laboratories apparatus was installed on the *John T. Hutchinson*, one of the new 12,000-ton capacity ships of the Buckeye Steamship Company under command of Captain Harold Jacobsen. On one voyage between Conneaut, Ohio, and Duluth, and back to Detroit, made in July, the author was aboard to observe the behavior of the apparatus and study its effectiveness as a navigational aid. The major apparatus units consisted of an indicator and control panel mounted in the forward end of the pilot house as shown in Figure 1, and synchronizer and transmitter cabinets installed in the after end of the chart room as shown in Figure 2. The antenna was mounted eight feet above the pilot house

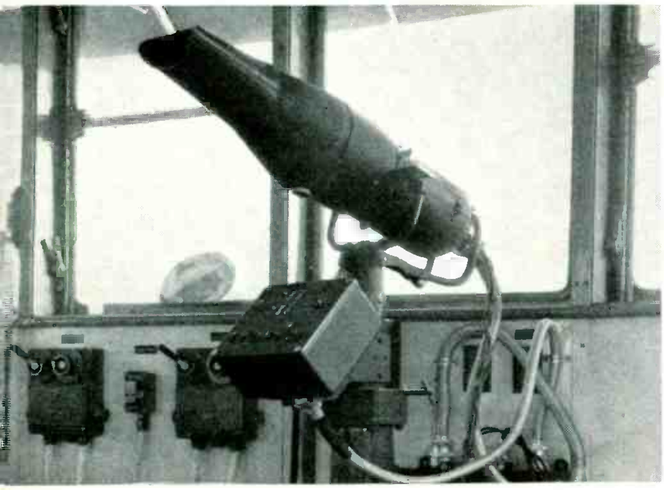


Fig. 1—Indicator and control box on a pedestal in the forward end of the pilot house

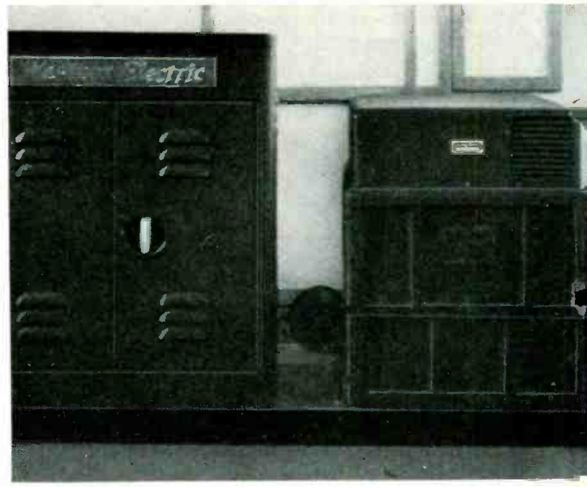


Fig. 2—Synchronizer and transmitter cabinets in the after end of the chart room

as shown in Figures 3 and 4, and made one complete revolution every five seconds. In addition, there was a compass repeater mounted on the forward bulkhead of the pilot house and used to associate the radar apparatus with the ship's gyro compass so as to give a true north indication on the scope. A motor generator set in the dunnage room completed the equipment.

Forty-kilowatt radar pulses are sent out at a rate of about 1,000 per second. Each pulse is approximately 0.6 microsecond in length and is at a frequency of 9,400 megacycles. A 7-inch cathode-ray tube with a long-persistence screen is used for the indicator. A cursor dial mounted on the face of the tube may be rotated to any position by a knob on the underside of the indicator. The cursor dial is of amber plexiglas and thus gives a yellow scope picture. Around its outer edge are marked two degree scales—the outer reading from 0 to 360 degrees in a clockwise direction, and the inner, 0 to 360 degrees in a counter-

Fig. 3—Rear view of pilot house, showing the radar antenna in its mounted position

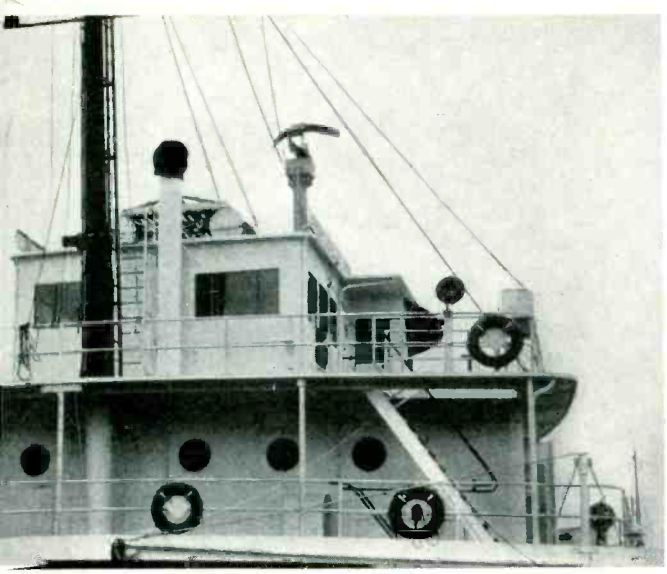
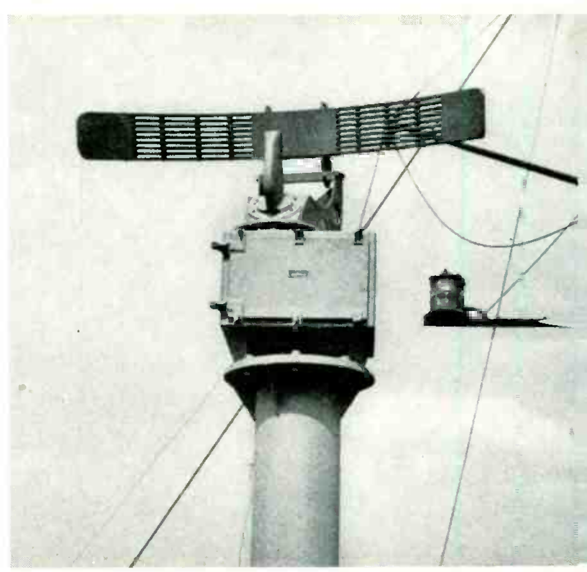


Fig. 4—The antenna, eight feet above the pilot house, is fifty feet above water when the ship is loaded



clockwise direction. A line is marked on the cursor dial from the center to the zero-degree point of the scale, and parallel to this line and running across the dial are four lines on each side. When the central line of the cursor dial is placed in the direction of the ship's course, these parallel lines on each side permit a rapid and accurate estimate of the distance objects will be when they are abeam. A bright line on the scope, running from the center to the outer edge, and controlled from a switch on the antenna which operates every time the antenna points dead ahead, gives the ship's heading. All the scope pictures are step with the heading marker, the central cursor line is slightly above the ship's heading marker. The azimuth indicated at the north index is 302 degrees, but had the cursor line been directly over the heading marker, the true azimuth of 300 degrees would have been indicated. When the central line of the cursor dial intercepts a target, the reading on the inner scale at the ship's heading marker gives the bearing of the target with respect to the ship. Thus, in Figure 6, the target under the central line of the cursor dial bears 328 degrees from the ship's heading, or 32 degrees off the port bow.

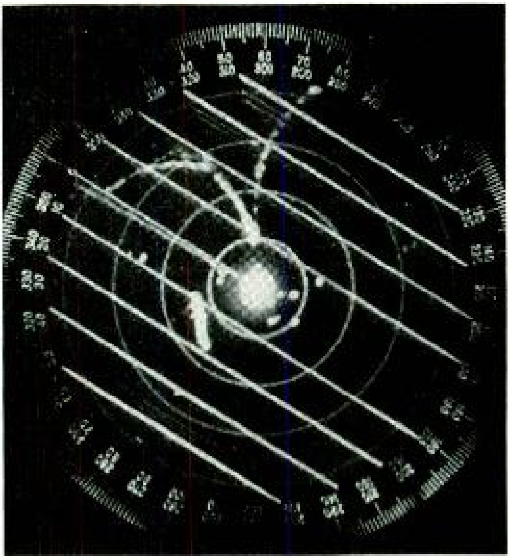


Fig. 5—A typical scope picture using five-mile range circles. North index evident at 58 degrees of the outer scale, and the ship's heading marker at 2 degrees of the inner scale

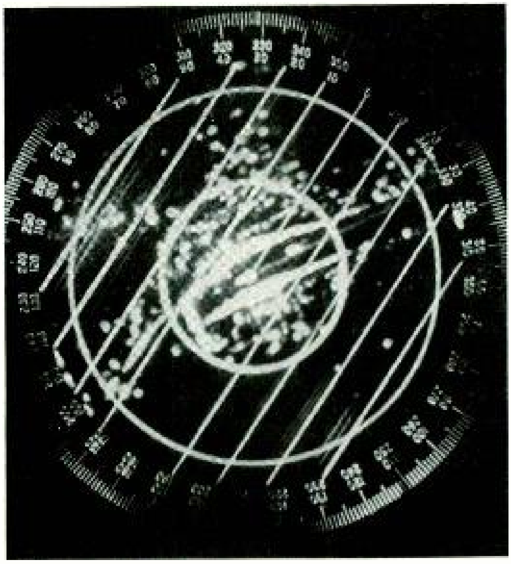


Fig. 6—Here the cursor dial central line has been placed on some target. The bearing of the target from the ship may be read opposite the ship's heading marker

oriented with true north at the top, and a small index mark appears at the top of the scope to indicate this point. In Figure 5, this may be seen overlapping the 58-degree mark on the cursor scale.

In ordinary operation of the radar, the central line of the cursor dial is kept over the ship's heading marker, and under these conditions, the ship's azimuth heading is indicated by the inner cursor scale at the north index. In Figure 5, apparently because the ship was turning and the operator did not quite keep the cursor dial in

All land masses, ships, buoys, and other objects appear as bright areas on the scope, which thus gives a chart of the area surrounding the ship. Targets on shore, such as beacons or lights, are usually masked by reflections from the surrounding land. Distances to the various objects can be estimated very closely from the range circles, which appear as bright lines on the face of the scope. The range circles are either one mile apart when the control box range switch is in the "short" position, or five miles apart in the long

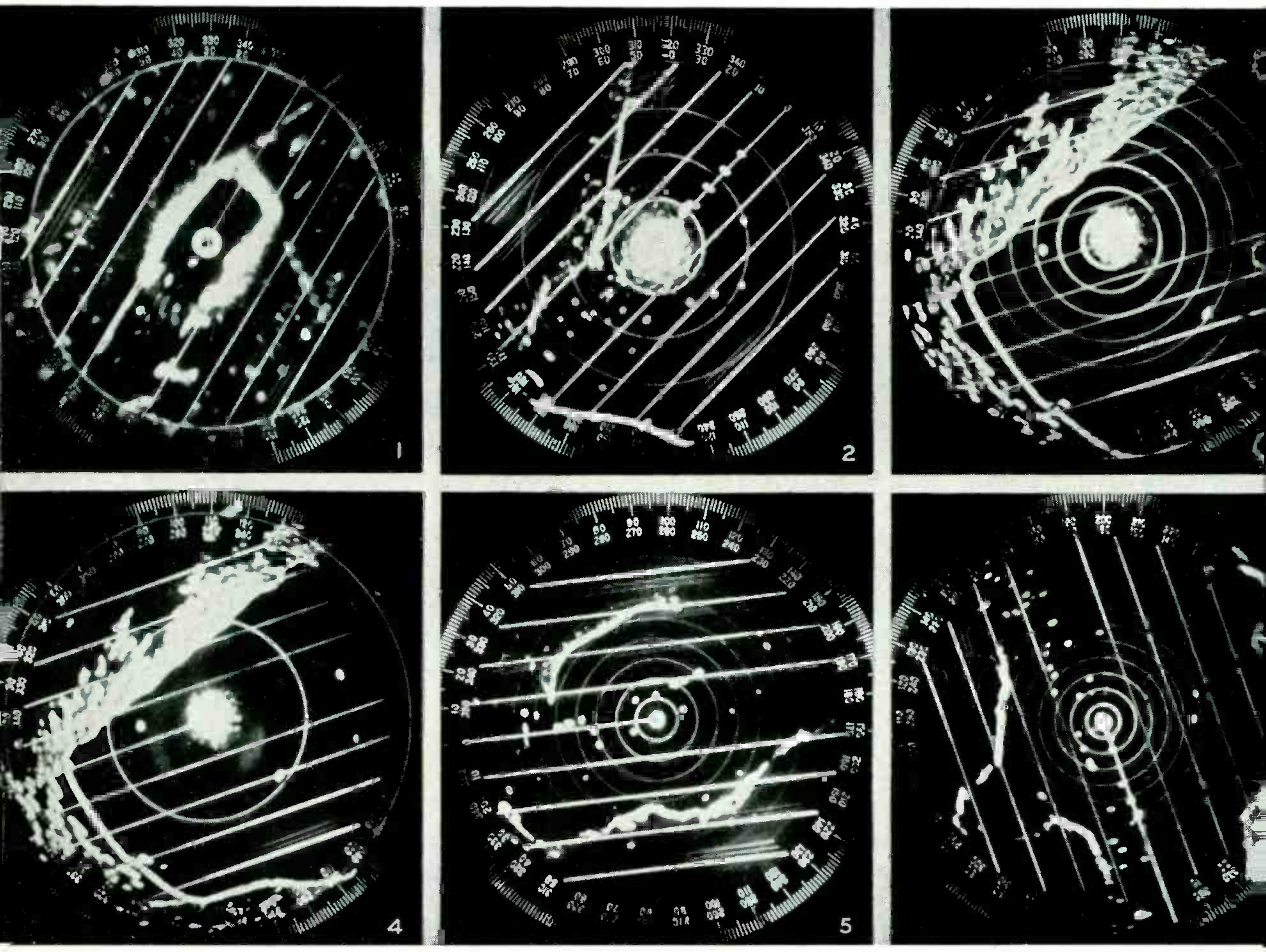


Fig. 7—Typical scope pictures: Nos. 1 to 3, inclusive, with one-mile range circles; Nos. 4 to 6, inclusive, with five-mile range circles. 1—Detroit River, one-half mile below Ambassador Bridge; 2—Lake St. Clair, just leaving Detroit River; 3—Lake Superior, six miles from Duluth piers; 4—Lake Superior, seven miles from Duluth piers; 5—Lake Erie east of Point Pelee; 6—Lake Huron, northeast of Saginaw Bay

range position, and adjustment is also provided to permit the distance scale to be varied, and thus the separation of the range circles may be made greater or less, depending on the range of the objects of interest of the moment. In Figure 7, for example, the one-mile circle at the upper left is out near the edge of the scope and thus only objects up to one mile distance appear. At the upper right, on the other hand, eight one-mile circles appear. Similar manipulation is possible with the five-mile circles. The scope picture at the lower left of Figure 7 shows two five-mile circles, thus giving a scope picture extending ten miles from the ship while the picture at the lower right shows thirteen five-mile circles, and extends the scope picture to sixty-five miles from the ship. This picture was taken in the center of Lake Huron. Dots for more than forty ships can be counted on it. Distances as great as this are possible only under unusual conditions. Provisions are also made for using a single range circle that is adjustable in range, and under control of a range knob may be set to any range desired. No scope pictures with this circle in use are shown.

It will be noticed that on all of the scope pictures there is a small bright circle immediately surrounding the ship's position. This is caused by the outgoing transmitter signal, and is offset because of a delay network that stores all video signals for 2.2 microseconds. In narrow waters, this causes some distortion at the center of the picture, but it may readily be allowed for. Also noticeable in most of the pictures is a bright line immediately astern of the ship. This line really consists of two or three bright spots caused by multiple reflections between the antenna and the ship's stack. Similar multiple reflections are sometimes obtained from nearby ships within a thousand or 1,500 yards, particularly when they are abeam.

How effective radar is in navigating a ship may be seen by comparing scope pictures with the corresponding areas, Figure 8, on an actual chart. In Figure 9, for example, which is a section of U. S. Lake Survey Chart No. 62 showing the lower reaches of St. Mary's River, a number of points are indicated for which correspond-

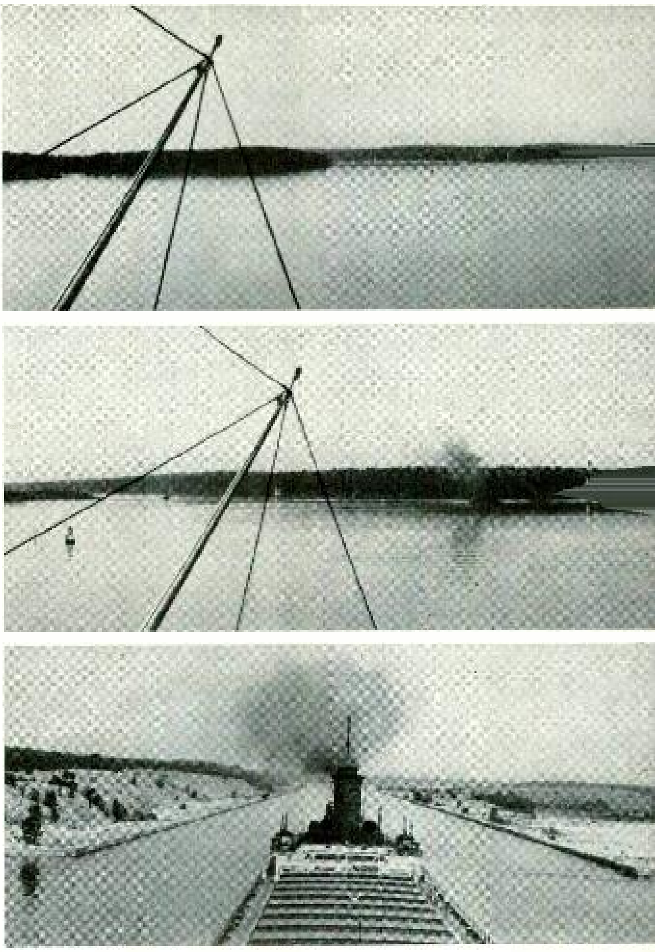


Fig. 8—Photographs taken before reaching and after leaving the West Neebish Channel. 1—Before reaching numbered point 8; 2—After leaving point 8; 3—Just leaving Channel and before reaching point 9

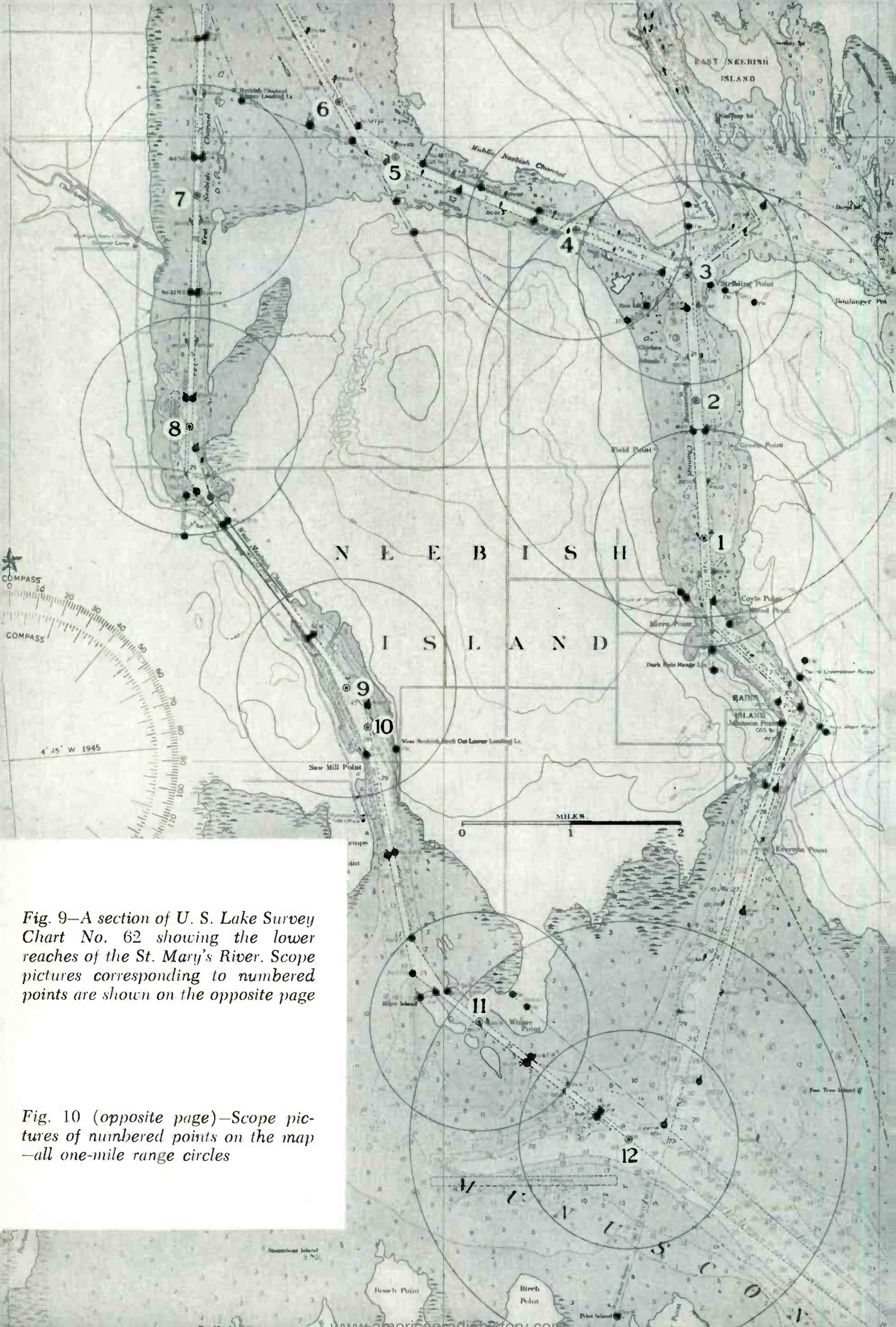
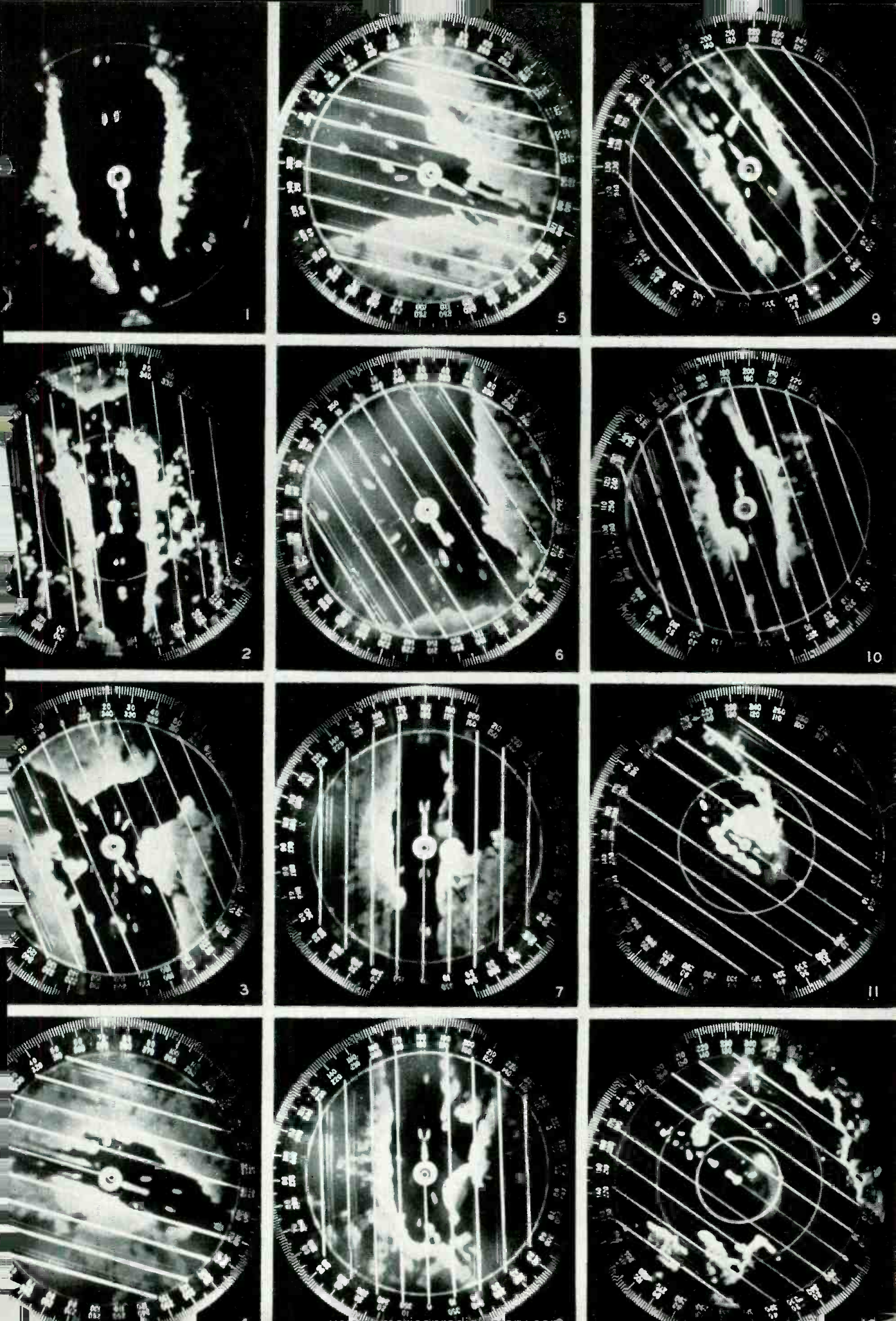


Fig. 9—A section of U. S. Lake Survey Chart No. 62 showing the lower reaches of the St. Mary's River. Scope pictures corresponding to numbered points are shown on the opposite page

Fig. 10 (opposite page)—Scope pictures of numbered points on the map—all one-mile range circles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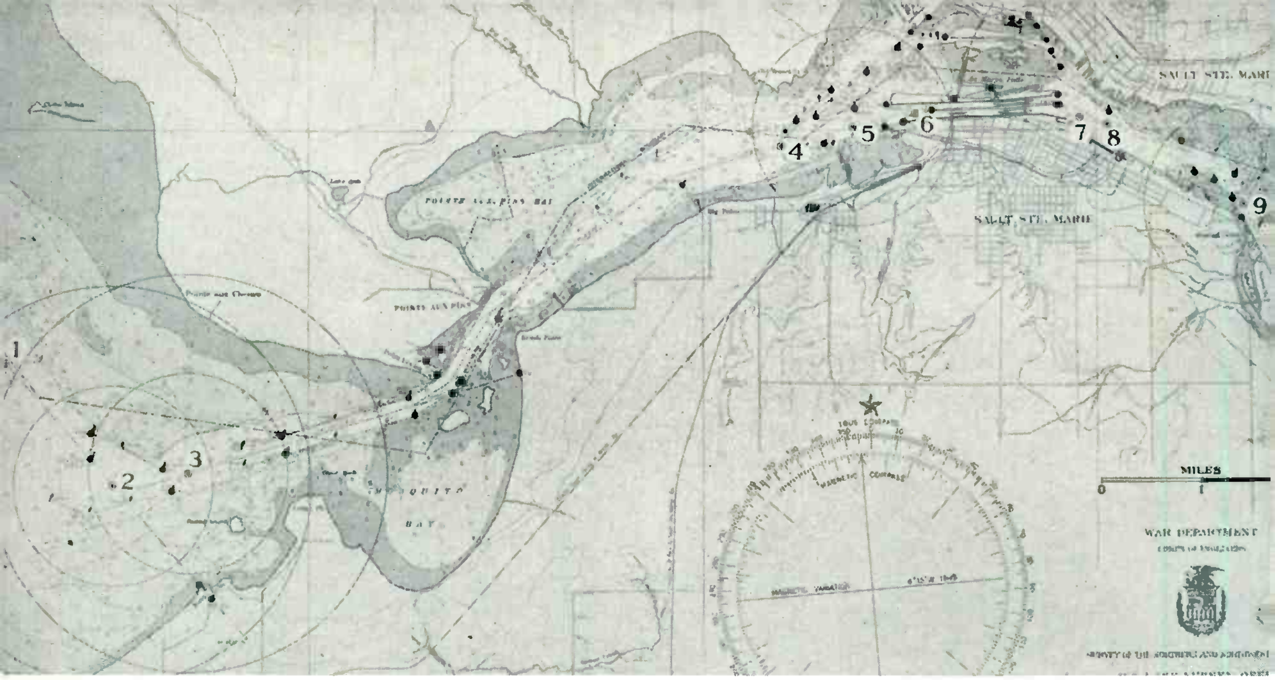


Fig. 11—Section of U. S. Lake Survey Chart No. 63, showing the upper reaches of the St. Mary's River and the locations of Sault Ste. Marie. Scope pictures correspond to numbered points in Figure 12

ing scope pictures are given in Figure 10. Photographs taken by a camera on top of the pilot house, Figure 8, are for positions shortly before and after point 8 and slightly before point 9. Figures 11 and 12 show a similar display for a section of Chart No. 63 for the upper reaches of the St. Mary's River, including Sault Ste. Marie. One or two-mile circles for some of the positions on the chart have been drawn to correspond to the range circles of the scope pictures. The faithfulness with which the scope picture represents the chart is apparent, and becomes much more so after one has used the system for a short time and become familiar with the differences in the type of patterns made by buoys, other ships, and land masses. Even thunder clouds will appear on the scope as irregular nebulous masses.

THE AUTHOR: R. C. NEWHOUSE, Radio Development Engineer, received a B.E.E. degree from Ohio State University in 1929. After three months as a member of the technical staff in the Toll Systems Department of the Laboratories, he returned to Ohio State under a fellowship granted by the Guggenheim Fund for the Promotion of Aeronautics to permit work on a radio altimeter. He received an M.S. degree in 1930 and immediately rejoined the Laboratories Technical Staff. As a member of what is now the Specialty Products Development Department, he engaged in the development of aircraft radio transmitters, and acoustical and radio altimeters. He received the 1938 Lawrence B. Sperry award from the Institute of the Aeronautical Sciences for the development and first practical application of the radio altimeter. In 1939 he transferred to the television research group. With the approach of the war emergency in 1940, he returned to Specialty Products where he supervised the circuit development of a number of radars for aircraft and ground service. He now directs the efforts of a group engaged in the development of radar for commercial applications and of radio-telephone sets for aircraft and shipboard service.

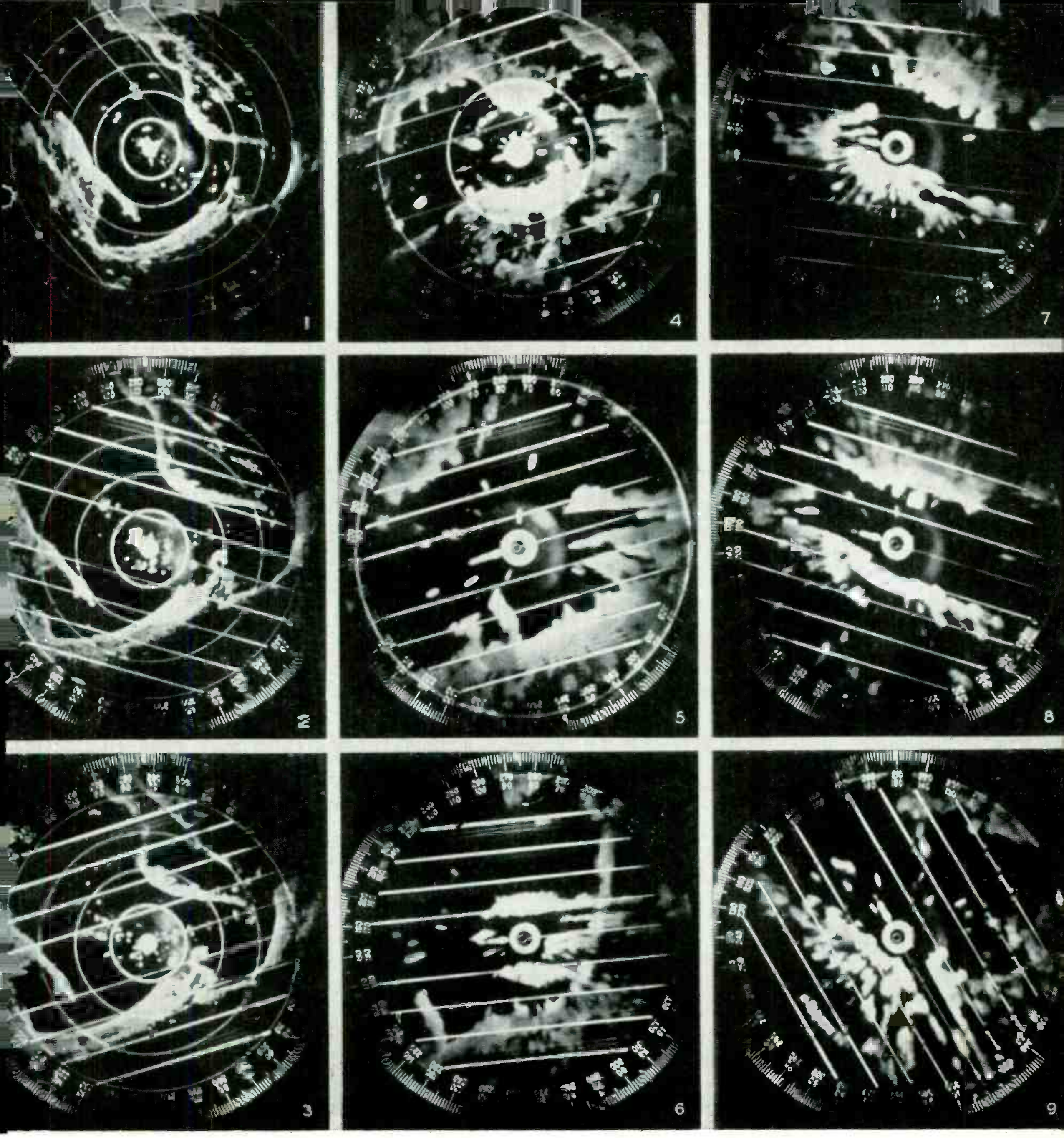


Fig. 12—Scope pictures corresponding to numbered points on Fig. 11—all one-mile range circles

Under fair-weather, daytime conditions, the radar, of course, is of little assistance, but at night it is very helpful, and in fog or bad weather it is indispensable. Heavy fog makes the narrow waterways unnavigable with the ordinary facilities. All ships must anchor, and the traffic piles up badly. With adequate radar equipment, however, navigation may be safely undertaken under almost any conditions. One night in a bad fog while all the other shipping was forced to tie up, Captain Jacobsen safely proceeded the whole length of the St. Mary's River by use of his radar.

TELEVISION: 20TH ANNIVERSARY

HERBERT E. IVES
Research
Consultant

"This afternoon at about three o'clock, connection was made by wire to Washington and the small disc connected. A perfect image was received. Kingsbury, Knapp and Etheridge were seen exceedingly satisfactorily—The first viewing of human beings at a distance of hundreds of miles was completely successful." This entry, which I find in my log book under the date of March 26, 1927, marks the attainment of the first goal of television research in these Laboratories. The trial referred to took place over circuits set up between Washington and New York on which television over long distances was to be publicly demonstrated eleven days later. It was the culmination of work carried on over several years, and although the end of that particular project, it marked only the beginning of the studies and development that have now led to television networks spanning the entire country.

In January, 1925, development work had been completed on the system of sending pictures over telephone lines that was to be used in March of that year for the transmission of pictures of the Coolidge inauguration from Washington to New York, Chicago and San Francisco, and soon thereafter to be in commercial service. Today it is in world-wide use by news associations. In discussion with H. D. Arnold, then Director of Research, it was agreed that we should undertake, as our next problem, to speed up the picture system to the point where the product would be "television"—that is, the production and transmission of a picture in a fifteenth of a second, instead of in seven minutes. At Arnold's request, I prepared and submitted to him on January 23, 1925, a memorandum surveying the problem and proposing a program of research. The survey discussed the characteristic difficulties of securing the requisite sensitiveness of pick-up apparatus; the wide frequency bandwidths which from our experience with picture transmission were indicated as necessary for television; the problem of producing enough modulated light in the received image to make it satisfactorily visible; and the problem of synchronizing apparatus at separated sending and receiving ends. It concluded with the proposal of a very modest attack capable, however, of material expansion as new developments and inventions materialized.

The apparatus proposed for immediate construction comprised two Nipkow discs mounted at the ends of a single axle, each with a spiral of fifty pin holes. This number was chosen as appropriate to the rendering of the face and shoulders of the subject and on the calculation that the frequency band required for a fifteen per second scanning—about ten times that for voice transmission—could be reached on available transmission channels. A photographic transparency, later to be superseded by a motion picture film, was to be used at the sending end, and to secure enough light for the photoelectric cell, it was proposed to focus the crater of a carbon arc lamp on the cell by a lens at the disc plane. At the receiving disc, a crater gaseous glow lamp, modulated by the amplified photoelectric current, was to be imaged on the pupil of the observer's eye. Thus at each end the maximum possible optical efficiency for utilizing the light was insured.

A Laboratories case "System of Television" was shortly authorized, and work initiated along the lines proposed. By May the apparatus was completed and in operation. A memorandum of May 12, 1925, by J. G. Roberts, General Patent Attorney, records: "I witnessed today a demonstration of Mr. Ives' system of television. He has constructed and put in operation substantially the system he described in his memorandum of January 23, 1925, to Mr. Arnold. In viewing the picture at the receiving end, I could distinguish with fair definition the features of a man's face like that of a picture at the transmitting end and also observed that when the picture at the transmitting end was moved forward or backward, or up and down, the picture at the receiving end followed these motions exactly."

Motion picture film in place of the stationary transparency was used in July, 1925, but was put aside because of the urgency of other developments of considerable promise. Cutting the apparatus in two and devising means for the synchronous operation of the two ends was undertaken under the direction of H. M. Stoller on May 12. Two synchronous motors capable of driving the discs with a deviation of less than one-half the diameter of the disc apertures were delivered on November 25, and henceforth all the experiments were made with the sending and receiving ends working in different parts of the laboratory—the first step toward *tele*-vision. A second development at this time was the design of a light source for the receiving end which did away with the original focusing of a point source on the eye. It consisted of a flat-cathode neon glow lamp, with a uniform bright area of glowing gas covering an area as large as the rectangle scanned by the disc. These lamps, which were used in all the subsequent work, permitted direct viewing of the image by both eyes, or even by several observers. The apparatus was no longer a "peep show."

With the two ends separated and with the flat-cathode glow lamps, motion pictures from a projector driven in synchronism with the discs were successfully reproduced in December, 1925. Further work on film was sidetracked by the development of a method of scanning objects without intermediate photographic amplification.

This beam, or spot, scanning method was devised by Frank Gray. It consists in directing an intense narrow beam of light on the subject and moving the beam rapidly across and from top to bottom of the field in a pattern traced out by the holes of the scanning disc. By this means the average illumination is reduced in the ratio of spot to field size (in our case 2,500 times) so that what would be intolerable as adequate floodlighting becomes almost unnoticeable, but remains equally efficient for scanning purposes. This method, it was found, had been previously proposed, but apparently with no realization of one of its major advantages: that it is not restricted in use to flat surfaces, as originally disclosed, but is suitable for objects in the round. With this method, light source and photocell are reversed in their rôle, and it is the photocells, not the light source, that should be made larger and manipulated in position. Cells in multiple, of a size never before attempted, were thenceforth used in appropriate positions around the scanned object.

On March 10, 1926, at the conclusion of ceremonies at Bell Telephone Laboratories commemorating the fiftieth anniversary of

At the Washington end of the first long-distance television conversation

the telephone, F. B. Jewett, President, and E. B. Craft, Executive Vice President, were invited to visit the telephone laboratory. There they talked over the telephone, with the expressions and movements of the face of the speaker being clearly seen by the distant listener.

Had our conception of the problem been satisfied by the production of image dissecting and recovering apparatus, operable from one room to another, we could have designated and announced this apparatus as "television." From the beginning, however, it had been considered a necessary part of our obligation as an enterprise enged in the transmission of information over great distances, to produce for vision a close parallel to what had been done for voice. It would be television when the laboratory experiment was expanded to cover distances beyond any the eye could reach. Accordingly, consideration was given to the problem of putting the photoelectric signals on practical long-distance communication channels. J. W. Horton and R. C. Mathes of R. V. L. Hartley's group, who had been closely connected with the picture transmission development, devoted themselves to this problem. The frequency range from 15 to 20,000 cycles per second generated by the apparatus had to be put on the transmission medium—wire line or radio—at the proper uniform level, free from phase shift, and delivered with the necessary amplification at the receiving end, a problem of the same sort, but of exaggerated scale, as in picture transmission.

While this work was under way, attention was turned to a method, outlined early in 1925, of exhibiting the picture to an audience of considerable size—the visual equivalent of a public address system. It employed a long neon tube containing 2,500 separate external electrodes, which was bent back and forth in fifty rows in such a way that there were fifty electrodes in each row. Signals were distributed by a commutator to each electrode in turn, in synchronism with the sending disc. On the grid, 2 by 2½ feet in size, a human face and shoulders were reproduced in the pink glow of the neon gas and of a size and brilliancy sufficient to be seen in a moderate-sized auditorium. With a loudspeaker, it reproduced the voice and sight of the subject before the scanning transmitter.

In December, 1926, the characteristics of the line coupling apparatus had been worked out, the "big screen" was functioning, and it appeared possible at an early date to stage a test of actual transmission of vision to a distance. In a memorandum to Mr. Craft of January 13, 1927, a program for several demonstrations was outlined. With characteristic enthusiasm, Mr. Craft declared for a single demonstration to feature all the apparatus and both wire and radio transmission, and pledged the coöperation of all departments necessary to accomplish this by April, three months away. Washington was selected as the far point for the wire demonstration, and the Laboratories' station at Whippany, New Jersey, for the radio demonstration.


FAR-OFF SPEAKERS SEEN AS WELL AS HEARD HERE IN A TEST OF TELEVISION

LIKE A PHOTO COME TO LIFE

Hoover's Face Plainly Imaged as He Speaks in Washington.

THE FIRST TIME IN HISTORY

Speaker Seen, Heard Far Off By Television

Successful Test Brings Face and Voice of Hoover From Capital to Gifford, Head of A. T. & T., Here

Audience 'Looks In' On a Larger Screen

Vision and Speech Also Taken Successfully From Radio Station in Jersey

Developed Television Test

The Laboratories' television demonstration of 1927 as told by the New York Times *at the left, and the* New York Herald Tribune *at the right*

Immediately thereafter, the wire transmission arrangements were undertaken by a group from the Department of Development and Research of the American Telephone and Telegraph Company under A. B. Clark. Additional loading coils had to be manufactured for the existing open-wire line, cable connections between the Long Lines terminals and the demonstration centers had to be provided, and the whole procedure for maintaining line characteristics set up. The work at the Whippany laboratory, under O. M. Glunt, was directed by E. L. Nelson. A frequency of 1,570 kilocycles was selected, and a complete radio sending station capable of transmitting the new type of signal was assembled, together with suitable receiving apparatus for use at the New York end of the radio circuit. A small building in Washington near the Chesapeake and Potomac office was rented and equipped. A large amount of duplicate apparatus had to be built to handle the multiple demonstration program. All the work had to be scheduled to come through in proper sequence and date, involving the coöperation of many departments.

In the log book already quoted, the entry for April 7, 1927, is "Television demonstrated." The stage was the Laboratories' auditorium at 463 West Street, which was equipped with apparatus for sending and receiving locally, and for receiving television programs from Washington and Whippany. The principal event was an address by Herbert Hoover, then Secretary of Commerce. As he spoke in Washington, his face was shown on the large screen to a group of fifty guests in New York while his voice was heard from an associated loudspeaker. Following this, a program of amateur vaudeville was sent by radio from Whippany and similarly viewed. Then guests in Washington were individually seen and talked with by friends in New York, using the small individual receiving discs. Local transmission at either end made it possible for all to comprehend the process of image analysis, transmission and recomposition.

In the years immediately following, a number of developments were announced which together embraced practically all the applications of television that have thus far offered promise of general use. In 1928, the development of large dimension apparatus of great light gathering power permitted outdoor scenes to be televised by daylight. In 1929, television in color by a three-color, three-channel method was shown. In 1930, a complete two-way telephone-television system was set up between the Laboratories and 195 Broadway. It was maintained for over a year, and was used by more than 10,000 people. While these developments were not ready for exhibition in 1927, they were nevertheless all scheduled and in part worked out then, so that they belong properly in the account of the launching of television at that time.

In the twenty years that have elapsed since these pioneering developments, the "head and shoulders" target of the first television scanning have expanded into the extended scene of the stage and arena. For the greater sensitiveness and rendering of detail necessary, electronic scanning methods have in large part superseded the earlier mechanical devices. For the study of the transmission problem, which is the peculiar obligation of the telephone industry, the apparatus of 1927 served well. By its use the fundamental data were obtained which guided in the transition from the open-wire line to the coaxial cable, on which television images were transmitted ten years later in 1937, and from line of sight radio to the radio relay of 1947.

THE AUTHOR: Herbert E. Ives received the B.S. degree from the University of Pennsylvania in 1905, and the Ph.D. degree from Johns Hopkins University in 1908. After his discharge as a Major in World War I, Dr. Ives joined the Technical Staff of the Laboratories. He was in charge of the general development of picture transmission, first demonstrated in 1924, and of television demonstrated in 1927. He later engaged in the development of outdoor television, of color television, and of two-way television. Since then, he has engaged in a number of research studies in television and optics, and in 1938 he established experimentally the change in the rate of a moving atomic clock, thus furnishing the first direct proof of the system of compensation for motion embodied in the theories of Larmor, Lorentz and Einstein. During the war he worked with the N.D.R.C. on devices for facilitating military operations at night.

Plaque by J. Juszko

Apparatus for making ultra-sound waves visible

ULTRA-SOUND WAVES MADE VISIBLE

G. W. WILLARD
Physical
Research

Ultrasonic waves, in common with those of audible sound, light and radio waves, are subject to reflection, refraction, diffraction and interference. Means of making these effects visible are limited, but when ultrasonic waves are produced in a liquid, it is possible to show, in dimensions convenient for viewing or photographing, the course of a beam through lenses, prisms, reflectors and apertures immersed in the liquid. Diffraction and interference effects are also easily shown and studied.

Ultrasonic waves are produced by a thin piezoelectric plate of quartz to which an electric oscillator applies a high-frequency voltage. The plate becomes alternately thicker and thinner and thereby generates in an adjoining transparent liquid a correspondingly high-frequency ultrasonic wave. This wave travels out through the liquid with a velocity not appreciably different from that of audible sound and reacts by means of refractive index changes in the liquid on a light beam that passes through the liquid. Diffraction spectra like those obtained with an optical grating are produced in the light beam, Figure 1. This is known as the Debye-Sears ultrasonic light diffraction phenomenon.

In the equipment used to obtain the accompanying illustrations, light from the source LS, Figure 2, is focused by the condenser lenses CL onto an aperture plate P1. It passes through a narrow slit therein, then through the lens L1 which produces a parallel light beam that passes through the ultrasonic cell, and is focused by lens L2 back to a line image at the plane P2. The cell is formed of two glass sides W and has metal bottom and ends. A sound-absorbing pad P is placed in one end. The other end of the cell is partly closed by a 10-megacycle quartz plate which radiates the sound waves. The cell is several times as long as the diameter of the lenses L1 and L2, but may be moved lengthwise to place any part of it in the light beam.

With a suitable electrical and optical arrangement, this device may be used to modulate, in accordance with an electric signal, the light that passes through the ultrasonic beam. A curve of light transmission versus signal voltage is shown in Figure 3. With another arrangement one may form on a screen a visual image of the course of the ultrasonic beam itself. In Figures 4 to 10 photographs of such beams are shown: unrestricted, reflected, refracted, focused and absorbed.

An oscillator-amplifier, shown in the head piece, applies up to several watts of power at ten megacycles to the quartz radiator. With water in the cell, ultrasonic waves travel down it at the speed of 1.5 x 10^6 mm/sec. This gives, at 10 megacycles, an ultrasonic wavelength of 0.15 mm, or about seven waves per mm. When ultrasonic waves are propagated through the cell, there is produced in the liquid alternate regions of compression and expansion, which in turn cause alternate regions of increased and decreased index of optical refraction in the liquid. These closely spaced index variations act to produce diffraction spectra somewhat as do the transparent and opaque regions of an optical line grating.

Here the similarity between the ultrasonic grating and the ruled grating ends. With the ultrasonic grating it is possible to change the proportion of light diffracted into a given order by merely changing the amplitude of the sound waves. With the optical grating no change is possible, except by changing gratings. Figure 1 shows diffraction spectra produced by ten megacycle ultrasonic waves in water, when using first the full mercury spectrum and then only the mercury green lines. With zero voltage applied to the ultrasonic radiator, all the light is undiffracted and falls in the zero order at the center. On increasing the voltage, more light is diffracted, more orders appear, and less light falls in the zero order. This continues until little or no light is left in that order, as is shown here for 100 volts. At 150 volts light reappears in the zero order. In the lowest three views a very wide slit has been used so that the separate orders almost overlap.

It is this feature of the ultrasonic grating which makes it so useful. For if one places

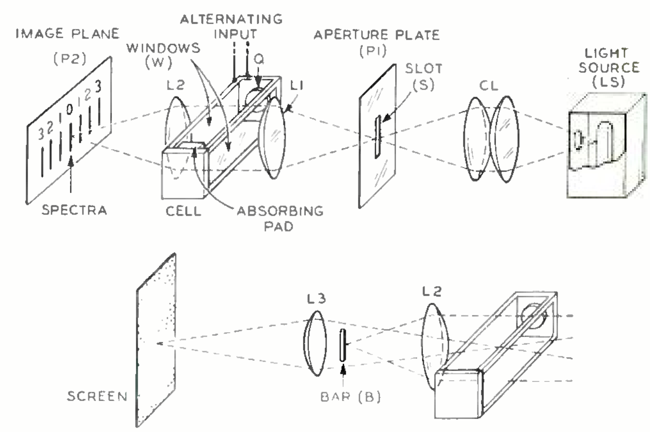


Fig. 2—The upper diagram shows the arrangement used to produce the ultrasonic light-diffraction spectra shown in Figure 1. By the addition of a bar B, as shown below, light may be valved and by the further addition of lens L3 an image of the ultrasonic beam may be cast on a screen as is illustrated in the following figures

in the plane P2 of Figure 2 a narrow bar B, the light in the undiffracted zero order is completely stopped, as shown in the lower assembly of that figure, but the diffracted light of the higher orders passes. Thus the transmitted light increases with the sound amplitude and hence with the voltage applied to the radiator. This is also shown in Figure 3, where with zero voltage applied (no sound waves), no light passes. As the sound amplitude and voltage increase, the light transmission increases rapidly up to about 90 per cent for white light.

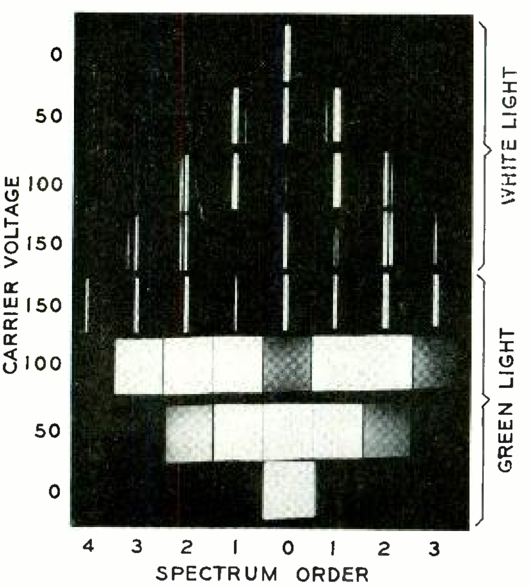


Fig. 1—Diffraction spectra produced by ten megacycle ultrasonic waves in water. The upper narrow line spectra are made with a narrow slit-aperture, the lower broad spectra with a very wide slit which is used in light-valving

Thus, if the voltage is turned up and down by hand, or if modulated electrically, the light is likewise modulated or valved.

By the further addition of a lens L3, beyond the bar B, it is possible to focus the center plane of the cell on the screen which will then be totally dark when no sound waves are present in the cell. With sound waves, however, an image of the ultrasonic beam will appear on the screen, as is shown in Figures 4 to 10.

The narrower the ultrasonic beam, the more pronounced are the diffraction effects. This is illustrated in Figure 4A, B and C where the beam width is reduced from 85 to 42 and to 21 wavelengths, respectively. When the beam width is halved, a given range of diffraction effects are condensed into one-fourth the distance from the radiator. Beyond the point n=1 the beam spreads and is separated into a strong central beam and successively weaker side beams—all virtually radiating from the center of the quartz radiator. This corresponds to the beam from a microwave antenna.

Figure 4D shows diffraction around a wire 21 wavelengths wide. At the center of its shadow there is some energy at all distances from the quartz radiator.

Refraction of the ultrasonic beam through a cylindrical lucite lens is shown in Figure 4E. Since the velocity of sound in lucite is greater than in water, this plano-concave lens converges the ultrasonic beam to a focus. At the focal point f of the beam may be seen the diffraction effect which makes a star appear in astronomical telescopes as a bright spot surrounded by successively weaker rings.

Another means of concentrating ultrasonic energy is shown in Figure 5. A quartz radiator Q focuses spherical waves at the center of curvature of the radiator.

Examples of ultrasonic reflection are shown in Figure 6. In the top view the beam is first reflected from a glass plate upwards to the water-air surface, then from this surface, which is just outside the view shown, down to the metal bottom of the tank, and then up again. The next view shows the beam successively reflected from the two inclined surfaces of a steel V-block. P is an absorbing pad to prevent further reflections. The third view presents four reflections of the reflecting power of the water-to-steel surface. The last view of the unrestricted beam is for comparison.

Reflection and transmission of an ultrasonic beam through thin wedges and plates is illustrated in Figure 7. The top view gives three separate examples of transmission through wedges of increasing taper. When the thickness is a multiple of the half-wavelength of sound in the wedge, the transmission is high. At other points there is mainly reflection. A similar but more complicated phenomenon occurs in thin parallel plates which are angularly disposed to the beam. The middle view of Figure 7 shows transmission through a thin glass plate where, at the angle used, there is effective resonance, large transmission through the plate and little reflection. At a slightly different angle, shown in the bottom view, there is no resonance, and nearly complete reflection.

Reflection of the beam from a quarter-inch-thick plexiglas plate mounted for

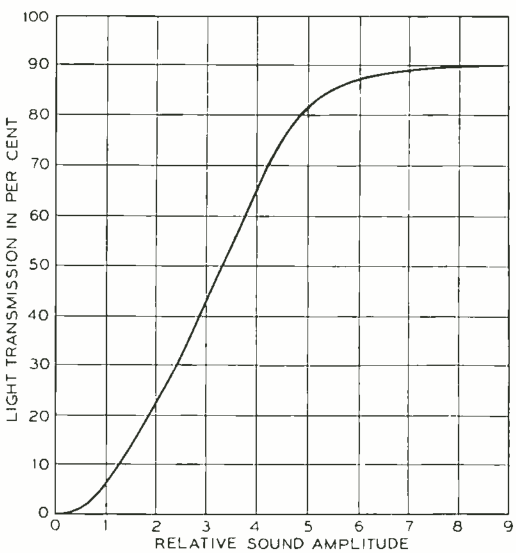


Fig. 3—Light-valving characteristic of an ultrasonic light valve when using white light and the bar and slit apertures described in Figure 2. The sound amplitude is proportional to the modulating voltage. The transmitted light is that portion of the total which is diffracted into all but the zero order spectrum at the center

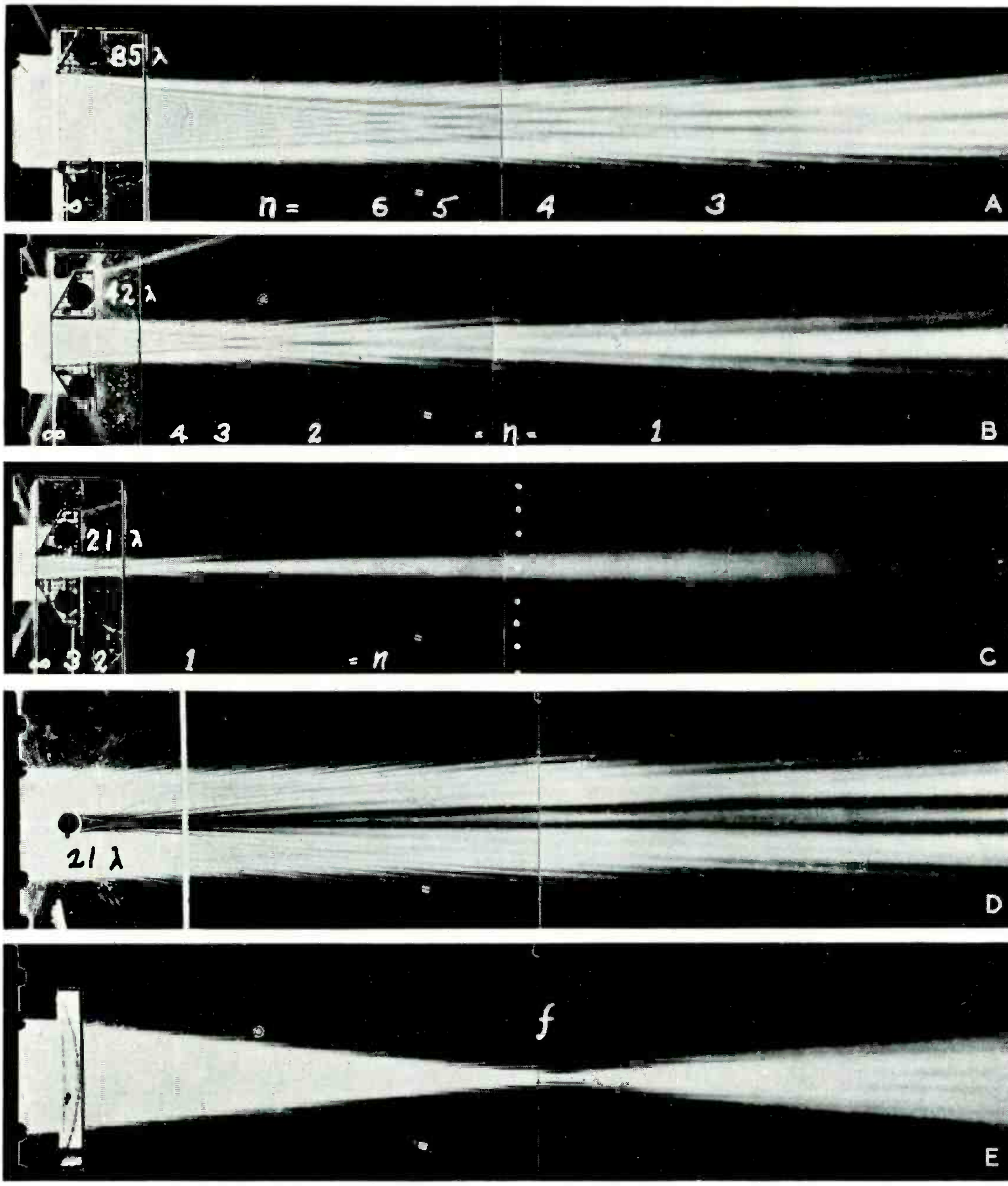


Fig. 4—A, B and C show the diffraction in ultrasonic beams of widths decreasing from 85 to 21 wavelengths at the defining aperture at the left. The beam at A is like a light beam through a very narrow slit, that at C simulates a microwave radio beam with a strong center portion and weak side beams. D illustrates diffraction around a wire 21 wavelengths in diameter—note that the sound reappears in the center of the shadow. E shows focusing of the beam by a lens and the diffraction effect at the focus f which is well known in telescopes

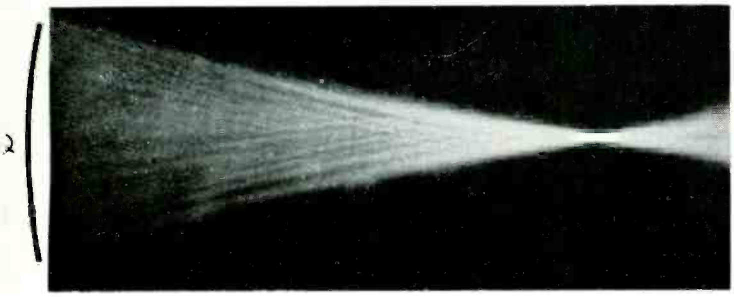


Fig. 5—Another means of concentrating ultrasonic energy. A concave quartz radiator Q focuses spherical ultrasonic waves at the center of curvature of the radiator. Again diffraction prevents the focus from being infinitely sharp

Fig. 6—Reflection of a narrow ultrasonic beam. At A the reflection occurs first from the glass plate G, then from the upper water-air surface of the cell; and finally from the bottom of the tank, the latter two reflecting surfaces are out of the view. B and C show reflections from steel blocks st. The beam is finally absorbed in the wool pad P. At D is shown the unrestricted beam

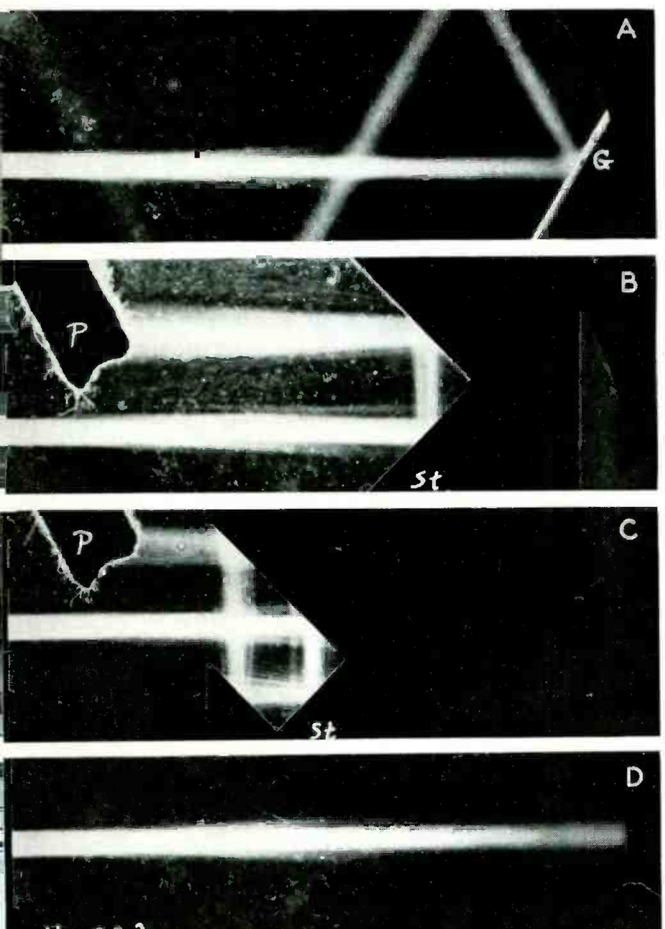
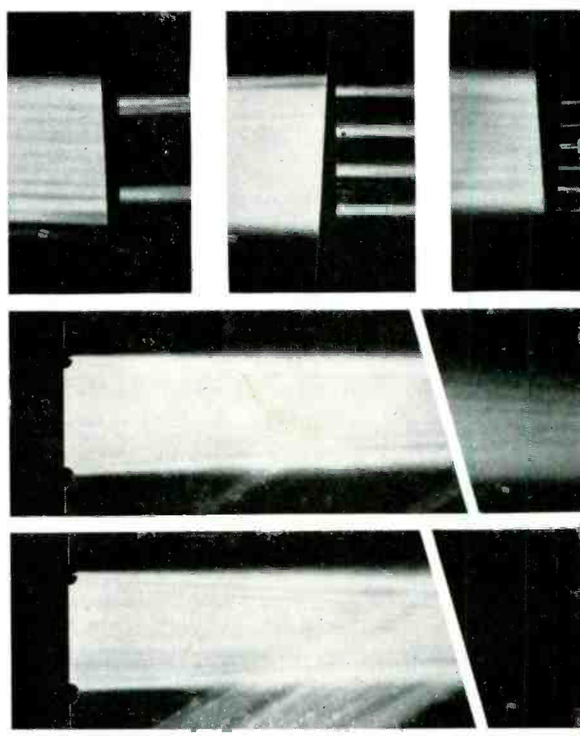


Fig. 7—Transmission of a wide ultrasonic beam through aluminum wedges of increasing taper is shown at A. Transmission occurs only where the wedge thickness is such as to give internal resonance. B and C illustrate transmission and reflection from an untapered glass plate held at slightly different angles to the beam



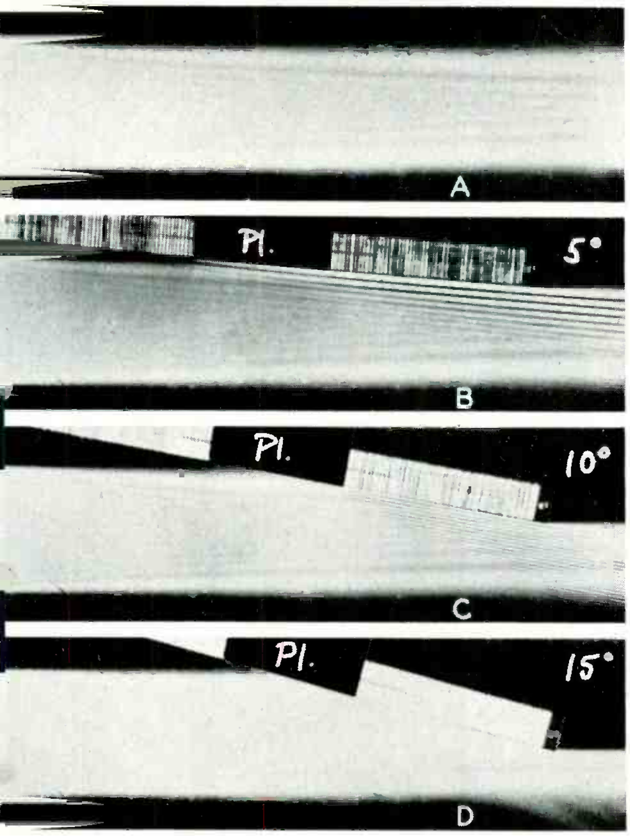


Fig. 8—Shows reflection at nearly grazing incidence from a Plexiglas plate PL which has vertical striations across its width. Note at the extreme right the standing wave striations parallel to the reflector. These are produced where the incident and reflected waves pass through each other

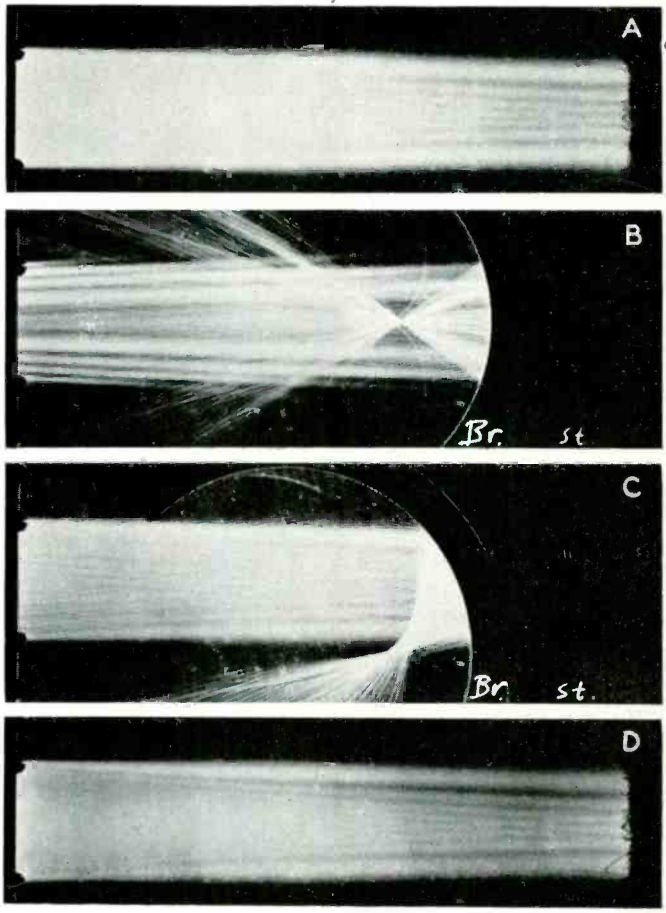


Fig. 9—Reflection of an ultrasonic beam from a cylindrical brass reflector Br. At B the beam is centered on the reflector and gives a very sharp focal spot. At C it is off center and produces the poor focus well known in optics as a caustic

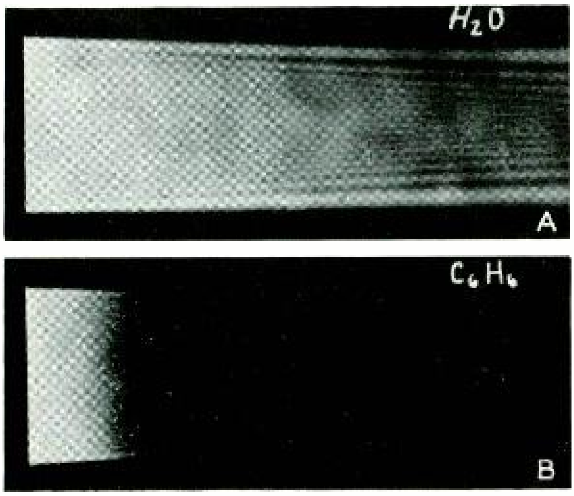
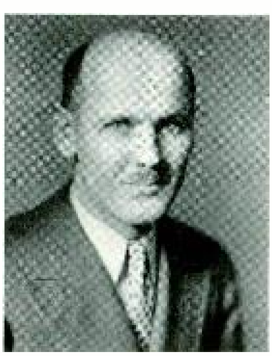


Fig. 10—Difference is absorption or attenuation of ultrasonic waves in different liquids

nearly grazing incidence is shown in Figure 8. Where the reflected and incident beams pass through each other, there are standing waves parallel to the reflector. This is shown by the straight, dark lines which are parallel to the reflector surface. Near grazing incidence (5-degree view), the standing waves are far apart. As the angle is changed from grazing (10-degree and 15-degree views), the standing waves become closer and closer. At perpendicular incidence they would occur at one-half-wavelength separations. Figures 6, 7 and 9 show many examples of these standing wave striations at regions where different portions of the beam cross each other.

An ultrasonic beam reflected from a concave, cylindrical metal surface is beautifully illustrated in Figure 9. The sharpness of focus halfway from the reflector to its center of curvature is very pronounced in the B view. When the beam is reflected from an off-center portion which corresponds to using part of a very wide beam, the optical effect of spherical aberration is shown by the poor focus and caustic.

The remarkable difference in absorption or attenuation of ultrasonic waves in different liquids is illustrated in Figure 10. The top view indicates that the absorption in water is hardly noticeable, since the beam is little weaker far from the quartz radiator than near it. However, in benzene, a liquid of as low viscosity, the absorption is thirty times as great, Figure 10B. The beam will travel a foot in water before its amplitude is cut down to one-half, but in benzene only a quarter inch. This attenuation does not include losses by diffraction and spreading. In the megacycle frequency range the attenuation in liquids increases with the frequency squared so that at thirty megacycles the attenuation would be nine times as great. Thus, operating at successively lower frequencies decreases the attenuation until, for example, submarine detection becomes practical in the kilocycle frequency range. On the other hand, with the lower frequencies, spreading of the beam by diffraction increases, and in the audible range the sound coming from a loudspeaker bends out in all directions.



THE AUTHOR: G. W. WILLARD joined the Laboratories in 1930 and has since been engaged in studies of piezoelectric materials and their applications. Just prior to and since the war he has worked mainly on ultrasonic investigations. Extensive measurements have been made of ultrasonic velocity and its temperature dependence and of the attenuation of ultrasonic waves in liquids. In connection with these measurements, it has been necessary to investigate in detail ultrasonic light-diffraction phenomena, and the radiation and propagation of ultrasonic waves. Mr. Willard was graduated from the University of Minnesota with the Bachelor's degree in 1924 and Master's degree in 1928. For two years he was a graduate student at the University of Chicago.

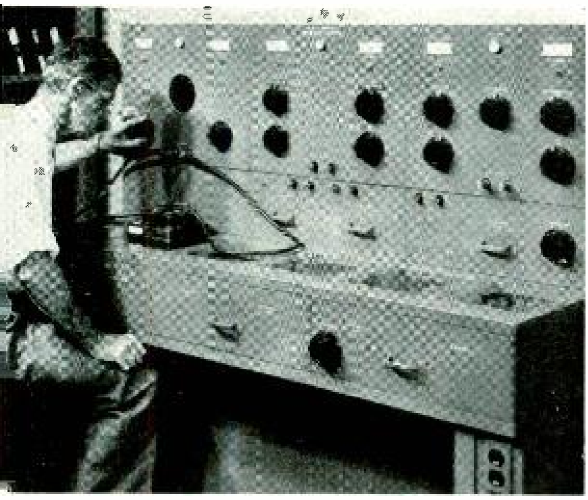


Fig. 1—A. G. Eckerson using the new meter test set at the Murray Hill Laboratory

METER CALIBRATION AT MURRAY HILL

Murray Hill Laboratory's Instrument Bureau now has its own meter test set. It was designed by the Electrical Measurements Group at West Street and is similar to the one in use at the Whippany Laboratory,* except in the arrangement of the standards, and in the use of a-c rather than batteries for its primary power source. Shown in Figure 1, the set provides complete facilities for calibrating a-c and d-c voltmeters up to 750 volts, and a-c and d-c ammeters to 100 amperes. In addition, it also provides means for testing wattmeters with direct current. Power is obtained from the commercial a-c source, and the set includes rectifiers for d-c requirements.

The set has two circuits for d-c meters and one for a-c meters, each circuit having a separate control panel with switches, pilot light, variacs and voltage regulator. Meters to be tested above thirty volts alternating current or seventy-five volts direct current are placed in one side of the center drawer with the standard in the other side, and no power can be applied until the drawer is closed. Other types of meters rest on the shelf adjacent to the standard under the plate glass window or in the upper three right-hand drawers, Figure 2.

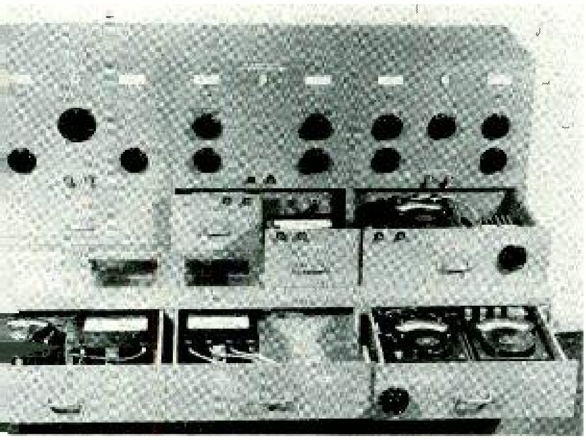


Fig. 2—Drawers are provided for the standard meter and for the higher voltage meters being calibrated

*Record, *February, 1945, page* 57.

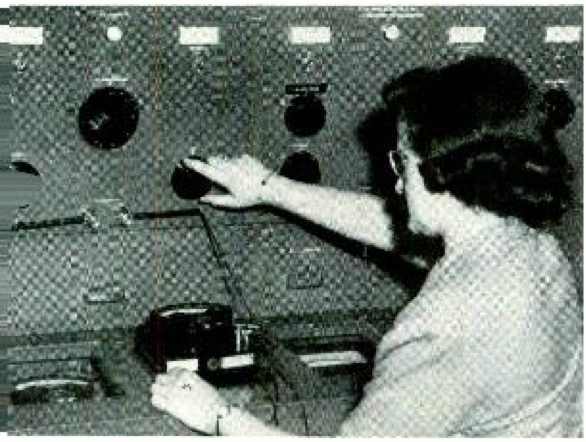
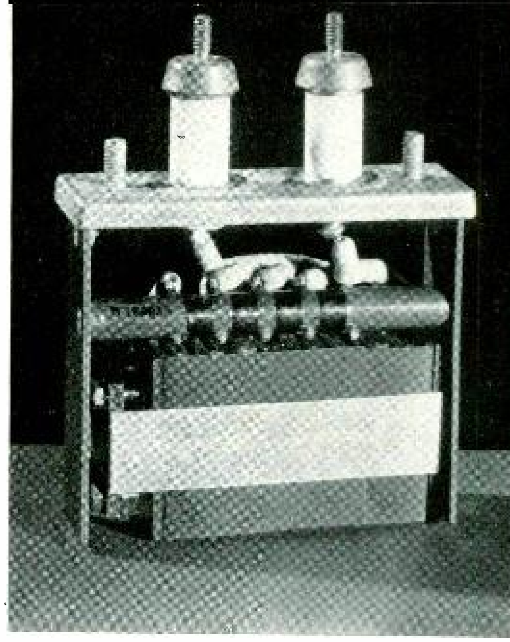


Fig. 3—Ruth Dorchak of the Murray Hill Instrument Bureau moved slightly toward the right to accommodate this photograph. The standard meter is under the window at the left of the meter being calibrated. Current through both meters is changed by slowly turning the "fine" variac knob



CAPTORS FOR HIGH-VOLTAGE PULSE NETWORKS

M. C. WOOLEY
Transmission
Apparatus
Development

Radar depends for its operation on short high-powered pulses of high frequency. These pulses, which are sent out at rates varying from a few hundred to a few thousand pulses per second, are produced by a vacuum tube supplied with power in the form of uni-directional pulses of high voltage. Of several ways in which these uni-directional pulses are produced, one of the most common is by charging capacitors to a high voltage and then allowing them to discharge for the brief interval of the pulse. One of the requirements, however, is that the pulses be nearly rectangular in shape. Since a capacitor discharge by itself is not of this shape, the pulses are passed through a shaping network to produce the desired form. A coil and capacitor network of the type shown in Figure 1 is usually employed, in which the capacitors besides serving as elements of the network serve also as the pulse generators.

Depending upon the type of radar, the pulse networks must supply pulses of power ranging from 50 to 1,500 kilowatts peak at rates from 4,000 pulses per second for the low-power types to 200 pulses per second for the high-power types. The high voltage and current at which the capacitors in the network operate, the high ambient temperature that must be provided for, and the relatively close tolerances allowed, drastically restrict the type of capacitor that can be used. Mica capacitors meet the requirements, and they were used for the early designs. Mica was relatively scarce, however, and the large amounts that would be required coupled with the labor involved in stacking by hand the hundreds of laminations required for each network indicated a need for some other type of capacitor. Paper capacitors,* because they are easily constructed, were particularly attractive, and the requirements for precision and stability were within the capabilities of high-grade paper construction. Very little was known of the ability of paper capacitors to stand up under this type of service, however, and it was necessary to undertake extensive laboratory tests to determine their performance characteristics in this application. On the bases of preliminary results, paper capacitors were designed and used in radar equipment early in the war. The laboratory tests were continued, and as a result information was obtained which made possible the design of all later condensers to secure the desired length of life without unnecessarily large margins which would be wasteful of space and weight.

Like other dielectric materials, impregnated paper is most efficient when used in thin sections. In practical designs, therefore, a number of layers of paper are used between the two foil electrodes, and the total thickness between electrodes is limited to approximately twice the thickness of the paper on which this is printed. These foil electrodes with their interleaving layers of paper dielectric are wound into a roll, called a unit, which is later pressed flat. For the voltages used in pulse networks, the total thickness of dielectric required is greater than the maximum used in a single unit, and thus it is necessary to connect two or more units in series to form a capacitor section. Each such section provides one capacitance of the network, and a number of these sections are assembled together. To avoid large capacitance changes after the assembly is completed, the units are held under pressure by a clamping arrangement that also allows for variation in the over-all height of the stack resulting from slight differences in the paper thickness. Since the volume of the units is usually small, it is necessary for the clamps and insulators also to be small, so as to constitute only a small portion of the total volume. Typical assemblies using this construction are shown in Figures 2 and 3.

A steel band is provided to hold the assembly together, and the condenser units, insulation, and clamping device are assembled within this band. Proper pressure for the units is obtained by adjusting screws which, backed by the steel band, permit the required pressure to be applied. Figure 2 shows such a capacitor for eight kilovolts, and a much smaller one for operation at four kilovolts. The larger assembly provides two 1,500, two 3,000, and nine 6,000 micro-microfarad capacitances, which may be used in various combinations to obtain a variety of pulse lengths. One terminal is common to all capacitances, which simplifies the use of the capacitor in a network of the type shown in Figure 1.

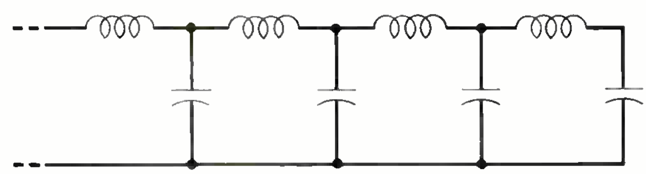


Fig. 1—Typical network used for pulse shaping

The other capacitor of Figure 2 is one of the smallest physically of the paper capacitors designed in these Laboratories for pulse-forming networks, and provides six capacitances that are of approximately 1,800 $\mu\mu$f each.

To insure the proper length and shape of pulse, the individual capacitances must be within ± 7 per cent of their nominal values, and the sum of the component capacitances must be within ± 5 per cent of the sum of their nominal values. It was found practicable to meet this accuracy commercially through proper manufacturing techniques and control, and capacitors were produced in which as many as thirteen capacitances composed of thirty-nine units were mounted in a single assembly.

Because of the high operating voltages and of the necessity for keeping the change in capacitance small even with extreme changes in temperature, mineral oil was used for the impregnant. To prevent flashover, the network container is also filled with oil. Since it was necessary to test the

*RECORD, *January*, 1943, *page* 123.

on top of each other there will be space between them for circulation of oil.

Over one hundred designs of paper capacitors for pulse-forming networks have been prepared during the past few years. These capacitors have ranged from 400 to 25,000 $\mu\mu$f in capacitance, and were for use at potentials ranging from 4,000 to 40,000 volts under ambient temperature conditions ranging from −40 to +185 degrees F. For the most part, these designs have been manufactured commercially for use in the many types of radar equipment produced by the Western Electric Company.

Where the capacitances required are low, paper capacitors become difficult to make to close capacitance limits because the area of foil required is so small that it is difficult to control it with sufficient accuracy. Furthermore, the space taken up by the capacitor clamping arrangements becomes a large proportion of the total volume of such small capacitors. For such capacitors, paper is not the best dielectric to use, nor is it when the operating temperatures are very high. Above a temperature of about 200 degrees F., the losses in paper increase rapidly, and thus tend to raise the temperature still higher. A runaway condition may result that ends in failure of the capacitor. In applications involving low capacitances or unusually high operating temperatures, therefore, and also in some instances where their mechanical features are desirable, ceramic capacitors have been used to advantage.

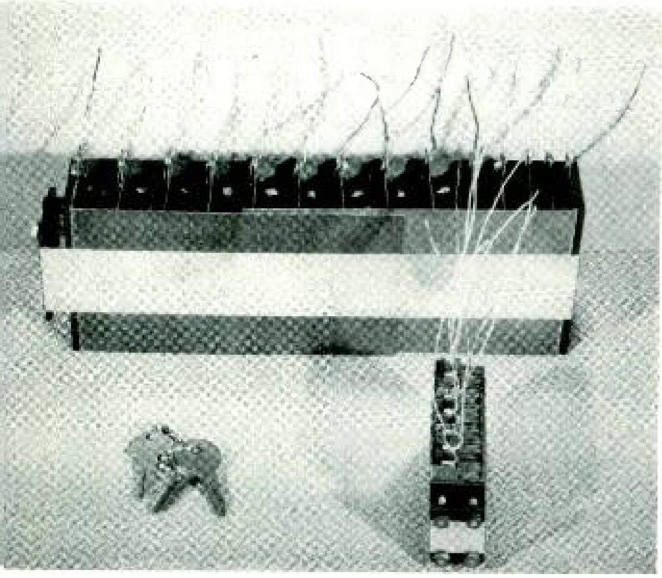


Fig. 2—An 8-kv capacitor assembly containing thirteen capacitor units, and a much smaller unit for operation at 4 kv with six capacitor units

capacitor assemblies before they were sealed with the coils in the completed network, a method of carrying out manufacturing tests in temporary containers was devised. This avoided the necessity of individual containers with high-voltage terminals for the capacitor assembly, which would have required considerable extra space in the network containers. Instead, the coils are laid across the top of the capacitor assemblies and placed in a closely fitting container.

A complete network incorporating a capacitor assembly like the smaller one of Figure 2 is shown in the photograph at the head of this article. G. F. J. Tyne was responsible for the coils for practically all of these networks, while the complete network design was under the direction of A. J. Grossman.

Several of the capacitor assemblies may be mounted in the same network container, and in some of the high-power equipments the losses in the capacitors and coils are great enough to cause appreciable heating. The assembly of Figure 3 is of this type, and to facilitate the dissipation of heat, the end plates of the capacitors are made larger than the rest of the assembly so that when several assemblies are stacked

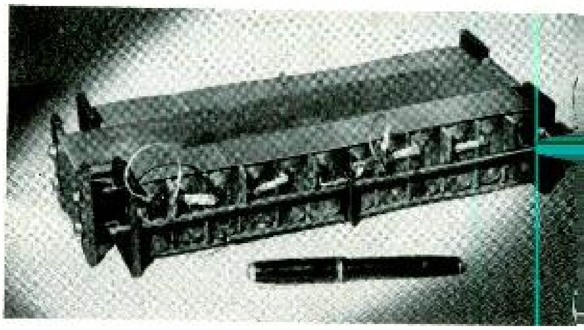


Fig. 3—Where large heat dissipation must be provided for, the end plates of the assembly are made wider than the capacitors to permit free circulation of the oil

The usual form of such capacitors is a tube of the ceramic material with a continuous coating of silver on the inside and one or more distinct coatings on the outside. Figure 4 shows two such capacitors, the smaller one having two capacitances of 250 $\mu\mu$f for operation at 2,600 volts peak, and the larger, a single capacitance of 6,000 $\mu\mu$f for operation at 10,500 volts. Where it is necessary because of high voltage to use two ceramic capacitors in series, the terminal on the inner silver coating (the terminal at the extreme end of the capacitors in Figure 4) is omitted, and two silvered bands with terminals are applied on the outside. The capacitances from the two bands to the inside coating are thereby placed in series in a single assembly that is easily mounted.

For high-voltage uses, ceramic capacitors are also operated under oil to minimize external flash-over and corona. The high value of dielectric constant obtainable in ceramics makes it possible to obtain relatively small capacitors even though the voltage stress in the ceramic must usually be made much lower than that in paper capacitors. Ceramic capacitors have not been used so widely as the paper type in pulse networks, but in those applications where they have been used, they have permitted large savings of mica, which might otherwise have been required.

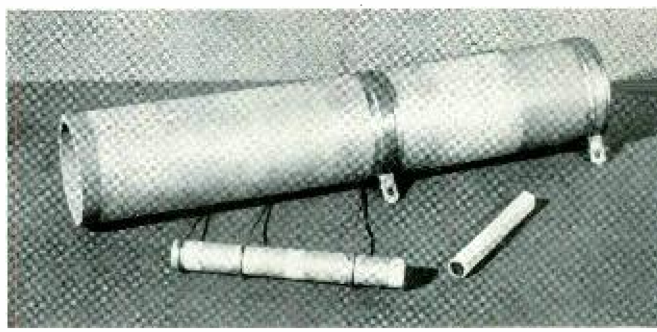


Fig. 4—Two sizes of ceramic capacitors used for pulse-forming networks, the smaller one having two capacitances of 250 $\mu\mu$f and the larger, one of 6,000 $\mu\mu$f

THE AUTHOR: M. C. Wooley, after receiving the B.S. degree in Electrical Engineering from Ohio Northern University in 1929, joined the Apparatus Development Department of these Laboratories. Until 1935 he was connected with the development of retardation coils for various Bell System uses. Since then he has been working on the design and development of capacitors. During the war period, his work was almost entirely confined to war applications such as those described in this issue.

EMERGENCY INSTALLATION OF TC RADIO EQUIPMENT IN MICHIGAN

About 7:15 p.m. on Sunday, April 6, H. S. Black called four of his engineers, saying that two AN/TRC-6* radio sets were needed immediately in northern Michigan to provide emergency telephone service between St. Ignace and Mackinac Island, the submarine cable carrying a dozen circuits to the island having been broken by ice.

The components of the two radio sets were located at 140 West Street, 180 Varick Street and Neshanic, New Jersey. It was necessary to remove the equipment from 140 West Street and 180 Varick Street before 6 o'clock the next morning.

The four engineers, J. W. Beyer, F. A. Muccio, W. F. Miller and C. R. Meissner, came to New York City and at 10 p.m. started to disassemble a tower located on the roof at 140 West Street. The process of removing this tower was about half completed when assistance was obtained from mechanics of the New York Telephone Company. With Mr. Meissner working with them, they completed this job and lowered the tower sections to the thirty-first floor for the elevator trip to the loading platform.

The other three engineers went to 180 Varick Street to collect the various components located on the seventh, tenth and thirteenth floors. Hundreds of items had to be procured in this building; not only the heavy frames, but also such things as test equipment, cables, instruction books, drawings and spare tubes.

Earlier in the evening, S. H. Willard had arranged for a moving van to transport the radio sets to Michigan. He opened 180 Varick Street, and personally arranged for elevator service and porters. As fast as components could be removed from laboratory set-ups, they were taken to the loading platform and packed in the van. The work at 180 Varick Street was completed about 3:15 a.m., and activities were transferred to 140 West Street.

In addition to the tower, various items of test equipment were brought down from the tank room. Everything was loaded, and the van left the building at 4:15 a.m., one and three-quarter hours before the deadline that was set. The van had to go to the main office at New Rochelle so the driver could get shipping papers, and also a little sleep.

The four engineers proceeded to Neshanic

Tower of the AN/TRC-6 microwave equipment installed on Mackinac Island

*Signal Corps designation for an 8-channel radio system. Record, *December*, 1945, *page* 457.

where what proved to be the greatest task of all was to lower, disassemble and pack a 50-foot tower which had stood in one location for several years. Lacking the usual facilities, special methods had to be improvised for lowering the tower. This operation was made more difficult because of a very high wind. Disassembling the tower was likewise difficult because of rust on the many bolts. While this tower work was proceeding, cables were collected from operating positions and storage locations, test equipment gathered together, and such things as tower anchors, guy wires and additional sections for the 140 West Street tower. It was found that clamps to assemble these sections were not available at Neshanic but were at the Holmdel Radio Laboratory.

Inside the "radio station" at Mackinac. Seated at the switchboard is R. C. Bero, Michigan Bell; at the radio set, F. A. Muccio of High Frequency Transmission; and at the oscilloscope, J. R. Lundberg of Michigan Bell

An emergency call brought one of the Holmdel engineers to the Neshanic field laboratory with the necessary clamps.

The many, many items were finally collected and packed in a van. The van left Neshanic at 4:55 p.m. Monday for Detroit. Muccio and Miller, seated beside the driver, rode in the van. Having worked all that day and the night before, they decided that Allentown was far enough for the first leg. Tuesday, however, they really traveled—420 miles to Lodi, Ohio. About 1 p.m. on Wednesday, they reported to the telephone people at Detroit and from there on were driven in a comfortable car. By lunchtime Thursday, they were in St. Ignace and soon, with the help of four Michigan Bell supervisors, had equipment for one terminal unloaded at the central office. Since the ferry to Mackinac Island carries only passengers, they loaded the other terminal on it and plowed through the ice to the island. After selecting the location there, they went back to St. Ignace and set up there. Since the office was on high ground, two 8-ft. sections were enough for the tower, and with everybody lending a hand, it was tipped up into place.

Next day, Saturday, permission had been granted to set up the island terminal in a little boat house, and the tower alongside. On Sunday everything was assembled and tested on the ground, and the 50-foot tower was slowly winched up into place. Contact was made at once with St. Ignace and they heaved a deep sigh of relief after shouting Dom Pedro's famous slogan. Meanwhile, the Michigan Bell people had run wires and placed a No. 3 magneto switchboard alongside the terminal as a link between the community dial office and our radio system. At 1 o'clock on Monday, April 14, the installation, furnishing 8 circuits, was turned over for traffic, and Muccio and Miller began to think of airplane schedules homeward.

The telephone people told them that their nine-quad cable began to give trouble on April 5 and went out the next day, evidently due to damage from ice in shoal water. A few days later the Coast Guard cable failed for the same reason.

Dr. Buckley Addresses the National Geographic Society

Science Unravels Speech was the subject of O. E. Buckley's talk before the National Geographic Society on March 14—a demonstration lecture given as part of the centennial observance of the birth of Alexander Graham Bell. Before a capacity audience of over 3,500 in Constitution Hall in Washington, Dr. Buckley described and demonstrated the voder, the vocoder, and visible speech, including a device for converting visible speech patterns back into audible speech.

Franklin Institute Honors Dr. Southworth

G. C. Southworth of Radio Research at Holmdel has been named the first recipient of the Stuart Ballantine Medal of The Franklin Institute, in recognition of pioneer contributions to microwave techniques which proved of great value to wartime radar and the post-war development of new communications systems.

This is the second medal awarded Dr. Southworth by The Franklin Institute in two years. In 1946 he received its Levy Medal, another high award in the field of science, for his discovery that the sun gives off short-wave radiation similar to that employed in radar.

The citation for the Ballantine Medal reads: "In consideration of his pioneer work in electromagnetic microwave technique, a material contribution to the development of communication and reconnaissance radar."

The medal, presented at The Franklin Institute Medal Day exercises in Philadelphia on April 16, was recently established to honor the late Dr. Stuart Ballantine. Present at the ceremonies, in addition to Dr. Southworth, were Ralph Bown, Harvey Fletcher, A. G. Fox and W. A. Tyrrell.

W. S. Gifford Wins 1946 Wedge Award

Walter S. Gifford, president of the American Telephone and Telegraph Company, has been awarded the inter-industry Wedge Award for 1946. Formal presentation of the award will be made in the near future.

The Wedge Award is an unusual presentation to the man or woman in any industry whose accomplishments are reflected toward the betterment of mankind, being a symbol of devotion to duty, integrity and benefit to others.

"Mr. Gifford was selected by the committee for the highly prized award from a long list of leaders in business, science and industry for his remarkable achievement in improving and expanding telephone service, especially long distance, in 1946, without which recovery of the national economy would have been immeasurably retarded if not permanently impaired," Owen R. Cheatham, president of the Georgia Hardwood Lumber Company which sponsors the award, declared.

On April 8, Medals for Merit were conferred on three Laboratories engineers in recognition of their development of one of the most effective weapons of the war, the electrical gun director. Left to right are O. E. Buckley; D. B. Parkinson, C. A. Lovell, and J. J. Kuhn, the three recipients; and Brigadier General E. E. MacMorland, who made the presentations

Medals for Merit

For developing one of the most effective weapons of the war, the electrical gun director, three Bell Telephone Laboratories engineers, C. A. Lovell, D. B. Parkinson and J. J. Kuhn, were awarded the Medal for Merit, the Nation's highest civilian award, on April 8. Brief presentation ceremonies were held at West Street. The citations were as follows:

"For exceptionally meritorious conduct in the performance of outstanding services to the United States from November, 1940, to August, 1945, in connection with the successful development of electrical mechanisms for directing gunfire against aerial targets, thus contributing materially to the effective employment of anti-aircraft artillery in the war."

The awards were presented by Brigadier General E. E. MacMorland, commanding officer of the Ordnance Department, Frankford Arsenal, Philadelphia.

Design Group of Electronic Department Transferred to Allentown

In order to effect a closer coördination with manufacturing operations of the Western Electric Company, the design functions of the Electronic Apparatus Development Department of the Laboratories will be performed at the Electronics Shop of the Western Electric Company at Allentown, Pa., and will be under the general supervision of V. L. Ronci. It is expected that the move of personnel affected by this change will take place between September 1 and December 1 of this year.

News Notes

MOBILE radio-telephone transmitters owned and operated by the Associated Companies were brought into emergency service 19 times in 1946 to bridge gaps in land lines caused by floods, sleet and snow. A total of 547 commercial calls and 42 official calls was handled over distances up to 58 miles.

THE FOLLOWING members of the Laboratories attended an M.I.T. Electronics Conference: K. K. DARROW, A. H. WHITE, J. A. HORNBECK, J. P. MOLNAR, H. D. HAGSTRUM, C. HERRING, J. B. JOHNSON, G. E. MOORE, K. G. MCKAY, W. SHOCKLEY, J. R. HAYNES, F. E. HAWORTH, HARVEY FLETCHER, L. A. WOOTEN, J. A. BURTON and N. B. HANNAY. Papers presented were *Thin Film Thermionic Phenomena* by G. E. MOORE and H. W. ALLISON; *Secondary Electron Emission From Barium-Strontium Oxide* by J. B. JOHNSON; and *The Print-Out Effect and Its Use in the Study of Motions and Electrons in Silver Halide Crystals in an Electric Field* by J. R. HAYNES. Dr. Shockley was chairman of one of the sessions at the Conference.

A. H. WHITE and L. A. WOOTEN recently visited the General Electric at Schenectady.

A. C. WALKER made several trips to Allentown, where he visited the Western Electric Company's crystal-growing plant for discussions on the operation problems involved. Mr. Walker also gave a talk on *Growing Synthetic Crystals* before the supervisory group on crystal processing at Kearny.

J. R. TOWNSEND attended meetings of the Mechanical Standards Committee of the American Standards Association in New York. He also attended that Association's panel discussion in Washington that was devoted to *Tolerances for Sheet Metals.*

J. C. STEINBERG has been appointed a member of the Committee on Hearing, Division of Medical Sciences, National Research Council.

PAPERS PRESENTED before the Institute of Radio Engineers winter convention were *Targets for Microwave Radar Navigation,* by S. D. ROBERTSON; *An Adjustable Wave Guide Phase Changer,* by A. G. FOX; *Measurement of Delay Distortion in Microwave Repeaters,* by D. H. RING; *A Method for Measuring the Instantaneous Frequency of a Frequency-Modulated Oscillator,* by L. E. HUNT; *Experimental Determination of Helical-Wave Properties,* by C. C. CUTLER; and *Experimental Studies of a Remodulating-Repeater System,* by W. M. GOODALL.

Informal luncheon of Laboratories engineers who participated in the first public demonstration of television by wire from Washington and by radio from Whippany twenty years ago. Standing: S. Brand, D. K. Gannett and J. G. Knapp; in large circle: F. W. Reynolds, G. R. Stilwell, H. E. Ives, M. W. Baldwin, Jr., Frank Gray, J. R. Hefele, P. H. Betts, E. F. Kingsbury, A. L. Johnsrud and H. M. Stoller. Seated in left foreground: A. W. Horton, Jr., R. C. Mathes and E. L. Nelson

W. A. TYRRELL spoke on *Wave Guides for Electrical Transmission* before the Pittsburgh and Chicago Sections of the A.I.E.E.

V. F. MILLER investigated the use of bank covers during cleaning operations at the Waverly exchange in Philadelphia.

Photo—American Red Cross

IN MEMORIAM

Members of the Laboratories who died in the service of their country

ERNEST G. GRAF	JOSEPH KELLY
DAVID F. GREENHAGEN	EVERETT T. URBANSKI
SARKIS KARIBIAN	WILLIAM G. SCHIFF
EDWARD A. FERN	JOSEPH T. MURPHY
STANLEY W. ERICKSON	ROBERT F. HEALY
ORRIN F. CRANKSHAW	JOHN K. GARDNER
HARRY A. MALONE, JR.	GERARD E. DAVIS
EUGENE H. SHEEHAN	NORMAN A. SORGER
THOMAS M. PEPE	JAMES J. KAHN

E. C. ERICKSON attended American Gage Design meetings at the Bureau of Standards in Washington and special American Standards Association meetings on measuring problems.

W. G. LASKEY visited the Kolmar Avenue Plant of the Western Electric Company in Chicago to discuss message registers with I. G. Barber and W. J. Malcolmson.

P. W. BLYE participated in the March 5 Science Forum broadcast over Station WYG, Schenectady. His topic was *What's News in the Party Line*. Science Forum programs help to acquaint the radio public with the achievements of modern research and engineering, and to promote on the part of laymen listeners an interest in, and appreciation of, scientific endeavor in many fields.

R. F. GLORE discussed relay problems with Western Electric people at Hawthorne.

P. B. DRAKE, F. C. KUCH, R. G. MCCOY, E. D. MEAD and C. W. SPENCER conferred on apparatus questions with the Taft-Pierce Company in Woonsocket, R. I.

D. T. EIGHMEY, at Hawthorne, discussed the manufacture of the new operators' head telephone set and miscellaneous handset problems.

C. A. WEBBER conferred with engineers of the Illinois Bell Telephone Company, Chicago, on studies of air conditioning.

F. E. ENGELKE discussed at Burlington a variety of hearing aid matters concerning current production; J. R. POWER, the manufacture of artificial larynges; J. M. ROGIE, W. KALIN and T. H. CRABTREE, hearing aids; and F. S. CORSO and L. VIETH, hearing aids and sound instrument problems.

B. F. RUNYON discussed the initial production of UB relays at Hawthorne.

G. R. YENZER was in Burlington on recorder production problems.

F. F. ROMANOW attended a meeting of the Executive Committee of the Sound Equipment Section and also the meeting of the Audio Facilities Committee of the Radio Manufacturers' Association on March 25 and 26 in New York.

O. C. ELIASON visited Chicago, Madison, Louisville, and Cincinnati on matters pertaining to air conditioning in central offices.

R. A. SYKES attended the conference of Subcommittee TR-9.1 on quartz crystal units of the Radio Manufacturers' Association.

J. P. MESSANA discussed Kovar glass seal terminals with the Mermaseal Company, Elkhart, Indiana.

D. A. MCLEAN and J. R. WEEKS visited the National Research Corporation, Boston, to discuss metalized capacitor paper.

A. B. BAILEY attended the Antenna Conference at the U. S. Navy Electronics Laboratory, San Diego, at which the improvement program covering ship and shore antenna systems was discussed.

M. WHITEHEAD conferred at Sprague Electric Company, North Adams, Mass., on electrolytic capacitors.

C. R. TAFT went to the Navy Department in Washington for radar discussions; and J. W. SMITH to the Bureau of Ordnance for similar discussions.

F. E. NIMMCKE spoke on *Radar* before "The Penguins" Club in Orange, N. J.

V. I. CRUSER discussed antennas with engineers of the Harris-Seybold Company in Cleveland.

H. A. BAXTER's recent trips to Boston and Providence concerned manufacturing problems of radar components. Mr. Baxter also visited the Gleason Gear Works in Rochester on similar problems.

W. H. DOHERTY and A. K. BOHREN attended conferences with Laboratories and Western Electric personnel at Burlington.

B. O. BROWNE was at Burlington for discussions of 10-kw FM transmitters.

E. D. PRESCOTT visited the Dahlstrom Metallic Door Company in Jamestown, N. Y., on equipment for FM transmitters. Mr. Prescott also spent several weeks in Burlington.

W. H. C. HIGGINS and S. J. STOCKFLETH visited the Diehl Manufacturing Company, Somerville, N. J. Mr. Higgins attended a conference at Frankford Arsenal, Philadelphia. He also addressed the Morris County Reserve Officers' Association, Morristown, on *The Principles and Application of Radar*.

A. E. HARRISON was in Akron and Cleveland on problems concerning radio transmitters used at those locations for the Bell System urban and highway mobile radio service.

C. G. REINSCHMIDT was at the Western Electric plant in Burlington from March 14 to April 4 in connection with shop problems on radio-telephone equipment.

R. H. RICKER, at Burlington, discussed manufacturing problems on the mobile telephone equipment with Laboratories and Western Electric personnel.

J. C. BAYLES was at the Winston-Salem radio shop from March 25 to 27.

W. H. DOHERTY was chairman of the session on *Microwave Components and Test Equipment* at the Institute of Radio Engineers' Convention in New York.

M. H. COOK spent several days during March at the radio shops in North Carolina.

S. C. HIGHT and R. A. DEVEREAUX conferred with Bureau of Ordnance men in Washington on March 18. Mr. Hight also made two other trips there later in the month.

J. H. COOK chose *Airborne Radar* as his topic when he addressed the Lehigh Valley Section of the American Institute of Electrical Engineers at Scranton.

P. L. HAMMANN conferred with engineers at the Philco Corporation in Philadelphia.

F. L. LANGHAMMER and representatives of Western Electric visited the Atlantic Manufacturing Company in Philadelphia regarding the procurement of antennas.

P. H. SMITH attended a meeting of the Institute of Radio Engineers' Technical Committee on Antennas.

May Service Anniversaries of Members of the Laboratories

45 *years*
Jacob Weber, Jr.

30 *years*
William Belits
A. R. Bertels
C. J. Dietz
B. R. Eyth
L. L. Glezen
C. H. Haynes
J. R. Irwin
William Orvis
L. E. Parsons
W. J. Scully

25 *years*
H. C. Atkinson
C. A. Bieling
B. R. Blair
R. W. Bogumil
D. R. Brobst
Mary Fitzsimmons
L. D. Fry
A. P. Goetze
A. W. Horton, Jr.
Madeline Merker
F. J. Prachnaik
Ernest Sanchez
R. V. Terry
Henry Walther

20 *years*
E. L. Alford
Frank Gritson
D. A. S. Hale
Timothy Harrington
J. R. Harvey
A. J. Hunter, Jr.
P. C. Jones
A. S. Lawrence
J. F. McEneany
George Meyerdierks
Emil Munger
T. W. Quinn
S. M. Ray
P. T. Rottstock
Christine Smith
F. W. Theel
Margaret Tobin

10 *years*
R. H. Beyer
Watson Richardson
P. T. Sproul
V. J. Vierling

Engineers frequently dictate by telephone, directl to typists, their brief, well-prepared copy, whil longer and less well-prepared copy is dictated t stenotypists like Margaret Brownlie of Transcriptio

Typing classes during business hours give new typ ists the opportunity to develop rhythm and evennes of touch and to perfect themselves in speed and ac curacy. This in-hours training program was orgar ized by the Personnel Department in collaboratio

HIGHLIGHT EXPERIENCES OF RECENT GRADUATES IN CLERICAL AND TRANSCRIPTION WORK

with the General Service Department and is con ducted by Priscilla Raymond, Instructor in Secretaria Studies in the School of Commerce of New Yor University. She is shown standing above in th classroom with (left to right) June Esposito, Jea Weiss, Marie Faella, Edna Hallal, Mary Sulliva and Catherine Loeffel. In the second row are Mar garet Gerdes, Gloria Sandhop, Mary Blackmor Patricia Hayes and Dolores Iannone; and in the rea Louise Bonomi. Later, after typists have become pro ficient, those interested receive stenographic train ing, and as they meet requirements advance in th stenographic field at various Laboratories location

Engineering dictation frequently contains Greek sym bols and mathematical equations. To accommodat the extra letters and symbols required, Transcriptio uses especially designed typewriters with removabl keys. In the photograph at the left Catherine Roth i shown changing a typewriter key preparatory to typin

Weddings at the Laboratories are marked by gifts and a decorated desk for the bride. Virginia Curry is putting final touches on such a desk in Transcription. Virginia was graduated in '47 from Memorial High School, West New York, New Jersey

During the Alexander Graham Bell Centennial Celebration, these junior clerical members of the General Service Department visited the museum, where they are seen viewing the switchboard used by Bell in opening New York-Chicago telephone service in 1892

Relief periods morning and afternoon are given to the girls at the Laboratories. Leaving Transcription together are Joan Marciano (left) of Woodrow Wilson High '47 and Jean Weiss of Flushing High '47

In the Laboratories Cafeteria these junior clerks and typists, all recent graduates, are enjoying their luncheon. Clockwise around the table, they are: Beatrice Pask, Grover Cleveland High; Catherine Loeffel, Bishop McDonnell High; Virginia Curry (standing at left); Mary Riebel, Yorkville High; Catherine Coleman, Yorkville High; Louise Bonomi, Bishop McDonnell High; Joan Marciano, Woodrow Wilson High; Evelyn Wentsch (standing) and Frances Ziske, Jamaica High; Gertrude Alefeld, Woodrow Wilson High; Eleanor Scheuch, Woodrow Wilson High; Jean D'Amico, Theodore Roosevelt High, all of the Class of February, 1947

M. N. Yarborough discussed the AN/APS-23 project with Winston-Salem personnel during a three-day visit there. Others who visited Winston-Salem for conferences were F. C. Willis and J. R. Haviland.

R. E. Carpenter visited Burlington, as did C. R. Hornby and C. Flannagan.

J. F. Morrison and E. L. Younker presented a paper entitled *A Method of Determining and Monitoring Power and Impedances at High Frequencies* before the IRE Winter Convention in New York. P. H. Smith also presented a paper at the convention entitled *Theoretical and Practical Aspects of FM Broadcast Antenna Design.*

J. M. Barstow described the M1 carrier telephone system to members and guests of the North Carolina Utilities Coördinating Commission on March 18 in Raleigh. After the talk, about forty of the seventy-five people attending the meeting motored to Nashville, N. C., where they inspected the M1 system now operating over the wires of the Carolina Power and Light Company.

H. C. Fleming made special tests on a type-K twist repeater at Springfield, Mass.

A. L. Whitman participated in tests of a new overseas transmitter installed at Lawrenceville to make available a second circuit to Moscow for the Foreign Ministers' Conference.

W. J. Farmer and J. B. Dixon discussed wire-joining problems at Clearing, Nebraska, in connection with an inspection survey.

C. S. Gordon and C. C. Lawson visited Point Breeze to discuss wire manufacturing problems.

S. M. Sutton and L. R. Smith conferred on factory methods of installing pulling eyes on corrosion-protected cable at Point Breeze.

A. P. Jahn, A. Mendizza and S. M. Arnold inspected corrosion-resistant steel wire samples exposed to weathering tests at Bridgeport, Conn., and Fort Hancock, N. J.

R. H. Colley and R. C. Eggleston attended a meeting at Minneapolis of American Standards Association Committee 05—Wood Poles, of which Mr. Colley was chairman. Mr. Colley spoke on March 19 before the Science Club of the University of Georgia at Athens, Ga., on *Trees, Poles, and Telephone Lines.* He also addressed the Operation and Engineering Section of the Southeastern Electric Exchange at Augusta, Ga., March 20, on *The Selection and Use of Modern Wood Preservatives.*

F. F. Farnsworth and G. Q. Lumsden correlated methods of bleeding prevention in southern pine poles at Jackson and Meridian, Miss., and Birmingham, Ala. Mr. Lumsden, I. M. Miller, and J. Leutritz, Jr., inspected the pole test plot at Gulfport, Miss.

A. H. Hearn continued his investigation of methods of treating Douglas fir poles at Nashua, N. H.

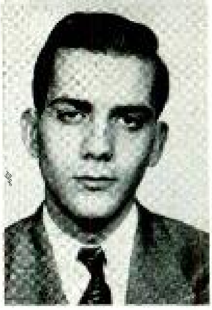
C. H. Amadon led a discussion group on round timbers at the annual Wood Products Clinic at Spokane, Wash.

R. J. Kent visited the Long Lines Plant at Philadelphia in connection with a field trial of a cable lubricator.

A. D. Knowlton, George Risk, R. G. Koontz and R. V. Rice visited the Western Electric Radio Shops at Winston-Salem to discuss problems in connection with power line carrier and video equipment.

R. S. Skinner, J. T. Motter, R. L. Lunsford and H. A. Miloche conferred at Hawthorne on dial equipment problems.

Angeline McDermott's thirtieth service anniversary in Transcription at West Street was the occasion for flowers and gifts. In this gathering are, left to right: Catherine Roth, Mary Mulhern, Anna Kiernan, Eleanor Ringel, Mrs. McDermott, Ethel Carr, Loretta McBride and Lydia Covalence, all of Transcription



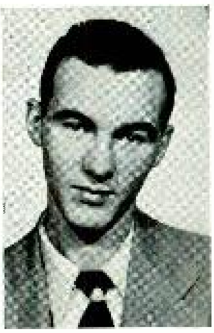
V. J. Capitini

S. F. Swiadek

W. A. Arny

Lieut. Burke

W. E. Maier



E. T. Clifford

Lt. Col. Roe

RECENTLY RETURNED VETERANS

VINCENT J. CAPITINI has returned to the Graybar-Varick building in the Tabulating Department after serving in the Navy at the Great Lakes and Iona Island (N. Y.) Stations.

EDWARD T. CLIFFORD of the General Service Department spent his year of military service in the Army Medical Corps. His post assignments included Camp Polk and Mason General Hospital.

STANLEY F. SWIADEK was an aircraft mechanic when he first went overseas to Germany and later became a clerk in the finance group. A member of the Electronic Apparatus Development Department, he now works in Building T.

W. ALFRED ARNY has returned to the Murray Hill Laboratory after approximately sixteen months in the Army. For the greater period of his service he was stationed at Fort Benning, Georgia.

LIEUT. MARY M. BURKE of the Army Medical Department was a hospital dietitian in Kennedy General Hospital, Memphis, for two years and then transferred to Bruns General Hospital, Santa Fe, New Mexico. She is now a member of the Systems Development Department in the Graybar-Varick building.

WILLIAM E. MAIER, a Technical Assistant in the trial installation group, was assigned to occupational duty with the 201st Aviation Engineers at Istres, France. Later he was on similar duty at Illesheim, Germany.

LIEUT. COLONEL JOHN C. ROE'S military career dates back to the Mexican Punitive Expedition in 1916. He also saw action in France during World War I with a combat division at the Voges Mountains, the Argonne and Saint-Mihiel. In World War II he was ordered to duty from the Reserves with the rank of Captain in the R.O.T.C. and assigned as a battalion commander at Fort Dix. His next post was Professor of Military Science and Tactics in the R.O.T.C. at Xavier High School in New York City, where he was Headmaster for three years. Colonel Roe later served as battalion commander at Fort McClellan.

News Notes

J. W. Schmied and R. C. Terry represented the Laboratories in interference proceedings before the Primary Examiner at the Patent Office in Washington.

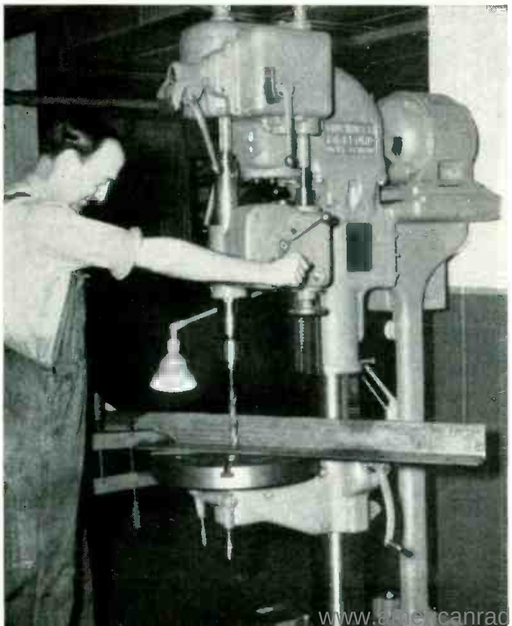
M. C. Biskeborn inspected special equipment being built for the Laboratories at the Geophysical Instrument Company. Mr. Biskeborn has been awarded first prize in the 1946-47 Prize Papers Contest of the Maryland section of the American Institute of Electrical Engineers for his paper *Attenuation Instability of Flexible Coaxial Cable in the Microwave Region.*

A. S. Windeler, G. J. Schnaible and R. A. Kempf witnessed special field tests that are being made on the coaxial cable between Baltimore and Washington.

"Favorite Brunette" of the New York Telephone Company is Elaine Petrillo, who was selected by the artist Russell Patterson, shown with her, to appear on Bob Hope's April 8 radio program in Hollywood to publicize his new movie, "My Favorite Brunette." One of fourteen girls selected from all over the country, Elaine spent two weeks in Hollywood, all expenses paid, and received hair restyling by experts and a Perc Westmore make-up as part of the trip. She is well known at the Laboratories, where she was a member of the Commercial Relations Department for three of her four years of Bell System service

WHAT'S NEW

It's a pleasure for James Marshall to operate this new drill press in the Building Shops Department. The press is one of several pieces of new machinery being installed in the Shop in a post-war program to replace old equipment



Anthony Ripepi (left) and N. L. Lamattina, battery and departmental service attendants, prepare to move some of the seventy new typewriters recently received for the Transcription Department

Maryalice Corey of the Accounting Department watches with interest as she is vaccinated against smallpox by Nurse Gertrude Thomas. As the RECORD *went to press, over* 3,000 *members of the Laboratories had been vaccinated by the Medical Department*

Intent on their work in a Laboratories sculpture class in Building are, left to right: Gertrude Haufe, Helen Ozard, Helen Hajinian and Paula Patterson

The instructress, Irma Rothstein, demonstrates a molding technique to Julia Haege, while Christopher Hartley, awaiting his turn, builds a torso

W. T. Gebhardt (right) of the Building Service Department receives the Award of Merit on behalf of the Laboratories from Commissioner C. J. Fletcher of the Bureau of Motor Vehicles. Mr. Gebhardt is one of the six Laboratories chauffeurs whose record of driving 38,364 miles without accident won for the Laboratories its third award since 1942. Present when the award was made at the Commercial Vehicle Luncheon of the 17th Annual Safety Conference and Exposition in New York were W. C. Burger, H. E. Crosby, G. F. Fowler and Daniel O'Neill

OBITUARIES

T. H. Roberts
1878-1947

Jacob Mayer
1886-1947

Charles Haug
1892-1947

G. E. Counihan
1895-1947

A. H. Shangle
1881-1947

S. A. Milne
1881-1947

A. J. Ketschke
1881-1947

Thomas H. Roberts, March 8

Mr. Roberts retired from the Laboratories in January, 1944, with over forty-four years of service in the Bell System. His telephone career began in The Bell Telephone Company of Pennsylvania, from which he transferred to the Installation Department of the Western Electric Company and traveled in this country and South America supervising switchboard installations. In 1920 he came to West Street, and, as a member of the Systems Development Department, worked on the original panel tandem system development and the panel suburban tandem system development. He also specialized in the design and development of sender circuits for both panel and crossbar switching systems.

After his retirement, Mr. Roberts became a member of the National Defense Research Council, where he worked on war projects in the Empire State building.

Jacob Mayer, March 31

Mr. Mayer joined the Laboratories as an instrument maker in 1922. Following an initial period of eleven years in the Model Shop, he was transferred in 1933 to the technical group concerned with magnetics research and development. In this latter period he constructed a wide variety of experimental fixtures and apparatus for physical research, and performed critical operations required in the preparation of metallic crystals for investigation of their properties.

Charles Haug, April 7

Mr. Haug, a milling machine operator in the Development Shops Department, had completed thirty-one years of continuous Bell System service when he died. In that span he had witnessed many transitions in the milling machines he had operated since first coming to the old Model Shop, and he had engaged in confidential work during two world wars. In the second one, he had performed specialized work on vacuum-tube details.

George E. Counihan, April 13

Mr. Counihan joined the Western Electric Company student course in 1913 at Hawthorne where some six years later he was placed in charge of the first panel-dial engineering school. By 1928 he was in charge of the Engineering Methods Department there and in 1929 he transferred to the Laboratories' local systems group of the Equipment Development Department on the design and development of panel dial equipment.

He was responsible for the equipment development work for the automatic message accounting trial installation in Washington, D. C., and was concerned with the introduction of multi-frequency key pulsing in No. 3 toll switchboards in step-by-step areas. More recently Mr. Counihan had planned the modification of Panel Offices to permit their connection with No. 4 toll switching offices in the Philadelphia, New York and Chicago areas.

Amos H. Shangle, April 2

Mr. Shangle, a member of the Technical Staff who retired in June, 1946, with twenty-eight years' service, had been a member of the Switching Apparatus Development Department since 1929. Before that time he had spent seven years, beginning in 1918, in the drafting group of the Apparatus Development Department. During the later years of his services he was engaged in investigating and in designing tools and apparatus for telephone maintenance work, a project which assumed unusual importance in World War II because of the inability to replace defective plant apparatus with new. He also was engaged in work on the gun director.

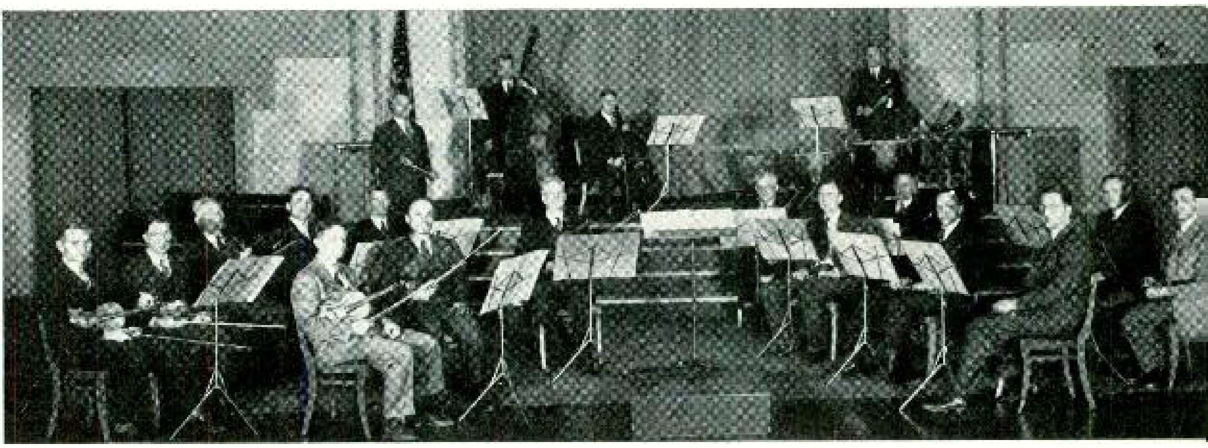
During the war, Mr. Shangle was chairman of the Roselle Defense Council. He had also served his community as Councilman and later as Fire Commissioner of Roselle and as president of the Lake Arrowhead Community Club.

S. A. Milne, April 12

Mr. Milne retired from the Laboratories on July 1, 1946, after twenty-six years of service in the Patent Department where he was a drafting supervisor. He had joined the Laboratories as a draftsman in 1920, became Chief Draftsman in 1926. Mr. Milne is survived by one son, J. Robert, a veteran of World War II.

Albert J. Ketschke, March 22

Mr. Ketschke, upon his retirement in 1933, had completed thirty-five years of service which began in the Western Electric Company in 1898. He had done assembly and test work at West Street from that time until 1922, except for two years from 1913 to 1915 when he was located at Hawthorne. In 1922 he became a Technical Assistant in the Research Department where he worked on telephone instruments until his retirement.



Laboratories musicians enjoy themselves by playing serious music with the Orchestra on Tuesday evenings in the West Street Auditorium. Their director is L. E. Melhuish, standing, baton in hand, on the stage in front of the flag. Also on the stage are C. R. Eckberg, bass; U. A. Matson, cello; and Fred Johnson, tympany. To the left are the violinists, in the front row, left to right: J. C. Gabriel, concertmaster; Tigran Ayvavian and A. L. Whitman; and in the rear row: R. N. Breed, C. D. Koechling, assistant director; John Leitl, A. J. Lovecky and H. M. Yates. To the right in the first row are: P. G. Edwards and W. S. Ross, flutes; E. W. Houghton, oboe; and W. A. Kreuger, bassoon; and in the rear row: H. C. Green and E. L. Erwin, clarinets; and H. M. Spicer, bassoon

Microwave Radio Terminal Tested at the Pentagon

Microwave radio relay circuits are being tested by the Signal Corps for communications between the War Department offices in the Pentagon and Headquarters, Army Ground Forces, at Fort Monroe, Virginia, according to Brigadier General William O. Reeder, Acting Chief Signal Officer of the Army.

The equipment being used is an ultra-modern type developed by Bell Telephone Laboratories during the war for the Signal Corps. It has facilities for eight telephone conversations simultaneously, or a maximum of ninety-six printing telegraph circuits, or a combination of telephone and telegraph circuits.

"The Saturday Evening Post's" Series on BTL Due May 7

The first part of a three-installment story concerning Bell Telephone Laboratories will be the leading article in the May 10 issue of *The Saturday Evening Post*, which appears on newsstands Wednesday, May 7. The two succeeding articles will appear in the issues of May 17 and May 24.

The articles encompass the history and development of the Laboratories, as reflected in its scientific and engineering accomplishments, from the pre-BTL days of General John J. Carty, former Chief Engineer of the American Telephone and Telegraph Company, to the present day.

The expansion and development of telephony, together with the birth of such modern marvels as sound motion pictures, radio broadcasting, and electronic recording which have stemmed from basic telephone research, are also described.

Particular attention is paid to the progress of the Laboratories under the leadership of F. B. Jewett, and the last article in the series chronicles its work in recent years under O. E. Buckley, especially the war program and current research and development projects.

While the article is naturally the expression of the point of view of a professional outside writer, those who have read it believe it presents very well some of the fundamentals of the Laboratories' accomplishments and objectives, and many persons, both inside and outside the Bell System, should find interest and value in reading it.

Author of the article is Milton Silverman, whose byline over technical stories is familiar to *Post* readers. The holder of a doctorate in chemistry, Silverman was associated with the NDRC during the war and has had wide experience in science-writing and editing. He is particularly adept at achieving technical accuracy without sacrificing interest and easy comprehension by the intelligent layman.

The story has been in preparation for almost a year, during which time Silverman twice visited BTL for a total of nearly a month. He had extensive talks with a number of Bell System executives, scientists and engineers as well as others outside the Laboratories who are familiar with its work.

The series is illustrated by photographs taken by Gus Pasquarella, the *Post's* well-known photographer, who spent two weeks at the Laboratories making more than 100 pictures.

Record-Breaking Flight

United Air Lines introduced their new Mainliner 300 (Douglas DC-6) to the public on Saturday, March 29, with an inaugural record-breaking transcontinental flight from Long Beach, Calif., to LaGuardia Field, N. Y. One of the outstanding publicity features of the flight was the inclusion of mobile telephone facilities for the use of newspaper and radio correspondents.

The NC-37506 "Age of Flight" was used for the flight. Two Western Electric 238-C mobile telephone equipments were installed on the airplane and arranged for operation from a single 41A control unit located in the forward lounge. W. C. Hunter of Specialty Products Development supervised the installation and demonstrated the mobile telephone equipment during the flight.

Leaves of Absence for Military Service Have Been Discontinued

Since July 1, 1946, the practice has been continued of granting leaves of absence to employees inducted into the Armed Forces under the Selective Training and Service Act of 1940 as amended, and such leaves have also been granted to employees who enlisted in the Armed Forces or Merchant Marine if they were subject to induction in accordance with Government regulations. In view of the expiration on March 31, 1947, of the provisions of the Selective Training and Service Act of 1940 authorizing induction of persons into the Armed Forces for training and service, leaves of absence will not be granted to employees who enlist in the Armed Forces or Merchant Marine on or after April 1, 1947. However, any such employee will receive, at the time of application for reëmployment, the benefit of whatever rights, if any, he may then be entitled to by law.