The new Key West-Havana telephone cable

J. J. GILBERT
Transmission Development

Culminating a development program begun about 20 years ago, the final splice in a new submarine cable between Key West and Havana was made in April, 1950. This cable and another laid a few days earlier between the same points are the first of the deep water type to be equipped with built-in repeaters and will provide as many as 24 high-grade telephone circuits. The over-all lengths of the two cables are approximately 115 nautical miles[1] (n.m.) and 125 n.m.

Each cable transmits in a single direction and contains three intermediate repeaters spaced about 36 nautical miles apart, operating over the frequency band from 12 kc to 108 kc. The repeaters appear as bulges in the cable itself, about 3 inches in diameter, tapering off in both directions to the cable diameter of a little over 1 inch. The length of a bulge, including the tapers at each end, is about 35 feet.

Commercial telephone service between the United States and Cuba dates back to 1921,[2] when three submarine cables were laid between Key West and Havana. Each of these cables is capable of furnishing a two-way voice-frequency telephone circuit and two carrier-frequency telegraph circuits. Each cable consists of a single conductor continuously loaded with iron wire, insulated with gutta-percha, and is provided with a low resistance return conductor consisting of copper tapes wound over the insulated core and exposed electrically to the sea water. Depth of the water in the Florida straits eliminated from consideration the

[1] One nautical mile as applied to submarine cables equals 6087 feet or 1.15 land miles.

[2] A.I.E.E. *Transactions*, February, 1922, page 1 (W. H. Martin, G. A. Anderegg, B. W. Kendall).

types of cable commonly employed for telephone purposes on land or in shallow water. It also made use of loading coils impractical, because the frequent mechanical irregularities involved were considered a hazard in laying the cable.

Increase in circuit requirements resulted in the laying of a new cable between Key West and Havana in January, 1931,[3] embodying advances in the communication art. Initially, this single cable provided three telephone circuits, using carrier frequencies, a different band for each direction of transmission. While the 1921 cables were operated up to only 3800 cycles per second, the 1931 cable operated at frequencies up to about 28,000 cycles.

One of the major improvements in the 1931 cable over the 1921 cable was the insu-

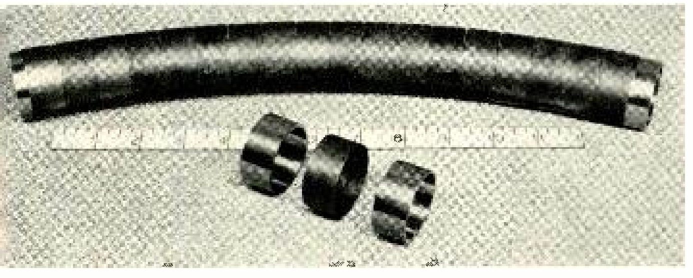


Fig. 1—An assembly of the steel rings showing the flexibility of the repeaters.

lation. This material, known as Paragutta, was developed at Bell Laboratories and is composed of deproteinized rubber, deresinated balata, and wax. The characteristics of Paragutta made it possible to operate the cables at much higher frequencies and so provide extra transmission channels. No magnetic material was used for inductive loading, but some additional inductance was obtained by increasing the thickness of the insulating layer.

In 1940, need for additional circuits to Cuba resulted in the installation of new terminal equipment on this cable, making it possible to operate seven two-way circuits.

Not long after the 1931 cable was laid, a radical step in submarine cable development was proposed by O. E. Buckley and O. B. Jacobs—a practical means for including repeaters in the cable itself[4]. Obviously, repeaters similar to those for land lines could not be used. The absence of land sites where repeaters might be located and the hazards involved in employing artificial islands—storms and ocean currents—indicated that the only safe type of repeater would be one that could rest on the ocean bottom. This immediately established the requirement that the repeater be able to resist enormous hydrostatic pressures.

Another important requirement is that the repeater remain free of trouble or need of replacement of parts over long periods of years. Servicing, even at intervals of several years, would be undesirable because of excessive costs, and there is always danger of damaging a cable if it is disturbed after reaching a safe resting place at the bottom of the ocean. Electron tubes must therefore have an extremely long life, say twenty years, and other circuit elements must remain free from trouble over a like period. Electric power for the operation of these tubes must be supplied from the shore[5]. Schemes for doing this had been proposed by E. T. Burton[6].

Construction of the repeater to solve these problems introduced a further requirement in that there should be no interruption to the smooth and continuous process of laying the cable from the ship, especially in deep water. This means that the repeater should be built so that it could be passed overboard from the cable ship like any other length of cable, being flexible enough to pass around the drums and sheaves employed in the conventional laying operation. The circuit elements, therefore, have to be small and compactly assembled.

In spite of considerable interruption due to World War II, the many phases of the development were carried out to a successful conclusion. The electron tubes about which the amplifiers were built were developed by Electronic Apparatus Development. These tubes give promise of long life and have the

[3] *Bell System Technical Journal,* April, 1932, page 197.

[4] U. S. Patent No. 2,020,297.

[5] Electric power is supplied from the Key West end and transmitted over the same cable conductors that carry the voice circuits.

[6] U. S. Patent No. 2,020,875.

ruggedness required to withstand the vibration and shocks in the course of laying and lifting the cable. Counterparts of those used in the cable have already passed a life test of ten years and give every indication of continuing ten years or more longer.

A three-stage feedback amplifier was designed around this tube, and with this amplifier, circuits of a quality comparable to those of a land line carrier system of the same length have been obtained. Design of the circuit elements, in cooperation with Apparatus Development, produced components suitable for the restricted space assigned to them.

The completed amplifier consists of an articulated assemblage of units enclosed in a flexible structure of overlapping steel rings that furnishes mechanical protection against hydrostatic pressure and damage during laying. Figure 1 shows an assemblage of these rings to illustrate the flexibility. Over all is a closely fitting copper tube 1¾″ in diameter to keep out the water. The whole unit is about seven feet long. Into each end of the structure is led the insulated cable conductor through a watertight seal. To keep the ocean still farther from the interior of the repeater, this seal includes a "core tube" of copper extending over the cable insulation for a distance of about seven feet at each end of the repeater. The repeater housing and tubes are provided with corrosion protection and armor wires as a continuation of the cable armor.

Manufacture of the repeaters was done under conditions of extreme care. Special air conditioned space was provided at the Murray Hill Laboratories, where carefully supervised personnel worked under conditions that would insure freedom from contamination due to dirt and perspiration. Improved materials and techniques developed during the war were used in this work.

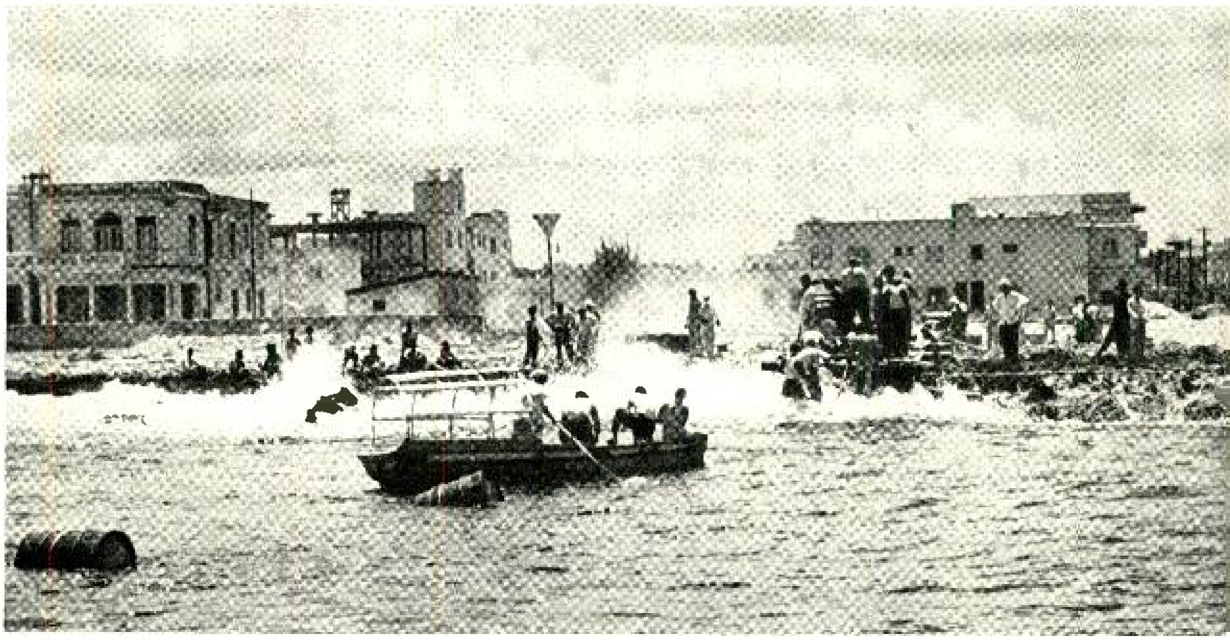


Fig. 2—Oil drums supporting the cable were pulled onto the coral Cuban beach by a winch. This location is about five miles from the center of Havana.

As in the case of the earlier cables the new cable itself is of the coaxial type, but it had to be designed and built to a higher degree of precision than heretofore required. For example, large impedance irregularities must be avoided, since they affect the gain frequency characteristic of the repeaters. Besides, from previous experience, it was realized that unless the mechanical design of the cable was properly done, its electrical characteristics would be permanently altered by the stresses occurring in deep water laying, and this would upset the fine balance that is desirable between repeater gain and cable loss.

Solution of these mechanical and electrical problems required manufacture and tests of short cable specimens. These short lengths, as well as the final cable, were manufactured by the Simplex Wire & Cable Company of Cambridge, Mass., incorporating the results of a cooperative development program arranged between them and the Laboratories. An important item in this study concerned methods of using new insulating material, Polyethylene, which for submarine cable insulation appeared to have many points of superiority over gutta-percha and Paragutta. Also involved were the development of a satisfactory sealing compound for the stranded central conductor and methods of jointing Polyethylene to meet the special requirements imposed by a repeatered cable. The excellent quality of the final cable is a tribute to the manufacturer in a difficult and exacting field.

Before embarking on the Key West-Havana project, a trial installation of 20 n.m. of the cable, with repeaters inserted, was made in depths of water as great as 12,000 feet. Western Union's cable ship *Lord Kelvin* was used for this trial, as well as for the final laying, providing valuable experience for the latter. Transmission measurements made on the cable and repeaters at various stages in the operation, which included tests of twelve hours while the cable was on the ocean bottom, indicated satisfactory and stable conditions; even after extraordinary stresses involved in lifting the cable and repeaters in two miles of water the mechanical condition was declared to be as good as new.

Advances in cable manufacturing methods were made use of in building the new cable. The central conductor consists of a solid wire 0.131 inch in diameter, on which are spiraled three copper tapes each 0.0145-inch thick and 0.148-inch wide closely conforming to the solid wire. It was made by a newly developed process that resulted in a high degree of control of the diameter and roundness of the tape stranded conductor, and at the same time introduced the sealing material that prevents the entrance of water into the interstices of the conductor. Greater uniformity of insulation diameter was obtained by means of a photoelectric diameter gauge controlling the operation of the extruding machine. Since the impedance of the cable is a function of the ratio of the insulation diameter to the central conductor diameter, these two measures resulted in a very uniform impedance for the cable. In the insulating process, precautions were taken to insure

(Continued on page 163)

THE AUTHOR: After receiving his AB degree from the University of Pennsylvania in 1909, J. J. GILBERT spent the next eight years in graduate study and teaching. He was an instructor in physics at the University of Pennsylvania, graduate student at Harvard and University of Chicago, and instructor at Armour Institute of Technology, receiving the EE degree from the latter in 1915.

At the beginning of World War I, he enlisted in the Army, where he rose to the grade of Captain in the Signal Corps. At the close of the War, he joined the Technical Staff of the Laboratories, becoming engaged in the development of submarine telephone and telegraph cable. This work took him, in 1929 to 1931, to Europe, where he directed activities in German and British submarine cable factories.

During World War II, he was involved in several war projects related to submarine cables, and also took part in the development of methods for laying communication wire from airplanes. Following the war, he returned to peacetime submarine cable work and the application of some of the techniques to land lines. He is head of the Submarine Cable Department and supervises the development, manufacture, and installation of deep water submarine cables, including the Key West-Havana cable described in his article.

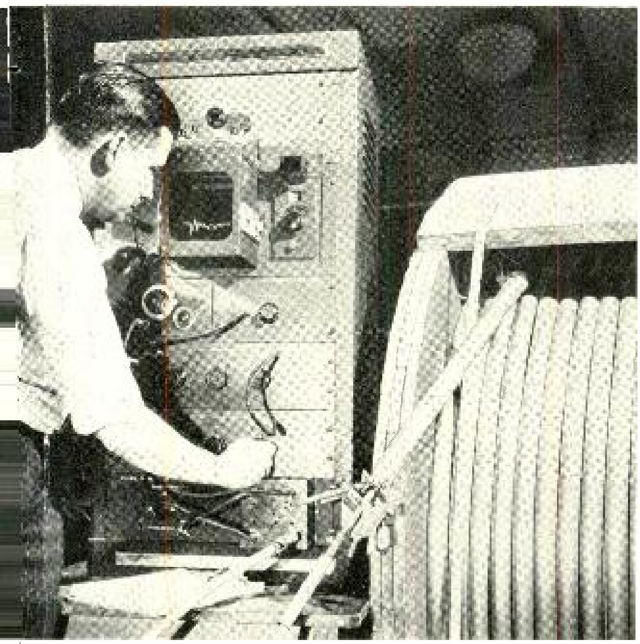


Fig. 1—Operating a field set to obtain pulse echo measurements.

Pulse testing of coaxial cables

A. W. LEBERT
Transmission Systems Development

Transmission "smoothness" of coaxial cables at the high frequencies used for carrier telephone and television circuits is of paramount importance because these circuits must be able to transmit signals covering a broad frequency range, with a minimum of distortion. Changes in impedance due to manufacturing variations in the diameters of the inner and outer conductors, or in the effective dielectric constant produced by the Polyethylene discs, result in transmission irregularities which cause echoes, with consequent distortion of the transmitted signals. Impedance changes and magnitude changes of the internal irregularities may also occur from physical distortions resulting from stresses set up during transit and installation of the cables.

This requirement of "smoothness" led to pulse testing of coaxial cables to detect, locate, and evaluate quickly internal structural irregularities, and to measure accurately the relative coaxial impedance over a broad band of frequencies. Measurement and control of the impedance of individual coaxials is extremely important, since impedance differences between coaxials spliced together may produce worse echoes than those resulting from internal irregularities within a single coaxial. Prior to the introduction of the pulse testing method in 1940, single frequency bridge measurements of the inductance and capacitance of each reel of cable were the only means employed to determine the average impedance, as a measure of quality control. Location and evaluation of large irregularities on long lengths of cable were also possible by means of single frequency impedance measurements, but for the short lengths in the factory, the labor involved in locating even gross irregularities by such a technique would have been excessive. Hence, before the advent of pulse testing, no attempt was made to determine the magnitude of internal irregularities in the factory.

The pulse echo set possesses the advantage of combining laboratory, field, and factory means of locating and evaluating internal structural irregularities and of simultaneously measuring the relative coaxial impedance over a broad frequency band. Present equipment and networks make it possible to determine the impedance of coaxials to an accuracy of ±0.04 ohm. This means that junction irregularities may be controlled, and reflections which are about 75 db below the original pulse, detected. The position of isolated irregularities can be determined to within ±50 feet on a line as far as a mile from the sending end.

Use of the pulse technique has permitted factory measurement of a large sample of coaxials, and has made it possible to detect those coaxials which do not meet transmission requirements. In brief, the manner of doing this in the factory is to make pulse impedance and echo measurements on the coaxials as they are produced in the several forming machines. These measurements make it possible for the factory to control the quality during production, and to assign the coaxials to positions of relative impedance prior to cabling. In an 8 coaxial cable, the lowest impedance coaxial is assigned to Position 1 and the highest impedance coaxial to Position 8. Coaxials and paper covered pairs are formed into a core on the stranding machine and the core covered with a lead, or composite Polyethylene-lead sheath. Following this operation, or after applying armor when this is required, further impedance measurements are made on a sampling basis to determine whether subsequent manufacturing processes have materially affected the coaxials. This control procedure has resulted in substantial improvement in cable uniformity.

A typical field set is shown in Figure 1 and a block schematic of the basic circuit is shown in Figure 2. The 5000-cycle sine wave base oscillator drives the pulse generator which delivers a pulse through the hybrid coil to the coaxial under test. If there are no irregularities in the cable and it is terminated in its characteristic impedance, no reflections, or echoes, occur since the pulse energy is dissipated in the terminating network. Actually, the pulse always encounters some irregularities along the length of the cable and at the termination and these reflect part of the energy back to the transmitting end. These reflections are delivered to the vertical plates of a cathode ray oscilloscope through the hybrid coil, attenuator, and video amplifier, to be observed as "pips" on a horizontal line on the oscilloscope. The base oscillator also drives a sweep generator so as to synchronize the oscilloscope sweep with the generated pulse. A phase shifter or ranging circuit, such as those used in radar, controls the start of the sweep, making it possible to locate irregularities by measuring the time for the pulse to make the round trip between test apparatus and the irregularity. The magnitude of the reflected pulse can be compared directly with the original pulse by means of the attenuator adjacent to the hybrid coil.

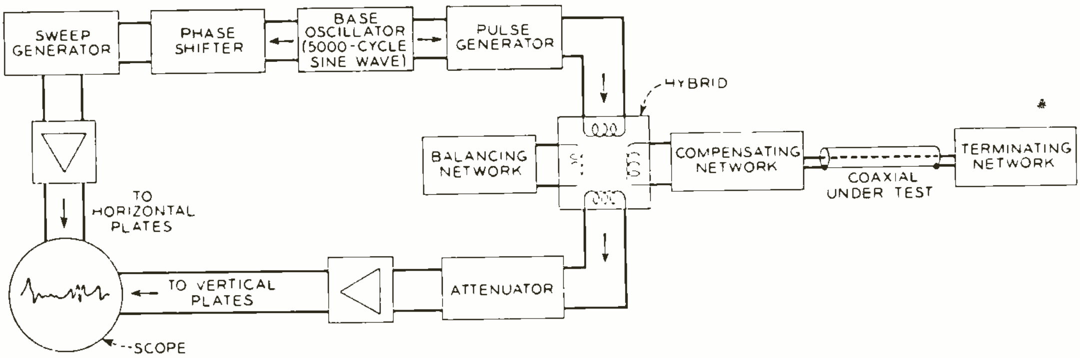


Fig. 2—Block diagram of pulse echo set.

Adjustable networks are used at each end of the cable to reduce the magnitude of the terminal echoes when measuring the internal echoes and to evaluate the impedance of the cable. In the ideal case the characteristic impedance of a line with uniform constants is a smooth curve with frequency; therefore, the network used to terminate the

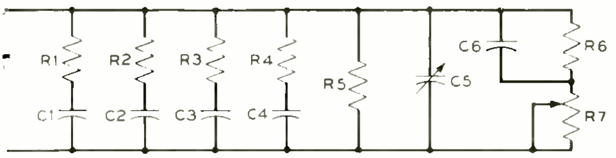


Fig. 3—Terminating network.

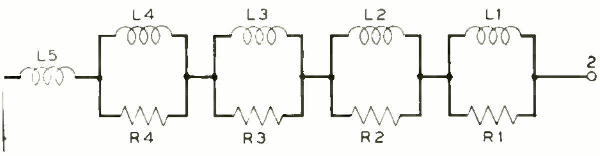


Fig. 4—Compensating network.

cable should also have an impedance which is smooth with frequency, so that no energy will be reflected from the network but will be absorbed entirely in the network. Actually, because of the existence of internal irregularities, the impedance frequency characteristic is not a smooth curve and because of the randomness of the internal irregularities the impedance frequency characteristic from cable to cable will differ. A terminating network design, however, can be based on an average characteristic only, and therefore some energy is practically always reflected from the network. A typical terminating network composed of a number of parallel branches is shown in Figure 3. The type and number of branches, together with the adjustability of capacitor C5 and resistance R7, have made it possible to adjust the network to match a particular coaxial so that the resulting reflection due to the network is approximately 70 db below the magnitude of the original pulse.

At the transmitting end, the hybrid coil is essentially a bridge. When it is properly balanced, the impedance in the line and network windings of the hybrid coil are equal and the attenuation between the associated transmitting and receiving windings is very high. Hence, this problem becomes one of keeping the impedances of the line and of the balancing network equal over the frequency band involved. A simple solution for this end of the cable is obtained by introducing a network on the coaxial line side of the hybrid coil which reduces the reactance component of the coaxial impedance to zero and makes the resistance component flat with frequency. Such a network is shown in Figure 4 and is designated as a compensating network.

Since the combined impedance of the compensating network and the coaxial under test is a resistive impedance, the required balancing network should be a simple resistance. In practice, however, the use of a fixed network can compensate for only one value of impedance. Since there are small differences in impedance between coaxials, the use of such a network results in an impedance which is essentially a resistance with a small amount of parallel capacitance. Therefore, the balancing network requires a small variable capacitance in parallel with the resistance network, Figure 5, to compensate for the differences between coaxials. With this arrangement, under optimum balancing, the direct transmission loss between the transmitting and receiving sides of the hybrid coil can be made as high as 70 db.

Although it would appear that when the balancing and terminating networks are properly adjusted, and the coaxial under test is free of irregularities, no reflections would occur, in actual practice it is not possible to build networks which exactly

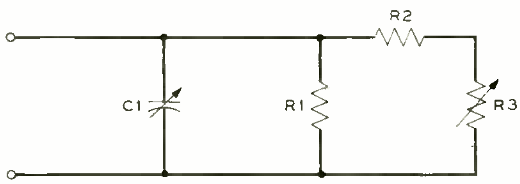


Fig. 5—Balancing network.

match the impedance characteristics of all coaxials, over the entire frequency band. Consequently, a small echo having the general shape of an M or a W, will usually appear on the oscilloscope screen, the W being more common.* When viewed on the oscilloscope screen the terminal echoes appear in two places—at the left hand, or send-

* Analysis of these reflections by H. Nyquist indicates that the best practical match to the cable is obtained when the middle positive peak is approximately twice the magnitude of the negative peaks on either side.

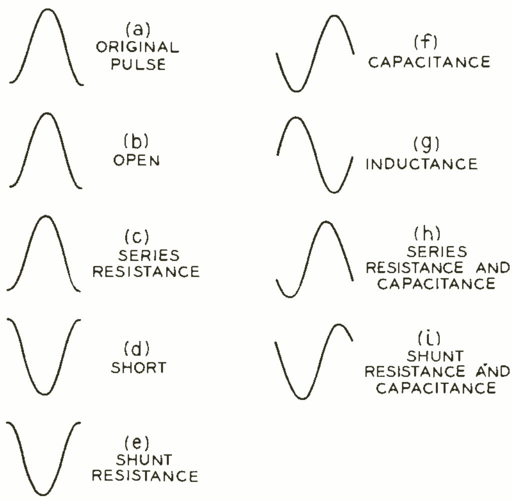


Fig. 6—Reflections or echoes resulting from various types of irregularities.

ing end, and again at the right hand or terminating end.

A knowledge of the significance of the shape of reflections is helpful in understanding the adjustments of a network when determining the impedance of a coaxial. To illustrate, a reflection from an open or a series resistance is a duplicate of the original pulse, as indicated in Figures 6b and 6c. Reflections from a short circuit or a shunt resistance have the same shape as the original pulse, but are turned over, Figures 6d and 6e. The reflections from a capacitance or inductance are, to a first approximation, the first derivatives of the original pulse in which the magnitudes of the two halves of the pattern are equal, Figures 6f and 6g.

In practice, the irregularities are seldom localized, but are distributed over a length of the coaxial and frequently are encountered as a combination of one or more of the types of irregularities mentioned. Typical illustrations of these are a series resistance superimposed on a capacitance which results in a reflection as shown in Figure 6h; a shunt resistance with capacitance produces Figure 6i. Now referring to Figure 6h, if the series resistance were reduced, the reflection would approach that obtained from just the capacitance. If the series resistance becomes less than zero, the effect on the shape of the returned pulse is the same as that of placing a shunt resistance between the two conductors; the reflection will take the form shown in Figure 6i. Thus, in the presence of a capacitance irregularity, the reflection from a changing resistance appears to shift from one lobe to the other, depending upon the value of resistance. If no capacitance irregularity is present, a resistance variation from shunt to series will cause the reflection pattern to move in the vertical plane between Figures 6e and 6c.

An application of the above technique is used in those cases where the presence of irregularities near the end of the cable makes it difficult to recognize the W shape normally observed when the networks are adjusted to match the coaxial impedance. For example, where the shape is unrecognizable, the procedure followed is to adjust the capacitance of the balancing network, C1, in Figure 5, using several dial settings and varying the resistance, R3, for each setting. When the capacitance of the balancing network and of the coaxial under test are made equal, changing the value of R3 will cause the terminal echo to move up and down in the vertical plane on the oscilloscope screen. When this condition is satisfied, the middle positive peak can be made approximately twice the magnitude of the negative peak. Repeating this procedure with capacitance, C5, and resistance, R7, of the terminating network, Figure 3, accomplishes a similar purpose for echoes near the terminating end. In practice, impedance measurements are made by combinations of adjustment of both balancing and terminating networks.

Frequently, however, the magnitude of echoes close to the end of the cable are sufficiently large as to make recognition of the W pattern impossible even with the above technique. Then, the procedure followed is to adjust the resistance, R3 in Figure 5, in the balancing network using several dial settings and varying the condenser, C1, for each setting so as to obtain a capacative or an inductive pattern as shown in Figure 6. When the resistance of the balancing network is equal to that of the coaxial under test, the positive and negative lobes of the pattern will be equal and the capacitance dial can be set so as to obtain a pattern of a pre-determined size. This process is repeated with the terminating network when it is required.

The impedance of the coaxials can then be evaluated in terms of earlier calibration of the networks. Since the networks were adjusted to match the cable by means of a transmitted pulse, the impedance thus determined has been called pulse impedance. Because the basic calibration of the networks, using a pulse only, introduced problems which could not be solved readily, a calibrating technique using both pulse measurements and a single frequency of 2 megacycles was devised. As a result, impedance evaluations of the coaxials in terms of this calibration are relative rather than absolute.

This calibrating procedure was applied to the terminating network. The balancing network was then calibrated against the terminating network by making pulse impedance measurements on a number of coaxial cables with both networks; thus, on the average, impedance measurements with either network would be the same.

Considerable study has been given to the shape and width of the pulse used to make impedance and echo measurements. A pulse bandwidth of 4 megacycles was selected because of its relation to the bandwidth of present day television signals. To simplify the design of broad band amplifiers, it was necessary to have the amplitude of the harmonics above 4 megacycles decrease rapidly; a 0.25 microsecond pulse having a shape which approximates that of a raised cosine wave, somewhat like that of an elongated half sine wave, was found to satisfy the bandwidth and harmonic amplitude requirements.

THE AUTHOR: Following his graduation from New York University in 1932 with the degree of B.S. in Electrical Engineering, A. W. LEBERT spent several years in capacitor development before coming to the Laboratories in 1936. Starting in Transmission Engineering, he became particularly concerned with open wire carrier, studying attenuation, crosstalk, and noise on the type J and type C systems, and participated in field trials of these systems. Just prior to World War II, he engaged in fault location studies, continuing in this activity during the war for the armed forces on the Spiral Four carrier system. Toward the end of the war, he extended these studies to coaxial cables and has continued in this work since the war.

Miniature four-wire terminating set

R. L. CASE
Transmission Systems Development

A second member has been added to the family of "miniature" voice-frequency equipments started with the V3 amplifier.* This new member is a miniature four-wire terminating set. At terminals of carrier circuits or four-wire voice frequency circuits, it connects the four-wire transmitting and receiving branches to a two-wire switchboard circuit, and at terminals of a two-wire circuit, it may be used to connect the two-wire switchboard circuit to the transmitting and receiving sides of the two-wire terminal repeater. By using smaller coils, capacitors, and resistors, by designing the circuit so that fewer components are required, and by assembling the components compactly in a single container, it has been possible to secure a terminating set less than one-quarter the size of its predecessor. Since the demand for these sets is expected to be upward of 10,000 a year, it is economical to use die cast and molded housings, which has also contributed to a lower cost.

A circuit schematic for the miniature terminating set is shown in Figure 1. When speech is delivered by the switchboard to the terminating set associated with a carrier circuit, the speech energy is divided, part being delivered to the modulator circuit of the carrier channel where it is transmitted, and the other part to the receiving branch where it is blocked from further transmission at the output of the demodulator. When the receiving branch of the carrier circuit delivers energy to the terminating set, the energy is divided between the two-wire line and the balancing network. If the balancing network achieved a perfect balance, no energy at all would be fed across the hybrid coil from the receiving to the transmitting side. The compromise network plus the building out units provide adequate balance for the use of this set at all two-wire switching points.

The terminating circuit contains a hybrid coil, a repeating coil, and two 1.08-mf capacitors in the transmitting side, an attenuator in each four-wire side, a compromise balancing network, and eleven small capacitors for building out purposes. The configuration of the circuit is such that capacitors in the repeating coil and the balancing network branches prevent any dc supervisory currents that may be present on the two-wire line from flowing into the terminating set.

Since capacitors are one of the main factors determining the size of the terminating set, a design was chosen to reduce the physical size of the required capacitors. To this end an unequal-ratio hybrid of

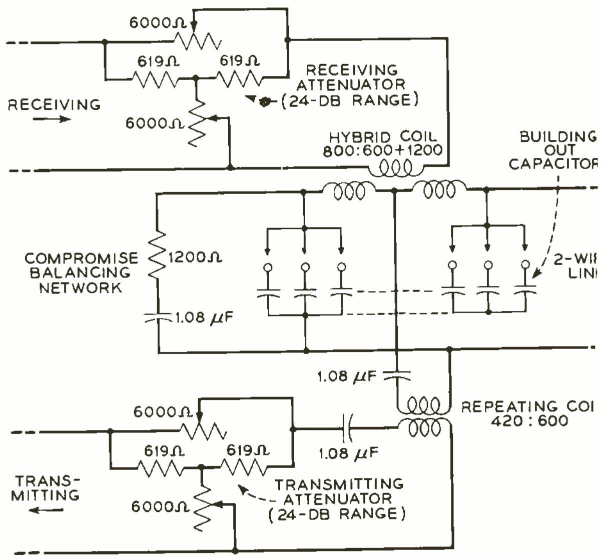


Fig. 1—Schematic of the new miniature four-wire terminating set.

* Record, *February*, 1949, *page* 45.

2:1 impedance ratio betwen line and network was chosen so that a resistance of 1200 ohms and a capacitance of 1.08 mf could be used in the balancing network in place of the customary 600 ohms and 2.16 mf used with a 1:1 ratio hybrid. This arrangement also reduced to one-half the electrical capacitance of the building out capacitors required in the network.

With this unequal-ratio hybrid arrangement, smaller size capacitors can also be used with the repeating coil to form the high-pass filter that suppresses signaling and switchhook interference, thus preventing them from affecting the modulator on the four-wire transmitting side. In addition, this design eliminates the need for the 2.16-mf capacitor previously required in the two-wire line for impedance purposes and the corresponding network balancing capacitor.

Allen Bradley potentiometers of A and B taper are coupled together and two 619-ohm resistors added to make an inexpensive small size attenuator of 600 ohms nominal impedance and a loss range of about 24 db. These attenuators permit independent continuous adjustment of losses in each direction to faciltate setting up proper circuit levels. The plug-in pads in a variety of sizes that were formerly required are no longer needed.

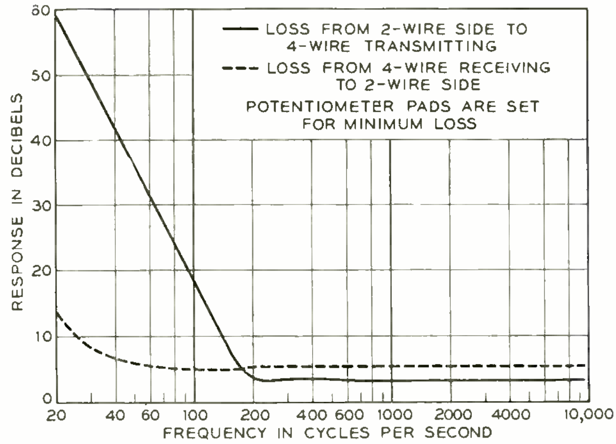


Fig. 2—Loss frequency characteristics of the new set measured between 600-ohm lines.

For building out the network and the two-wire circuit, eleven small capacitors are provided, ranging in capacitance from 0.0027 mf to 0.05 mf. Some of these are used to build out each terminating set with its office cabling to have the same shunt capacitance as the set with the longest cabling, so that the impedance looking into the two-wire side of all the sets may

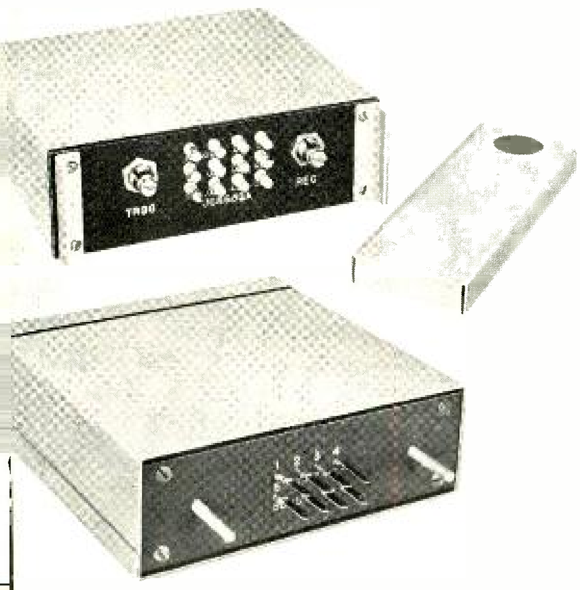
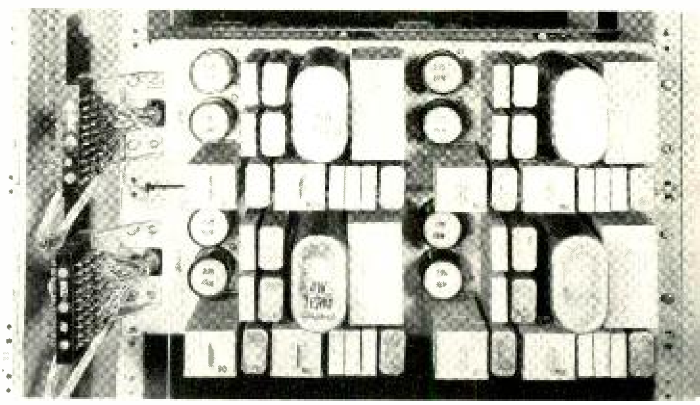


Fig. 3 (at left)—Front and rear views of the miniature terminating set.

Fig. 4—Four of the former type of four-wire terminating sets.



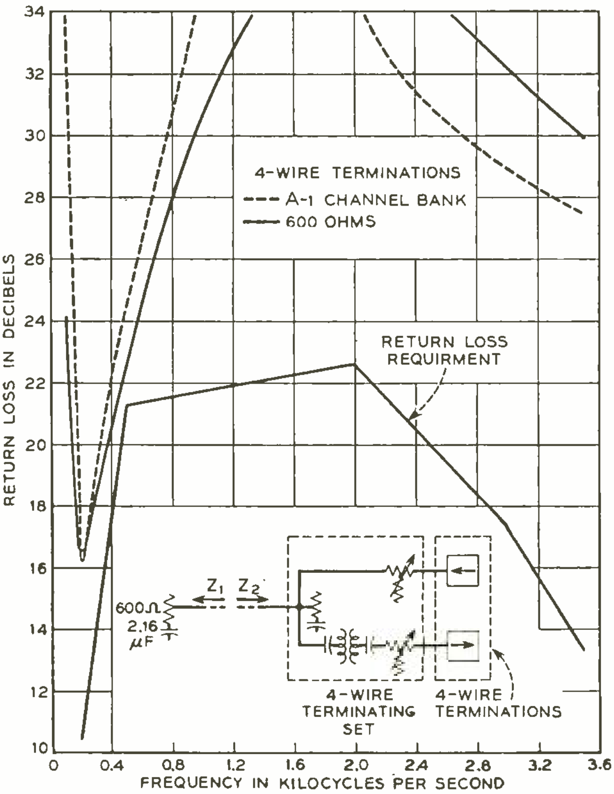


Fig. 5—Return loss characteristics: with channel bank termination; and with 600-ohm termination. The characteristics are well above the requirements.

be alike. Sufficient capacitance is also available to build out the network circuit so that when a carrier circuit with its terminating set is switched to another similar circuit, the compromise network with its building out capacitance will balance the other circuit and all the intervening cabling between the two terminating sets. Thus a high loss from the four-wire receive to the four-wire transmit sides of the terminating set can be obtained. Any building out capacitor in the set can be connected either in the line or the network side.

The impedance improving pad required with the former set has been eliminated, partly by circuit design and partly by a relaxation of requirements. This pad may be seen in the four-wire transmitting side of Figure 6, which is the circuit schematic of the earlier type of four-wire terminating set. In this circuit, the other differences mentioned above may also be seen.

Representative transmission - frequency characteristics of the four-wire terminating set for both the transmitting and receiving directions with 0 db attenuator losses are shown in Figure 2. Because of the 2:1 impedance ratio of the hybrid, and the arrangement of the transmitting repeating coil, the losses at 1000 cycles differ in the

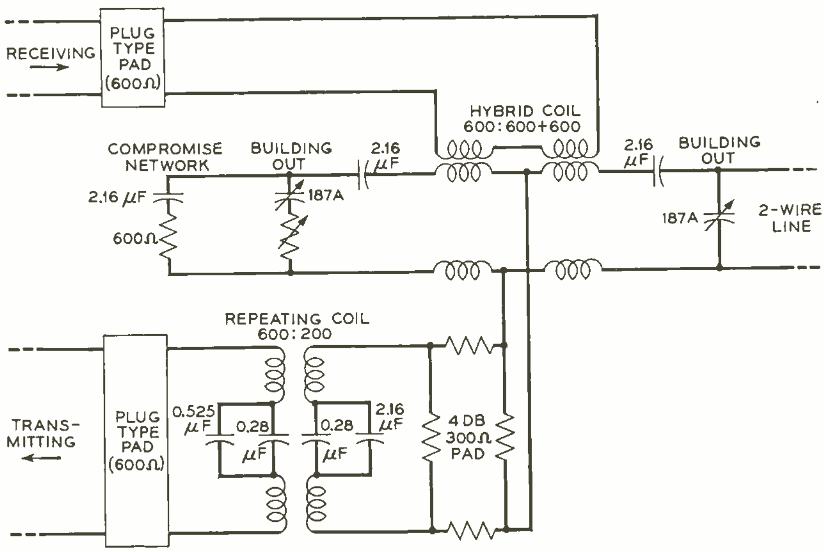


Fig. 6—Circuit schematic of the earlier four-wire terminating set. In this circuit, the differences described in the article may also be seen.

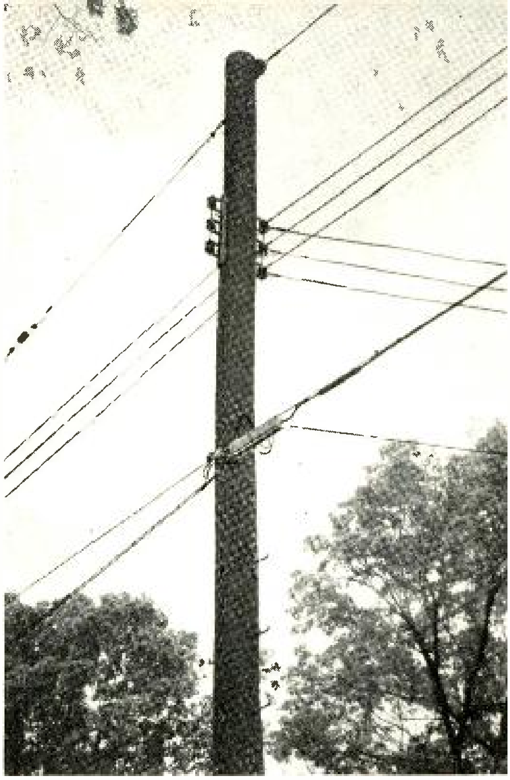
two directions, but this can be equalized by the attenuators. The characteristics of this set are substantially the same as for the old carrier terminating set, and are essentially flat with frequency over the transmitted voice band. Below 250 cycles, the transmitting direction has a low-frequency cut-off to reduce switchhook and signaling interference to the connected carrier circuit. Where necessary to reduce transient effects on the long circuits caused by high-frequency speech components, a low pass filter may be added externally on the four-wire transmitting side.

The terminating set assumes four-wire connecting impedances of nominal 600 ohms. Since other long distance circuits may be switched to the two-wire side of this terminating set, it is important that the impedance of the two-wire side should be substantially 600 ohms plus 2.16 mf, which is the ideal impedance to which all two-wire switched circuits are designed so that the compromise networks of all circuits may balance any connected circuit. Typical return loss characteristics indicating the degree of balance of the two-wire side of this terminating set against a compromise network of 600 ohms and 2.16 mf are shown in Figure 5. These measurements were made with the compromise network of 1200 ohms and 1.08 mf of the set and with the transmitting and receiving legs connected to either 600 ohms resistance or to carrier channel banks. It will be seen from the illustration that these characteristics are well above the requirements for suitable operation.

Front and rear views of the miniature terminating set are shown in Figure 3. The unit is mounted by the studs at the rear, and the external wiring connected to the terminals on the rear plate. Adjustments of building out capacitance are made by straps on the terminals at the center of the front plate. Adjustment of transmitting and receiving attenuator losses are made by turning the attenuator shafts just over the designations TSRG & REC on the front plate. The terminals and attenuator are covered when the adjustments have been completed. Four of the four-wire terminating sets that the miniature set replaces are shown in Figure 4. Two sets occupy the left half and two the right half of the double mounting panel. A reduction of four and one-half to one in size has been obtained by the newer methods that have been utilized in the design and construction of the apparatus.

THE AUTHOR: R. L. CASE received the A.B. and B.S. degrees from Denison University in 1921, and joined the Laboratories in July of that year. In 1926 he received his M.A. degree from Columbia. During his early work at West Street, he engaged in the transmission design of two and four-wire telephone repeaters, echo suppressors, and the terminal equipment for the first transatlantic radio circuits. In 1929 he was placed in charge of a group responsible for the design of repeaters, and later of amplifiers and associated equipment for voice-frequency program broadcasting facilities. In World War II he was responsible for voice and carrier wire-line facilities for the Armed Forces. Since then he has been concerned with the transmission design of radio control terminals and voice-frequency repeaters of which the V3 amplifier is a recent development.

New types of cable terminals


One of the new strand-mounted terminals.

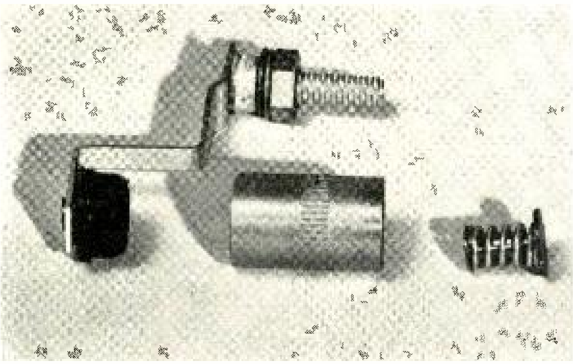
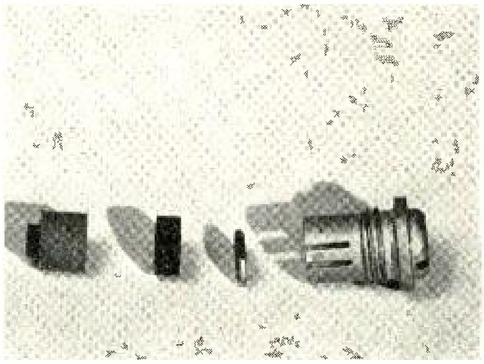
Cable failures caused by lightning present one of the major maintenance problems in aerial cable plant. Where it is desirable to protect the cable against lightning damage, it has been the practice to add separate lightning arrestors which are mounted on the pole and to make connections between them and the distribution terminals by jumper wires. This arrangement is subject to trouble, uses an undesirably large amount of the available pole space, and is expensive.

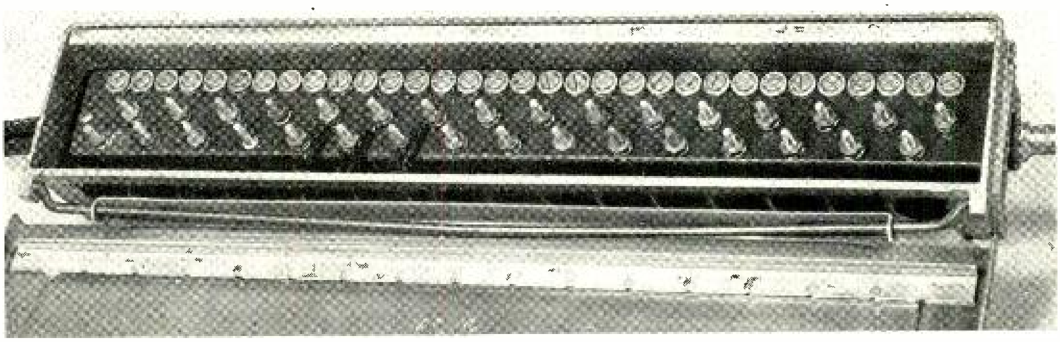
There is an increasing use of small cables extending to outlying areas resulting in an increase in the electrical breakdown hazard which is offset only by more frequent use of lightning arrestors. There is also an increasing trend toward pressurized cables which necessitates a gas-tight terminal, a requirement not met with the present terminal designs.

Recent studies have led to the development of new gas-tight aerial cable terminals which provide lightning protection and terminating facilities in a single housing without any significant change in size over the present unprotected terminals. In addition, the current carrying capacity of the new type of protector unit has been materially increased.

The terminals consist essentially of a cast block of Selectron (a plastic having very low electrical leakage) in which the ends of the stub cable conductors and cable sheath, binding posts and protector wells are imbedded. The blocks are mounted in weatherproof, dirtproof housings and can be attached to suspension strand, pole, or building surfaces.

The lightning arrestor or protector unit consists of a compact assembly of small cylindrical protector blocks and a lead alloy pellet in a small threaded cap which screws into a well in the terminal blocks



Details of the binding post protector well assemblies (left) and of the protector unit (coded 107-B protector).



The new 16-pair gas-tight protected terminals (coded NC-16).

thus providing a closely fitting metal to metal seal between the protector cap and the protector well. When the potential exceeds the spark-over voltage of the gap between the carbon blocks, discharge takes place through the blocks and pellet to the cap which is grounded. If the current is sustained as in an occasional power contact, the pellet melts and allows the metal parts to contact, thus providing a low resistance path to ground.

New gas-tight non-protected Selectron terminals have also been developed for use in areas where protection against lightning is not necessary. These terminals are the same as the protected types except that the protector units and associated wells are omitted.

Gas-tight terminals in both the protected and non-protected types are being produced in 10, 16, and 26 pair sizes in the Western Electric's Point Breeze plant.

These new terminals and the principal features of the design were conceived by the late L. W. Kelsay prior to his retirement in 1948.

(*Continued from page 152*)

mechanical stability of the Polyethylene.

Since joints in the insulated conductor are always regarded as potential sources of trouble in submarine cables, efforts were made to reduce the number of such joints to a minimum. The tape stranded central conductor was manufactured in continuous lengths of about 12 n.m., care being taken to avoid having joints in the central wire and in the individual tapes occurring in close proximity. Problems of inspection and measurement prevented insulating such long lengths in a continuous process, but insulated conductor lengths as long as 6 n.m. were found to be practicable.

Thanks to the skill and cooperation of the Captain, officers, and crew of the *Lord Kelvin,* laying the cable was accomplished without great difficulty, although faced with problems of avoiding the existing cable network and opposing the effects of the gulf stream, which is both strong and erratic at times. The new cable was kept about 5 n.m. away from the existing cable network and at the Havana end, a landing site three miles west of the earlier cables was chosen.

During the laying operation, electrical tests were made continuously between the ship and the land terminals. Mechanical measurements, too, were made, using special tension measuring equipment. In laying submarine cable, it is important to control carefully the tension on the cable so that it will lie on the bottom without being suspended between peaks and yet not produce loops of excess cable. Actually, the final length of each cable varied less than one-fifth of a mile from the estimated length.

After still further testing of the completed installation the twin cables were opened to regular commercial service in the latter part of June, 1950. All channels met their test requirements satisfactorily and the performance of the twin cables has been up to expectations.

Waveguide filters for pulse transmission studies

P. A. REILING
Transmission Research

In connection with research in pulse modulation, it became necessary to separate a group of microwave channels transmitted in a waveguide into individual channels and subsequently to recombine them. Microwave filters which perform these functions have already been described in the RECORD.* For the particular studies referred to, however, a somewhat different technique was chosen. A total of eight channels with 30-mc separation between mid-bands of adjacent channels were provided by the filter array developed. Four of these channels were transmitted as a group in one waveguide, and another group of four at the same frequency in another waveguide. Both of these sets of four channels could be separated, or combined, independently in the same filter structure.

A simple block schematic indicating the filter functions is shown in Figure 1. Two signal bands, X and Y, are directed over separate paths to opposite ends of a wave guide array of separating filters. Here they are separated into eight channel bands, each of which is then passed through the individual channel apparatus, indicated by the dashed lines shown connecting the separating and combining filters. The combining filter array then inverts the separating process: the eight channel bands are combined to form the pair of composite signal bands, X and Y emerging from opposite ends of the combining filter array.

The separating filter array consists of four waveguide hybrid-type filters each of which diverts two channels with the same mid-band frequency to their respective channel apparatus. How this is accomplished is indicated schematically in Figure 2, which shows a circuit with a hybrid coil at each end, two channel reflecting networks, and two quarter wave length delay networks. Input applied to arm A1 of the hybrid coil is equally divided between the half-power arms B1 and C1; no direct transmission between arms A1 and D1 results. Energy at frequencies in the channel centered at frequency f1 is reflected by the two networks labeled f1, but that in the lower arm passes through the one-quarter wave length delay network both before and after reflection. Thus the reflected energy returning toward the left in the lower branch is out of phase by 180 degrees with that in the upper branch. As a result, the reflections are in phase in the middle conductor and are thus trans-

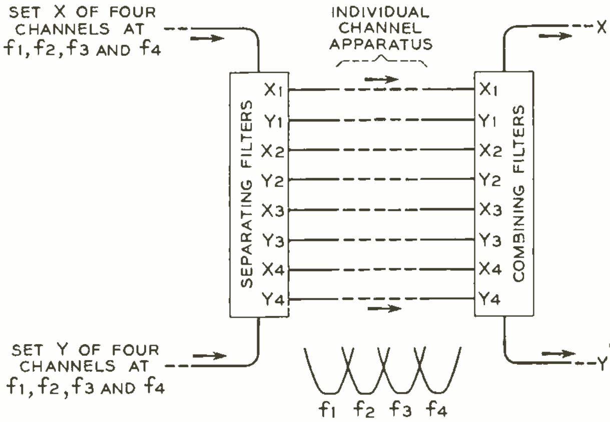


Fig. 1—A set of four incoming channels is connected to one end of the separating filter chain, and another set of four to the other end, and the eight individual channels are separated by the filter. In a similar manner, the chain of combining filters takes eight individual channels and forms two groups of four.

* RECORD, *September*, 1948, *page* 372.

mitted out the branch D1. Energy outside the band f1, on the other hand, passes through the networks f1 and thus through the hybrid at the right, and appears at A1′, none being transmitted out branch D1′.

In an exactly similar manner, energy in the band f1 applied at A1′ would pass out

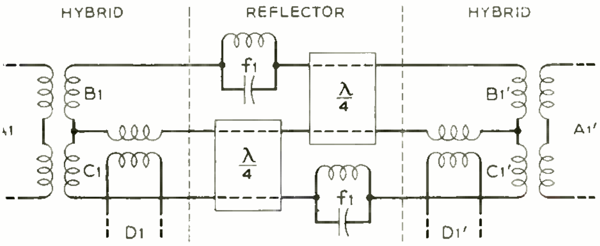


Fig. 2—A wire circuit analogy of the chain of a separating or combining filter unit.

branch D1′, while energy outside the band f1 would be transmitted through the circuit and out A1.

Four such circuits, each designed for a different frequency are shown connected in tandem in Figure 3. If four channels, X1, X2, X3, and X4, are applied at the left of this circuit, and four channels Y1, Y2, Y3, and Y4, with the same mid-band frequencies as the respective X channels, are applied at the right of the circuit, the eight channels will be separated out over the side branches as indicated. Of the four channels entering at the left, X1 will be separated out by the first section, X2 by the second, X3 by the third, and X4 by the last, and no energy will remain to continue out the right-hand end of the circuit. Of the four channels entering at the right,

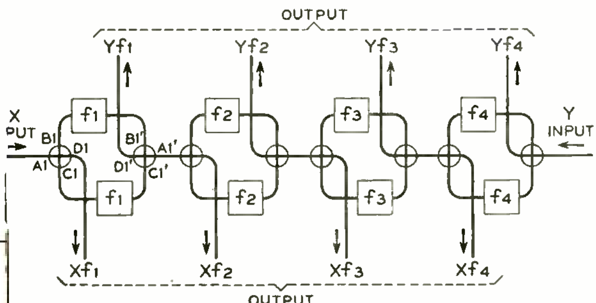


Fig. 3—Block schematic of the chain of separating or combining filters.

Y4 will be separated out by the right-hand section, Y3 by the next, Y2 by the next, and Y1 by the left-hand section. Such an arrangement could thus serve as the separating filter of Figure 1 to distribute the eight composite channels into the eight individual channels.

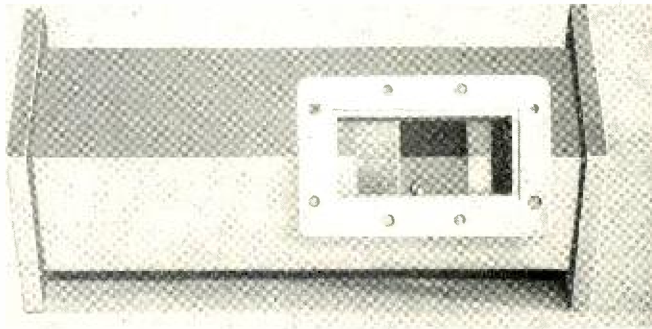


Fig. 4—One of the eight waveguide hybrid units forming a separating or combining filter.

It may also be seen from Figure 2, that were a single channel at frequency f1 applied to the branch D1, the energy would be out of phase in the upper and lower branches. After reflection from the filters in the two branches, however, the reflected energy would be in phase at A1 because the energy in the lower branch has been shifted 180 degrees in phase by the delay network. The channel entering at D1 therefore would pass out through A1. Similarly a channel at frequency f1 entering at D1′ would pass out through A1′. Eight channels applied at branches Y1, Y2, Y3, and Y4, and X1, X2, X3, and X4 respectively would in the circuit of Figure 3 thus be combined into two groups; the group consisting of Y1, Y2, Y3, and Y4 will flow out at the right, and that consisting of channels X1, X2, X3, and X4 would flow out at the left. The circuit could thus serve as a combining filter shown at the right of Figure 1, and would thus combine the separately amplified channels for transmission.

The various elements comprising this circuit may be duplicated in waveguide structures in a variety of ways, some of which have already been described.* In the pulse

* Loc. cit.

studies referred to above, however, the method differs from those previously employed. In the filter arrays the main waveguide is square in cross-section, but the branch taken off at one corner is standard oblong waveguide, being twice as wide as it is high. A photograph of this unit is shown in Figure 4. Within the square section is a diagonal septum as indicated in Figure 5. Waves entering either end of the square section with their electric vector at right angles to the septum, as indicated in the upper part of Figure 5, pass through the guide and are not transmitted out the corner branch. Waves enter-

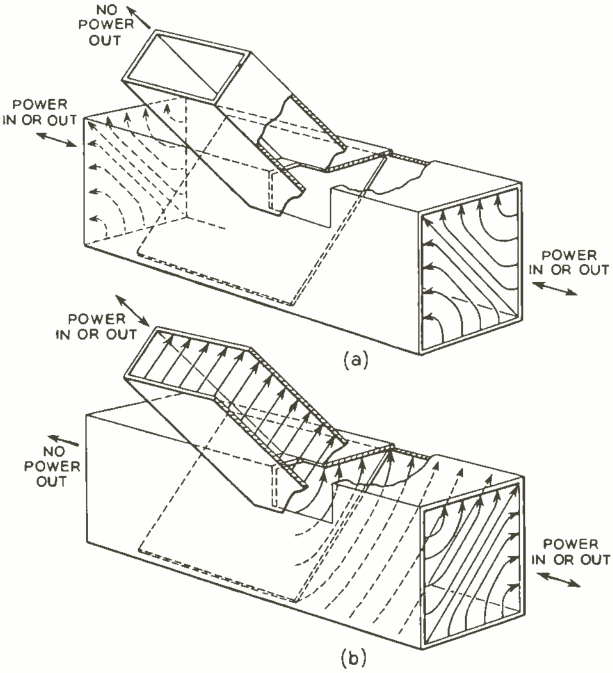


Fig. 5—Perspective drawing of the waveguide hybrid unit showing its effect on entering waves polarized in two directions.

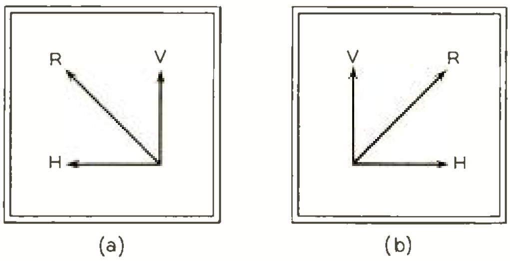


Fig. 6—Cross-section of hybrid unit showing resolution of diagonally polarized waves.

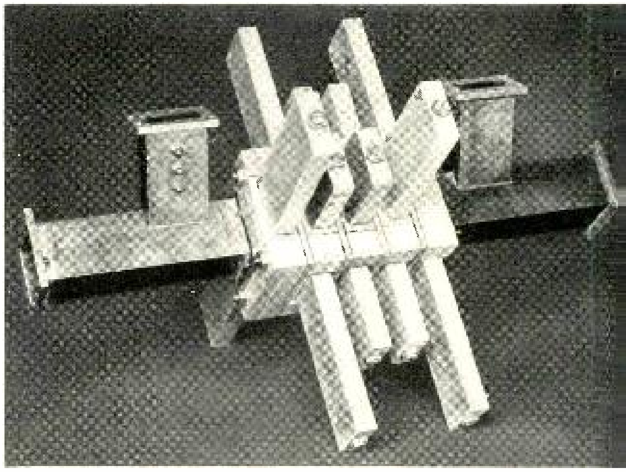


Fig. 7—A waveguide hybrid unit on each side of a delay and reflecting unit is the equivalent of Figure 2.

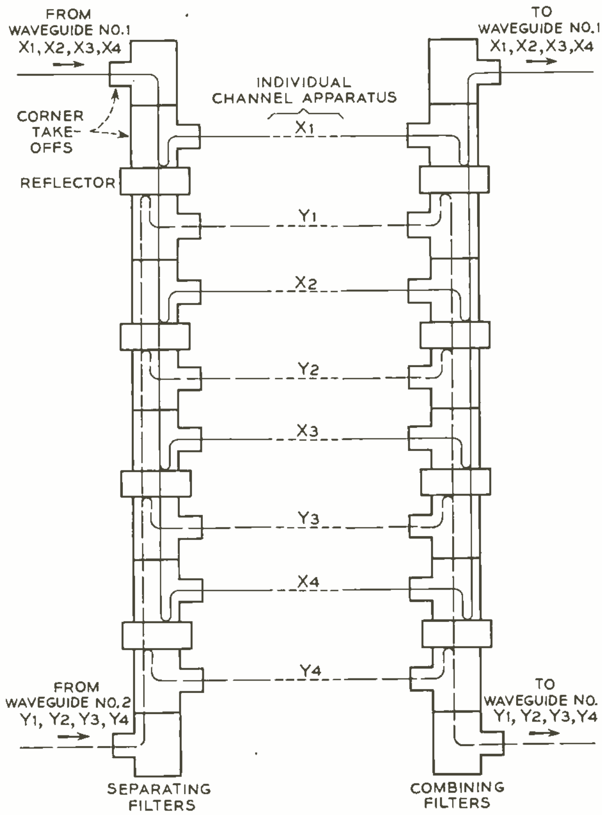


Fig. 8—Arrangement of waveguide units corresponding to Figure 1.

ing from the right and polarized parallel to the septum, on the other hand, will not pass through the square guide but will pass out the corner branch.

If a waveguide structure capable of reflecting waves of frequencies in the vicinity of f_1 and at the same time rotating their direction of polarization by 90 degrees were connected at the right end of the waveguide section shown in Figure 5, waves polarized as in the upper part of Figure 5 would be returned to the section polarized as indicated in the lower part of Figure 5. This reflected wave would then be transmitted out the corner branch and none would be transmitted through the square guide past the septum.

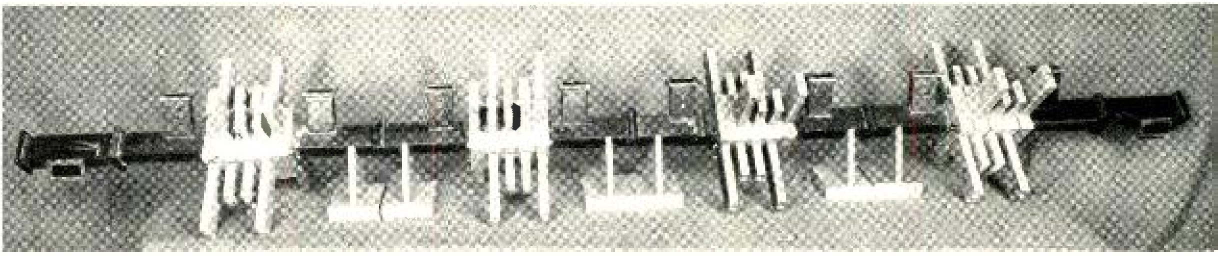


Fig. 9—A complete separating or combining filter.

This rotation of the polarization of the reflected wave is accomplished by quarter wave length sections of square waveguide and reflecting networks in the form of resonant cavities. The wave leaving the coupling section of Figure 5 is polarized diagonally across opposite corners, and may be considered as composed of two right angle components. This is indicated in Figure 6, where R represents the resultant electric field vector polarized diagonally and H and V the two right angle components. Two sets of reflecting cavities are employed; one to reflect the vertical component and one the horizontal component. Each set consists of two full-wave and two half-wave lengths of closed waveguide projecting perpendicularly from opposite sides of the square waveguide to which each are coupled by quarter wave sections as shown in Figure 7. The cavities reflecting the H component are offset one-quarter wave length from those reflecting the V component, thus corresponding to the reflecting sections of Figure 2. One component therefore travels one-quarter wave length further before reflection and one-quarter wave length further after reflection than the other component, and thus one component of the reflected wave will be 180 degrees behind the other. This turns over the direction of one reflected component so that a wave polarized as in the left-hand diagram of Figure 6 before reflection will be polarized as in the right-hand diagram after reflection. This reflected wave will thus pass out the corner branch as shown in the lower diagram of Figure 5.

The two wave components of Figure 6 correspond to the currents in the upper and lower branches of Figure 2, and on this basis the waveguide section shown in Figure 7 is closely analogous of the circuit of Figure 2. The complete waveguide separating filter consists of four sections such as Figure 7 connected together, and is shown in Figure 9. At each end is a coupling section through which the outputs from both of the waveguide transmission lines are supplied to the filter.

Four sections like that of Figure 7 connected together to form the separating filter of Figure 9 and another set of four to form the combining filter would thus appear as in Figure 8, which is a waveguide counterpart of the block diagram of Figure 1. The combined four channels entering from the left at the top of Figure 8 are designated X_1, X_2, X_3, and X_4, and those entering from the left at the bottom have the same mid-band frequency and are designated Y_1, Y_2, Y_3, and Y_4. The paths of the X channels are indicated by light solid lines drawn inside the guides, and those of the Y channels are similarly indicated but by dashed lines. Keeping in mind the

THE AUTHOR: PAUL A. REILING joined the Laboratories in 1926, and after completing a three-year series of student assistant courses became a Member of the Technical Staff. He then attended the College of the City of New York and received a B.S. degree. Mr. Reiling's work in the Research Department has included studies of feedback amplifiers, varistor modulator circuits, and carrier systems. During the war, his work was concerned with the design of numerous nonlinear-coil pulser networks used in Navy radar systems. At present he is continuing studies of PCM circuits.

action of the hybrid section as indicated in Figure 5, one can readily visualize how the eight channels are diverted to their individual amplifying channels. After amplification and regeneration, these channels enter the combining filter at the right and follow the paths indicated. All the x channels are combined and leave at the top of the combining filter, while the Y channels are combined and leave at the bottom.

The use of quadrature fields in square waveguide yielded filters with input and output sections which could be easily constructed. The filter elements depended only on linear dimensions making for relatively simple mechanical construction. Experimentally observed characteristics were in remarkably close agreement with theoretical characteristics established as performance requirements.

425A Electron Tube

Another in the series of miniature cold cathode tubes manufactured by the Western Electric Co., Allentown Plant, is the type 425A electron tube. It is a gas filled tube designed specifically for use as a ringer tube in the new 501 type telephone sets, and is similar in principle to the four-element 411A tube used on four-party selective ringing lines subject to induced voltages from external sources. The fourth element provides separate control and main gap circuits, and allows higher induced voltage without interference from main gap break down. The new tube resembles the Western Electric 426A tube described in the January, 1951, RECORD, in physical appearance, except for the fourth electrode. It is permanently mounted on a plastic angle bracket similar to that of the 426A tube, to facilitate mounting into the 501 type telephone set.

Average characteristics of the 425A tube are as follows:

Starter breakdown voltage	80 V
Starter voltage drop at 3 ma	70 V
Anode voltage drop at 10 ma	70 V
Required transfer current at 110 anode volts (min.)	400 microamperes
Required cathode transfer voltage (min.)	−40 V
Ionization time, starter gap	5 ms
Deionization time, main gap	1 ms

An opaque coating is applied to prevent stray light from adversely affecting the operating characteristics.

The LD-R1 single sideband radio receiver

G. RODWIN
Transmission Systems Development

Some years ago, a short-wave single sideband radio receiver was installed for the overseas radiotelephone service. Since that time, a number of such systems have been placed in operation by the Long Lines, their correspondents in foreign countries, and the armed forces. Some of the first receivers manufactured had provision for reception of only one sideband, but were arranged to permit the equipment for the other sideband to be added readily. The need for additional circuits came very quickly, and at present all the systems have the equipment for "twin" reception. Recently, a new receiver, known as the LD-R1 has been developed and put into service. It performs all the functions of the older type and has many new features that take advantage of recent progress in the art. With appropriate terminal equipment as many as four talking circuits can be obtained. The rearrangement of circuits and the use of miniature tubes and more compact filters and transformers have resulted in reducing the volume of the receiver so that the complete set now occupies a single 7-ft cabinet instead of the three similar cabinets required for the older set.

The LD-R1 operates over the frequency range from 4 to 23 megacycles. It has an unbalanced 75-ohm input and is capable of receiving single sideband signals with carrier reduced as much as 20 db below one of two equal tones which completely load the transmitting equipment.* The receiver will function with the older type LC transmitter, the newer type LD transmitter now going into manufacture, or any other transmitter which produces the suitable type of emission. This new receiver has many novel features, such as a choice of either crystal or electric first beating oscillator, limiters for reconditioning the received carrier, an automatic frequency-control circuit with very few adjustments, a squelch circuit which prevents false operation of the automatic frequency control during periods of poor signal-to-noise ratio, a common main amplifier for both sidebands and carrier, and a distribution of selectivity and automatic volume control action that minimizes cross-modulation and maintains maximum signal-to-noise ratio.

A block schematic of the receiver is shown in Figure 1. The main branch goes through the upper part of this illustration. Connection to the antenna is made by a 75-ohm coaxial transmission line which is brought to the antenna jack. A patching coaxial plug connects the transmission line to the receiver input jacks. The provision of a removable patch at this point permits a signal from a test generator to be connected to the circuit for testing. From the input jack the signal is passed through an attenuator with 10 db steps from 0 to 30 db to provide protection against cross-modulation from very strong signals. Following the attenuator, there is a single stage of high frequency amplification, with gang-tuned input and output circuits, providing gain and selectivity. The signal is then passed to the first demodulator, which is fed by voltage either from a crystal oscillator and a combined amplifier and harmonic generator or from a continuously tunable oscillator.

At the output of the first demodulator, the signal has been stepped down to a band centered around 2800 kc. Additional gain

* For an explanation of this reference level, see an article by A. A. Oswald, *Proc. I.R.E.* December, 1938.

and selectivity is provided by the 2800-kc amplifier and its associated filters. These filters have high rejection characteristics for frequencies 100 and 200 kc away from mid-band so as to avoid interference effects in the 100-kc circuits later in the receiver. The signal next passes to the second demodulator into which is also fed the output from the second beating oscillator. Here the signal quency amplifier with considerable feedback which supplies the receiver output to the outgoing lines. A VU meter and monitoring jacks provide the operator with a convenient means of supplying the correct volumes to the lines.

It is essential to the satisfactory operation of the receiver that the carrier at the 100-kc intermediate frequency be maintained very

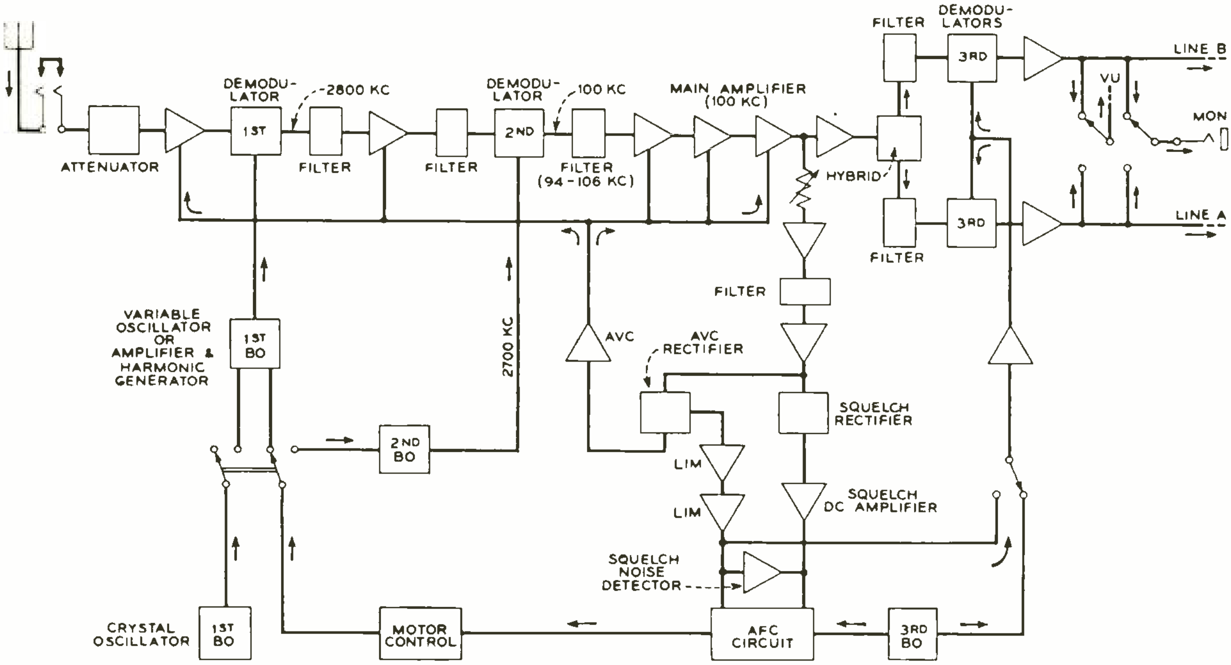


Fig. 1—Block schematic of the LD-R1 single sideband radio receiver.

band is converted to a band centered around 100 kc, and then passes through a 94 to 106-kc filter to the main four-stage 100 kc amplifier. Following this latter amplifier, the signal passes through a hybrid coil into two crystal, channel-group filters. These select the bands on either side of the carrier. The connections of these filters to the hybrid coil are such as to reduce the reaction of the filters on one another. Each channel group is converted to voice frequency in a balanced copper-oxide demodulator, which is supplied with a 100-kc carrier. This carrier may be supplied from a local crystal oscillator, or it may be derived from the incoming carrier after it has been converted to 100 kc and reconditioned. Following each third demodulator is a two-stage voice fre- accurately in frequency because the final demodulation may be produced with the use of the local 100-kc crystal oscillator, and the privacy equipment normally employed at the terminals requires accurate frequency reproduction of the modulation. This is accomplished by taking the carrier from the output of the third stage of the main 100-kc amplifier, comparing it with the output from the local 100-kc crystal oscillator, which is held to within ±1 cycle, and then using the difference frequency to adjust either the first or second beating oscillator.

This carrier from the third stage of the main amplifier is amplified and then passed through a crystal band-pass filter only 40 cycles wide, which has high discrimination to all frequencies but the carrier. After another stage of amplification, this carrier is passed to two rectifiers—one to supply automatic volume control, and the other, a squelch circuit. The output from the AVC rectifier is amplified and then used to control the gain of all the amplifiers in the main path up to and including the third stage of the 100-kc main amplifier. Another connection from this AVC rectifier takes carrier prior to rectification, passes it through two limiters, and thence to the automatic frequency control circuit. Also connected to this latter circuit is the 100-kc output from the local crystal oscillator. These two frequencies are compared, and a two phase output proportional to the difference between them is produced. This two phase current is used to operate a motor-driven capacitor which adjusts the frequency of either the first or second beating oscillator. A simple switch permits the desired selection. In one position, the first modulator is supplied from a crystal oscillator while the motor-driven capacitor controls the frequency of the second beating oscillator. In the other position of the switch, the motor-driven capacitor controls the frequency of the continuously variable first beating oscillator, while the second beating oscillator remains uncontrolled. With either arrangement, the carrier frequency at the output of the second modulator is always held closely to 100 kc.

The crystal first beating oscillator has a choice of ten crystals. When the selecting switch is set to the crystal controlled position, the output is connected to a double triode, the first element of which may be used either as an amplifier or as a harmonic generator, and the second element as a limiter. The output of the limiter passes through a tuned selection circuit and thence to the first demodulator.

With the switch in the other position, the variable first beating oscillator is selected, its double triode being used as an amplifier and limiter. The second element also provides the 180-degree phase shift required for feedback, and the motor-driven capacitor connected across a resistor in the feedback path is controlled by the two phase current from the AFC circuit, and holds the output of the variable oscillator to a frequency that will insure 100 kc at the narrow band filter.

The second beating oscillator is also a two tube circuit with feedback, and when the crystal oscillator is used for the first demodulator, the motor-driven capacitor controls the frequency of this second beating oscillator in the same way as described above for the first beating oscillator.

Since during fades or when there is a

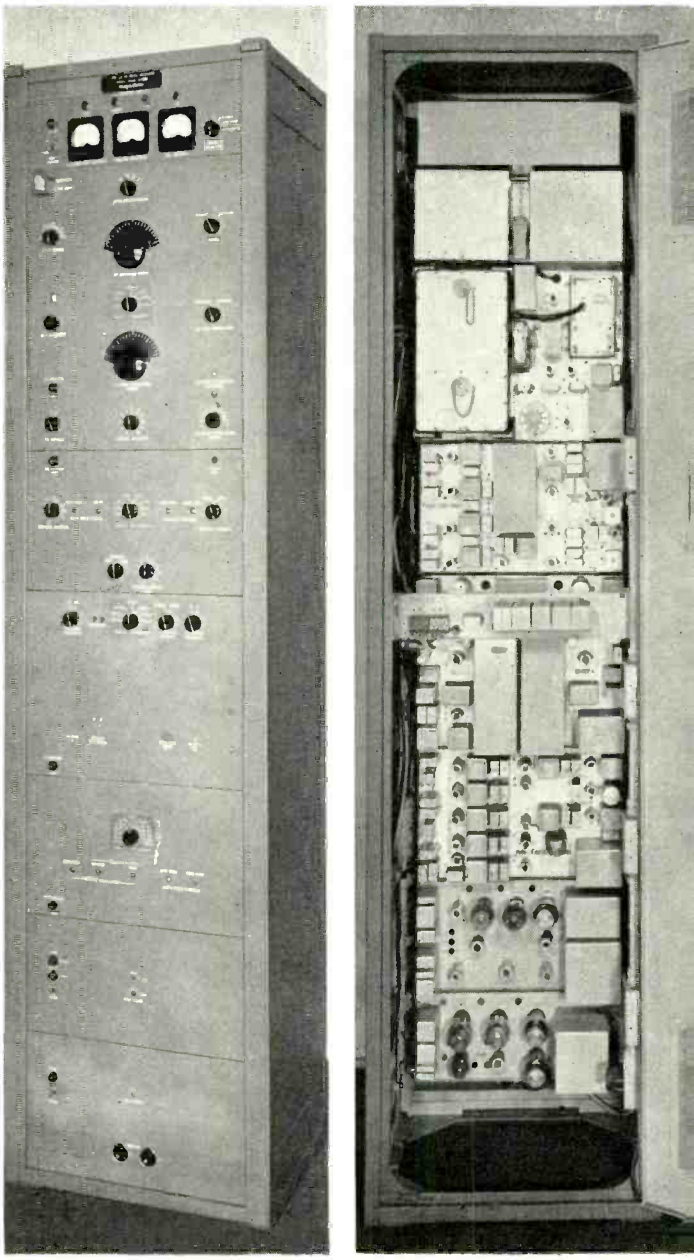


Fig. 2—The Western Electric LD-R1 receiver.

large increase in noise at carrier frequency, the two-phase control current might momentarily depart from its correct frequency and thus detune the receiver, a squelch circuit is provided to disable the AFC circuit during these periods–thus allowing the frequency of the first or second beating oscillators to remain at the value they had just before the fade. This squelch circuit is supplied from both the squelch rectifier, which is one of the two rectifiers following the second amplifier in the 100-kc carrier circuit, and from a squelch noise detector supplied from the second limiter in the same circuit.

Besides being used for AFC, AVC, and squelch control, the reconditioned 100-kc carrier is also used as one of the alternate supplies for the third demodulator. The other alternate is the 100-kc crystal oscillator used also with the AFC circuit.

Figure 2, left, shows the front view of the complete receiver. The top panel contains the carrier meter, the output VU meter, the panel-selecting metering switch, the alarm circuits, and a d-c meter for measuring the plate and screen currents of most of the vacuum tubes. The second panel contains circuits and controls that convert the incoming high frequency signals to a band centered around 100 kc. The third panel contains the main 100 kc amplifier, carrier selecting and limiter circuits, and the squelch circuits. The fourth panel has the channel selecting filters and circuits, and the low frequency amplifiers. The fifth panel contains the automatic frequency control circuits and the 100 kc local oscillator. The sixth and seventh panels are the regulated power supplies.

A rear view of the apparatus side of the panels is shown with door open in Figure 2, right. In this later photograph may be seen the d-c and high frequency wiring on one side and the 115 volt a-c wiring on the other side of the cabinet.

The complete receiver operates from a 115 volt ± 5 per cent, 50-60-cycle supply, and takes 500 watts. A safety switch arrangement is provided to protect the operator from all voltages over 150 volts when mats which cover the wiring are removed for testing. The cabinet with all necessary equipment installed weighs about 550 pounds.

In the design of the equipment, considerable attention was given to the position of the controls. All of these appear on the front of the set, so that the operator can see the meters as he makes adjustments. The controls which are required only in the initial setup are screwdriver operated. The normal shifting to a new frequency is carried out by knobs located to insure easy operation.

THE AUTHOR: G. Rodwin received an A.B. degree in 1923 and an E.E. degree in 1925 from Columbia University. For about four years, he engaged in radio research for the R.C.A., but since 1930, has been occupied in radio research and development with these Laboratories. He has done considerable work in connection with equipment for transoceanic radio receiving and for the point-to-point services. During the war, he was engaged in radar and microwave development. Since 1945, his work has been in connection with a number of new designs of single-sideband radio equipments for use by the Bell System and the Armed Services.

In a classroom of Great Neck High School Miss Marion Ryan coaches a radio play. Through the box on the table, two absent pupils participate.

BTL Development Benefits Laboratories Family

Some time ago the RECORD published a description of the Executone equipment for connecting a home-bound child to his school classroom*. H. W. Nylund of Transmission Engineering read the story, little thinking his daughter Lucy would be the first Laboratories child to use the system. But that is just how it turned out, and Lucy is prouder of her father and his associates than ever.

Last October, Lucy, then 12 years old, had a mishap that put her in the hospital for several weeks, and then temporarily confined her to her home. The School Department of Great Neck where Lucy lives was acquainted with the Executone device through information sent out by the New York Telephone Company. Extension of schooling to homebound students is a part of Great Neck's program, and this was a good chance to use it. Arrangements were made with the Telephone Company to install one terminal in a high school classroom and the other in the Nylund home. By a coincidence a lad in that neighborhood, a classmate of Lucy's, was also homebound so a set was installed for him also. Service was begun just after the Christmas Holidays.

A class for English and Social Studies taught by Miss Marion Ryan was selected for the experiment. Classroom work includes much more than the questions and answers familiar to our older readers. Lucy takes a part in presentations of playlets and radio shows; and dramatizations of familiar incidents. Once her classmate, in his home, played the piano for the classroom singing. During breaks, the children gather 'round the "talk-box" and chat back and forth with their absent classmates.

"Every day," says Miss Ryan, "new ideas are coming up for use of the system. Best of all, these two children are not growing used to isolation, but still feel that they belong to the school group."

November, 1949, page 390.

John J. Remelius, installer of the New York Telephone Company, makes an adjustment on the school terminal in Great Neck.

From her home, Lucy Nylund, daughter of our H. W. Nylund of the Transmission Engineering Department, follows the classroom work.

Military Electronics Develops New Radar Fire-Control System

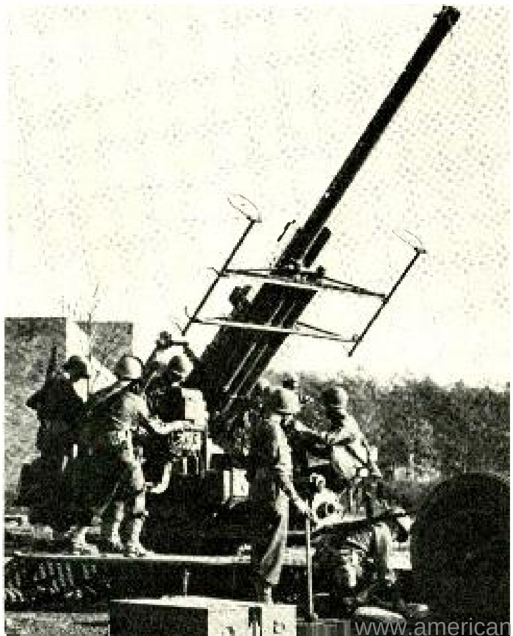
The new fire-control radar and the van in which it is transported.

Development of a new and far more effective fire-control system for automatically aiming anti-aircraft artillery has been announced by the Laboratories, with the approval of the Army Ordnance Corps for whom the project was undertaken.

The new fire-control system is already in production by Western Electric, also operating under an Army Ordnance contract. The Western Electric contract is for about $137,000,000.

Many radical improvements have been incorporated in this outgrowth of the Laboratories' M-9 electrical gun director* and its associated radar systems, which proved so remarkably effective against Nazi planes and "buzz bombs" in World War II†. This earlier fire-control system, a major "secret weapon" of the war, worked almost entirely automatically. Radar found and tracked a hostile plane, and fed continuous information concerning its location into a computer, which was the heart of the system. At the same time, data relating to wind velocity, muzzle velocity of the shells, temperature and similar factors, were given to the computer. This machine then automatically calculated where a shell should explode in order to bring the plane down, and automatically aimed the guns to do just that.

One of the 90-mm anti-aircraft guns. This picture was taken in November, 1943, when a battery equipped with the earlier M-9 gun director was exhibited at Murray Hill.



Adaptable to firing either 90-mm or 120-mm anti-aircraft batteries, the new fire-control system operates on the same general principle as its predecessor, but its many improvements and refinements make it far more effective and flexible than the World War II version.

Details of the new system are classified for security reasons but it can be said that much more information concerning hostile craft can be assembled and processed, and the entire system works more accurately, more quickly and more easily. This is due to a number of new circuits and circuit elements which have been introduced into the system. Naturally the system is geared to handle high-altitude, high-speed targets, and to take into account advances in plane and projectile performance which have been made since the war.

Being extremely compact and portable, the new system can easily and quickly be moved cross-country anywhere the gun battery can go. In addition, the equipment is unusually light in

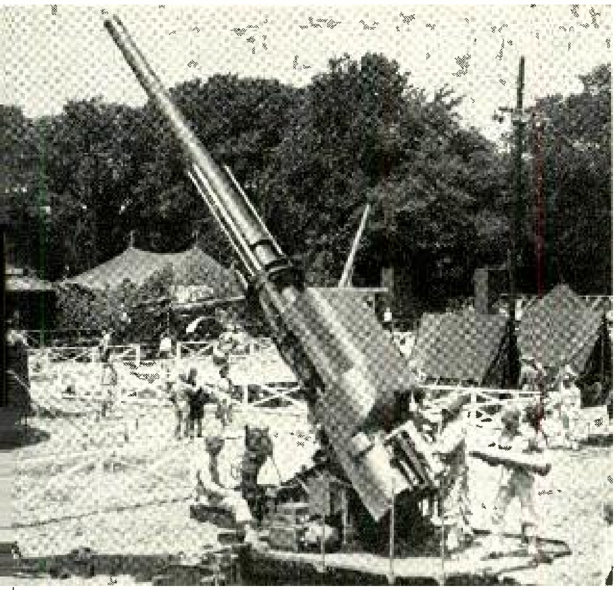
---

*Record, *January*, 1944, *page* 225.
†Record, *October*, 1950, *page* 466.

weight and can readily be transported by plane. It is also floatable so that it can be towed across rivers or lakes.

Housing for the equipment was designed by the Douglas Aircraft Company, Inc., and the housing units are being manufactured by The Glenn L. Martin Company, both as subcontractors of the Western Electric Company.

The Army Ordnance Corps asked the Bell Laboratories-Western Electric team to undertake research, development work and manufacture of the fire-control system not only because of their wide experience with the highly successful gun director and radar of World War II, but also because of their unique qualifications in the field of electronics. Many of the basic principles of fire-control systems, for example, are similar to those employed in the complex



A 120-mm anti-aircraft gun of the type which will be pointed by the new fire-control radar.

switching mechanisms which underlie the dial system of the modern telephone network. Many of the components of the intricate computer which is the heart of the fire-control system—switches, relays and vacuum tubes—as well as some of the circuits, are also found in the telephone system. The close association between the Laboratories and Western Electric in the Bell System for many years also provides an ideal working arrangement for ensuring complete coordination between research and development on the one hand and manufacturing on the other, in putting these new and highly complex fire-control systems in production.

1951 I.R.E. National Convention

Several Laboratories people took part in the 1951 I.R.E. National Convention held in New York, March 19-22, at the Waldorf-Astoria Hotel and Grand Central Palace. J. W. McRae gave the principal address at the annual meeting of the Institute, March 19, speaking on *A Challenge and a Promise*.

In the session on Information Theory, with C. E. Shannon presiding, M. W. Baldwin, Jr. presented his paper *Subjective Sharpness of Additive Color Pictures*. W. H. Doherty presided at the session on Frequency Control and Generation, which was organized by E. P. Felch. W. J. Albersheim and J. P. Schafer presented a paper entitled *Echo Distortion in the FM Transmission of Frequency–Division Multiplex*, at the Communication Systems meeting.

The Symposium on Amplification of DC Signals included papers on *Direct-Current Amplifiers Employing Magnettors*, by E. P. Felch, V. E. Legg, and F. G. Merrill, and *Drift Compensation in DC Amplifiers for Analogue Computers*, by W. E. Ingerson.

At the session on Propagation, A. B. Crawford and W. C. Jakes, Jr. gave a paper, *Selective Fading of Microwaves*, and O. E. De Lange, *Propagation Studies at Microwave Frequencies by Means of Very Short Pulses*.

M. J. Kelly spoke on *Educational Requirements for Development Engineers in Electronic and Communication Technology* at the symposium on Matching Schools and Industry.

R. Bown presided at the session on Microwaves I—Waveguides A, in which four other Laboratories people took part. S. E. Miller and A. C. Beck gave their paper *Low-Loss Waveguide Transmission;* A. P. King, *Dominant Wave Transmission Characteristics of a Multi-Mode Round Waveguide;* and M. Aronoff, *Radial Probe Measurements of Mode Conversion in Large Round Waveguide with TE_{01} Mode Excitation.* At the session on Waveguides, S. E. Miller and W. W. Mumford gave their paper, *Multi-Element Directional Couplers*.

The Symposium on Recent Advances in Color Television with A. G. Jensen presiding, included W. T. Wintringham's paper *Plans of Adding Color to Television*. R. L. Dietzold presided at the session on Circuits III—General.

Laboratories engineers were also among members of the convention committees: *Technical program committee*, W. H. Doherty, E. P. Felch, A. G. Jensen, and W. W. Mumford; *institute activities*, W. H. Doherty and A. G. Jensen; *registrations*, A. C. Peterson, Jr.; and *facilities*, M. W. Baldwin, Jr., and J. P. Kinzer.

What Becomes of the Operators?

The problem of taking care of telephone operators at dial cutover time can be and is being solved by intelligent and careful planning or what might be called "Human Engineering."

Let's see what advance planning meant in two central offices of the Bell of Pennsylvania.

The Madison Central Office at Lansdowne, Pa., normally employed 207 operators. During the construction and testing period which preceded the cutover in July, 1949, human planning was going on. Replacements for the normal turnover of the working force were made by bringing back 44 former employees who were glad to work for a few months without any commitment as to permanency. Thirteen others were temporarily transferred from other offices where they could be spared; three who wished to resign were persuaded to stay on. Temporary employees were hired with the definite understanding that their jobs might not last beyond the cutover date.

When the old board was cut out, 120 operators were transferred to Lansdowne Toll, about two blocks away, where they handle toll and assistance calls; 13 employees returned to their home offices; 58 were transferred to other offices in the district and three to other Bell companies —a total of 194. Of the 13 who left the service, three had deferred their resignations, ten had come back temporarily from private life.

Of a smaller central office, Mr. W. L. Lees, Assistant Vice President-Personnel, said in an article in *The Telephone News,* the Bell of Pennsylvania employee magazine:

"In the Clairton, Pa. (Western Area) Office, which was cut over to dial in March, 1950, there were a total of 64 employees before the cut, and 0 after the cut.

"After the cut, the following was done: 7 borrowed employees were returned to their home offices; 6 regular employees were transferred to other departments; 29 regular and 4 temporary employees were transferred to other central offices; 10 regular employees, who had wanted to leave previously but had agreed to work to the date of cutover and who were more interested in 'keeping house' than in working after cutover, resigned after having been offered transfers to other locations; 1 temporary employee, who had been offered a transfer, and 7 former employees, who had been working part time only until the cutover, terminated their employment.

"These two central offices are pretty good examples of what has happened at dial cutovers throughout our Companies and of the human engineering that goes into the employment side of the picture. Where there are nearby offices, of course, the problem is much less difficult than it is where the office to be cut is isolated and where long travel distances, or lack of transportation, are major problems.

"Human engineering, however, has worked so well that in 20 postwar dial conversions, where operating personnel were involved, only 11 out of the 1,019 regular employees terminated their employment and then only after they had been offered transfers to other offices—but, because of the distance involved, they were unable to accept a transfer, therefore, they were granted termination payments. As against those 11 regular employees who terminated their employment, continued employment after the cutover was given to 41 temporary employees who had been employed with the understanding that they would have work only until the offices were cut to dial, so the score really is a plus 30."

All Lackawanna commuters, as well as many others who enter the front door of the West Street building in the morning, know "Jim" Barton, the guard at the main entrance. The photograph shows him as guest of honor with friends and supervisors at a luncheon commemorating his fortieth anniversary at the Laboratories. Left to right, seated, are S. B. Cousins, Mr. Barton, George McDermott, L. P. Bartheld, and John Hanley. Standing, in the same order, are Roger Clifford, W. A. Tracy, Joseph Doherty, B. R. Young, H. C. Atkinson, Vincent Burns, and W. C. Somers.

Out-of-Hour Lecture Series

F. A. Korn, Switching Systems Development Engineer, was the third speaker in the series of informative out-of-hour lectures. His talk, entitled *The No. 5 Crossbar Dial Telephone Switching System,* was given February 15 at Murray Hill and on February 26 at West Street.

Mr. Korn sketched briefly the history of crossbar developments from the beginning of what is known as No. 1 crossbar for large cities, through tandem and toll applications, and now No. 5. The new No. 5 system was designed primarily for areas on the outskirts of large cities, where calls to metropolitan offices and other suburban offices require interconnection with many different types of equipment. Because of its unusual flexibility, the system can also be used in comparatively small isolated cities.

By means of slides showing simplified block diagrams, the lecturer gave a clear picture of the manner in which a subscriber's call is completed within a local central office, and also the completion of calls to and from distant offices.

Design of the apparatus and equipment arrangement was illustrated with photographic slides and a sample frame containing relays and protective covering arrangements, was shown.

On-The-Job Conference of representatives of A T & T, Western Electric, Bell of Pa., and the Laboratories was held right in the storeroom of the Norristown office. Those around the table are, left to right, M. G. Killoch, A T & T; W. I. McCullagh; BTL (hidden); G. J. Litty, Bell of Pa. (hidden); W. Whitney, BTL, Chairman, (at head of table); F. N. Williamson, Western Electric; G. A. Hurst and R. B. Miller, BTL; and E. C. Zipf, Western Electric. This picture was used in Western Electric's magazine, WE, Jan.-Feb., 1951, in an article describing the Engineer of Installation Organization.

On the Job Conference

The production of telephone systems does not end with design, manufacture and installation; before they can be placed in commercial use, many tests must be made to insure that the thousands of circuits and the associated apparatus are in first class working order before being turned over to the Telephone Company. Here is where cooperative work really begins—A T & T, Western Electric, the Associated Telephone Companies, and Bell Laboratories all work together to produce a system that provides telephone service of the quality that American people have come to expect.

One instance of this cooperative effort occurred recently in the new No. 5 crossbar central office installed in Norristown, Pa. A committee of representatives from the several companies mentioned was established to study new load and acceptance performance requirements and test methods. This committee, headed by W. Whitney, of Switching Systems Development, included G. A. Hurst, of Switching Maintenance, W. I. McCullagh, Switching Development, and R. B. Miller, Quality Assurance. They met with the other representatives right on the job, around a portable table in a storeroom, and even spreading out drawings on the floor when necessary to have more space.

Their objectives were to decide on the adoption of new testing requirements and methods and new ways of simplifying and cutting down the test interval of the new No. 5 office being installed in Norristown. Actually, the discussions were not limited to Norristown, but the improved methods devised in Norristown will apply to subsequent No. 5 installations. The trial of the new methods has been extended to the New Brunswick office where another installation is now in progress.

I.R.E. Appointments

At the January meeting of the I.R.E. Board of Directors, J. W. McRae was reappointed Standards Coordinator. He also was appointed to the Executive Committee of the Institute. R. A. Heising was made Chairman of the Committee on Constitution and By-Laws; F. B. Llewellyn, Chairman of the Committee on Policy Development, and A. G. Jensen was made Chairman of the Standards Committee. Mr. Jensen was also appointed Chairman of the Committee for coordination with international electrotechnical organizations.

W. H. Doherty, who was elected to the Board of Directors last Fall, attended his first meeting of the Board.

News of the Telephone Pioneers

Dr. Perrine talks to Life Pioneers, while J. L. Richey, his assistant, operates the demonstration equipment.

Life Pioneers Hear Dr. Perrine

"More Waves, More Words, Less Wires," the famous demonstration lecture by Dr. J. O. Perrine of A T & T was the feature of the Pioneers' Life Member Club meeting in the West Street Auditorium on February 1. After a short business meeting during which Marjorie Broderick, on behalf of the Women's Activities Group presented a brief case for use by the Life Members' Secretary, there followed a luncheon for eighty-odd Life Members and guests. The West Street Chorus, led by Russell P. Yeaton, rendered a number of popular songs; they were accompanied by Grace Wagner and Betty Garrow.

Dr. Perrine's talk was a vivid presentation of the carrier art as developed in the Bell System during thirty-five years. Assisted by J. L. Richey, A T & T, and G. A. Bunyan, New York Tel, he demonstrated carrier principles by means of a four-channel carrier system* developed for the Signal Corps in World War II. In this, all carriers have audible frequencies, so that the audience could hear the original transmitted speech from one of four records, the carrier, the sideband, and finally the recovered signal. Dr. Perrine also used one of the Laboratories' microwave demonstration sets to illustrate line-of-sight transmission, reflection, refraction and polarization of these waves, as well as superposition of the carrier system on them.

Dr. Perrine retired from A T & T at the end of February, so that this was one of his last appearances.

*Record, *December*, 1943, *page* 168.

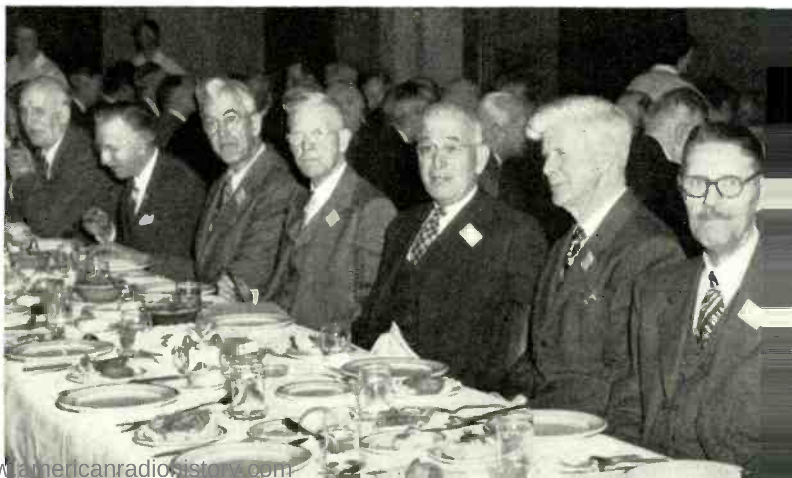
Hospital Visitation Plan

One of the features of the Telephone Pioneers organization is visiting the sick. This activity was especially important during World War II, because of the many telephone people in military service who had been wounded and were hospitalized.

Due to the present Korean situation, the Pioneer Hospital Visitation plan, in modified form, is being reactivated. This plan provides for hospital visits to all telephone people who are in military service and are patients in Government hospitals in the United States and Canada. It applies to all such patients, not merely to those who are Telephone Pioneers, but also includes members of the immediate families of telephone employees. Here's how the plan works.

Upon receiving information about a person who is hospitalized, from any chapter's territory, this information is forwarded to the chapter secretary in whose territory the hospital is located. Representatives of one of the local chapters in

Grace Wagner and Betty Garrow as they accompanied the West Street Chorus when they sang for Pioneer Life Members.



Some of the Life Members at lunch. Left to right, F. C. Willis, W. A. Belits, J. C. Field, L. E. Dickinson, George Hamm, Thomas Cruger, and Claude Deyo.

that area then visit the patient and a report is made to the relative or other person who is to be advised.

Results of the plan during World War II showed great appreciation on the part of relatives of the patients and it is expected that the reactivated plan will pay similar dividends in happiness and reassurance.

Pioneer Parties

Five hundred New Jersey Council Pioneers and their guests temporarily took over the National Broadcasting Company tour facilities on February 26 following a TV party at the Centre Theatre. The show was the Firestone Hour with Thomas L. Thomas as the star. Enthusiastic reports came from members attending, both as regarding the "workings" of the show and the broadcasting facilities. Including this TV party. New Jersey Council members and guests to the number of 1934 have attended the four social gatherings beginning last October. Two more regional meetings in New Jersey are scheduled, to be followed by the entire chapter's yearly joint picnic to be held June 9 at Farcher's Grove, Union, New Jersey.

Three hundred New York Council Pioneers and their guests attended the Telephone Hour performance at Carnegie Hall on March 12. Guest soloist for the program was the Swedish tenor Jussi Bjoerling.

Employees' Benefit Committee Annual Report—1950

Under the "Plan for Employees' Pensions, Disability Benefits and Death Benefits," the Employee's Benefit Committee submits the following report on its operations:

During 1950, the Laboratories averaged 5,807 employees. The extent of benefit coverage is indicated by the fact that 5,407 employees, 93 per cent, had two or more years of service and were eligible to sickness and death benefits under the Plan, in addition to the accident benefits to which all employees are eligible.

Sickness disability benefit cases increased 15 per cent and related benefit sickness absence 7 per cent.

During 1950, 82 employees retired with service pensions, and 3 with disability pensions. As of the end of the year there were 392 retired employees on the service pension roll, 22 were receiving disability pensions and 2 were receiving special pensions.

The Committee reports with regret the death of 20 active employees, 13 retired members of the Laboratories and one employee on leave of absence.

There were 81 leaves of absence in effect at the beginning of 1950 and during the year 117 were granted, including 20 for military service, and 112 were terminated, leaving a total of 86 leaves outstanding as of December 31, 1950.

The members of the Employees' Benefit Committee are: S. B. Cousins, Chairman, R. Bown, A. B. Clark, F. D. Leamer and W. H. Martin, and as alternate members J. W. McRae, B. R. Young, M. R. McKenney and M. H. Cook. J. W. Farrell and Dr. C. E. Martin act as counselors to the Committee, J. S. Edwards is Secretary and K. M. Weeks is Assistant Secretary.

J. S. Edwards, *Secretary,*
Employees' Benef.t Committee

Benefit Payments for Year 1950

Payments by Laboratories into Pension Trust Fund	$3,159,485
Other Payments by Laboratories:	
Disability Pensions	24,061
Accident Benefits and Related Expenses	25,600
Sickness Disability Benefits	345,918
Sickness and Accident Death Benefits	125,733
Payments Following Deaths of Retired Employees	59,365
Total Payments by Laboratories under the Benefit Plan	$3,740,162
Payments by Laboratories to the Federal Government for old age benefit purposes under the Social Security Act	264,104
Total	$4,004,266

Payments by the Trustee from the Pension Trust Fund for service pensions amounted to $777,597. The balance in the Fund on December 31, 1950, was $32,706,646. This Fund is irrevocably dedicated to the payment of Laboratories service pensions and can be used for no other purpose.

Nurses Aides in Summit

On November 13, 1950, the Summit Chapter of the American Red Cross reactivated their Nurses Aide Training Program at the request of Overlook Hospital in Summit. Lois Burford, Jean Wilson, Ethel McAlevey and Charlotte Bortzfield of the Laboratories at Murray Hill joined the class.

Thirty-six hours of classroom work, four hours of orientation, and forty hours actual work in the hospital were required to complete training. As graduate Nurses Aides the girls will work in the hospital approximately one-hundred and twenty-five hours a year assisting professional nurses and also may be called upon to work at blood banks or in an emergency.

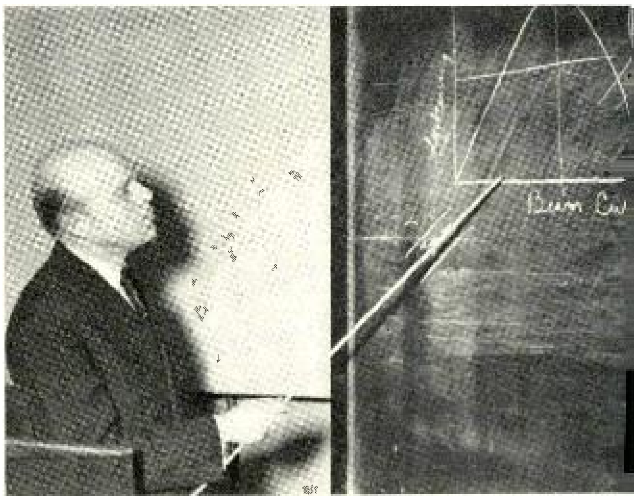
Graduating and capping exercises were held at the Red Cross Chapter House in Summit on March 1, 1951.

Jane Melroy, of Murray Hill, Vice Chairman of the Nurses Aides, and Ruth Kendall, formerly of Murray Hill, are graduate Nurses Aides under earlier programs and have been serving at Overlook Hospital.

Deal-Holmdel Colloquium

A former member of the Laboratories staff, A. M. Skellett, returned to Deal to address the meeting of the Deal-Holmdel Colloquium on February 16. Dr. Skellett is presently with the National Union Radio Corporation and his talk was on some results of research there on dark trace cathode ray tubes. In these tubes an electron beam produces a dark trace on a screen composed usually of alkali halides by the production of "F-centers" which absorb light. The usual screen material is potassium chloride which gives a purple color.

It was brought out that dark trace tubes have been developed in order to get longer persistence of the image and to allow projection of this image on a large screen. The most persistent of standard phosphors is far too faint to be useful for projection purposes and for some applications the persistence is not long enough. With dark trace tubes, the intensity of the projected image can be increased by using more illumination and the persistence is so long that the problem is rather one of reducing it to reasonable lengths by erasure of the image. The process of erasing depends on migration of the color centers, and this can be speeded up by running the screen at quite high temperatures. Formerly, these temperatures were obtained by using large amounts of infra-red radiation. One of the major improvements resulting from the researches described is the use of electron bombardment to heat the screen and the mounting of the screen on a very thin mica or glass plate to reduce the heat capacity. With these techniques, erasure times of five to eight seconds are now readily obtainable.



Dr. Skellett, formerly of the Laboratories, lecturing at the Deal-Holmdel Colloquium.

K. K. Darrow gave a talk on *The Elementary Particles of Physics* at the March 2 meeting of the Deal-Holmdel Colloquium. Some old experimental evidence on elementary particles was reviewed and newer evidence which makes the term "elementary" appear to be a misnomer was mentioned.

High Court Rules on Telephone Rate Appeal

The Massachusetts Supreme Judicial Court recently ruled that a net return to the New England Telephone and Telegraph Company of less than 8.5 per cent on stock capital and 6.23 per cent on all capital is below the level where confiscation begins. The decision was made on the company's appeal from an order setting a rate of return of only 4.85 per cent on the company's invested capital.

In its decision the court sent the case back to the regulatory agency and, in effect, directed that new rates be established which will produce earnings of not less than 6.23 per cent.

Massachusetts' highest court declared: "Here is one of our greatest and most necessary public utilities. It cannot be permitted to fail in its service to meet an insistent public demand. It did so by borrowing $120 million on demand notes from a source which fortunately was available to it. It must repay this money in the near future. It cannot expect to retain this borrowed money indefinitely as a part of its capital structure. Its only means of repayment is by obtaining new capital. Concededly it must not increase its debt ratio. It must therefore sell a substantial amount of stock. On the evidence, it can do this only if it is allowed a return on stock capital substantially larger than (that) allowed by the Department."

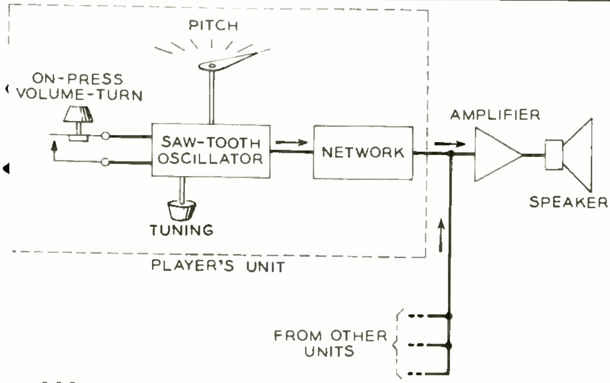
The Court's decision has the effect of allowing most of the $15 million which the company sought in its rate applications of 1947 and 1948. These rates would have yielded a 6.5 per cent return and while the Court did not say that such a return was unreasonable, it did say that anything less than 6.23 per cent was "below the level where confiscation begins." The Court went on to say that "it does not follow that a considerably higher return might not fall within the range of reason and might not have been allowed by the Department . . ."

The Court further declared that "a public regulatory board cannot assume the management of the company and cannot under the guise of rate making interfere in matters of business detail with the judgment of its officers reached in good faith and within the limits of a reasonable discretion."

Musical Score and Frequencies 4

Among the minor uncertainties of life is what an engineer may come up with when you ask him to do something funny—as B. McMillan discovered when he asked L. A. Meacham, who plays in a string quartet, to burlesque one for a Murray Hill Chorus' Christmas party.

Meacham's first thought was the conventional one of getting some mouth organs and tin whistles from the 5 and 10. Then he remembered how engineers like to play tunes by twiddling the dials on oscillators. Why not have four people operating four oscillators feeding into a loudspeaker? The oscillators and circuit



Vobble arm controls pitch by varying potentiometer. 'wo other potentiometers control volume and tuning.

arrangements could be inexpensively built of standard radio parts. Working for two nights in his cellar, Meacham produced the instrument.

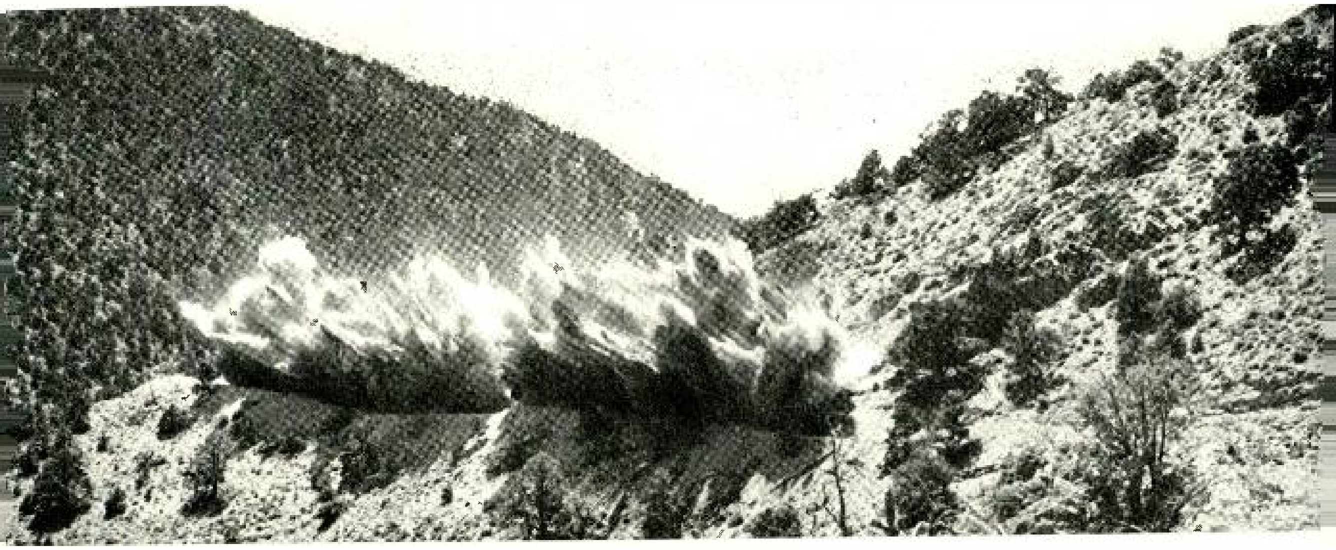
By swinging an arm over a graduated quadrant, each player can vary the pitch of his oscillator over a range of about 2½ octaves (6 to 1 in frequency). The four controls are arranged to cover the vocal ranges of soprano, alto, tenor and bass, respectively, but can be changed to cover a male quartet by changing a few capacitance values. A waveform-shaping network emphasizes or suppresses various harmonics and thus affords a different tonal quality for each player, a feature which is accomplished in musical instruments by acoustical means.

For some kinds of music, steady tones without vibrato are essential. But experimenters soon

Wobble Organ was first played publicly at a concert of the Murray Hill Chorus at Summit High School by (left to right) B. McMillan, L. A. Meacham, Phyllis Taylor and Anne Codington. For transportation the four playing units are unplugged from each other and packed into a case containing loudspeaker and other electrical parts.

discovered that a much more lively effect could be obtained by wobbling the pitch control, producing the vibrato effects of violin or trombone. Appropriately the instrument was dubbed the "Wobble Organ."

Intriguing to play and watch, the device does satisfying things with serious music, its voice-like quality producing novel effects with compositions ranging from folk songs to Bach chorals. It also offers possibilities in the teaching of music to children and in rehabilitation centers. Meacham has been awarded a patent.



Telephone Outside Plant ordinarily is poles, wire and cables; and the men who put it up are familiar sights to all of us. Telephone construction work took a new form in connection with the coast-to-coast radio relay network. In the Pacific Company's territory, there are seventeen radio relay stations, to all of which access roads had to be built. Biggest problem was a five-mile road which rises 2350 feet to a mountain top in the Stillwater range. Over six tons of dynamite blasted the rock before the five bulldozers could go to work. Pacific Company men did nearly all the work on these roads.

Organization Changes

M. E. Strieby, who was a member of the Laboratories from 1929 to 1940, and since then in Long Lines, has been transferred to that organization's Information Department. Since leaving us, Mr. Strieby was successively engineer of transmission, a civilian consultant on communications for the War Department, staff engineer for overseas and special services, and staff executive concerned with specialized facilities such as television. In his new post he will be responsible for lectures and demonstration work.

Specifications and Drafting

G. Sawyer has been appointed Drafting and Records Engineer, replacing W. A. Bischoff, who has retired.

General Staff

E. H. Kampermann, formerly in charge of Stockrooms, Shipping, and Receiving, and the Central Instrument Bureau at Murray Hill, has been placed in charge of the Stockrooms and the Reproduction Group and now reports to R. C. Carrigan.

C. A. Grant, who formerly reported to R. J. Ficken has been transferred to Mr. Kampermann's new organization and placed in charge of the Stockrooms.

R. J. Ficken, who is in charge of Traffic, now reports directly to Mr. Carrigan.

Outside Plant Development

C. F. Wiebusch, Assistant Cable Engineer, has been appointed head of a new department that has been set up for a special military project. In this position he reports to Vice President W. H. Martin.

L. Vieth and F. F. Romanow have been transferred from Station Instruments to head groups under Mr. Wiebusch.

Citizenship Activities

Good citizenship is more than just being a law-abiding person. It requires participation in the job of making the communities we live in the kind of places that we want for raising our families and enjoying our way of life. Laboratories' people are very well equipped for doing just that, and many of them take an active part in municipal government, school boards, church work, and other worthwhile activities.

Among the many school board members in the Laboratories, J. J. Kuhn, Switching Apparatus Engineer, who has served on the Elizabeth, New Jersey, School Board for seven years, has recently been made President of the Board. Commenting editorially on the election, the

Elizabeth *Daily Journal* recognizes "The orderly and reserved Commissioner Kuhn who has for so long served with distinction on the Board of Education."

Reflecting not only the influx of Laboratories' people into the Morristown area in recent years, but also their interest in local government, C. C. Lawson and J. W. Geils have been elected to the Morris Township's Board of Education. B. Slade was appointed to the Morristown Planning Board.

A Morristown resident for fourteen years, Mr. Lawson has been active in community affairs, notably with the Parent-Teachers Association and as past President of the Morristown Little Theater. Mr. Geils, who came to live in the area in 1946, promptly demonstrated his interest in education by spending several hundred hours of his spare time in rebuilding the Public Address System of Vail School. Mr. Slade's appointment follows his efforts in the Morristown Civic Association of which he is President.

J. M. Duguid has spent nineteen years in School Board work in Springfield Township. From 1930 to 1949 he was a member of the local School Board, and president, 1947-1949, and from 1936 to 1949 was a member of the Regional Board composed of representatives from six adjoining townships. After resigning from this work, he has now become a member of the Board of Trustees of Overlook Hospital in Summit, New Jersey.

April Service Anniversaries of Members of the Laboratories

45 *years*

P. T. Higgins

35 *years*

R. O. Burns, Jr.
A. W. Dring
F. E. Engelke
M. A. Froberg
F. S. Mayer

30 *years*

E. L. Baulch
J. H. Connerty
D. H. Gleason
F. H. Hewitt
C. D. Koechling
W. A. Marrison
W. I. McCullagh
V. Montagna
E. W. Olcott
M. O. Schrum
C. A. Smith
T. A. Spencer

25 *years*

A. L. Beach
S. Doba, Jr.
H. C. James
Dorothy Muller
F. E. Nimmcke
H. E. Powell
L. J. Steinbach
T. J. Walsh
I. V. Williams

20 *years*

J. Jordan
P. Murphy
R. C. Terry

15 *years*

A. L. Blaha
Louise Carbone
J. Caroline
J. G. Compagnoni
Margaret Ely
A. E. Gerbore
C. E. Howard
A. F. Mott
C. G. Schenk
R. E. Strebel
C. C. Ward
J. J. Whelan

10 *years*

G. A. Backman
J. E. Ballantyne
R. W. Barr
Helen Camp
A. W. Johnson
Pauline Joslin
J. J. J. Kernahan
R. W. Ketchledge
E. D. Knab
W. P. Knox
Gladys Kwait
Mildred Malone
G. J. McArdle
Marie Morgan
L. P. O'Donoghue
A. Ortiz
W. T. Quinn
Mary Reiners
J. W. Schaefer
W. H. Schweyher
C. E. Shannon
C. E. Smedberg
G. J. Thiergartner
Verna Toepfer
F. J. Zeller

P. T. Higgins
45 *years*

F. E. Engelke
35 *years*

F. S. Mayer
35 *years*

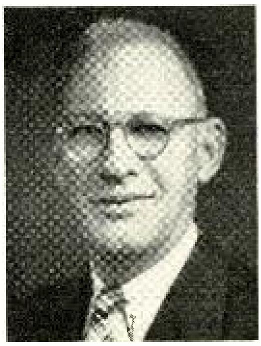
R. O. Burns, Jr.
35 *years*

M. A. Froberg
35 *years*

A. W. Dring
35 *years*

RETIREMENTS

C. T. Boyles



George Dobson

E. L. Nelson

Recent retirements from the Laboratories include George Dobson with 41 years of service; E. L. Nelson, 34 years; C. T. Boyles, 31 years; and Alice Kavanagh and Joseph Haverl, 29 years.

Edward L. Nelson

When Mr. Nelson became Technical Director of the Signal Corps Engineering Laboratories at Fort Monmouth last month, it was not his first experience in government service. Soon after entering the Laboratories in 1917, he helped develop radio telephone sets for subchasers and was loaned to the Navy as a civilian specialist on this class of apparatus. While in England with the equipment, he became a naval lieutenant, and subsequently he was stationed for a time at the Naval Radio Laboratory at the National Bureau of Standards.

On his return to the Laboratories following the war, Mr. Nelson engaged in research and development on radio telephone systems for ship-to-shore communication. Shortly thereafter radio broadcasting swept the country, and he was placed in charge of an engineering group responsible for the development of radio broadcasting transmitters and the associated speech input equipment. Starting with 250 watts, under Mr. Nelson's guidance the art grew until high-fidelity transmitters capable of outputs up to 50 kilowatts were available. In 1927, in connection with the Bell System television demonstration, Mr. Nelson was the leader of the group who set up the radio link used for the purpose between Whippany and West Street.

After a survey of radio possibilities in the aircraft field and extensive transmission tests in both the East and the West to determine the preferred operating frequencies, Mr. Nelson's department was responsible for developing a complete line of radio transmitters and receivers for this service, including units for ground station as well as for aircraft use. This equipment has been used extensively by the commercial airlines throughout the country. Following this, similar lines of standardized equipment for police cars and for harbor craft were developed.

During World War II, Mr. Nelson's group took an active part in the development of radar sets for both aircraft and ships. He was also associated with a number of radio communication projects which resulted in the development of tactical sets employed in airplanes, in tanks and in small landing craft. Postwar, his group developed the mobile and fixed station radio equipment used in the Bell System mobile radio service. More recently, he has been engaged on important military projects for the Navy.

Mr. Nelson is a graduate of Armour Institute, now the Illinois Institute of Technology. He is a Member of A.I.E.E., and a Fellow and past Director of I.R.E. As Educational Vice Commander of United States Power Squadrons, he has been in charge, for the past two years, of the extensive educational program carried on by this organization in the boating field. The Nelsons have five children—two girls and three boys—and three grandsons.

George Dobson

After many generations in Scarborough, England, George Dobson's family came to this country in 1896 and he with them. On graduation from Cornell (M.E. 1909) he joined Western Electric and a year later transferred to the "Physical Lab." During World War I he was an officer in the Signal Corps, and saw service in Paris as a member of Col. H. E. Shreeve's Research and Inspection Division; returning to West Street he continued with Mr. Shreeve, and in 1925, he went to Western Electric's commercial products group. From 1928 to 1936 he had charge of technical information and training on sound recording for E.R.P.I.'s motion picture clients. Then returning to the

Laboratories, he was successively in Commercial Products and in Switching Apparatus Development until 1941, when he was made superintendent of all the Laboratories' New Jersey shops. This job grew with our war effort, and eventually Mr. Dobson supervised a large organization, in addition to relations with many shopwork subcontractors. At the end of the war, Mr. Dobson returned to Switching Apparatus Development where he worked on tools for central office maintenance.

Long active in the American Legion, Mr. Dobson has been post-commander, county commander and national "chef de chemin de fer du '40&8'." During the recent war he was chairman of his local draft board. The Dobsons have a son and two grandchildren. They expect to remain in Short Hills, where he will soon be looking around for some way to serve his community.

Claude T. Boyles

As a boy in a little Virginia town, Claude Boyles learned telegraphy, and so later he got a job with the Signal Corps on the Alaska telegraphy system. After five years of that and four years in other jobs, he joined us in 1920 as a wireman. His ability as a leader was soon seen, and in 1921 he was put in charge of the switchboard and the maintenance of the generators in our steam-driven power plant. Two years later he was given charge of all building services, and in 1928 he took up his present supervision of traffic. This work included shipping, receiving and salvage; in 1948 supervision of stockrooms, central instrument bureau and office machine maintenance was added.

Another boyhood interest—photography—has become Mr. Boyles' principal hobby and one in which he has won real distinction. His pictures have brought him two American gold medals; gold and silver medals and a cup from three English exhibitions and a host of other photographic honors from camera clubs here and abroad. He has been president of the Camera Forum of Summit, president of the Metropolitan Camera Club Council, and is esteemed as a judge of pictures.

With retirement in view, Mr. and Mrs. Boyles made an intensive study of places to live and have bought a 96-acre farm near Cabot, Vermont. The house will afford ample space for Mr. Boyles' other hobbies—printing and woodworking—and he will convert his maple sugar house into an advanced base for photographing the wild animals in his woodlot.

Joseph Haverl

For six years Joe Haverl kept West Street's fifth and sixth floors clean; then he became a building service hand at Graybar-Varick. One of his jobs there was to bring the engineers charged storage batteries and take the discharged ones away; another was to move materials between stockrooms, engineers and the shipping floor. So passed another 23 years, and now Joe has retired.

With two daughters—one on Long Island, one in Boise, Idaho—Mr. and Mrs. Haverl expect to get around a bit and to enjoy their five grandchildren. A native of Czechoslovakia—he came over in 1907—Mr. Haverl thinks the open country around Boise would be more to his taste than New York City.

Alice Kavanagh

Alice Kavanagh, who had had previous experience with the Navy as a typist, entered the Transcription Department at West Street in 1921. She showed special aptitude for Greek work, and became an expert in mathematical typing. Because of her experience, and knowledge of departmental procedures, she was assigned to assist with the "swing shift" of part-time typists who were recruited during the war

Joseph Haverl

Alice Kavanagh

to work during the early hours of the evening. She also assisted at one time in the administration of routines in the Transcription Department at Graybar Varick, and at the time of her retirement was an assistant to the supervisor of the Stenographic group at West Street.

Miss Kavanagh lives in Belle Harbor with her married sister and her mother, whose illness has prompted her retirement. Her cheerful smile and pleasant voice endeared her to all those with whom she came in contact.

News Notes

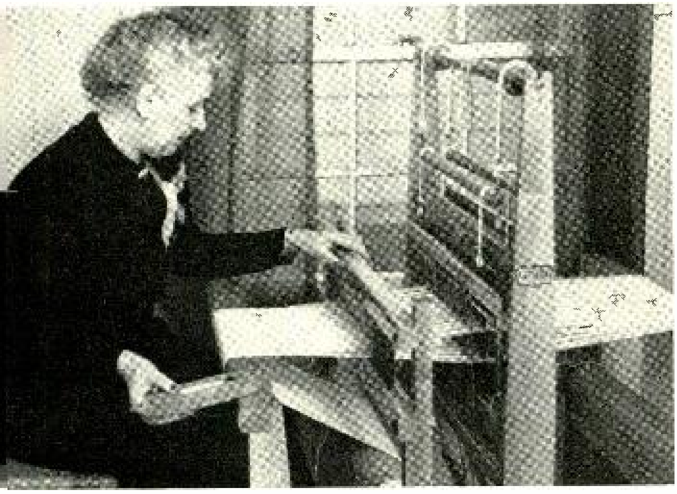
At the invitation of Mr. Kappel, Vice President, A T & T, Dr. Buckley gave a talk at the Operating Conference dinner on February 7 at the Waldorf-Astoria Hotel, speaking on *Some Prognostications in Telephony.* In February, Dr. Buckley attended a meeting of the National Inventors Council, held at Eglin Air Force Base near Pensacola, Florida.

M. J. Kelly, D. A. Quarles and J. B. Fisk attended conferences at Sandia during the week of February 19.

Paul S. Olmstead of Station Instrumentalities has been elected a Fellow of the American Statistical Association "for his contributions in the field of statistical control of quality and the improvement of industrial practices by the aid of statistical theory." Dr. Olmstead, a graduate of Princeton (B.S. 1919 Ph.D. 1923) joined the Laboratories in 1922. Between 1926 and 1936 in Quality Assurance he helped to lay the foundations of statistical quality control. Since 1936 he has been planning field trials for new station instruments and interpreting their results. He is a Fellow also of the American Society for Quality Control, of the American Physical Society, and of the American Association for the Advancement of Science.

Shortly after Anne Kiernan came here in 1911, she was placed in the Transcription Department where most of her work involved distribution of typing assignments to the other girls of the department. Since 1921 she has been a supervisor, and last year she was placed in charge of all Transcription Service in New York. During the years, Miss Kiernan has developed a friendship that has expanded to include practically everyone in the Laboratories. Her willingness to assist the engineers in their typing needs is well known and appreciated, and her ability to get along with people was well attested at her fortieth anniversary on February 10. She is shown above with B. R. Young at her anniversary luncheon.

While Mrs. Wright (then Marie Grent) was in school in Geneva, Switzerland, she learned to weave, and years later she took further instruction in the Art Students' League. Now she has two looms in her home, on which she has woven a variety of decorative fabrics such as dress woolens, upholstery materials, guest towels, and luncheon sets. One of these is shown on the loom. Weaving is a good relaxation after a busy day, says Mrs. Wright, it keeps hands and feet active and there is a deep satisfaction in seeing the work grow with each pass of the shuttle.



At the invitation of Dr. Buckley, Earl R. Mellen, President of Weston Electrical Instrument Corporation, and a group of executives of that company visited Murray Hill on February 15. The occasion for the visit was the desire of the Weston representatives to show to Laboratories people concerned some of the more recent instrumentation developments of their company. They also visited some of the Laboratories' activities while at Murray Hill.

Efforts are now being made to increase the activities of the Still Camera Club in the New York Area. Plans are being made to provide monthly meetings at which selected speakers will address the members, and exhibits of the work done by members will be held every two months.

Because of restrictions in the use of aluminum, some of the Bell System's microwave stations will be equipped with antenna horns made of steel; enough aluminum is available to equip these horns with aluminum throats. Tests at Holmdel have shown that the combination horn is substantially as good as the aluminum horn. Recently R. R. ANDRES, accompanied by C. B. Cottrell of Western Electric, visited a metal-working company which will supply these horns.

ANY COAXIAL LINE has a number of important transmission characteristics such as "iterative impedance" and "transducer loss." To secure general agreements on the practical significance of terms of this nature and to establish specific values which can serve as standards for air-dielectric lines in the industry is the function of a Committee of the Radio and Television Manufacturers' Association of which A. W. LEBERT is secretary. Recently Mr. Lebert visited Boston for a meeting in connection with his work on this Committee.

LINE AMPLIFIERS for coaxial cables are sealed in manufacture and must be returned for periodic checkup to Service Centers equipped with the specialized test gear needed. From time to time, changes in amplifier design or in the transmission elements with which they are used, have required alterations in this test equipment. To check the accuracy of such alterations, G. B. Engelhardt, with A. E. Lidle of Western Electric's Engineer of Shops organization, recently visited the Distributing Houses at Atlanta and Dallas.

PAPERS OF FUNDAMENTAL importance were presented by Laboratories' metallurgists at the February St. Louis meetings of the Institute of Metals Division of American Institute of Mining and Metallurgical Engineering. E. S. GREINER presented *Transitions in Chromium*, authored by M. E. FINE, W. C. ELLIS and himself. R. G. TREUTING talked on *Atomic Relationships in the Cubic Twinned State*, of which he is co-author with W. C. ELLIS.

Ice Storm in the Deep South

Once again the Bell System "restoration team" was called upon as a result of one of Nature's freak storms, this time in the deep South. On January 31 and February 1, sleet, snow, and zero temperatures struck large sections of the south and southwest, causing an estimated $7,500,000 damage to the telephone plant. Mississippi bore the brunt of the storm, with one-fifth of its telephones and two-fifths of its toll lines knocked out of service. Large sections of the telephone plant in Tennessee, Kentucky, Louisiana, and Alabama were affected, and in Southwestern Bell Territory, Texas, Kansas, and Arkansas suffered damage. Throughout the storm stricken area, more than 94,000 phones and 6,000 toll circuits were put out of service, and 241 exchanges (including connecting companies) were isolated.

Southern Bell rushed 1,000 men from other parts of its territory to help out; Southwestern had 750 men on the job in Texas, and Long Lines put 275 men on toll line restoration, bringing crews from as far away as Illinois and Missouri. Western Electric had to supply more than 17,700 poles, 43,800 crossarms, and 15,000,000 linear feet of drop wire, along with innumerable other items of equipment. Although complicated by the rail strike and icy highways, telephone men usually found the right equipment at the right place when they needed it.

A trio of Southern Bell plant men at Jackson, Mississippi, inspect a pole which snapped under the weight of ice-encrusted wires. Mississippi was the hardest hit state in Southern Bell's territory.

Despite the fact that telephone service in many areas was reduced to a minimum during and following the storm, long distance calls in Southern Bell territory rose so sharply that the company's over-all total for the period was slightly above average.

Two weeks later, and when most of the job of restoration had been completed, a second freeze-up on February 13 caused additional damage of $1,300,000 in Southwestern Bell Territory, giving them a brand new problem to cope with.

Page Turners for Polio Patients

When H. A. Doll, formerly at Whippany, was transferred to Burlington, North Carolina, the loss to his home town of Denville, New Jersey, was certainly a major gain to the Greensboro-Burlington-Winston-Salem area. Since going to Burlington, where he is in charge of specifications, Mr. Doll has become endeared to the community by his activities in spreading happiness to those confined to the hospital, especially the young polio patients. As he puts it, "To keep their minds from being in braces."

Although not acting as a committee representative, and without making any appeal for funds, somehow, his deeds of helpfulness have a contagious effect, and other folks at Burlington join in to provide dolls, toys, and entertainment facilities for the patients.

Recently, initiated through Mr. Doll's efforts, the Burlington Chapter of the National Secretaries Association, purchased a Reck Page Turner for use by polio patients unable to use their hands. Frank Reck, of the Switching Apparatus Development Department at West Street, is the inventor of this ingenious device. Primarily designed for wounded veterans of

The page turner in use.

World War II, the pages of a book or magazine can be turned with a very slight toe or finger pressure, or by nodding the head. One of the machines is shown in use in the accompanying illustration.

When the patient closes the contact, a motor inside the turner causes an arm with a masking tape reel to move and touch the upper right-hand corner of the page. It picks up the page as another member dips under it, and as this assembly moves to the left, a transparent finger follows in order to hold the page flat.

Eventually, the masking tape surface loses its adhesive quality, so about 5 inches more is pulled from the reel, and the apparatus is ready again to provide many more hours of independent reading pleasure.

Leah Joy Hall, who is on military leave from the Mathematics Computing group in the Physical Research Department, appeared on a nation-wide broadcast on December 27, when she was one of five WAVE recruits chosen as the most outstanding at the Great Lakes Naval Training Station. Since that time, she has completed her basic training and has been assigned to the School of Electronics, also at Great Lakes, a 36 weeks' course, the longest given in any subject. Now a Seaman Apprentice, she will then be rated an Electronics Mate.

Thirty-three Years Ago

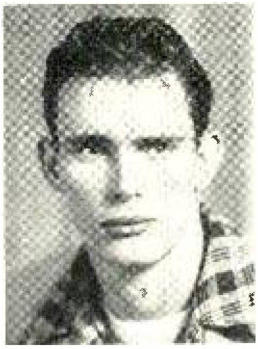
In World War I, Western Electric's vacuum tube shop was a part of the organization that became the Laboratories and its management had to ask draft boards to defer quite a few workmen in order to maintain military schedules. In the following affidavit, executed by the late J. W. Upton, then in charge of the shop, one sees "vacuum tube" as somewhat less than the household word that it has since become to be:

"The work in which each group of employees is actively engaged under my supervision consists in the manufacture of what are known as Vacuum Tubes, for use in connection with wireless telephone and telegraph apparatus, which has been ordered from said corporation by the War and Navy Departments of the United States Government. These vacuum tubes, briefly described, consist of evacuated glass vessels containing complicated glass and metal structures, and are required in virtually all of the radio telephone and telegraph oufits which are now being furnished by said Western Electric Company, Incorporated, to the Army and Navy of the United States . . ."

The applicant, twenty years old, was a welder and was paid $17.50 a week.

M. J. Losty

Isabel Johnson



M. H. Merchant

G. E. Helmke

Called to Active Duty

During February, four more of our Laboratories people were granted leaves of absence for military duty, bringing the total to thirty-one since July, 1950.

Isabel M. Johnson, who has been a stenographer since she came to the Laboratories in January, 1949, has been called back into service in the WAVES. She is a reservist, and returns as a Petty Officer, First Class Radioman.

George E. Helmke, Laboratory Technician in the Electron Dynamics group, came to the Laboratories in 1937. From October, 1942, to November, 1945, he served in the Navy, becoming a fleet radioman. As a member of the Naval Reserve, he returns to service as a Radioman First Class.

Martin J. Losty, a clerk in the Commercial Service group at Murray Hill, who came to the Laboratories in June, 1947, has been called into the Army.

Murdock H. Merchant, an assembler of electronic apparatus, was first employed May, 1950. He has enlisted in the Army, where he hopes to become a cook or baker.

News Notes

Patent department activities recently include E. R. Casey's trip to the Patent Office in Washington, R. A. Heising and G. S. Indig having been registered to practice before the United States Patent Office in Washington, and E. W. Adams, Jr. being admitted to practice before the New York State Bar.

F. G. Foster was the guest speaker at the February 6 meeting of the New Jersey Mineralogical Society at Plainfield. His subject was the *Identification of Minerals and Metals by Microscopic Methods,* demonstrating techniques used in securing microphotographs by means of elementary apparatus and by use of the latest equipment in the modern laboratory.

Pin holes or other minute irregularities in a metal coating can often be detected with a microscope, but to study a surface in detail, metallurgists like to make an electrographic record. Metal is transferred by electrolysis from the specimen surface to an adjacent sheet of filter paper. Developed by chemical reagents to give different metals identifying colors, the image on the paper constitutes a map of the specimen surface. H. W. Hermance and H. V. Wadlow have co-authored a chapter on this technique in the new book, *Physical Methods in Chemical Analysis*, put out by the Academic Press. Mr. Wadlow also presided at the morning session of the Sixth Annual Symposium of the Metropolitan Microchemical Society.

Electron metallography was the subject of a talk by R. D. Heidenreich before the Dayton Chapter of the American Society for Metals, Dayton, Ohio. At the New Jersey Mineralogical Society in Plainfield F. G. Foster explained how optical metallography is employed to identify materials.

W. A. Shewhart, who is in charge of user preference studies, is also a member of the Visiting Committee for the Department of Social Relations at Harvard where psychologists, sociologists and anthropologists are investigating how people behave. Dr. Shewhart contributes long experience in statistical technique; brings back the latest scientific thought on behavior.

MARY WIGGINS— SECRETARY

Mary Wiggins gets ready for another day at the office.

Here she selects a technical memorandum in response to Dr. Germer's request.

Typical of the career girls who have followed their Laboratories' groups from West Street to Murray Hill is Mary Wiggins. Formerly living in a midtown girl's club, she is now one of three who have an apartment in Summit. Helping Miss Wiggins to make a home there are Sue Sciarillo of Electronics Research and Miss Grace Freeland, formerly principal of one of Summit's elementary schools.

At Murray Hill, Miss Wiggins is secretary to H. W. Bode and L. H. Germer of Physical Research. Out of hours she is a member of the Executive Board of the Junior Fortnightly Club, one of the affiliates of the State Federation of Women's Clubs. One of Miss Wiggins' projects in her club is making recordings of books for the blind. Other fields of interest in Miss Wiggins' life include her bridge club, square dancing, attendance at lectures, and music.

Miss Wiggins' home is in Greenport, L. I., where she visits her parents from time to time.

Mathematical equations in Dr. Bode's dictation do not frighten Mary.

Miss Wiggins' partner is Lois Burford; opponents, Dorothy Angell (left) and Miriam Harold.

Typing the morning's dictation.

The evening meal is light work with all three helping. Mary prepares coffee, Sue is doing the cooking, while Grace Freeland sets the table.

Needlework, knitting and reading (interrupted by conversation) occupy part of the evening.

Music is one of Mary's favorite hobbies.

Mary sits for her portrait.

RECENT DEATHS

E. R. Morton, *February 20*

Mr. Morton, who had been a member of the technical staff since coming to the Laboratories in 1923, was a pioneer in the development of electronic controls. He was the holder of over 50 patents on electronic controls and other devices, and contributed to the development, during World War II, of radar, sonar, and other Bell Laboratories developments for military use.

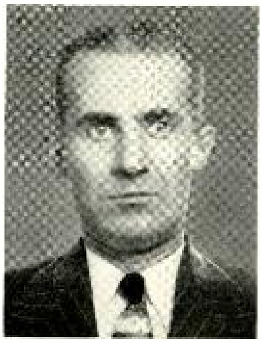
Mr. Morton was born May 28, 1896 in Swanton, Vermont. He was educated at Stevens Institute, from which he received the master of engineering degree in 1917, and at Harvard University, where he studied during 1919-20.

In the early days of his career, he engaged chiefly in the design and development of power apparatus; this included, in the 1920's, motors for the first television system developed by the Laboratories and also those for early sound picture recording and reproducing. From 1936 to 1940, he designed special purpose relays used in telephone and other communication systems.

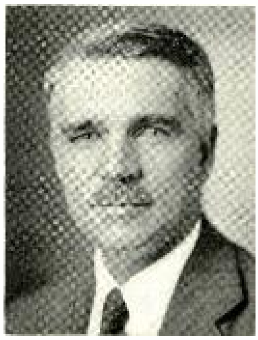
During World War I, Mr. Morton served with the Signal Corps and Air Service, and developed aerial mounts that were resistant to vibration and which contributed to the advances of aerial reconnaissance.

He was a Senior Member of the Institute of Radio Engineers, member of the American Cryptogram Association, New York Cipher Society, which he served as president in 1949; Motor Sports Club of America, Sports Car Club of America, Aircraft Owners and Pilots Association, and the Telephone Pioneers.

E. R. Morton
1896-1951



C. R. McIver
1907-1951



C. R. Moore
1882-1951

E. Dietze
1891-1951

C. R. McIver, *March 11*

Mr. McIver came to the Laboratories as a draftsman in 1929, after being employed by several outside concerns. He advanced to design draftsman in apparatus development and radio development and, in 1937, was made a member of the technical staff in the Apparatus Standards Group.

Becoming a supervisor in this group in 1941, Mr. McIver became still more active in standardization efforts. During World War II he was responsible for all apparatus drafting standardization, working in cooperation with Western Electric and Government Agencies. Under his direction, various wartime drafting standards books were prepared. He represented the Telephone Group (Bell System and the Independent Telephone Association) on the Army-Navy Industry Committee for drawings and drafting room practices and on several sub-committees.

Since the war, Mr. McIver continued standardization activities, working in cooperation with Western Electric on planning and circulation of design standards. He was an alternate member of ASA committees in standards for drafting practices and ASA committee B27 on plain washers.

In 1950, he was placed in charge of Drafting and Standardization, including all apparatus, equipment, and circuit drafting and illustration work.

Mr. McIver was born in New York City May 14, 1907. He obtained his education in a public vocational school, and attended the evening schools of Cooper Union, Polytechnic Institute of Brooklyn, and Columbia University.

Charles R. Moore, *March 17*

Charles R. Moore, who retired from the Laboratories in 1946, died suddenly on March 17.

Mr. Moore came to the Laboratories in 1916, after nine years as Instructor and Assistant Professor of Electrical Engineering at Purdue and the University of Illinois. He was the only student in Purdue's history to receive both the

B.S. in M.E. and E.E. degrees simultaneously, being granted them in 1907, and received the E.E. degree in 1910.

Shortly after coming to the Laboratories, he was placed in charge of transmission development. During World War I he was supervisor of a laboratory boat on Long Island Sound for investigating submarine detecting devices. Following the war, he returned to transmitter design, contributing major improvements to high-quality type transmitters. In 1928, he was placed in charge of tool development in the Outside Plant Development Department, where one of his most important contributions was the single-sleeve rolled joint and the tool for making it. Just prior to his retirement, he was engaged in station apparatus development, in charge of development of a new dial for subscriber's telephones. The 35 patents issued in his name indicate his many contributions to the telephone art.

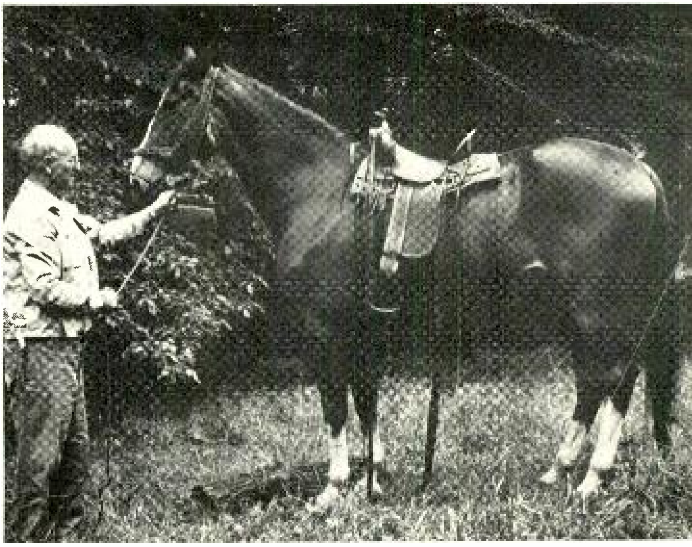
Always interested in young people, Mr. Moore returned to his first love, teaching, after his retirement. He became an Associate Professor in Electrical Engineering at Newark College of Engineering, and was also Faculty Advisor to the Student Branch A.I.E.E. there. Many Laboratories' engineers enjoyed his friendship and wise counsel before his retirement, and these relationships continued for the remainder of his life.

EGINHARD DIETZE, *February 25*

On graduation from University of Michigan (B.S. in E.E. 1917) Mr. Dietze entered A T & T where he soon was making transmission studies of telephone circuits. In 1919, when the D & R was formed, he joined the local transmission group. This work he continued in the Laboratories; it involved theoretical and field work on the design of telephone station circuits and instruments, and the development of testing methods and apparatus such as a reverberation meter and a sound meter.

During the war Mr. Dietze was a member of N.D.R.C. and head of its calibration section on Sonar. Since then, he has been connected with the transmission design of the 500-type telephone set and other new station sets. For some years he was chairman of the IRE committee on acoustic terminology; when it was merged with a similar A.S.A. committee, he became one of the joint chairmen.

Mr. Dietze retired in January after a long illness. At his death he and Mrs. Dietze were residing in Bradenton, Florida.



While showing how a western saddle would look on his police horse, P. T. Higgins, who is completing 45 years of service this month, had this picture taken. A horseman all his life, Mr. Higgins has recently achieved his ambition of owning a place in the country large enough to keep several horses.

"Telephone Hour"

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

April 2	Jascha Heifetz, *violinist*
April 9	Lily Pons, *coloratura-soprano*
April 16	Marian Anderson, *contralto*
April 23	Artur Rubinstein, *pianist*
April 30	Ezio Pinza, *basso*

News Notes

FOR NEXT YEAR's annual meeting of the A.S.T.M. at which the Society will celebrate its 50th anniversary, G. R. GOHN is acting as Chairman of the Technical Program Committee. In Philadelphia J. R. TOWNSEND attended a meeting of the Society's Nominating Committee. W. E. CAMPBELL went to Washington, D.C. for a D-2 Committee meeting on Petroleum Products and Lubricants. He also attended a meeting of the Board of Directors of the American Society of Lubrication Engineers in Philadelphia.

R. M. BURNS talked on *Chemists in the Telephone Industry* before the Ann Arbor, Michigan Section of the American Chemical Society. He also visited the Institute of Nuclear Studies in Chicago and the Hawthorne Plant of the Western Electric Company.

TANTALUM ELECTROLYTIC CAPACITORS, whose small size is proving highly advantageous in miniaturized equipment, were discussed by M.

Whitehead, B. M. Bowman and Western Electric's engineers W. T. Maquire, R. A. Walker and H. H. Cowan during a visit to the General Electric Company at Pittsfield, Mass., where some of these capacitors are being manufactured. These capacitors were also the subject of Mr. Whitehead's talk to the Northern New Jersey Subsection of the I.R.E. in the Murray Hill Auditorium.

Much current activity in magnetics is being devoted to core materials, notably the Permalloys and the ferrites which permit the broadband transmission needed in systems like L3 coaxial. One practical problem is to secure a supply of the materials in the face of shortages and to insure the composition and quality upon which the transmission advantages importantly depend. P. P. Cioffi and B. E. Stevens explored this question with the Allegheny Ludlum Steel Company at Brackenridge, Pennsylvania, and the Magnetic Metals Company in Camden, New Jersey. Core manufacturing angles were discussed by V. E. Legg at Winston-Salem and Chicago. C. W. Thulin discussed the manufacture of transformers for the L3 system at Haverhill. Magnetism was also the subject of a series of lectures by R. M. Bozorth at the California Institute of Technology. In Johnsville, Pennsylvania, Mr. Bozorth attended a meeting of the Ferromagnetic Committee of the Office of Naval Research.

R. A. Sykes is heading up an I.R.E. committee which seeks to establish national standards for piezoelectric crystals, the use of which continues to spread in communication equipment. The committee also includes W. P. Mason as vice chairman, and W. L. Bond. Mr. Sykes was at the meeting of the Quartz Crystal Sub-committee of Electronics Industry Advisory Committee at the Pentagon Building. Elizabeth Wood and Mr. Bond attended the American Crystallographic Association meeting that was held in Washington.

Engineering decisions, particularly where service life is involved, must in many cases be made on a calculated risk basis. Under these conditions, a control trial is generally carried on. Thirteen years ago a new battery was installed in a central office in Roanoke, Virginia, and it was decided to float it at a slightly higher voltage than normal, which, it was felt, would make it possible to abandon the monthly check charges that had been common practice for many years and to give the battery only a yearly equalizing charge. This battery is now approaching its guaranteed life of fourteen years, and recently H. T. Langabeer and C. H. Achenbach conducted tests on the battery and found it still to have over 100 per cent of its rated capacity. As a result of the successful behavior of the Roanoke battery, this method of operating will be applied generally in the Bell System, thus securing not only economies in operation but longer lives for the batteries.

Often the thought occurs to a development engineer that if a related group could be talked into a few simple changes in their designs, his own problems would be considerably simplified. And then when the two groups get together at a conference table, each learns the other's difficulties. Recently A. S. May and W. W. Halbrook went to Allentown where, after an interchange of views with L. H. Von Ohlsen on some mechanical problems concerning the 416A Tube and its use in waveguide cavities, each group planned modifications to meet the other's needs.

A new universal operating room desk, the No. 23, has been developed by the Laboratories, and the first installation has recently been made in an A4A crossbar toll office in Pittsburgh. The desk is capable of furnishing both toll and local information, rate and route information for operators, and toll charges to subscribers, and also of serving as an intercepting desk. G. H. Peterson and A. C. Gilmore went to Pittsburgh for the occasion and to discuss related operating and circuit questions with the local engineers.

Station wire, used on subscribers' premises, now comprises conductors individually insulated with thermoplastic polyvinyl chloride compound and an outer jacket of the same type

"I give up—see if you can convince him that it isn't a bone!"

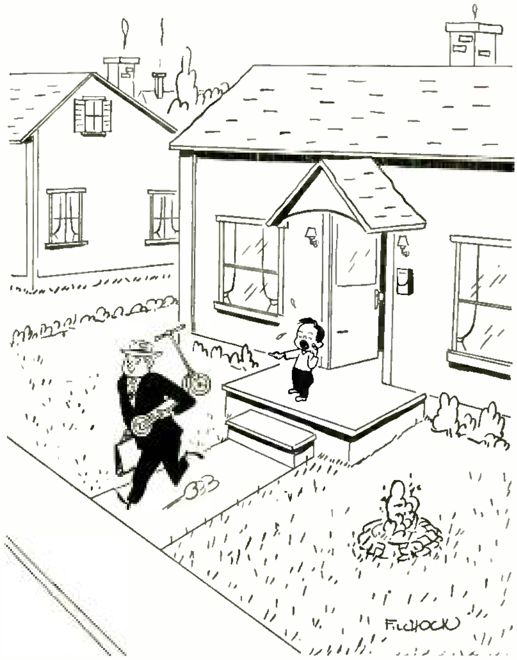
of compound to provide a round wire which makes a neat installation when fastened to the wall with staples. The thermoplastic compounds, which are extruded on the wire by forcing them through a heated die, were formerly purchased pre-mixed and ready for extrusion; now the necessary ingredients are weighed out automatically and mixed in the plant in equipment developed by the Western Electric Company especially for this job. Proposed changes in the mixing and extruding processes were discussed by V. T. Wallder and W. K. Oser with Western Electric engineers at Point Breeze.

The increase in power requirements of the L-3 coaxial system, particularly on longer power sections, may result in voltages high enough to produce corona within the coaxial unit and so degrade transmission. M. W. Bowker and J. M. Dunham have been at Kingston, New York, initiating tests on a section of the New York-Albany coaxial cable to determine the effectiveness of a heavy gas as an agent for raising the corona threshold, and what changes the use of such a gas might necessitate in standard pressure testing techniques.

Automatic ticketing systems in the Los Angeles and San Francisco areas have been handling calls over networks steadily increasing in size. As a result, the dial pulses have to be transmitted over trunks consisting of various combinations of local and intertoll circuits and in some cases through concentrating switches. In cooperation with engineers of the Pacific Telephone and Telegraph Company, and equipped with laboratory test sets, A. A. Hansen recently spent two weeks making pulsing studies on various circuits in the San Francisco area to determine the best maintenance procedures. With this information as a background, he then spent a few days in Los Angeles studying the pulsing networks there and discussing improved maintenance procedures.

C. H. Townes has been granted an Ernest Kempton Adams Research Fellowship by Columbia University. A former member of the technical staff of the Laboratories, Dr. Townes is consultant to the National Bureau of Standards and the Brookhaven National Laboratory.

H. H. Felder, G. M. Phillips, A. J. Pascarella, and T. H. Neely, together with representatives of the Long Lines and O & E recently visited the Long Lines office in Albany for a field trial of a transmission measuring and noise checking system now under development. Transmission measurements were made on all the intertoll trunks between Albany and New York, and talks were given to representatives of the New York Telephone Company and to Long Lines personnel on the operation and use of the new equipment.



"Boo! Hoo! Boo! Hoo! Daddy wants to use it at Murray Hill."

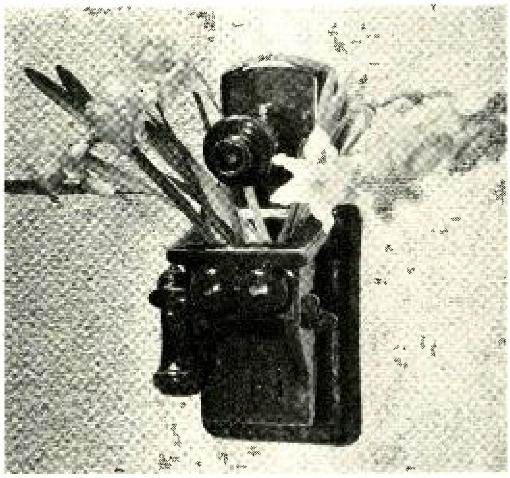
A new 4-A crossbar toll office was recently cut into service in Minneapolis, and W. G. Barrett, D. H. MacPherson, and R. C. Pfarrer of the Laboratories with M. G. Killoch of the American Telephone and Telegraph Company went to Minneapolis to make traffic measurements on the new office. Traffic measurements also called Mr. Pfarrer twice to Chicago: once with C. L. Beckham in connection with a No. 4 crossbar toll office, and once with M. G. Killoch of the A T & T in connection with the crossbar tandem office.

The development of new electronic apparatus for locating faults in central office wiring is now nearing completion, and R. W. Burns and A. Majlinger recently were at Philadelphia to make tests with these new facilities.

W. Y. Lang spent one week in Atlanta with representatives of the A T & T reviewing the maintenance of apparatus in an 81C1 teletypewriter switching office in service for Eastern Air Lines.

H. E. Kern has been appointed Chairman of Sub-Committee on Gas Analysis of Cathode Alloys of American Society for Testing Materials Commitee B IV, Section VIII.

Bouquets for the Treasury Department



With an extensive garden around their home at Hastings-on-Hudson, the Rudolph Mallinas have brightened many days for others by gifts of flowers and other growing things. During the past year Mr. Mallina has brought a bouquet of flowers or leaves each week to the Treasury counter at West Street. His Christmas contribution was a big spray of holly, festooned with lighted bells.

Some time ago Mr. Mallina found in a china shop the wall vase shown here, fashioned of pottery in the form of a telephone. Research in the Historical Museum files by Curator J. T. Lowe disclosed a superficial resemblance to the No. 85 set, introduced about the turn of the century. However, the "85" was a common battery set, hence would have no crank; and it also had a square, instead of a rounded, top. It may be, thinks Mr. Lowe, that the unknown potter was copying a non-associate instrument; or maybe he was following a childhood memory. At any rate the "bells" have never rung and the only message ever conveyed has been the message of the flowers.

News Notes

R. H. Colley and J. Leutritz, Jr., attended a conference at the Forest Products Laboratory, Madison, Wisconsin, for review of results of a cooperative investigation of coal-tar creosotes. The cooperators on the project include, besides the Laboratories representatives, technicians from among the creosote producers, a marine testing laboratory, the U. S. Forest Products Laboratory and the Division of Forest Pathology of the U. S. Bureau of Plant Industry. The work started in 1948 with the supervised production of the creosotes. Laboratory, marine and land exposure tests are involved. The Laboratories' function is primarily one of assisting in the correlation and interpretation of laboratory and test plot results.

J. B. Johnson has been appointed vice chairman of the Division of Electron Physics of the American Physical Society.

A new community dial office, the 356-A, is now being manufactured by the Western Electric Company, and the first installations have just been made in Roberts, Idaho, and Lodge Grass, Montana. This new office will be described in a later issue of the Record. In connection with these recent installations, and to discuss problems relating to the operation of community dial offices, A. Burkett recently visited the Mountain States Telephone and Telegraph Company with C. W. Anderson of the A T & T.

Engagements

Evelyn Boye—Robert P. Muhlsteff*
Claire Brinley*—Sanford G. Weber
Rita D'Esposito*—Stephen M. Renae
Patricia Thomas Fehr—John H. McGuigan*
Elizabeth Ink*—James E. Bryan
Ethel Lane*—Frank R. Monforte*
Lorraine Micone*—Paul F. Nielsen
Marie Sabatini*—Theodore H. Cortright
Veronica Sheehy*—Nicholas Tronolone, Jr.

Weddings

Stella Garcia*—Emil Varona
Gloria Maresca*—Norman Janwich

Births

Philip Lincoln Hawkins, February 12, to Mr. and Mrs. W. L. Hawkins. Mr. Hawkins is in the Chemical Laboratory.

Margaret Ellen Sparks, February 21, to Mr. and Mrs. Morgan Sparks. Mrs. Sparks, the former Bette MacEvoy, was a secretary in Physical Research. Mr. Sparks is in the Chemical Laboratory.

Michael John Strnad, February 23, to Mr. and Mrs. Albert Strnad. Mr. Strnad is in Electronic and Television Research.

Anne Yeager, March 1, to Mr. and Mrs. Robert E. Yeager. Mr. Yeager is in Transmission Systems Development.

*Members of the Laboratories. Notices of engagements, weddings and births should be given to Mrs. Helen McLoughlin, Sec. 11A, Ext. 296.