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Physical Research

Sound transmission in solids at ultrasonic frequencies

In telephone switching apparatus, in calculating machines, and in certain radar circuits, it is desirable to store information in the form of short pulses, and then, a short time later, to use them to actuate some circuit or device. One method of doing this is to send a very short pulse of sound waves down a rod from a piezoelectric crystal at one end, and to pick it up and convert it into electrical energy by another piezoelectric crystal at the other end. The time required for the waves to travel the length of the rod is the storage time. To store a large amount of information in a given length of rod, the pulses have to be very short, and to transmit a very short pulse without distortion, the rod must be of a material capable of transmitting a wide band of frequencies. Hence to obtain the desired results, it is necessary to have a material that will transmit waves at very high frequencies—often as high as 60 megacycles per second.

Apparatus used in the laboratories for measuring sound transmission in solids at ultrasonic frequencies.

For such a wide frequency range, liquids, including mercury, are unsuitable for this purpose because they have an attenuation proportional to the square of the frequency, which is too high for this purpose. Hence it is necessary to use solids, which have an attenuation loss proportional to the frequency. In thinking of solids suitable for sound transmission, one usually thinks of metals such as aluminum and magnesium, which will ring for a long time after they have been struck. From attenuation measurements at high frequencies, however, it was found that the granularity present in all metals introduced effects that precluded their use for high-frequency transmission. To solve practical problems, therefore, recourse had to be taken to non-granular materials such as glasses and fused quartz. Delay lines using fused quartz can be made to very exacting requirements, as will be discussed in a subsequent article.

Although sound transmission in granular metals does not lead to practical results for high-frequency delay lines, the techniques developed for studying it offered an opportunity to verify the theory of heat transmission suggested by Debye many years ago. Since heat is a mechanical vibration of the crystal lattice, Debye suggested that it was probably transmitted by the relative motion of adjacent molecules as is an acoustic wave. Judged by their end results, however, heat and sound transmission seem essentially different. A pulse of sound applied at one end of a rod arrives at the other end as a pulse of essentially the same form and after a short interval just sufficient to account for its transit time. A pulse of heat applied to one end of the same rod, on the other hand, does not arrive as a pulse of the same duration, and it arrives only after a much longer interval. There will be an appreciable period after the pulse is applied before any rise in temperature is experienced at the distant end. The temperature will then rise slowly, reach a peak, and then start a slow decline.

Although there was this wide apparent discrepancy between heat and sound transmission, neither confirmation nor refutation had been experimentally achieved. Most of the energy of heat is concentrated in the frequency range from 10^6 to 10^7 megacycles and, until comparatively recently, no procedures were available with which vibrations could be applied to a solid body at frequencies anywhere approaching those of heat. For the studies of ultrasonic delay lines, however, procedures were employed that could handle frequencies of the order of tens of megacycles, and it was found that at these very high frequencies sound transmission began to show characteristics similar to those of heat transmission. With these studies as a basis, it was found that heat transmission, after making corrections for the differences in frequency, is basically the same as that of sound, and thus it was possible to verify experimentally the earlier theory of Debye.

When an acoustic wave travels down a metal rod—using the word acoustic to represent a longitudinal compression or shear wave regardless of frequency—a small amount of the acoustic energy is converted to heat as the result of a mechanical hysteresis loss. If the component crystals are all lined up in the same direction, this is the only loss that is suffered, and since it is due to a hysteresis effect, a fixed loss is suffered for each cycle, and thus the total loss is directly proportional to the frequency.

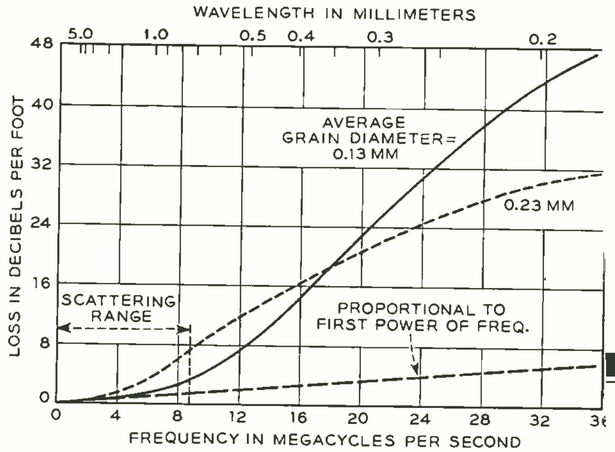

Fig. 1—Relationship between loss and frequency for sound transmission in aluminum rods.

This is generally referred to as the absorption loss of the crystals.

If the crystals are oriented at random instead of all being lined up in the same direction, however, another form of loss occurs. In some directions, the crystal grains are stiffer than in others and, as a result, there is a discontinuity at the crystal boundary that reflects the wave. This causes a scattering loss similar to the familiar Rayleigh light scattering effect that is responsible for the blue in the sky. The amount of this loss depends upon the relationship between the wave length and the size of the reflecting grains. When the wave length is greater than about three times the grain diameter, this scattering loss is proportional to the fourth power of the frequency, while when it is less than the grain

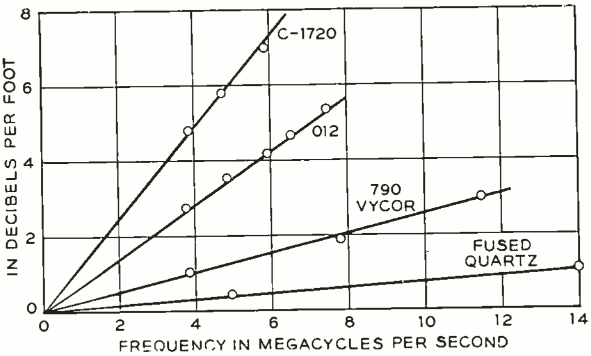

Fig. 2—Relationship of loss to frequency in quartz and three types of glass.

diameter, it is independent of frequency, but is inversely proportional to the grain diameter.

In making measurements of acoustic losses in delay rods, piezoelectric crystals of quartz are held against the two ends of a rod, which are made accurately parallel to each other and perpendicular to the axis of a rod. A high-frequency pulse is applied to the rod through one of these crystals and is picked up for measurement through the other. Both the amplitude of the received pulse and its time of arrival may be measured on an oscilloscope as shown in the photograph at the head of this article. It is possible also to make similar measurements after multiple reflections at the ends of the rod. By using a rod with a diameter that is at least 20 wave lengths of the frequency employed, reliable measurements can be made without difficulty.

Measurements made in this manner, using longitudinal waves, on two aluminum rods with different average grain size are plotted on Figure 1. At low frequencies, the loss is proportional to the frequency, and of a value agreeing well with measurements at much lower frequencies. The dotted line shows this straight line extended to the higher frequencies. As the frequency increases, the loss diverges from this curve, and up to about 8 megacycles for the 0.23-mm grain size, the divergence between the two curves is proportional to the fourth power of the frequency, and thus represents the scattering loss referred to above. The velocity of transmission of a longitudinal acoustic wave in aluminum is 6.32×10^5 centimeters per second, and the corresponding wave lengths are indicated along the top of Figure 1. For both specimens, it will be noticed that the fourth power loss holds until the grain diameter becomes smaller than about three times the wave length. Beyond this point, the curves start to flatten out and would become horizontal—loss independent of frequency—as the wave length became less than the grain diameter. Since the loss becomes inversely proportional to grain diameter as the wave length becomes equal to, or smaller than, the grain diameter, the loss is greater in substances of small grain size than those of large. This explains the crossing of the two curves in Figure 1.

That this fourth power of frequency loss superimposed on the first power loss is due to the presence of crystal grains in the material may be shown by measuring the transmission loss in substances in which the crystal grains are absent as in glass or fused quartz. The loss measured in fused quartz and in three glasses is shown in Figure 2. For each of these substances the loss is directly proportional to frequency, and is thus solely the absorption loss caused by the hysteresis effect.

In the strict sense of the term, it is only this absorption loss that is a true loss. The energy that is diverted by scattering is merely redirected along other paths and will ultimately arrive at the distant end of the rod, except for the losses at the sides and near end of the rod and for the absorption losses suffered in its travels. Since it travels a much longer path, however, a much longer time will be required for it to

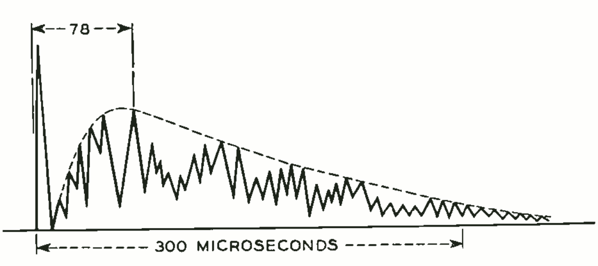

Fig. 3—Energy received at the far end of a brass rod after the application of an initial pulse of sound of the near end.

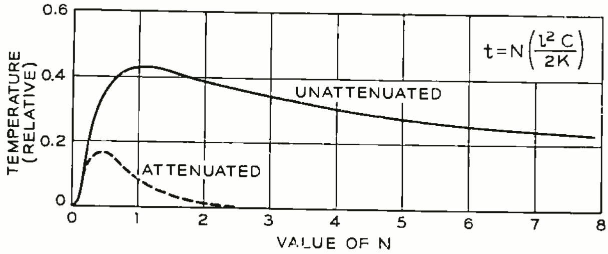

Fig. 4—Curves showing relationship between temperature and time. Solid line for heat transmission; dashed line for sound transmission at ultrasonic frequencies.

reach the end of the rod. In granular material, therefore, where most of the energy is scattered by reflection, it would be expected that when a pulse was applied at one end of the rod, a small amount of the energy would arrive at the distant end after an interval equal to the length of the rod divided by the velocity of transmission, and that this initial pulse would be followed by a trailing hash as the energy arrived that had traveled over reflecting paths of various lengths.

This is exactly what was found, as is shown in Figure 3. Here the energy received is plotted against time for a brass rod having an average grain diameter of about 1.25 mm. The initial high peak shown is the pulse applied at the sending end of the rod. So little energy gets directly through the rod that it does not appear at all on Figure 3. What does appear is only the reflected energy. This increases rapidly at first and reaches a peak after about 78 microseconds, and then decreases slowly for the energy that travels longer and longer paths.

In studies of sound transmission at lower frequencies than those plotted on Figure 1, the scattered energy becomes negligible because it varies with the fourth power of frequency. At 1,000 cycles, for example, it is only 10^{-16} times what it is at 10 megacycles, which is near the lower end of Figure 1. For these lower frequencies, therefore, the effect shown in Figure 3 is not noticeable; practically the entire energy of an applied pulse travels down the rod and is received as a pulse of essentially the same length as that applied at the transmitting end, and after a time interval equal to the length of the rod divided by the velocity of transmission.

In contrast with this, energy at the frequency of heat is transmitted exclusively over reflected paths. A short pulse of heat applied at one end of a rod thus does not arrive as a pulse of the same duration, but rather as a pulse of the general shape of that shown in Figure 3. Still another difference in heat transmission is that there is no absorption loss proportional to the first power of frequency. In lower frequency acoustic waves, this loss results from the conversion of some of the acoustic energy to heat, but no loss is occasioned, of course, in converting heat to heat. In heat transmission, therefore, there is no absorption loss; all the energy is transmitted by reflection, and the only true losses over the transmission path are those occurring at the sides of the rod.

When all the energy is transmitted by reflection, it is possible, by summing up the transmission over the reflecting paths of various lengths, to calculate the time at which the peak of the received energy curve, such as that of Figure 3, is reached. This turns out to be: $t=2l^2/v\Lambda$, where l is the length of the rod, v the velocity of transmission, and Λ is the mean path between reflecting particles. If values corresponding to the conditions of Figure 3 are substituted into this expression, however, the time found is only about half that indicated in Figure 3. This latter curve was for a frequency of 12 megacycles, and at these frequencies there is an absorption loss. The effect of this loss is to reduce the height of the peak somewhat and to decrease the value of time at which the peak arrives. With absorption present, the energy received over the longer paths is reduced relative to that received over the shorter paths and, as a result, the peak shifts toward the shorter paths. From the difference between the calculated value of t and that from Figure 3, the attenuation for brass is found to be 10 db per foot for 12 megacycles.

From the equations for heat transmission, it is possible to calculate the time at which the temperature at the distant end will reach its maximum value when a heat pulse is applied at the near end. This is found to be: $t = Cl^2/2K$, where C is the specific heat per unit volume, l is the length of the rod, and K is the heat conductivity. The temperature at other times may also be calculated, and the solid line of Figure 4 shows the curve of temperature plotted against time relative to the time of maximum temperature. If t_0 is the time of maximum temperature, any other time can be expressed as Nt_0, and the abscissa scale of Figure 4 is the N of this expression. The dotted curve of Figure 4 is the curve of Figure 3. Since the solid curve is for heat transmission and thus includes no absorption, it is higher and the peak occurs later than for the dotted curve which does include absorption.

Both curves are obviously members of the same family, but the upper curve is for frequencies of the order of a million megacycles and includes no absorption, while the dotted curve is at a frequency of about 12 megacycles and thus does include absorption. The former represents heat transmission and the latter acoustic, but acoustic transmission with the proper parameters will give both curves, and thus it is evident that heat transmission may be accounted for by considering it as acoustic transmission, but at much higher frequencies.

This has been confirmed in still another way. If heat and acoustic transmission are the same phenomenon, the terms of first two equations are the same, and may thus be equated. If this is done and the resulting expression is solved for K, it is found that: $K = (1/4) C v \Lambda$. Since a solid will transmit two shear waves as well as a longitudinal wave, there are in effect three parallel paths of transmission, and the corrected expression for K would thus be: $K = 1/4\ (C_l v_l \Lambda + 2 C_s v_s \Lambda)$, where the subscripts l and s apply to longitudinal and shear transmission. If the measured values of v and C, and values of Λ consistent with the degree of order, are inserted in this expression, the value of K is found to be that determined from experiment. By these studies of sound transmission through rods, therefore, it has been possible to verify experimentally the Debye theory of heat transmission.

THE AUTHOR: W. P. Mason received a B.S. degree in Electrical Engineering from the University of Kansas in 1921, and immediately joined the Technical Staff of the Laboratories. Here he took post-graduate work at Columbia University, and received an M.A. degree in 1924 and a Ph.D. degree in 1927. The first four years of his work with the company were spent in investigations of carrier-transmission systems. Since then, he has been occupied in the investigation of wave transmission networks, both electrical and mechanical, in piezoelectric crystal research, and in the study of the mechanical properties of liquids and solids. He is at present in charge of the Mechanics Research Department.

Register and sender frames in No. 5 crossbar

O. J. MORZENTI
Switching Equipment

Registers and senders* in the No. 5 crossbar system,† although performing the opposite functions of receiving and transmitting switching information, respectively, have many points of similarity. The time of action for each of them, unlike the marker, is largely controlled by apparatus outside the central office. With an originating register, for example, the time required is at least that necessary for a subscriber to complete dialing the desired number; with an outgoing sender, the governing factor is the speed at which the equipment in the distant office may be actuated. They both must "register" or store the dialed number. They both must count pulses, and "steer" them into the proper digital sequence. They are both required to time their various operations to assure proper functioning. They are alike also in both requiring access to markers for exchange of information for brief periods. This access is provided through connectors consisting of multicontact relays. All of these similarities have permitted the design of registers and senders to follow a uniform pattern.

*Record, *October*, 1949, *page* 385.
†Record, *March*, 1949, *page* 85.

Despite their common features, senders and registers of the No. 5 crossbar system are called upon to serve under such widely varying conditions that there are many points of dissimilarity also. Thus to meet immediate Bell System needs, there are five types of registers—one originating and four incoming—and four types of senders. Each

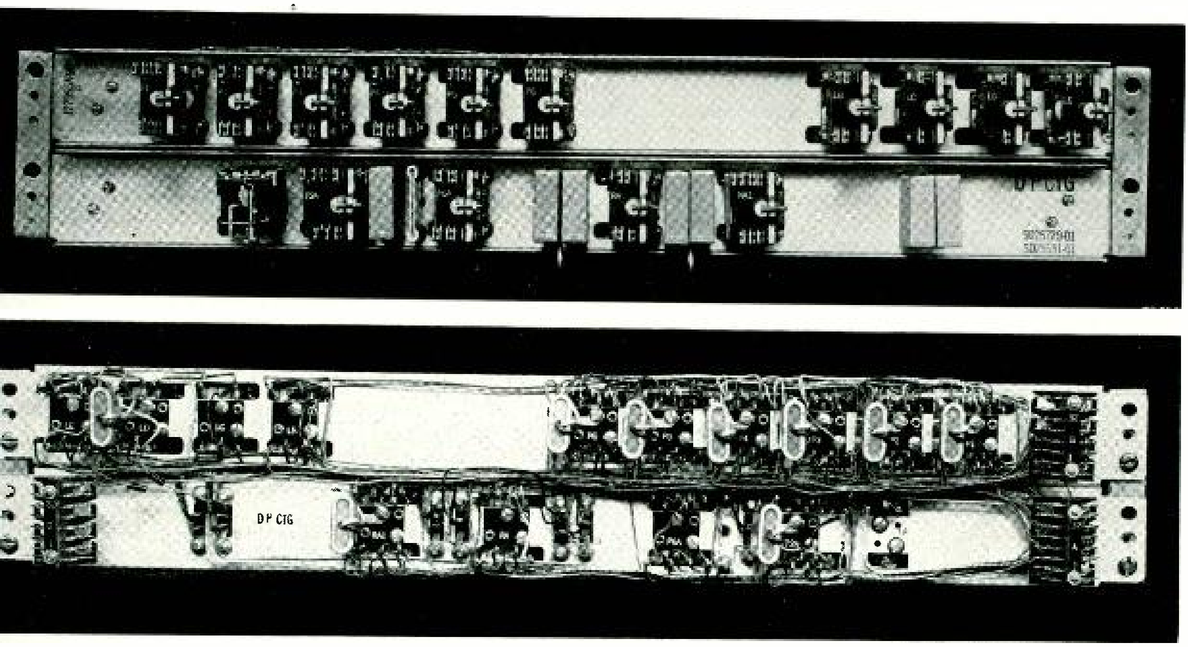

Fig. 1—A dial-pulse counting unit for the No. 5 crossbar system. Front view above and rear view below.

of these has a variety of optional features which are required in different combinations for different offices, depending upon the numbers of digits, lines, frames, classes of service, types of pulsing, the need for automatic message accounting, etc. An idea of the degree to which this differentiation is carried is shown in Table I, wherein the three categories, originating registers, incoming registers and outgoing senders, branch out into the nine types of registers and senders. These in turn are comprised of sixty-eight major features represented by functional units, of which thirty-four are always required in the system and thirty-four are optional.

In keeping with the standardization and simplification of manufacture that has been stressed in the design of the No. 5 system, it was desirable to reduce the wide variety of functional units and to arrange for their combinations in the fewest and simplest standardized patterns. The numbers of functional units have been reduced wherever practicable by making one unit serve in two or more places. Fourteen of the units are common to several types of registers or senders. For example, of the twelve possible types of units entering into the make-up of an originating dial-pulse register, six are also used in the incoming dial-pulse register.

With all optional features included, the maximum number of mounting plates required is twenty-two (for the originating register) and the minimum is fifteen (for the incoming revertive-pulse register). To secure greater standardization, it was felt desirable to fix on a space of twenty-two mounting plates for all cases. The positions of the functional units within any sender or register are also fixed to permit standard jigs and fixtures to be used in the shop for over-all operating tests. Each of the functional units has terminal strips at one end for loose-wired cross-connections between functional units. This loose wiring is readily run from standard drawings to interconnect whatever assembly of units is required for each office. A typical functional unit—the dial-pulse counting unit—is shown in Figure 1. Various functional units grouped to form a complete register for a particular office are shown in Figure 2. Figure 3 shows the register arrangement for a hypothetical central office requiring all of the functional units.

Since no register or sender requires more than twenty-two mounting plates, five of them may be arranged on a two-bay frame, with eleven mounting plate spaces in each of the bays. For the smaller registers or senders, or those equipped with only a few options, this arrangement results in vacant spaces. This loss of space, however, is more than offset by the resulting uniformity in manufacture and maintenance and in the ease with which additions or changes may be made.

Table I—Numbers of Functional Units and Options for Registers and Senders

	Total Number of Functional Units	*Basic Units (Always Required)*	*Optional Functional Units*
Originating Register			
Dial Pulse	12	4	8
Incoming Registers			
Dial Pulse	13	6	7
Multi-Frequency .	8	4	4
Revertive Pulse. . .	5	4	1
Central "B".	5	4	1
Outgoing Senders			
Dial Pulse.	6	4	2
Multi-Frequency .	5	3	2
Revertive Pulse. . .	7	3	4
Panel Call Indicator	7	2	5
Total	68*	34	34

*Of these 68, there are fourteen functional units used in several applications; thus there are only 54 discrete and different units.

The frame consists of two 23-inch bays with fuse panels at the bottom and multicontact relays at the top. The fuse panel arrangement is universal for all registers or senders, consisting of two panels, the one on the left bay caring for the even registers or senders and the one on the right bay, for the odd ones. Each panel is fused from a different frame feeder, so that if power should fail on one, only half the registers or senders will be put out of service. The multicontact relays at the top serve as connectors to concentrate the sender and register connector paths to the markers.

Cable forms are run up the outer edges of each frame at the rear to interconnect

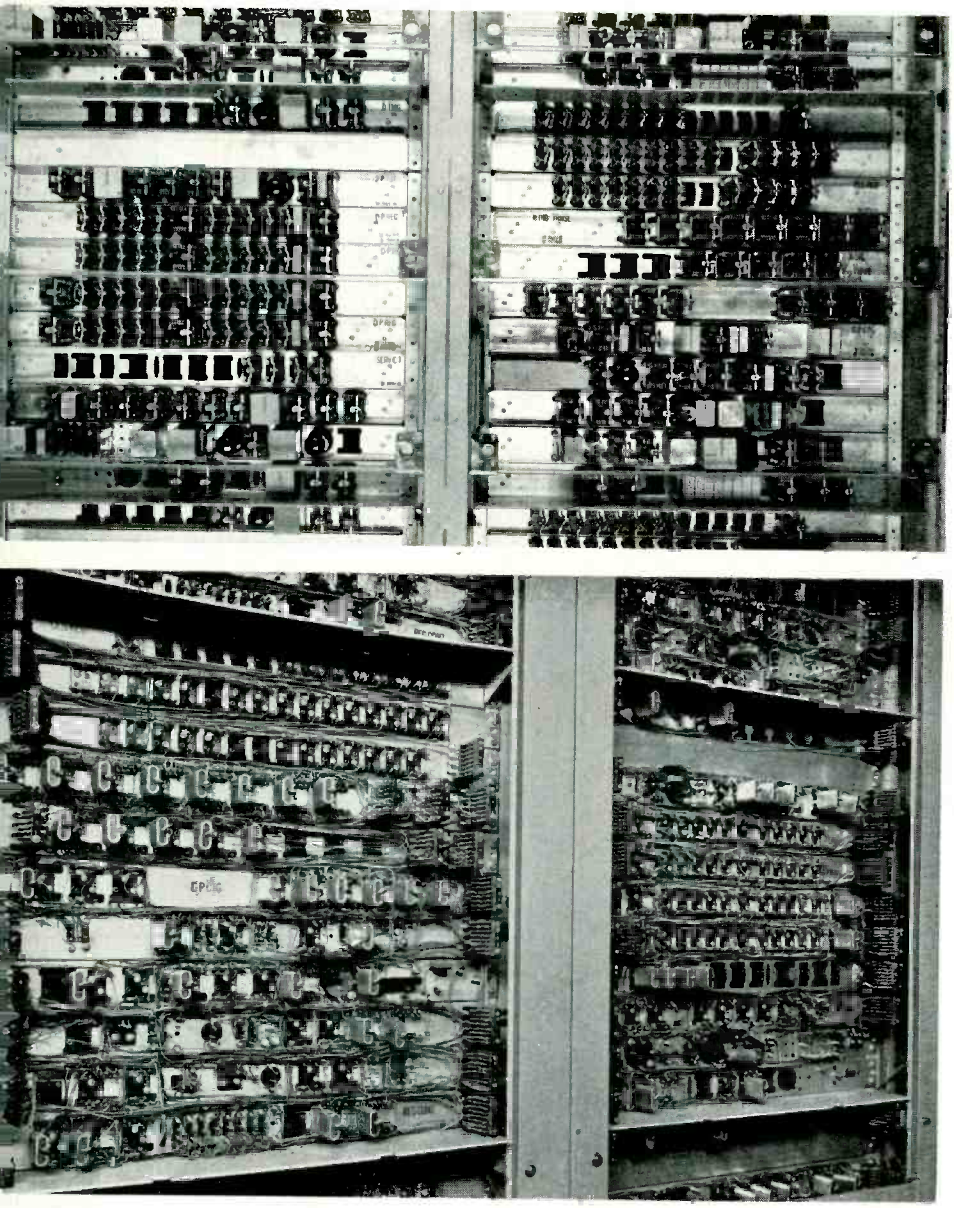

Fig. 2—An originating register for the No. 5 crossbar system. Front view above and rear view below. The counting unit of Fig. 2 occupies the fifth and sixth mounting plates from the bottom on the bay at the right.

the fuses at the bottom, the connectors at the top, the testing facilities in the frame upright, and the frame terminal strips to the sender or register equipments. They have leads brought out at the various mounting plate levels to connect to any combination of functional units which might be furnished. If one cable form included all the wiring needed for all types of registers and senders, it would, in any specific case, provide many leads not required, and add unjustifiable cost. After considerable study, ways were found, however, to standardize three frame cables to care for all conditions. One accommodates five originating registers; one accommodates any of the four types of incoming registers in any combination; and one accommodates any of the four types of senders in any combination. The single type of frame structure with standardized fuse panels, connectors, and other equipment common to a frame, thus becomes one of three possible types when the local cable is installed: an originating register frame, an incoming register frame, or a sender frame.

Front and rear views of a typical register frame are shown in Figure 4. The permanent cable may be seen at each side in the rear view. The flexible wiring between the two bays is that connecting the various functional units, previously discussed, that comprise a complete register.

Besides securing a flexible frame arrangement that requires only three types of frames for mounting any type of sender or call for a much longer time than this, however, and thus a single connector can serve a number of registers or senders. Just how many will depend to a large extent on the type of register or sender. A dial-pulse register, for example, requires considerable time to receive a long train of digits from an outlying office in comparison with the time it requires to pass this information on to the marker through the connector. Thus,

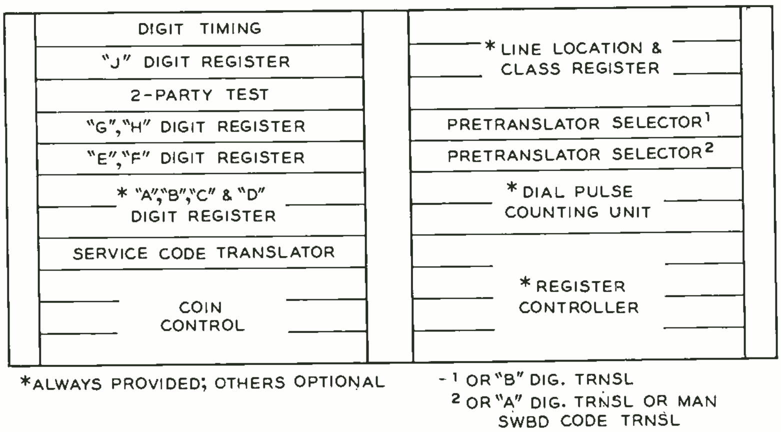

Fig. 3—A chart showing a fully equipped originating register (all units named and optional units and apparatus so indicated).

register, it has been necessary also to provide flexibility in grouping the registers and the senders for connection to the markers. Senders and registers are connected to markers to transfer information to them or to receive it from them. As stated previously, only a very short time interval is required for each transfer of information. The sender or register may be busy with a while the register is occupied in receiving the digits, other registers could be using the connector, and in the example chosen, this connector might serve as many as a dozen such registers. A multi-frequency register, on the other hand, receives its digits very quickly, and thus will be ready for connection to a marker much oftener. Therefore, a single connector cannot serve

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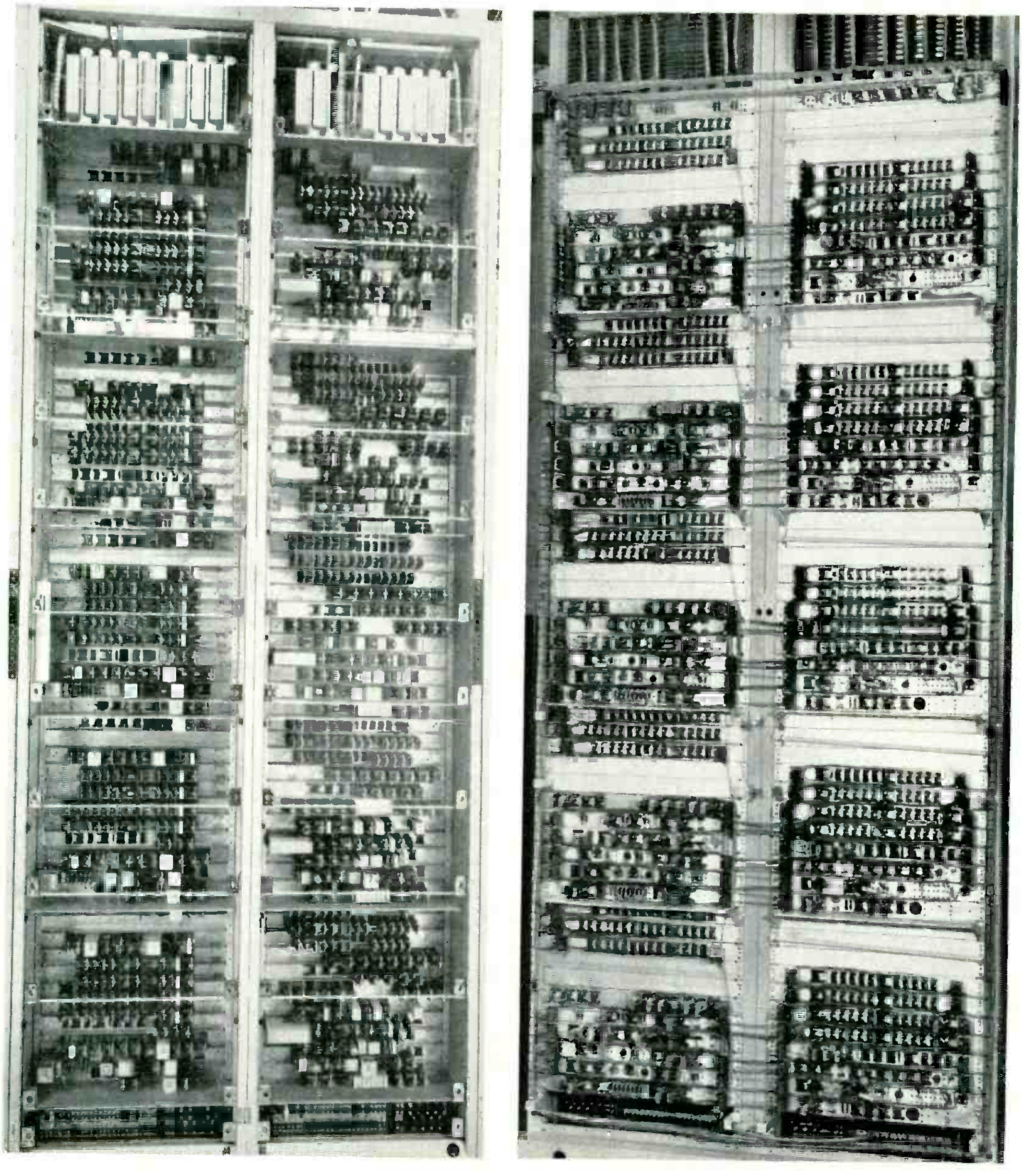


Fig. 4—Front view of an originating register frame in the Towson Office at the left, and rear view of a similar frame at the Hawthorne plant of the Western Electric Company at the right. The permanent cable may be seen at each side of the rear view. The flexible wiring between the two bays is that connecting the various functional units comprising a complete register.

as many multi-frequency registers as it can dial-pulse registers.

At the top of each frame are five groups of sometimes two and sometimes three multicontact relays, one group for each possible register or sender on the frame. The armature contacts of all five groups are multipled together for connection to the marker. If used in this manner, all five groups of multicontact relays would be part of a single connector. By mounting terminal strips at each end of the row and at two or three points within the row, however, it is possible to cut the multiple of the armature contacts at some point and thus split the connector. The terminal strips are so placed that the multiple may be cut to assign one register to one connector and four to the other, or two to one and three to the other. Of the registers or senders on a single frame, therefore, all five may be on one connector, one may be on one and four on the other, or two may be on one and three on the other, and thus essentially complete flexibility is secured. Further flexibility is obtained by multiplying connectors on different frames. Thus a single connector is able to take care of registers or senders on several frames. The same connector, however, cannot serve both registers and senders.

Because of the provisions made in the design of the No. 5 system, there is flexibility at every stage of the assembly. Functional units may be selected as desired to build any type of register or sender. The three types of frames with their common equipment are manufactured as separate entities. Frames and their registers or senders are then brought together in any combination. Finally, both senders and registers are grouped as required by traffic to supply suitable loads for the connectors. It is features of this type that make No. 5 adaptable to many types and sizes of office.

AEC signs contract with Western for Sandia

On October 8 it was announced by George P. Kraker, AEC Field Manager for Sandia Base, that the U. S. Atomic Energy Commission has signed a contract with the Western Electric Company, a subsidiary of the American Telephone and Telegraph Company, for the operation of the Sandia Laboratory at the Sandia Base.

The laboratory was transferred from the previous operator, the University of California, to the Western Electric Company on November 1. The new contract is effective through December 31, 1953.

The Western Electric Company is operating the Sandia Laboratory through a new, wholly owned subsidiary named the Sandia Corporation. The Sandia Corporation will call upon both the Western Electric Company and the Bell Telephone Laboratories for scientific services and technical and managerial assistance.

The Sandia Laboratory has been operated by the University of California since 1945 under the university's contract for the operation of the Los Alamos Scientific Laboratory. Several months ago the university expressed a desire to be relieved of its responsibilities at Sandia, and, as announced July 11 by the AEC in Washington, the Western Electric Company was selected as its successor.

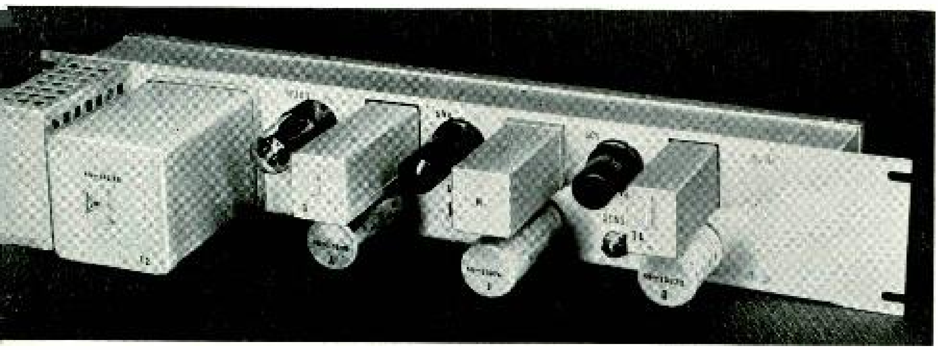
The date for the transfer of the Sandia contract was set jointly by officials of the AEC, the University of California and the Western Electric Company. The Sandia Laboratory is an important link between laboratory development work and manufacturing operations in the field of atomic weapons. It is operated under the general direction of the AEC Santa Fe Operations Office, Los Alamos, N. M., of which Carroll L. Tyler is manager.

A voice-operated busy signal

E. C. BORMAN
Transmission Engineering

In addition to the regular message telephone service, the Operating Telephone Companies are often called upon to provide leased telephone lines for the exclusive use of a subscriber. These lines are typified by such services as the C.A.A. Air Traffic Control Network. This network consists primarily of long multistation lines, and a portion of it connects approximately 550 Interstate Airways Communications Stations (INSAC) with the Airway Traffic Control Centers throughout the United States. In keeping with the C.A.A.'s program for modernizing the INSAC stations, Bell Telephone Laboratories has recently completed the development of a new key equipment known as the 111A.* One of the outstanding components of the 111A key equipment is a new voice-operated busy signal. This signal is applied to each of the multistation telephone lines terminating in the 111A key equipment, and is provided to identify the particular line on which a voice call is being heard. The specific need for this signal came about as a result of the requirement that incoming voice calls from remote stations on these multistation lines be heard on a single loudspeaker. The objectives of such an arrangement are to reduce cost, and to eliminate the operating confusion which resulted when individual loudspeakers were employed on each line.

A fundamental requirement of a voice-operated busy signal is that it be sufficiently sensitive to operate at low talking levels and yet not operate on line noise. As talking volume levels may vary considerably, from +10 vu to −30 vu corresponding to powers of 10 milliwatts and one microwatt, respectively, it is evident that the speech signal is too weak in itself to operate a lamp or other indicator, and that amplification is necessary. Since the line noise is amplified as well as the speech signal, frequency discrimination must be used to prevent false operation because of noise.



The voice-operated busy signal unit.

A second requirement is the incorporation of time delay in the release of the signal. This is necessary to prevent the busy signal from flashing on individual syllables or words, and to allow for reasonable lengths of pauses in speech. Of course, a long release time delay is undesirable, since that would result in poor circuit efficiency. Under these circumstances, the circuit would appear busy during the idle period that is involved and thus reduce the available circuit time.

A number of forms of voice-operated busy signals have been employed in the past for one purpose or another. For the

*Record, *October*, 1949, *page* 394.

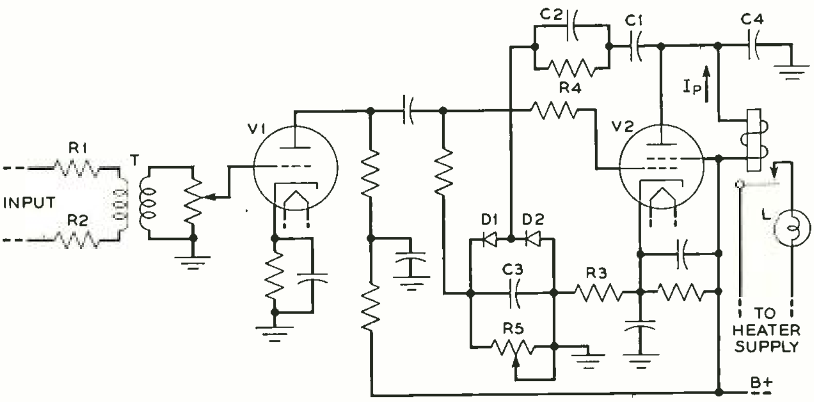


Fig. 1—Schematic of the circuit for the new voice-operated busy signal.

most part, they use the rectified voice current to operate the relay that controls the busy signal, and secure the time delay either by a system of slow-release relays or by delay networks in the amplifier circuit. To meet some recent needs of the Civil Aeronautics Administration, however, a simpler, more compact, and more sensitive voice-operated busy signal was required. In providing such a device, advantage has been taken of a "rectified reaction" type of feedback circuit which has been known to the art for a long time. By use of this circuit, it has been possible to obtain a large change in plate current for a small change in the level of the input signal. By allowing changes in plate current to control the operation of a relay, a signal is given whenever the speech input increases slightly above a specified level, and releases when it drops below this level. Delay is incorporated in the release and may be adjusted by changing the value of a resistor. Operation by noise is avoided by decreasing the effect of energy at frequencies below and above the voice band.

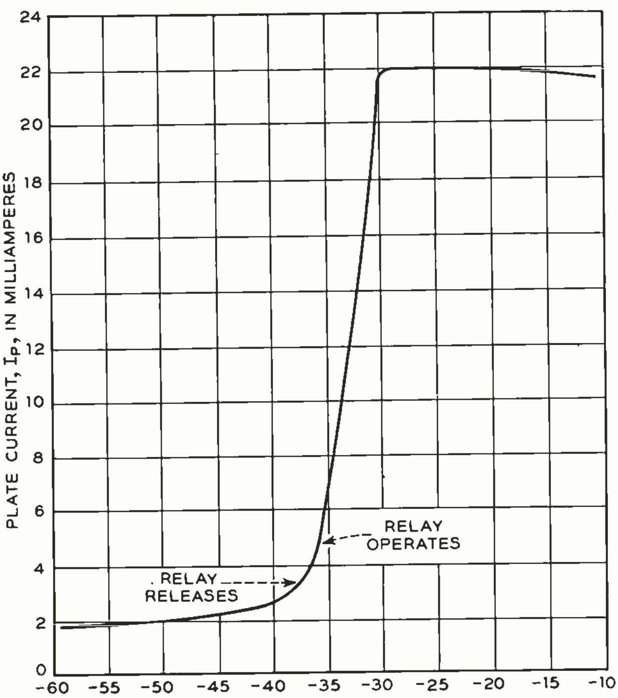


Fig. 2—Plate current characteristic of the rectified-reaction stage of circuit shown in Figure 1.

A schematic of the voice-operated busy signal is shown in Figure 1. Resistances R1 and R2 in the input circuit assist in providing a sufficiently high input impedance so that the transmission loss caused by bridging the busy signal across the line is small. A first stage of amplification is provided by V1, while V2 is the stage having rectified reaction. With no input signal on the line, V2 is biased almost to cutoff by virtue of the voltage drop across R3. That is, the control grid of V2 is highly negative with respect to the cathode, and as a result, the plate current, I_p, through the relay is very small, and the relay is non-operated. When speech appears on the line, it is amplified by V1 and applied to the control grid of V2, where it is amplified again. The output signal current of v2 flows mostly through the combination of c1, c2, and r4, since the relay winding has a very high impedance. The signal is rectified by the copper-oxide varistors, d1 and d2, and appears as a positive charge on the left side of c3. As this positive charge increases, it drives the control grid in a positive direction with a resultant increase in plate current. As the plate current increases, it reaches the operate value of the relay whose contacts are used to control a lamp or other indicator.

The plate current characteristic of the rectified-reaction stage is shown in Figure 2. At very low input levels, the plate current is small. As the input level increases, the plate current increases, slowly at first, but then rises abruptly for a small further increase in input level. The operate value of the relay may be chosen to have it operate anywhere on the steep portion of the curve, but for maximum sensitivity the relay should operate at as low an input level as possible. As the input level increases beyond this point, the plate current increases sharply to a relatively high value, and then becomes constant. It does not increase indefinitely because of two changes that are taking place. The first change is that the plate potential decreases because of the increasing voltage drop across the relay winding. The second change is that the voltage drop across r3 raises the cathode potential as the plate current increases. Both of these voltage drops tend to limit the plate current at high input levels.

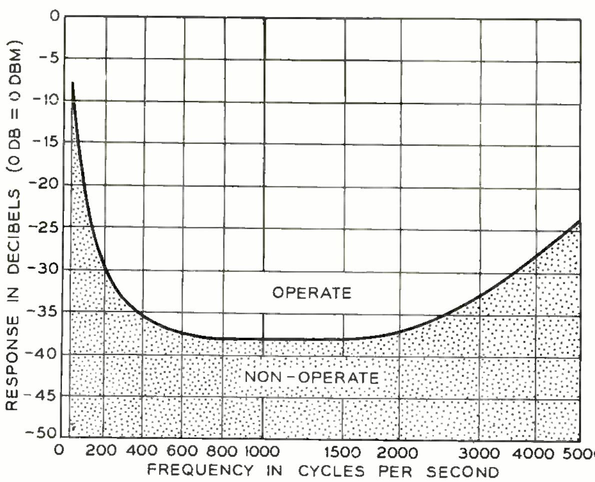
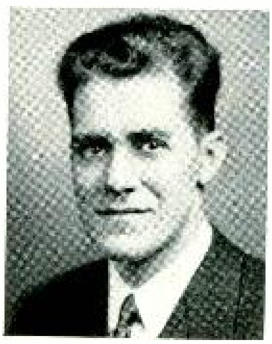


Fig. 3—Frequency response of the busy signal.

When speech ceases, the positive charge across c3 will leak off to ground through the back resistance of the rectifiers and the variable resistance, r5. As this charge diminishes, the grid potential assumes an increasingly negative value, causing the plate current to decrease. When the plate current has decreased to the value of current at which the relay releases, the lamp or indicator is extinguished.

THE AUTHOR: E. C. Borman joined the D & R as a messenger in 1930. Following the consolidation of this department with the Laboratories, he joined the local transmission group and engaged in field observations concerned with transmission rating problems. With the advent of the national defense program and the diminution of the transmission observation program, he became associated with the substitute materials program and civil air raid warning systems. During this time he studied at New York University and received the B.E.E. degree in 1942. In World War II he worked on speech privacy systems, air-ground communications, and the integration of land lines with military radio systems. Following the war he has been occupied with exchange area transmission problems. He received the M.E.E. degree from New York University in 1948.



The release or holdover time of the relay is governed by the rate of discharge of C3, which depends primarily on R5 and the back resistance of the rectifiers. By adjusting R5, the release time may be varied from approximately three to ten seconds.

Discrimination between noise and signal is obtained by frequency weighting. This is accomplished in the voice-operated busy signal circuit by attenuating the frequencies below about 300 cycles in the input transformer, and by attenuating frequencies above about 3,000 cycles by by-passing them to ground through the capacitor C4. The input transformer, T, is wound on the core of a G-type relay, and has a sufficiently low mutual inductance to suppress the low frequencies and yet have a satisfactory response in the middle voice-frequency range. The frequency response of the voice-operated busy signal is such that the sensitivity at 50 cycles is about 30 db less than that of 1,000 cycles, and at 5,000 cycles it is approximately 15 db less. This is shown in Figure 3.

The voice-operated busy signal described here employs a type of circuit that appears particularly suited for this application and permits the use of economical components. It is thought that this equipment will satisfy the increasing need for such a device in the telephone plant.

Changes in the Pension Plan

To All Active and Retired Members of the Laboratories:

We are glad to inform you that effective November 16, 1949, revisions have been made in the Plan for Employees' Pensions, Disability Benefits and Death Benefits which liberalize its minimum pension provisions.

The principal effect of the change is to provide increases in the minimum pension for full-time employees having twenty years or more of service at time of retirement. They will receive a minimum payment, which, when added to the amount (based on Company service and wages) receivable from Federal Social Security, if any, will be $100 per month after age 65, and $75 per month before that age. The increases are effective for those now on pension as well as for those who retire hereafter.

Since the establishment of our Plan in 1925, it has ranked high among benefit and pension plans. Over the years, it has been amended in the light of changing conditions and in such a way that the Plan has remained sound. This latest amendment is in keeping with those objectives.

We wish to acknowledge the valuable assistance obtained through discussions from time to time with many people throughout the organization, with pensioners, and with union representatives.

A new pamphlet containing the Plan as amended will be furnished to you as soon as it is printed.

D. A. Quarles,
Chairman, Employees' Benefit Committee.

November 21, 1949.

A completely electronic regenerative telegraph repeater

B. OSTENDORF
Telegraph Development

Relative to the age of telegraphy itself, the regenerative telegraph repeater[1] is a new device. Its use became possible only after the adoption of the printing telegraph system, and in its first form,[2] it utilized the mechanical distributor which was also employed for sending and receiving. This repeater satisfactorily achieved its major objective; but, with rotating brushes, regular and frequent maintenance is essential to successful operation. To avoid the disadvantages of brush and commutator maintenance, a repeater was developed that did not require them.[3] Although this latter repeater, the 106-type, avoided the use of brushes and commutators, it yet was mechanical in nature, and thus was subject to the limitations and disadvantages of mechanical apparatus that must be kept in almost continuous operation.

As often happens, however, a new device was ready by the time the need for it arose. The steady improvement in vacuum tubes prior to and during the war, and their rapid adoption as switching elements, suggested their use as substitutes for the mechanical elements of the regenerative repeater. Immediate wartime needs led to the development of an electronic repeater[4] that was made available to the Army, and performed satisfactorily.

In any regenerative repeater, two timing functions are required, which may be designated character timing and element timing. A telegraph character in the Bell System's start-stop code consists, as indicated in Figure 1, of seven equal-length elements plus a short period serving as a resting interval between successive characters of a continuous chain. The first of the seven is a "start" element and is always "spacing," and the last is a "stop" element and is always "marking," while the five elements between them, which may be either space or mark, permit thirty-two possible characters by the various permutations of mark and space. If these characters are to be properly regenerated, both the over-all length of the character and the positions and lengths of the five code elements that are involved must be accurately timed.

Although the electronic repeater developed for the Army avoided purely mechan-

[1] A device that sends out signals reformed as well as with renewed energy.

[2] RECORD, *August*, 1930, *page* 570.

[3] RECORD, *July*, 1936, *page* 355; *October*, 1936, *page* 45.

[4] RECORD, *April*, 1948, *page* 173.

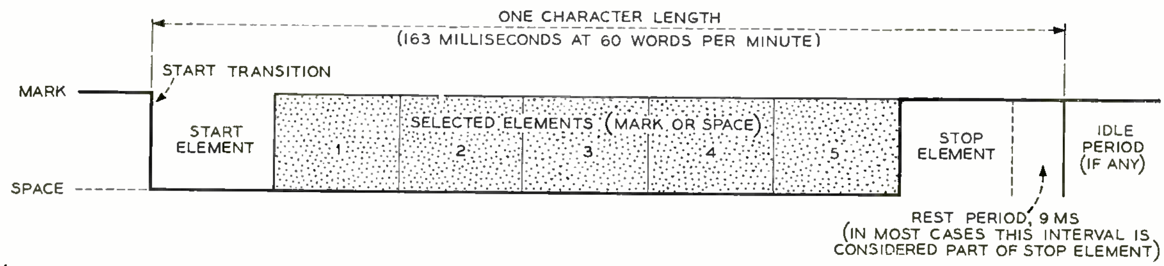


Fig. 1—A telegraph character consists of seven equal-length pulses beginning with a start and ending with a stop.

ical devices, it did employ a number of relays, and thus was not one hundred per cent electronic. A capacitor discharge was used for timing the length of the character, and, of course, features were included to meet Army requirements that would not be needed in a Bell System repeater. In providing a regenerative repeater for a new telegraph office proposed as one of the early post-war projects, it seemed desirable to take advantage of the reduced maintenance, precise timing, and flexibility of electronic operation to the fullest extent. A completely electronic regenerative repeater was therefore developed. It has been coded the 143A1, and is now in production by the Western Electric Company.

Basic timing in this new repeater is accomplished by a start-stop oscillator that starts without transients at the receipt of a start pulse and stops—also without transients—during the stop pulse. The principles involved in such an oscillator have already been described in the Record.[5] The frequency of the oscillator is such that there is just one complete cycle for each of the seven elements of a character, and an electronic circuit counts the cycles and stops the oscillator at the end of the seventh. The output of the oscillator is passed through an overloaded triode, which gives a square-topped wave of oscillator frequency. By then passing the square-topped wave through capacitors, narrow pips of voltage are obtained at the sides of each square half cycle—positive when the wave is increasing and negative when it is decreasing. The positive pips, corresponding to the mid-points of the incoming elements, are passed to a circuit that starts an outgoing element of the same sense, that is mark-

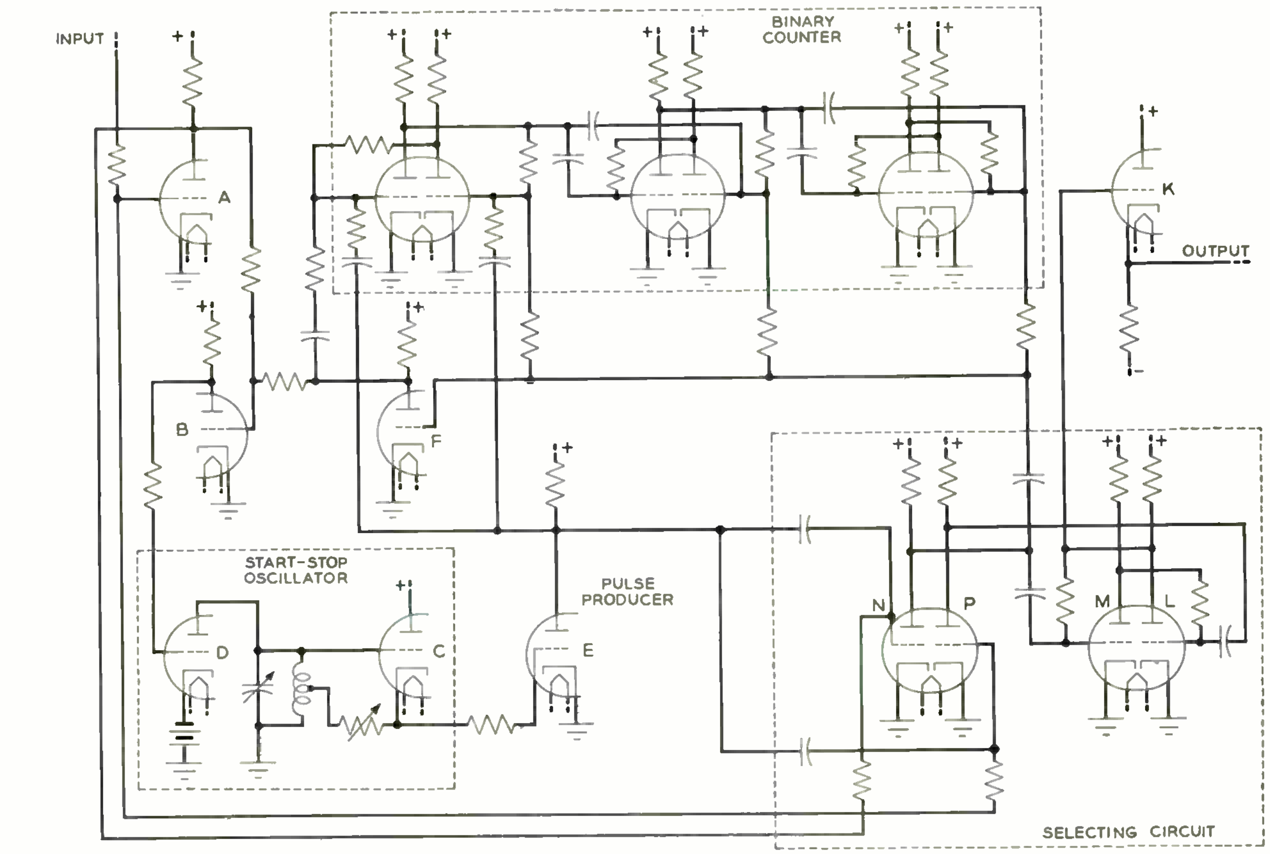


Fig. 2—Simplified schematic of the completely electronic regenerative repeater.

[5]Record, *May*, 1948, *page* 210.

ing or spacing, as the incoming signal. The next positive pip will similarly start the next element, and thus the length of each element is exactly one cycle of the timing oscillator. In this way, a new set of character elements is sent out corresponding to the incoming elements in their order and sense, but completely reformed and retimed, and starting just one-half element interval later than the beginning of the received character.

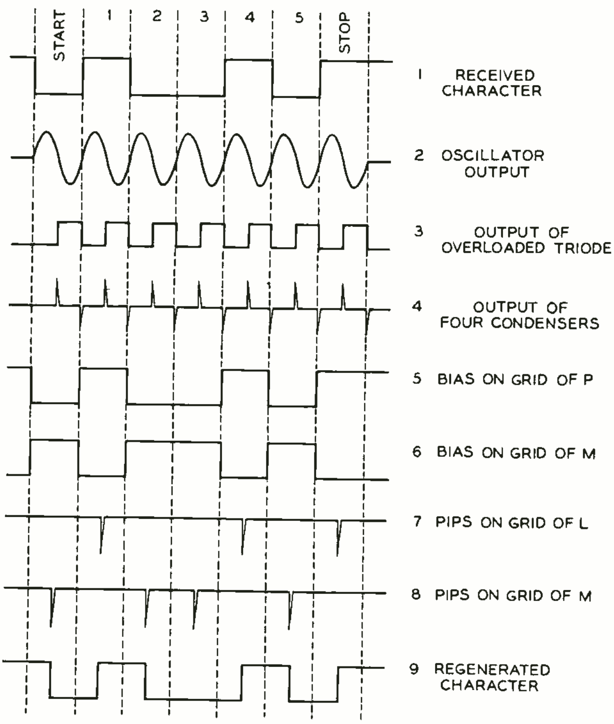


Fig. 3—Successive steps in the regenerating of a signal in the 143A1 *repeater.*

Incoming signals to the repeater are plus forty volts for marking elements and minus forty volts for spacing elements. They are applied to the grid of triode A shown at the upper left of Figure 2, and cause it to pass current during the mark elements and to cease passing current during space elements. The timing oscillator consists of a tuned circuit, shown at the lower left of the diagram, associated with two triodes, C and D. Triode C supplies sufficient energy when the circuit is oscillating to maintain the output at a constant level. Triode D, on the other hand, is used to start and stop the oscillations. When triode D is in the conducting condition, it forms a low impedance shunt across the oscillating circuit and prevents oscillation. When the voltage on the grid of D is lowered sufficiently to stop the flow of current through it, the tuned circuit shunted by it starts to oscillate. The grid of D, in turn, is supplied from the plate of triode B, and thus is at high voltage when B is not conducting and at low voltage when it is conducting. The grid of triode B is similarly connected to the plate of triode A. An incoming mark element causes A to conduct, thus lowering its plate voltage and blocking triode B. With B blocked, the voltage on the grid of D is high and D passes current and thus blocks oscillation of the tuned circuit. A space element, on the other hand, acts in the opposite direction, thus permitting oscillation. The voltage on the grid of B, however, is determined not only by the incoming signal but by an additional voltage, derived as described later, that prevents all input signals except the start from having any effect on the oscillator.

The output of the oscillator is applied to the grid of the overloaded triode E, and the plate of E is connected to four small capacitors that provide four sources of the positive and negative pips already referred to. The various steps leading to the formation of these voltage pips are illustrated graphically in the upper four lines of Figure 3. Leads from two of the capacitors run to the counting circuit of the upper part of Figure 2, which counts the negative pips and stops the oscillator at the seventh, while leads from the other two connect to the portion of the circuit that forms the elements for the outgoing character.

The reformed outgoing elements are generated by triode K and are space or mark depending on whether a low or high voltage is applied to its grid. This latter voltage, in turn, depends on whether the triode L is conducting or not conducting. Triodes L and M are interconnected in such a way that one and only one of them is always conducting ("flip-flop" circuit). This action has been more fully described in a previous article.[6] When L is conducting, its plate

[6] Record, *August,* 1948, *page* 325.

voltage will be low, triode K will not be passing current, and a space element will be sent out. When L is not conducting, on the other hand, its plate voltage will be high, and by making triode K conducting, a mark element will be sent out. The shift from L conducting to M conducting or vice versa is brought about by the application of a negative pip to the grid of the triode that is conducting, and these negative pips are obtained from the plates of triodes N and P when they are made to conduct momentarily.

The grid of P is biased by the input signals, and is thus negative during an incoming space element and positive during an incoming mark element. The grid of N, on the other hand, is biased by the plate voltage of the input triode, and consequently has bias of opposite polarity to that of P. Regardless of whether a marking or spacing element is being received, neither N nor P will be conducting, but the one with a relatively positive grid bias will be in a position to conduct at a slightly increased positive grid voltage.

Two of the capacitors in the output circuit of triode E are also connected to the grids of N and P, and thus the positive and negative pips derived from the sides of the square-topped wave of oscillator frequency are applied to both grids. Negative pips have no effect at any time, but positive pips will cause the triode with a positive grid bias to momentarily conduct. The resulting negative pips in the plate circuit of N or P are passed to the grid of M or L respectively, and thus a mark or space element in the output circuit is initiated depending on whether the incoming element was mark or space.

While a reformed signal is being sent out as described above, the negative pips in the output of triode E are being counted by the three double triodes shown at the upper part of the diagram. These three pairs of triodes are connected in "flip-flop" arrangements like triodes M and L, and two of the capacitors in the output of triode E connect to the two grids of the left-hand pair of counting triodes. The two grids of the middle pair are connected through capacitors to the left plate of the first pair, and the two grids of the right-hand pair are connected similarly through capacitors to the left-hand plate of the second pair. Positive pips on the grids have no effect, but negative pips flip the circuit from left conducting to right conducting or vice versa. Negative pips appear on the grids of the second pair only as the first pair shifts from right conducting to left conducting; and negative pips appear on the grids of the third pair only when the second pair shifts from right to left conducting. Before the beginning of a character, all three pairs are right conducting, and a succession of negative pips on the grids of the first pair causes the various pairs to act as indicated in successive lines of Table I, where L stands for left conducting and R for right conducting. When a pair changes from left to right conducting, there is no effect on the following pair, but when it changes from right to left conducting, the following pair is reversed. For this reason, the first shift will change all three pairs from right to left. After the eighth negative pip on the first pair of grids, all triodes will again be right conducting as at the beginning.

TABLE I—OPERATION OF THE BINARY COUNTING TUBES IN THE UPPER PART OF FIGURE 2.

Counting Pip	*1st Pair*	*2nd Pair*	*3rd Pair*
0	R	R	R
1*	L	L	L
2	R	L	L
3	L	R	L
4	R	R	L
5	L	L	R
6	R	L	R
7	L	R	R
8	R	R	R

*Extra pip supplied from selecting circuit.

There are only seven negative pips in a complete character, however, and thus to bring about a complete cycle, an eighth shift must be devised by other means. This extra counting pulse is obtained by using the first selecting pip from triode N of the output circuit. Since it occurs before the rest of the counting pips, it is called pip 1. A negative pip appears on the plate of N in the middle of the spacing start element, as shown in line 8 of Figure 3, and this pip blocks triode F which had been conducting previously. The resulting rise in the plate voltage of F is transmitted through a capacitor as a positive pip on the grid of the left half of the first pair of counting triodes. All the pairs are right conducting at this time, but the positive pip on the left grid of the first pair makes the first pair left conducting. This reverses the second pair which, in turn, reverses the third pair, and thus all three pairs are changed from right to left conducting as indicated in line 1 of Table I.

Connections from the right grids of all three pairs of counting triodes are also carried to the grid of triode F, and thus when all the pairs change to left conducting, the voltage on the grid of F is lowered, and F, which was made non-conducting by the negative pip from the plate of N, remains non-conducting, and subsequent pips from the plate of triode N have no effect on it. With F non-conducting, its plate voltage is high, and this holds the grid of B high. Triode B, which was made conducting by the arrival of the start pulse, is thus held conducting, and prevents the oscillator from stopping.

Each time one of the counting pairs changes from left to right conducting, the voltage on the grid of F increases a little, and after all three have changed at the eighth counting pip, the grid is at a high enough voltage to make F conducting. The resulting negative voltage on its plate blocks triode B, and the resulting high voltage on its plate causes D to pass current and stop the oscillator. The entire circuit is then in the condition to receive the next character.

Character timing by means of a counting chain has the advantage of always being in adjustment as long as the oscillator is in tune. It does not have the inertia problem of starting a cam wheel or distributor brush through a friction clutch, nor does it have momentum to be dissipated by a stop latch mechanism, as with mechanical units. Many of the disadvantages of the earlier types of repeater are thus overcome. Because the character-timing counting chain does not start until the middle of the start element, a false start element (or "hit") of shorter duration than a half element occurring during a stop or idle period would not cause the repeater to go through a complete character cycle. This feature is not provided in any other present design, and would be especially valuable where, for example, a regenerative repeater is used in a radio link carrying automatic full speed transmission. A short hit is very possible in such a circuit, and if one occurred during a stop element it would—without this feature—cause loss of synchronization along the entire circuit. This could cause mutilation of many characters before synchronization was restored.

Six-unit selecting code operation, though used at present in the Bell System only in teletypesetter circuits, is provided in the 143A1 unit by an adaptor circuit consisting of one additional vacuum tube. When this adaptor is installed, either five or six-unit codes may be regenerated by removing or replacing the vacuum tube in its socket.

In performance, the unit, when well tuned, tolerates 48 per cent displacement of either end of a signal element, and retransmits with negligible distortion. A measurement of frequency stability at 100 words per minute indicated a shift over a half-year

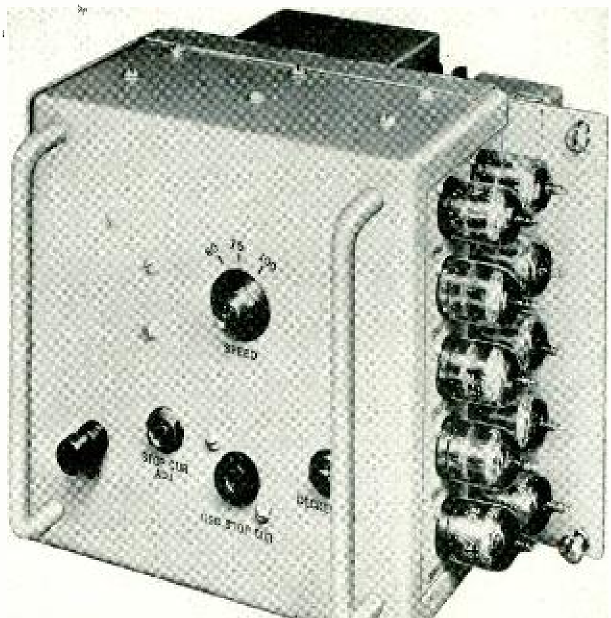


Fig. 4—The 143A1 *regenerative telegraph repeater.*

THE AUTHOR: B. Ostendorf, Jr., graduated with the B.S. in E.E. degree from Northwestern University in 1941, and came to the Laboratories in the same year. A brief period followed involving work on several telegraph and signaling circuits using cold-cathode gas tubes. This work was set aside with the oncoming of World War II, during which time Mr. Ostendorf engaged in the development of various components of a searchlight-control radar system, particularly indicators, antennas, pulse modulators, and a servo-mechanism. Since then, his work has been on such circuits as: regenerative repeater, telegraph signal distorting device, telegraph transmission measuring sets, a frequency-shift teletypewriter station set, and parts of telegraph service board.

period which caused only one per cent distortion of the last selecting element. In practice, five per cent maximum distortion is usually allowable before readjustment. Size and cost are comparable to a single regenerating unit and drive mechanism of the 106-type repeater.

An individual repeater is shown in Figure 4. Two of these one-way units mount side by side in the space of 7 by 19 inches. Miniature twin-triode vacuum tubes are used throughout, and are all mounted on one side as shown. The dial on the upper front of the unit selects one of three pre-tuned oscillating-circuit capacitors to permit operation at 60, 75, or 100 words per minute.

The entire unit is powered by central-office batteries, and hence has the further advantage over the 106-type repeater of not being subject to commercial power failures.

Patents Issued to Members of the Laboratories by the United States Patent Office From July to October, Inclusive

L. Armitage	J. W. Dehn	R. E. Hersey	C. A. Lovell	A. J. Rack
W. M. Bacon	F. R. Dennis	A. N. Holden	W. R. Luther	W. T. Rea
H. A. Baxter	W. H. Doherty	W. H. T. Holden (4)	W. P. Mason (4)	C. G. Reinschmidt (2)
B. S. Biggs	R. C. Edson	R. H. Hose	R. C. Mathes	A. R. Rienstra
R. B. Blackman	J. W. Emling (2)	E. J. Howard	B. McKim	T. D. Robb
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H. T. Budenbom	A. G. Fox	A. C. Keller	V. F. Miller	J. H. Scaff
E. T. Burton	R. W. Gillespie	L. W. Kelsay	O. Mohr	L. Schott
W. B. Callaway	G. Goodman	R. W. Ketchledge	B. M. Oliver (3)	A. M. Skellett
T. C. Campbell	R. H. Gumley	L. A. Kille	L. C. Peterson	T. Slonczewski
A. M. Curtis (3)	H. D. Hagstrum	F. W. Koller	K. W. Pfleger	G. O. Smith
C. C. Cutler (2)	L. N. Hampton	E. A. Krauth	G. S. Phipps	H. B. Smith
S. Darlington	R. B. Hearn	J. A. Krecek	J. R. Pierce	H. C. Theuerer (2)
K. H. Davis (2)	R. A. Heising (3)	L. Y. Lacy	R. K. Potter	M. C. Waltz
R. C. Davis	E. E. Helin	G. A. Locke	E. Praizner	H. S. Wertz

FRANK BALDWIN JEWETT, 1879-1949

A Tribute . . . .

The character of an institution reflects the characters of the men who build it. It is the character of Frank B. Jewett more than of any other person that is reflected in Bell Telephone Laboratories. His high idealism and his spirit of public service, which were displayed in all he did, have been the inspiration for all of us who have followed after him.

In Frank Jewett were combined a keen intellectual curiosity, the knowledge of a scholar, an ability to penetrate quickly to the core of a complex physical problem, and the common sense and good judgment to achieve practical ends. These outstanding abilities were joined in him with the virtues of kindness, unselfishness, human understanding, and devotion to duty. He it was who set our pattern of combining the efforts of men of different skills and disciplines to achieve by unselfish coöperation things that none of them could have done alone. With those he assembled about him, he created for the Bell System and for the Nation a long line of products embodying scientific genius and uncompromising technical integrity.

We who work in Bell Telephone Laboratories today are the inheritors of a proud tradition, a tradition that has been profoundly influenced by the life and character of Frank B. Jewett. He was a great and good man.

Oliver E. Buckley

Frank Baldwin Jewett

On the eleventh of November, Dr. Jewett went to the hospital in Summit for observation. During the evening he complained of a sudden pain, so severe that an immediate operation was indicated. After four days, recovery seemed assured; but he had a turn for the worse and died on November 18.

The career of Frank Baldwin Jewett, Chairman of the Laboratories' Board of Directors and Vice President of A T & T, was recounted at length in the RECORD* when, at sixty-five, Dr. Jewett laid down both of those responsibilities. The narrator was John Mills, his lifelong friend; and the opening sentences were: "A career, as that word is generally used, is a course of action conspicuous for nobility or success. It is a conduct in life which is meritorious and serviceable to a wide portion of society. . . . The formula for a career is a timely provocative idea in the mind of a man capable of inspiring confidence and gaining adherents."

Up to 1904 the narrative followed young Jewett from California to Chicago to Cambridge; then it and he crossed the river, "attracted by an offer from the American Telephone and Telegraph Company, whose headquarters were then in Boston.

"The company had a well-established engineering department concerned with the problems of transmission and switching, and of plant and traffic. Under the title 'equipment division,' covering development and design, it operated the telephone laboratories of the day. Although there was some cut-and-try in its laboratory work and a considerable emphasis upon inventions, the department approached the problems in a strictly scientific attitude and applied its conclusions in the best engineering manner. . . .

"The engineering department included men like . . . George A. Campbell . . . (who) recognized the need for men well trained in science to solve telephony's highly technical problems. It was he who discovered Jewett, and, in 1904, arranged his introduction to the telephone company. . . .

"His first job assignment was the investigation of an invention which had been offered to the company. It turned out that the inventor suffered from a misconception as to the physical possibilities of his device. The report attracted favorable attention on the part of the chief executives of the company and, what was even more exceptional, similar approval by its then patent department. Written commendation on a job well done came down the line. The

*October, 1944, pages 541 to 549.

JEWETT, FRANK BALDWIN, born, Pasadena, California, Sept. 5, 1879; son of Stanley P. and Phebe (Mead) Jewett; married Fannie C. Frisbie, Dec. 28, 1905; children: Harrison Leach and Frank Baldwin.

EDUCATION: A.B., Throop Polytechnic Institute (now California Institute of Technology), 1898; Ph.D., University of Chicago, 1902.

PROFESSIONAL SERVICE: Research assistant to Professor A. A. Michelson, University of Chicago, 1901-02; Instructor physics and electrical engineering, Massachusetts Institute of Technology, 1902-04; Transmission engineer, American Telephone and Telegraph Company, 1904-12; Assistant chief engineer, 1912-16, Chief engineer, 1916, Vice-president, 1922, Western Electric Company; Vice-president, A. T. & T. Co., in charge of development and research since 1925; President, Bell Telephone Laboratories, 1925-Oct. 1, 1940, Chairman board of directors until Sept. 30, 1944.

MILITARY SERVICE, WORLD WAR I: Major, Signal Corps, 1917; Lieutenant Colonel, Dec. 1, 1917; advisory member, Special Submarine Board of the Navy; member, State Department Special Committee on Cables; Awarded Distinguished Service Medal.

NATIONAL SERVICES: Vice-chairman, Engineering Foundation, 1919-1925; Chairman, Division of Engineering and Industrial Research, National Research Council, 1923-27, now member Committee on Scientific Aids to Learning; member, President Roosevelt's Science Advisory Board, 1933-35; member, National Defense Research Committee of Office of Scientific Research and Development; member, Coördination and Equipment Division, Signal Corps; consultant to Chief of Ordnance; President, National Academy of Sciences, 1939—; member, Committee on Post-War Research, 1944.

SOCIAL SERVICES: President and trustee, New York Museum of Science and Industry. Life member, Massachusetts Institute of Technology Corporation; President, M.I.T. Alumni Association, 1939-40; Trustee, Princeton University, Carnegie Institution of Washington, Woods Hole Oceanographic Institute, Tabor Academy.

PROFESSIONAL SOCIETY MEMBERSHIPS: Fellow, American Institute of Electrical Engineers (president, 1922-23); Institute of Radio Engineers; American Association for the Advancement of Science; American Physical Society; Acoustical Society of America; Academy of Arts and Sciences. Member, Institution of Electrical Engineers (British), New York Electrical Society, Society for the Promotion of Engineering Education, American Philosophical Society.

FRATERNITIES: Delta Upsilon, Sigma Xi, Tau Beta Pi.

HONORARY DEGREES: D.Sc., New York University, Dartmouth, 1925; Columbia, University of Wisconsin, 1927; Rutgers University, 1928; University of Chicago, 1929; Harvard, 1936; University of Pennsylvania, 1940; Dr. Eng., Case School of Applied Science, 1928; LL.D., Miami University, 1932, Rockford College, 1939.

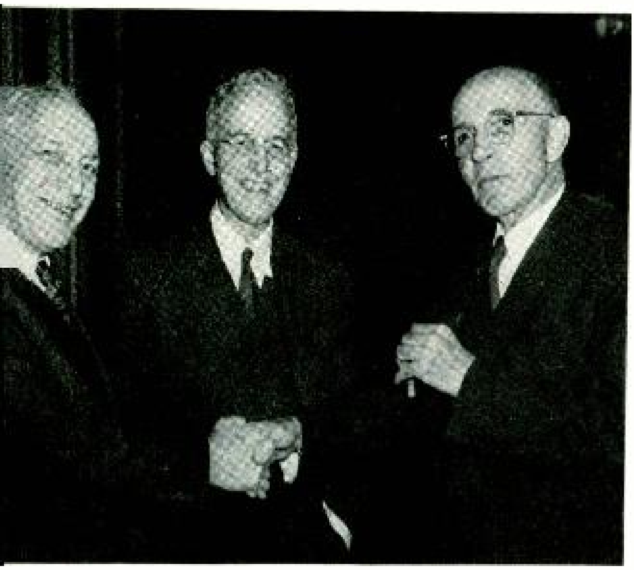
MEDALS: Edison medal, 1928; Faraday medal, 1935; Franklin medal, 1936; Washington award, 1938; John Fritz medal, 1939.

This formal record of a distinguished career is reproduced from BELL LABORATORIES RECORD *of October,* 1944. *Honors since that time are noted in this article.*

report was in the clear, logical and distinctly common-sense style which marks Jewett's analyses. It established him as one whose appraisal of physical factors and whose engineering judgment could be depended upon. As the years went on, more and more frequently the question would be: 'What does Jewett think of it?' . . .

"It was the quality of his engineering recommendations—his ability to see the woods despite the trees or even the trees through the woods—that marked Jewett's years in the telephone business. It was not the inventions he made, for he had a negligible number of patents. It was not experimental work, carried out with his own hands, nor apparatus or circuit designs. Almost from the very start he was in a position of expert consultant and of supervisor of other experts."

In 1907 the Engineering Department was moved to New York and put under the leadership of John J. Carty. Thus, there was started between Jewett and Carty a relationship which proved most fruitful. In the early winter of 1908, said Mr. Mills: "Jewett was sent on a mission to the telephonically unreachable Pacific Coast to help its engineers in their local transmission



At the Pioneers' Dinner on November 14, 1947, Dr. Jewett (right) enjoyed meeting many of his old friends: these two are S. B. Williams and H. A. Frederick, both now retired.

problems. He was followed later by Carty who was accompanied by Bancroft Gherardi. . . .

"The telephonic isolation of the Pacific Coast was emphasized to Carty and Gherardi by their own remoteness from their Eastern offices and by the demands and pleas of the local telephone company. The problems and possibilities of transcontinental service were earnestly considered in conferences to which Jewett was invited. After they returned, Carty wrote for H. B. Thayer, then vice president of the company, his famous memorandum. In this, on the assumption of more men and dollars for his department, he promised notable extensions in geographical range of telephony. He foresaw not only New York-Denver service and concomitant improvement of the service over shorter distances but, through the development of a satisfactory telephone repeater, San Francisco and New York. His vision went even further; it considered the impact of such a repeating mechanism upon the infant wireless art. And the impact, following in less than a decade, initiated the radio of today.

"Basic to such progress was the mission which was developing for Jewett—the idea underlying his career. This idea, in a word, was the coördinated application of the methods of scientific research to the problems of telephony. Later and more broadly, application to all electrical communication; and for all industries. At the moment it was specific to the problem of an adequate telephone repeater, the solution of which, it was believed, would be found in the new physics that dealt with streams of electrical particles, whether ions of gas or electrons. . . . "

Dr. Jewett divided the attack on repeater problems between the engineering departments of A T & T and Western Electric, and, in 1911, he was given general direction of it. A year later "he was transferred to the Western Electric Company. There, as assistant chief engineer, he was placed in charge of the newly formed research department and also of several related departments. Informally, through his association with Carty and Gherardi, he retained contact with the engineers at the A T & T, who were concerned with the field problems of transcontinental transmission. . . .

"With the Bell System the research idea was rapidly ascendant, and Jewett's inspiration and leadership increasingly wider. By 1925 he had become the A T & T vice president in charge of all development and research activities and president of the recently incorporated Bell Telephone Laboratories.

"Outside the Bell System, in the scientific and engineering world, the idea was quickly accepted—it was timely, and, in many instances, overdue. It was a natural —subconsciously an inevitable idea, the adoption of which awaited only exemplification and clear enunciation. Jewett had become its evangelist. Through his many contacts with university scientists, through his activities in the National Research Council and the National Academy of Sciences, through published papers and talks, through example and precept, he advocated a wider application of the research attitude of science. He was always its welcomed exponent. Not only was he loved for himself and for the things he had accomplished, but even more for the idea for which he stood and to which he gave support. . . ."

To World War II "Jewett contributed not only by his advocacy of research which had helped to prepare industry for the emergency, but also through plans and actions on the national stage and through suggestion and inspiration behind the scenes. Elected president of the National Academy of Sciences in the spring of 1939, he was in a strategic position to assist the formation of the National Defense Research Committee. As a member of that committee, he had responsibility for three lines of its activity: subsurface warfare—defense against enemy submarines and improved offense for those of the United States; communication—from secrecy devices to worldwide systems; and transportation. In this position Dr. Jewett was one of the managing directors of a unique scientific enterprise through which the scientists of the United States helped to win the war."

Activity continued for Dr. Jewett even in retirement. His presidency of the National Academy lasted until 1947, and he

At the Pioneers' Dinner a year later, Dr. and Mrs. Jewett looked over the roster of Life Members.

accepted appointment to advisory committees of the U. S. Departments of Agriculture and of Commerce. His interest in education continued with his Charter Trusteeship at Princeton and his Life Membership of the M.I.T. Corporation. He was a member of the visiting committees for three departments at Harvard and for the Museum of Comparative Zoology. As Sigma Xi lecturer during the year of 1947, he appeared before many of its Chapters across the country.

Had he lived, his plan was to devote an increasing amount of time and leadership to the launching of a foundation by cooperative action of scientists and industrialists, his firm belief being that such an institution should be free of political affiliations.

Three honors came to Dr. Jewett after his retirement: the Medal for Merit in 1946, the Hoover Medal in 1949, and the Industrial Research Institute's 1950 Medal. The last two would have been presented to him next year.

Dr. Jewett is survived by two sons, Harrison L. Jewett, of Short Hills, and Frank B. Jewett, Jr., of Minneapolis. His wife, who had been his close companion for over forty years, died late last year.

New Jersey State Chamber of Commerce at Murray Hill

Nearly three hundred members of the New Jersey State Chamber of Commerce visited Murray Hill on November 3. A program comprised of tours, lecture demonstrations and exhibits began at 2 p.m. in the Arnold Auditorium. It was followed by dinner in the new restaurant, at which O. E. Buckley talked.

The group met in the Arnold Auditorium, where R. K. Honaman, who sponsored their visit, welcomed them. He described the work of the Laboratories, and the facilities of the Murray Hill Laboratory as a background for the program. Because of the size of the group, it was divided into two sections; while one section remained in the auditorium for talks and demonstrations, others toured various laboratories. In the auditorium, A. F. Bennett spoke on *Telephone Instruments;* W. H. Doherty, *Television Transmission;* and W. E. Kock, *Microwave and Acoustic Lens Demonstration* and *Transistors.* During the tours, W. A. Munson and F. M. Wiener spoke in the free space room on hearing acuity, with Shirley Colby and Dorothy Thom assisting in the tests; D. H. Wenny and K. M. Olsen explained the place of metallurgy in the communications art; and A. C. Walker and G. T. Kohman demonstrated the growing of EDT and quartz crystals. In the Outside Plant laboratory, under the direction of R. J. Nossaman, M. W. Bowker, D. T. Sharpe and D. C. Smith demonstrated protection of outside cable in telephone service. J. Leutritz, Jr., discussed wood preservation; and T. J. Crowe, Murray Hill building features.

Working in pairs, the guides were: J. G. Segelken and A. P. Boysen; I. W. Whiteside and E. E. Wright; T. A. Durkin and A. J.

In the free space room, shown at the top of the page, Shirley Colby has her hearing acuity tested by listening to tones from the loudspeaker as F. M. Wiener explains. D. C. Smith of the Outside Plant Department, below, left, demonstrates a gas-pressure alarm to protect service on telephone cables, and W. H. Martin, at right, explains the voice mirror as visitors listen. Jane O'Keeffe is attendant at this exhibit.

New York-California Dialing

New York Herald Tribune, October 18, 1949

The first transcontinental dial telephone call in history was made at 4:28 p.m. on October 17 when an Oakland, Calif., operator, in two dialing operations, put through a call from Mark R. Sullivan, president of The Pacific Telephone and Telegraph Company, to Dr. Oliver E. Buckley, president of the Bell Laboratories in New York. The call took twelve seconds from the time the operator was given the New York number to the time Dr. Buckley picked up the phone.

Keith S. McHugh, president of the New York Telephone Company, who also talked with Mr. Sullivan during the call, said that service between New York and the Pacific Coast had been very good, "but with this new system, it will be even better."

The call marked the official opening of a regional dial-switching center at Oakland, which is the fifth center in the Bell System's basic plan for nation-wide dialing of long-distance calls by operators. Other centers are in New York, Cleveland, Chicago and Philadelphia, where the first of these centers was established in 1943.

Dr. Buckley received the call on a phone at an exhibit, "Looking Ahead With the Bell System," being shown at the New York Telephone's headquarters, 140 West Street.

The call was made via "Toll Crossbar Dial-Switching System." Known commonly as "operator toll-dialing," it involves intricate electronic switching systems at each dial-switching center. This equipment enables long-distance operators to dial, first, a regional code number and then the number desired by the customer without the assistance of any other operator.

With Dr. Buckley looking on, Keith S. McHugh, president of the New York Telephone Company, talks with a representative in Oakland, Calif., through the new dial-switching center opened in Oakland on October 17.

Prestigiacomo; G. E. Hadley and R. L. Shepherd; C. V. Lundberg and J. D. Tebo; and J. G. Walker and J. T. Lowe.

H. B. Ely and A. R. Brooks arranged for the visit with A. J. Akehurst as Plant coördinator. Corrine Hann and Hazel Reoch registered the Chamber of Commerce representatives. Exhibits in the lounge were under the direction of H. J. Kostkos and M. Sapan.

During the afternoon, representatives of various local Chambers of Commerce were photographed in groups while witnessing laboratory demonstrations. While the guests were at dinner in the evening, the photographs were developed, printed and identified. Before the visitors left at 8 p.m., they were given completed captioned photographs, showing local Chamber of Commerce members in typical Murray Hill laboratory scenes, for reproduction in their community newspapers the following morning. This work was directed by Hayes Jacobs and Helen McLoughlin.

"Hello, Capetown"

Direct radio-telephone service between New York and Capetown, Union of South Africa, was established November 14 by Long Lines' Overseas Division.

The new radio link, which will bring the Union of South Africa right to the fingertips of overseas operators, is 7,840 miles in length, and is the second longest span in Long Lines' overseas system. Longest is the 8,670-mile jump from San Francisco to Batavia, in the Dutch East Indies.

Direct service to Capetown is made possible by the construction of huge twin antennas at Lawrenceville, N. J. The antennas, which are aimed at the tip of South Africa, are rhombic in form and cover 6½ acres. Similar equipment was installed near Capetown by the Union of South Africa Telecommunications Department which operates the telephone system there.

H. H. Lowry Retires

Hiter H. Lowry

A single sentence can chronicle Hiter Lowry's official career; graduated by University of Kentucky and then entered Western Electric's student course in the famous "Class of 1909"; was head of equipment standardization in 1918; came to New York in 1919; became head of equipment development in 1920 and Assistant Director of Systems Development in 1944.

What does not appear on the formal record is the revolution in telephony, and the active part in it which he played during his forty years of service. In 1909, the Bell System served some three and a half million telephones by manual switchboards, and by voice-frequency lines. One by one came the innovations: wire line carrier, the panel dial system, the step-by-step system, radio telephony, the coaxial system, crossbar dial systems, toll line dialing. As each system moved from the breadboard into the development model, Hiter Lowry and his engineering associates followed it through the field trial, prepared the drawings and specifications for manufacture, kept an eye on the first commercial jobs. To some of those projects Mr. Lowry contributed directly—he designed the 1-D manual board with its separate upper and lower sections; he redesigned central office cable racks, so that they could be fabricated economically on the job; was project engineer for the initial Long Lines installation at "Walker Lispenard." When Bell System companies began using step-by-step systems, under his direction the equipment was adapted to their needs.

Early in Mr. Lowry's career, he served on a committee which brought about uniformity of practice among the companies as to central office circuits and equipment. From then on he took every opportunity to unify technical practices. One major achievement was the Bell System Drawing—made in the Laboratories, and distributed throughout the System. With these and the accompanying specifications—also made here—everyone concerned is automatically informed of the status of all equipment and when changes are made, the reasons therefor. New designs and improvements in existing designs are promptly brought to the attention of the operating companies. Acceptance of standardized designs has permitted the setting up of uniform methods of manufacture without which, it may safely be said, a production rate of a million or more lines of telephone equipment a year for the Bell System would not have been possible.

Since an equipment engineer's job is to see the circuit man's ideas embodied into manufactured products, he must appreciate the technical objective and understand the problems of the people who make, install and operate the equipment. All of this practical know-how Hiter Lowry had, and in getting it he built up an exceptional acquaintance in Western Electric and the Associated Companies. When opinions differed, he could point the way toward harmony, or carry conviction through his wide knowledge of what had been done under like circumstances.

In World War II Mr. Lowry found use for the versatility, loyalty and determination which he had infused into his group. All the military projects undertaken by Systems Development —notably airborne radar and communications systems—were channeled through Equipment Development, where they were prepared for manufacture. Often a new radar was carried through the pre-production stage so that the Armed Forces might have at least a few of the newest model. Long hours were a commonplace, but the men and women of the equipment engineering, drafting and shop organizations caught the spirit from Hiter Lowry and worked as a team to meet impossible schedules. For example, the airborne radar APQ/13 was designed and put into preproduction so that within 99 days enough were available to equip the first B-29 squadron to go into action in the Pacific.

So much for the achievements—but what about the man? A biography of Record length can only summarize in such phrases as "affection for and loyalty to the Bell System"—"quick to recognize good engineering"—"seemed to understand that we needed encouragement"—"injected humanity into mechanical jobs"—"had the breadth of understanding to direct the major effort, see to it that the job was properly manned, and let the men whom he selected do the detailed engineering, confident that their decisions would be respected and knowing that help was available from him if needed."

Dr. Schelkunoff Receives Medal

During the annual Medal Day exercises of the Franklin Institute, held at Philadelphia on October 19, the Stuart Ballantine Medal was presented to Sergei A. Schelkunoff. Dr. A. F. Murray, in presenting the medal, said:

"The ever-broadening field of radio engineering owes much of its progress into the newer, little-explored high frequency and microwave regions to our medalist, a mathematical theorist.

"During the past twenty years that he has been at the Bell Telephone Laboratories, his work has pointed the way to many important communication developments. One of these, of interest to those who observe network television programs, concerns wave propagation in the coaxial cable.

"Dr. Schelkunoff did early theoretical work on the propagation work of microwaves in wave guides. These guides later were used extensively in radar installations during World War II. He made the interesting discovery of the so-called TE_{01} mode of propagation, in which the attenuation of the guide decreases as the transmitted frequency increases. This discovery may have a direct bearing on long-distance guided communication in the future.

"Here are a few of the many theoretical problems on which our medalist has worked: antennas, both broadband and highly directive as well as metal lens antennas; radiating horns; the study of wave propagation in the upper atmosphere.

"Dr. Schelkunoff, during World War II, acted as consultant on wave propagation at the U. S. Naval Station at San Diego. To his credit is an unusually long and impressive list of 31 publications. He is the author of three books.

S. A. Schelkunoff, extreme right, receives the Stuart Ballantine Medal of the Franklin Institute from Richard T. Nalle, president of the Institute, while other 1949 *Medalists watch.*

"I present Sergei A. Schelkunoff, of Bell Telephone Laboratories, as a candidate for the Stuart Ballantine Medal, 'in consideration of his outstanding contributions to the extension of electromagnetic wave theory, particularly his concepts so helpful to the radio engineer.'"

←*Life* Visits Labs

Life magazine recently visited the Laboratories to make photographs for a picture-story on the new telephone set. Among the pictures taken was the one shown at left tracing high spots in the evolution of the telephone instrument by displaying many of the valuable telephones from the Bell System Historical Museum. Here *Life* photographer Eric Schaal directs Curator James T. Lowe in arranging the instruments as R. K. Honaman, Director of Publication, looks over the proposed layout.

A. S. Windeler, Laboratories engineer stationed at Point Breeze, confers with H. R. Longfellow, an engineer of Western Electric. Machine in foreground makes coaxial tubing: first it snaps insulating discs onto the central wire, then forms a copper tape around the discs, and finally wraps on a double layer of steel tape.

Changes in Organization

On November 1, R. E. Poole, Director of Military Electronics Development, became Director of Development at Sandia; W. C. Tinus, Radio Development Engineer, Acting Director of Military Electronics Development; W. H. C. Higgins, Radio Development Engineer, replacing Mr. Tinus; F. Cowan, New York General Service Manager, Technical Staff Engineer at Sandia; H. Schmitt, Murray Hill General Service Manager, New York General Service Manager, replacing Mr. Cowan; H. J. Wallis, Murray Hill Shops Manager, Murray Hill General Service Manager, replacing Mr. Schmitt; A. F. Leyden, Murray Hill Plant Operation Manager, Murray Hill Shops Manager, replacing Mr. Wallis; T. J. Crowe, Superintendent of Murray Hill Building and Grounds Operation and Maintenance, Murray Hill Plant Operation Manager, replacing Mr. Leyden; G. W. Lees, Jr., Murray Hill Office Service, Superintendent of Murray Hill Building and Grounds Operation and Maintenance, replacing Mr. Crowe; and W. C. Pitman, Jr., assumed responsibility for Murray Hill Office Service, replacing Mr. Lees.

Transmission and Switching

E. W. Waters has been appointed Executive Assistant to J. W. McRae, Director of Transmission Development, and J. D. R. Keller has been appointed Executive Assistant to M. B. McDavitt, Director of Switching Development.

Switching Development

F. S. Entz and J. Meszar have been appointed Switching Development Engineers, reporting to A. J. Busch, Director of Switching Systems Development.

Mr. Entz will succeed F. J. Singer as head of a group concerned with toll and manual circuit development. Mr. Meszar will take charge of a group which is concerned with A.M.A., apparatus performance, computers and training.

Station Apparatus Development

C. W. Halligan, Dial Program Supervisor, Western Electric Company, has been transferred to the Laboratories as Station Systems Development Engineer, reporting to A. F. Bennett, Director of Station Apparatus Development. In this capacity, Mr. Halligan is in charge of a new Sub-Department 4130, Station Systems Development.

Coincident with this change, activities in Switching Engineering and Switching Development with respect to key telephone systems, key equipments, and other interconnecting systems located on subscribers' premises, except PBX's and certain other of the larger related switching systems, were transferred to Station Systems Development. Switching Engineering will continue its responsibility for coördination of station with PBX and central office switching.

We're Sorry

From the story "Changes in Organization," last month's Record, three names were omitted: J. W. Farrell, Secretary and General Attorney, reporting to D. A. Quarles; and W. L. Casper and C. S. Demarest, Apparatus Consultants, reporting to W. H. Martin.

Sickness Death Benefits

The Bureau of Internal Revenue of the United States Government has recently ruled that payments of Sickness Death Benefits under this Company's Plan for Employees' Pensions, Disability Benefits and Death Benefits are subject to Federal Income Tax.

Thus, dependent relatives of deceased active or retired employees who receive such sickness death benefit payments will, under this ruling, be required to consider them as taxable income in the year received and determine their liability for Federal Income Tax after adding the amounts of Sickness Death Benefit payments received in each year to any other taxable income received in the same year.

The effect of this ruling should be carefully considered by all active or retired employees who have already filed, or who may hereafter wish to file with the Benefit Committee, a written direction for the payment of Death Benefits as provided for in Section 7, Paragraph 5 of the Plan.

Western Electric Limits Its Commercial Activities

The Western Electric Company will withdraw from commercial activities in microphones, loudspeakers, and disc reproducing equipment, according to an announcement made on October 10. Uninterrupted service and availability of maintenance parts have been assured to present users by an agreement between Western Electric and the Altec Lansing Corporation.

The continuing specialized needs of the Bell Telephone System, combined with the growing requirements of the Armed Forces for the development of complex electronic equipment essential to the Nation's defense, were cited as among the factors causing Western's decision to withdraw from the field.

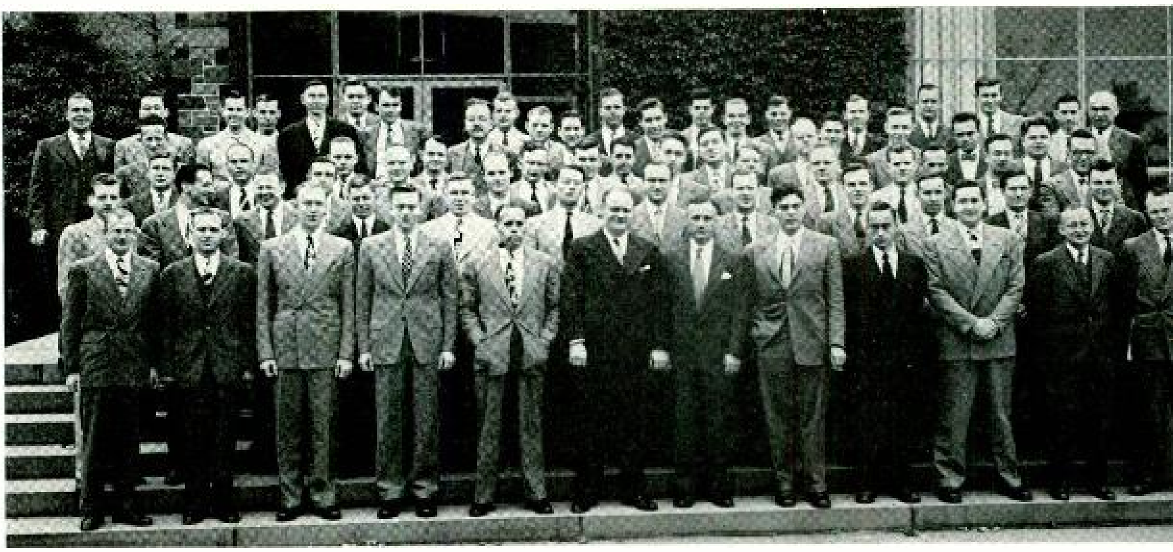
Altec was founded in 1937 to carry on the theater servicing activities of Electrical Research Products Incorporated—at that time a Western Electric subsidiary—and was made up of former Western Electric personnel.

The Graybar Electric Company will act as distributor for Altec in sales and servicing of equipment. Among the products affected will be the 109 reproducer series, the 633 and 639 microphones, and the 728, 755 and 757-type loudspeakers used extensively in broadcasting and high-quality sound system applications.

Electron Beams

Two recent additions to the Bell Laboratories series of books have been published by D. Van Nostrand. *Radar Systems and Components** by members of the Technical Staff will be reviewed in the January issue. The second is *Theory and Design of Electron Beams*† by J. R. Pierce. In the first part of this book, Dr. Pierce reviews the fundamental theory of motion of electrons in electric and magnetic fields, continuing with the development of the

*Price, $7.50. †Price, $3.50.



More than sixty members of the Communications Development Training Program were given a day at Murray Hill in October. In the course of lectures and laboratory visits, this photograph was taken on the steps of the well-known Arnold Auditorium.

Eight members of Systems Drafting Department were honored by a dinner at the Frontenac on the occasion of their thirtieth and thirty-fifth service anniversaries. H. H. Lowry is shown congratulating C. G. Von Zastrow on his thirty-fifth anniversary. Next in order, with thirty years, are: L. W. Drenkard, A. O. Easton and E. S. Wolek, seated. Standing in the rear are: J. M. J. Harriot, G. C. Berndt, C. Gittenberger and A. L. Hogan. Standing, right, is M. H. Cook.

theory and methods of electron focusing in devices other than electron microscopes and image tubes. Emphasis is given to the subjects of space charge and the effect of thermal velocities on focusing.

The use of problems at the end of each chapter has a twofold purpose. It makes it possible to use the book as a textbook and it also provides the reader with an opportunity to enhance his understanding of the text, because the problems emphasize the important material discussed in the text. Although references to other books and publications are given, the author has presented the material completely enough so that it can be understood without reference to other sources.

The Murray Hill Chorus

The Murray Hill Chorus of the Bell Laboratories Club will present its annual program of Christmas music at Murray Hill during the noon hour of December 22. A preview of some of this Christmas music will be heard at Lyons Veterans' Hospital on December 11. Favorite with the veterans, the Murray Hill Chorus has been described in their publication, *The Lyons Tale*, as "one of the finest industrial singing organizations in the East."

The chorus' first appearance under the leadership of its new director, Leo Collins, was marked by a special noon hour program at Murray Hill on November 23.

Noon Hour at Murray Hill

The increasing population at Murray Hill necessitated tickets and two performances for the second musical show by the Murray Hill Popular Orchestra given in October. Even so, more than 150 out of 950 applicants were unable to gain admittance. On the program were numbers by the fourteen-piece orchestra, the Harmonettes singing trio, tap dancing, and soloists—both vocal and instrumental. All were under the direction of C. H. Wallschleger.

This year the committee members are: Phyllis Taylor, representing the Personnel Depart-

December Service Anniversaries of Members of the Laboratories

40 *years*

C. S. Demarest

35 *years*

W. A. Knoop

30 *years*

E. H. Bartelt
B. A. Clarke
Helen Cruger
E. N. Danes
Carl Deelwater
W. S. Gorton
R. F. Massonneau
D. R. McCormack
A. J. Parsons
Joseph Popino
J. C. Roe
A. D. Soper
L. E. Stolzenberg
Michael Tompa
C. C. Towne
C. W. Van Duyne
M. J. Wean
C. A. Wingardner

25 *years*

Emil Alisch
Clement Bosch
G. A. Brodley
E. W. Conger
C. J. Gerth
Charlotte Hamilton
H. E. Johnson
Joseph McTaggart
H. M. Spicer

20 *years*

C. A. Bengtsen
D. W. Bodle
O. L. Boothby
C. A. Brigham
Patrick Currie
J. V. Domaleski
D. T. Eighmey
C. W. F. Hahner
J. F. Hanley
C. W. Jones
R. P. Muhlsteff
A. J. Rack
H. A. Sauer
Carmelo Vassallo

15 *years*

T. J. Corcoran
Dorothy Johnston
J. H. McConville

10 *years*

Emil Ellingsen
G. A. Gunzel
H. C. Hart
John Huntley, Jr.
M. E. Poulsen
Grace Torkelson
Bianca Zenon

ment; B. McMillan, Murray Hill Chorus; R. A. Chegwidden, Popular Orchestra; R. H. Nichols, Jr., Symphony Orchestra; J. J. Harley, Movie and Bell Laboratories Club; and A. J. Akehurst as Coördinator.

International Relations Group Fall Program

The International Relations Group of the Murray Hill Bell Laboratories Club opened its fall program with a talk by Colonel R. H. Ranger on *Wartime Scientific Intelligence and Resettlement of Scientists.* A few luncheon forums will be provided throughout this season for those interested in discussing international problems following prepared introductions by selected group members.

New York Section—A.I.E.E.

Laboratories' men serving on various committees of the New York Section of the A.I.E.E. are: *Executive Committee*—J. D. Tebo, vice chairman, New York Section; R. B. Shanck, chairman, Communication Division; C. Clos, chairman, Membership Committee; and S. P. Shackleton, chairman, Student Guidance Committee. A. R. Thompson, L. W. Morrison and R. B. Shanck are members of a Special Committee for Sponsored Sessions at A.A.A.S. conventions. *Communication Division*—R. B. Shanck, chairman; and W. T. Rea, chairman, H. J. Fisher, J. W. Geils, W. O. Arnold and A. E. Joel, Meetings and Papers Committee; M. A. Townsend, K. E. Gould and J. M. Dunham, Related Activities Committee; and A. L. Whitman, Publicity Committee. *Basic Science Division*—B. F. Lewis, secretary; M. E. Mohr, past chairman; J. D. Tebo, adviser; R. H. Van Horn, chairman; P. F. Weaver, Jr., Program Committee; and E. B. Payne, Symposium Committee.

Miss Haege Describes Guatemala Trip

A vacation trip in Guatemala which she took early last summer was described by Jewel Haege of Systems Drafting before the Pioneer Women's group on October 4. Miss Haege was the house guest of a Guatemala girl at the time of her wedding, and later visited many of the scenic and historic places. Her talk was illustrated by color slides which she took herself, and by a sound picture furnished by Pan-American Airways. Guests of the group were the Guatemalan consular secretary in New York, Señor Pedro Soberanis, and Señora Soberanis.

News Notes

DR. ISAIAH BOWMAN of Johns Hopkins University and a Director of the A T & T was escorted by DR. BUCKLEY on a visit to the Murray Hill Laboratories on October 18.

AT THE FALL GENERAL MEETING of the A.I.E.E. in Cincinnati, October 17-21, papers were presented by W. R. LUNDRY, *Attenuation and Delay Equalizers for Coaxial Lines;* J. P. KINZER, *Stability of Tandem Regulators in the L1 Carrier System;* K. E. GOULD, *Equalization of Coaxial Lines;* and L. W. MORRISON, *Television Terminals for Coaxial Systems.* L. G. ABRAHAM presided at the coaxial session. Among those who attended were R. K. HONAMAN, J. D. TEBO and R. I. WILKINSON, all of whom took part in meetings of various Institute committees.

A. B. CLARK visited Denver and the proposed microwave radio route between Denver and Omaha.

H. H. ABBOTT and R. W. HARPER attended the convention of the United States Independent Telephone Companies' Association in Chicago from October 10-14.

Nora Killeen serves refreshments at a reception on the occasion of H. H. Lowry's retirement. It was held in the Club Lounge at West Street; more than 1,500 attended.

D. A. QUARLES has written an article on *Electronics in Air Power*, which was published in the September, 1949, *Aero Digest*. Mr. Quarles has been recently appointed Chairman of the Committee on Electronics of the Research and Development Board.

J. W. McRAE spoke on *Apparatus Developments* at the meeting of the Deal-Holmdel Colloquium on November 4.

RETIREMENTS

Among those retiring from the Laboratories are R. P. MacLaren with forty-four years of service; R. L. Young and C. B. Robertson, 39 years; B. E. Behrens, 38 years; A. H. Heitmann, H. H. Kreft and L. C. Wescoat, 33 years; William Spangenberg, 31 years; H. E. Coffin and E. W. Newman, 30 years; L. K. Swart, 29 years; and A. J. Allan, 23 years.

Rowland L. Young

Between his graduation from the University of Pennsylvania (B.S. in E.E., 1907) and his joining the Bell System in 1911, Rowland Young had two years at Westinghouse and two in industrial journalism. In A T & T he has been identified with power developments, standards and trial installation of machines, engines, batteries, filter condensers and circuits for dial switching systems, and the later unit-type power plants for toll and manual offices. Floating voltage regulating systems for storage batteries, patented by him in 1923, have since been in general use. From 1929 he has specialized in power maintenance, Bell System Practices and the National Electrical Code. Coming to the Laboratories as Power Maintenance Engineer in 1934, these specialties have been continued in the power development group. Mr. Young has been active in the American Standards Association since 1931 as alternate on the Standards Council representing the "Telephone Group." He has also held membership on several committees developing standards for storage batteries, electrical measuring instruments and symbols for drawings. He is a member of the American Society of Safety Engineers and of the National Safety Council. One of his latest projects was the preparation of design specifications for Bell System equipment for safety of personnel.

From his many personal interests Mr. Young has accumulated a number of projects for his leisure years. A genealogical research and some very practical jobs of electrical wiring will, he thinks, more than occupy him during his first year of retirement.

R. L. Young

C. B. Robertson

Charles B. Robertson

Graduating from the University of Tennessee in 1910, Charles B. Robertson immediately joined the Bell System at Hawthorne. After completing the student course and about two years in the Apparatus Development Engineering Department, he was transferred to the General Cable Engineering Department, which later became the Outside Plant Development Department of the Laboratories. He was located at Hawthorne from 1910 to 1928, 1931 to 1938, and at Kearny from 1928 to 1931, and 1938 to the present time.

Mr. Robertson has been associated almost continuously with the work on lead-covered cable development and design for Bell System use. During the years up to 1931, he was actively engaged in the design of quadded land and submarine cables for long haul toll routes, and, in recent years, has been associated with the design of fine gauge cables for use in the exchange plant and stub cables for loading coil cases.

For the present, Mr. Robertson expects to maintain residence in Westfield and to continue with his hobbies of travelling, photography and fishing.

L. K. Swart

L. C. Wescoat

Leland K. Swart

L. K. Swart interrupted his education at Union College for a commission in the A.E.F., graduating in 1920 with the degree of B.S. in Electrical Engineering. While in Europe, he attended the Sorbonne University of Paris for one year. Immediately upon graduation he became associated with the Development and Research Department of the American Telephone and Telegraph Company. His early work was concerned with the development of telephone repeaters and economic aspects of the layout of cable and open-wire circuits. Later, his interest centered on inductive interference problems and the development and uses of cold-cathode gas-filled tubes. From 1943 on he worked on voltage recording devices and on protection of exchange cables and of carrier systems against lightning. His contributions are recorded in 48 patents.

Lewis C. Wescoat

Most of Mr. Wescoat's thirty-three years in the Bell System have been devoted to the development of power apparatus and systems for central offices and for sound picture equipment. Following his graduation by Pennsylvania State College in 1910 with a B.S. in E.E. degree, he was with the General Electric Company for six years. His first work at West Street was on power equipment for the semi-mechanical system then being installed in Newark. During the war period he was also associated with the design of power equipment for Signal Corps purposes. Later he was associated with the development of power plants for the first panel systems.

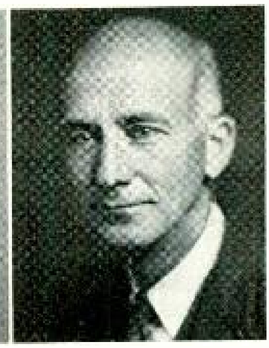
From 1929 to 1936 Mr. Wescoat was with Electrical Research Products on power engineering work and then on the development of equipment for sound reproducing systems for theaters. Since his return to the Laboratories in 1936 he has been in the test and analysis group of the Power Development Department where his work has been mainly on motors and control equipment for telephone systems.

In his home community of Packanack Lake, Mr. Wescoat has taken an active part in civic affairs. He has been a director of the civic association, a trustee of the church, an officer of the yacht club, and a district committeeman of the Boy Scouts. Before and during the war he was an instructor and examiner in the first-aid courses conducted in the Laboratories.

R. P. MacLaren

B. E. Behrens

A. H. Heitmann



H. H. Kreft

Bernard E. Behrens

Immediately after graduation from Colorado State College in 1911, Mr. Behrens joined Western Electric at Hawthorne. A year later he transferred to telephone instrument development at West Street. During World War I he worked on military telephones, and afterward made studies of telephone instruments of other manufacture. From 1924 to 1942 he worked on various microphones for special services on the telephone voice silencer, and on a sound-power telephone system. In the latter year he transferred to the engineering group concerned with semi-conductors, where he worked on thermistors as voltage standards for regulated rectifiers and also on thermistors for time delay devices. Two years ago he joined Apparatus Specifications where he has written up crystal units, thermistors and outside plant apparatus.

Mr. and Mrs. Behrens now live in New Providence, but on his retirement they expect to move to Blairstown.

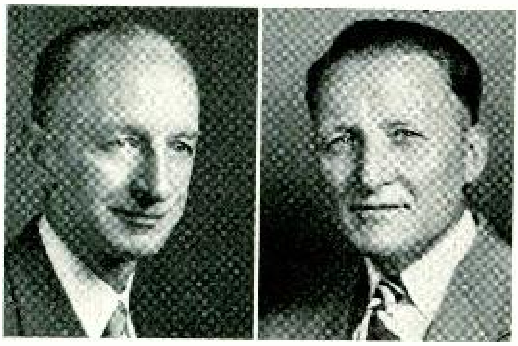
Raymond P. MacLaren

Mr. MacLaren's Bell System career began when he graduated from high school in Toledo and went to work as a plant man for the Central Union Telephone Company. It was good experience; he installed telephones and switchboards, cleared trouble, helped cablemen. After four years he went to Northern Electric, then to the independent company at Toledo. In 1909 he became an equipment engineer at Hawthorne, and in 1917, when the panel system was being started, he was sent to New York to learn the new art. Here he remained, to work first on equipment development for the initial New York City installations, and later, to prepare advance apparatus information so Hawthorne could get an early start in manufacture. This brought him into close contact with Apparatus Development, and for years he was a liaison between that department and his own.

During World War II Mr. MacLaren was transferred to Apparatus Card Catalog; later, he became specification engineer, and he checked engineering information to be sure that drawings and text are consistent and give a complete picture of what Manufacturing is to do.

Albert H. Heitmann

After Mr. Heitmann received his M.E. in E.E. degree from Ohio State in 1909, he was, for a year, in the Westinghouse research lab-



H. E. Coffin   Wm. Spangenberg

oratory, and for two years, on the faculty of his alma mater. In 1912 he entered A T & T to work until 1916 on inductive coördination and transposition problems, including those of the Transcontinental Line. After four years in charge of research work for Kellogg in Chicago, he returned to A T & T, and in 1934 came to the Laboratories. Here he has been concerned with the theory, development and application of loading coils. In this work he has participated in fundamental investigations on phantom circuit problems, and has played an important part in the reduction of crosstalk contributed by loading apparatus and repeating coils that are used in phantom group circuits.

The Heitmanns are giving up their home in East Rockaway, L. I., and are moving to Middlebury, Conn., to be near their daughter. Her husband, also from Ohio State (Ph.D. 1943), is a research chemist for U. S. Rubber.

Howard H. Kreft

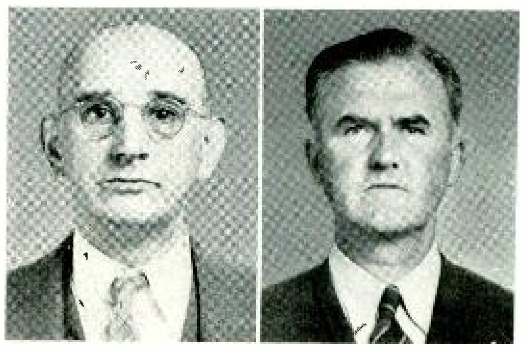
When Howard Kreft entered the Laboratories in 1916, he had had five years' experience on adding machines and typewriters. This was useful in his drafting work on telegraph printers, which continued until 1924. Then he transferred to central office equipment drafting. Between 1929 and 1934, he had charge of a drafting group for Outside Plant Development. From 1934 until the war he did drafting and checking for Apparatus Development, and then was transferred to Commercial Products. Returning to Apparatus Drafting, he has been primarily concerned with work on the U-type and wire spring relays.

Mr. Kreft's wife will be remembered by some of the old-timers as Carolyn Roeder, secretary to H. H. Lowry some thirty years ago. The Krefts plan to continue to live in Allenhurst, N. J., in their home by the sea, where Mr. Kreft will interest himself in horticulture and farming on a six-acre plot.

Harold E. Coffin

Harold E. Coffin entered the Laboratories just after World War I, and since he had had four years at Pratt in drafting and machine design, he became a draftsman. Until 1928 he worked mostly on commercial products; in that year he transferred to Electrical Research Products to organize and direct their drafting work. In 1934 he became a service engineer, and in 1936 was production man in ERPI's Bronx plant.

Returning to the Laboratories in 1937, Mr. Coffin became an apparatus draftsman, and,



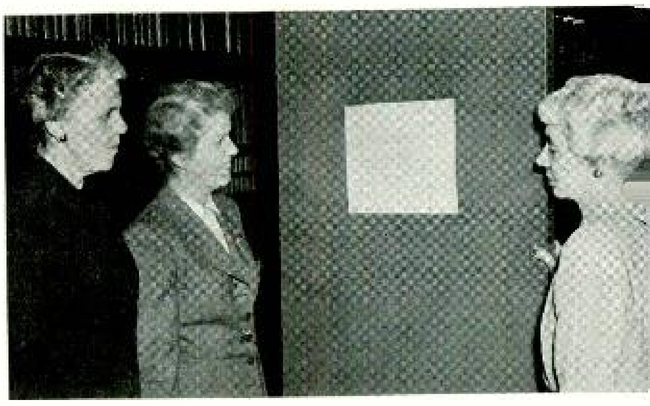
Ernest W. Newman, left, a sheet metal worker in the Development Shop, retired on November 9, and Arthur J. Allan, a chauffeur at the Deal Radio Laboratory, on October 31.

later, one of the Card Catalogue group. World War II brought him back to drafting; he worked at Graybar-Varick on Navy equipment. Following the war he continued in drafting at West Street.

Mr. Coffin expects to continue to live at Bellaire, L. I.

William Spangenberg

In 1918 Mr. Spangenberg was assigned to the apparatus drafting group where he was concerned with the design of apparatus for telephone systems, radio receivers and transmitters. During that time he was also associated with the design of submarine detection apparatus and with aircraft receivers. Later, when the Commercial Products Development Department moved to the Graybar-Varick Building, he was assigned to the drafting group at that location. There he was concerned with design of aircraft, and police and radio transmitters, receivers and speech input systems, including the stereophonic reproducing system. During the war he worked on mobile radio, on radar for naval fire control, and on battle announcing systems. Returning to West Street, he has worked on a variety of apparatus projects, specializing on wiring diagrams and on cable layouts.



Mary F. Price, Bell of Canada librarian, center, came down in mid-October to look into some practices of the American companies. Accompanied by Elizabeth Krauter of A T & T Personnel Relations, left, one of her visits was to the West Street and Murray Hill library locations. At the latter, this photograph was taken when Librarian Leah E. Smith, right, was referring to a temporary chart of book distribution in the newly established stack room.

News Notes

C. Breen and E. G. Hilyard discussed matters involving maintenance with engineers of Illinois Bell and Bell of Pa.

William Keister discussed the technical operation of the dial telephone at a meeting on October 10 of the Philadelphia Section of the American Institute of Electrical Engineers.

J. H. Waddell was in charge of the Third Symposium on High-Speed Photography which was given before the Society of Motion Picture Engineers in Hollywood, California, on October 10-14. He presented two papers in absentia, one for Pierre Mertz, *Perception of Television Random Noise,* and the other for J. T. Muller, *Measuring Shock With High-Speed Motion Pictures.*

A. Herckmans and F. A. Hoyt visited Pittsburgh in connection with the coin collector.

H. H. Staebner reviewed the manufacture of cotton sleeving at the Delco Appliances Company, Rochester.

D. W. Bodle conferred on cable protection at Pittsfield, Massachusetts, with New England Telephone Company engineers.

L. S. Inskip went to Syracuse to attend a meeting of the RMA Safety Committee.

J. W. Kennard, F. W. Horn, W. C. Kleinfelder, A. L. Richey and C. F. Wiebusch, with A. Paone of A T & T, were in New Britain, Connecticut, observing a trial installation of "stalpeth" sheath cable.

W. S. Bishop observed trials of a new station wire and dispenser package in the Richmond area of The Chesapeake and Potomac Telephone Company.

G. Q. Lumsden, with A. G. Wambach of A T & T, reviewed commercial greensalt treatments of jack pine and red pine poles at Montreal, Trenton and Toronto, Canada.

D. E. Trucksess conferred with the Power Equipment Company at Detroit upon new rectifier designs.

H. J. Berka visited the TD-2 stations in the vicinity of Philadelphia in connection with lighting problems.

Round table luncheon conference of the Model Railroad Club at West Street, left to right, sitting: R. G. Ramsdell, H. H. Hagens, R. V. Rice, P. Mallery, C. S. Knowlton and S. D. White; standing: O. H. Coolidge, J. N. Walter, T. H. Neely, C. W. Haas, R. M. Pease and A. Hartmann.

William A. Kreuger, one of the Laboratories' members of the Metropolitan Bell Symphony Orchestra, playing the bassoon at a rehearsal for the December 9 concert at Carnegie Hall.

R. H. COLLEY conferred with the U. S. Forest Products Laboratory at Madison, Wisconsin, on coöperative culture tests for evaluating wood preservatives, and on a correlated development program for wood preservation.

AT THE Western Electric Company in Chicago, H. A. MILOCHE discussed metal binding materials; J. IRISH and F. T. MEYER, circuit standards; D. H. WETHERELL, panel decoders; C. F. SPAHN, C. SCHNEIDER, R. MUELLER, and I. S. RAFUSE, relays; P. S. DARNELL, F. J. GIVEN, D. A. MCLEAN, H. G. WEHE and J. R. WEEKS, metallized paper condensers; J. J. MARTIN and R. BURNS, insulating materials; W. R. NEISSER, quality control for the network in the new combined set; J. H. SCAFF, magnetic materials; A. HERCKMANS, R. E. PRESCOTT and B. O. TEMPLETON, coin collectors; and W. L. TUFFNELL, H. F. HOPKINS, G. A. WAHL and L. VIETH, the new telephone set.

H. G. ROMIG, president of the Metropolitan Section of the American Society for Quality Control, presided over one panel of the all-day conference at Rutgers University on *Quality Control Answers the Needs of Industry*. E. B. FERRELL spoke on *Double Sampling Inspection in Pilot Production* during another panel.

W. L. BLACK is coauthor of an article with H. H. Scott on *Audio-Frequency Measurements* in the October, 1949, *Proceedings of the Institute of Radio Engineers*.

H. H. SPENCER, J. R. STONE and V. T. CALLAHAN observed the operation of the reserve engine equipment at the Martinsville, New Jersey, Wyndmoor and Buckingham, Pennsylvania, stations of the TD-2 system.

V. T. CALLAHAN discussed automatic gasoline engine alternator sets with the Duplex Truck Company engineers at Lansing, Michigan. He also conferred with engineers of the New England Telephone Company at Springfield, Massachusetts, upon the new 150-kw diesel engine-driven alternator sets being installed at that office.

N. V. MANSUETTO was in Milwaukee and Madison, Wisconsin, during the modification of the N1 carrier trial installation equipment.

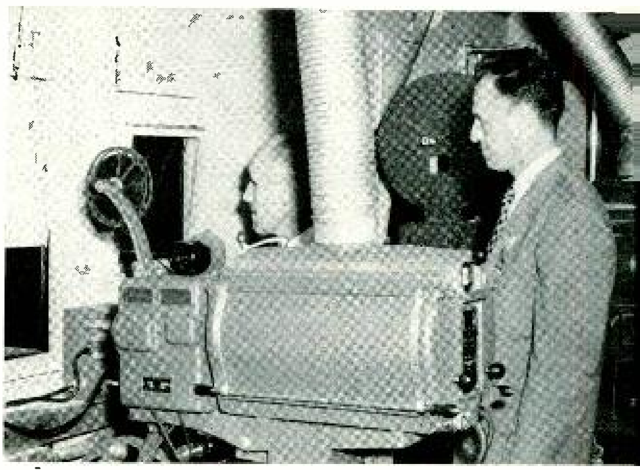
R. A. MILLER, H. W. AUGUSTADT and C. A. NICKERSON visited The Audichron Company at Atlanta on equipment procurement problems in connection with equipment for transcribed services systems.

R. A. MILLER, L. B. COOKE and J. Z. MENARD attended a meeting on intermodulation distortion measurements sponsored by RMA Committee on Audio Facilities.

H. W. AUGUSTADT presented a paper at the Audio Engineering Society Convention on *Longitudinal Noise in Audio Circuits*.

J. F. SMYTH has returned to West Street following a nine-month stretch of jury duty at the trial of the eleven Communist leaders.

Focus, frame register, and sound volume and quality are among the items that Nicolas Marinaro (left) and R. D. Wylie of Murray Hill Plant are checking as they run a reel through the new 16-mm arc machine. The 35-mm projector is shown in back of Mr. Wylie.



At Winston-Salem, L. C. Brown, O. P. Clark, A. M. Garblik, J. R. Harris, H. A. White, E. A. Bescherer and R. F. Lane discussed airborne radio equipment; and F. E. Nimmcke and B. H. Nordstrom, the production of new special equipment.

L. B. Cook and R. A. Miller attended a meeting of the TR10, Audio Facilities Committee, of the R.M.A.

W. S. Gorton, R. O. Grisdale, A. Herckmans, C. Kittel, T. N. Pope and Leah Smith, as members of a committee, attended the National Business Show for the inspection of microfilm readers.

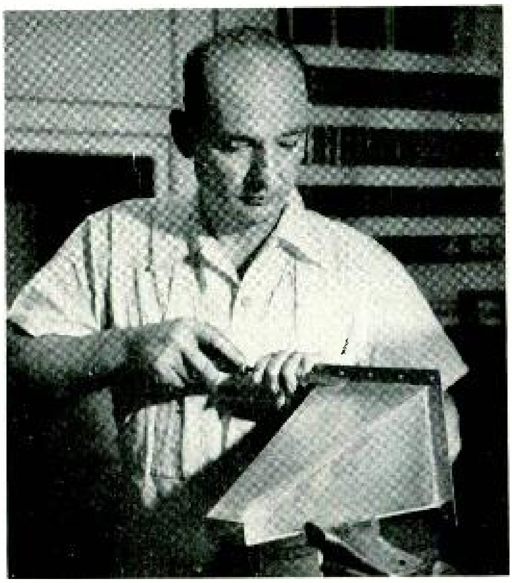
The Laboratories were represented in interference proceedings at the Patent Office by G. C. Lord and R. J. Fluskey before the Primary Examiner.

J. H. Felker has written on *Calculator and Chart for Feedback Problems* in the October, 1949, *Waves and Electrons Section* of the *Proceedings of the I.R.E.*

F. E. Nimmcke and B. O. Browne participated in a conference at the Cornell Aeronautical Laboratory, Buffalo, concerning antenna reflectors.

Problems relating to crossbar systems were discussed at various locations by A. O. Adam, L. T. Anderson, C. F. Benner, E. L. Erwin, L. G. Fitzsimmons, A. E. Gerbore, W. B. Graupner, R. E. Hersey, L. P. Johnson, C. D. Koechlin, F. A. Korn, W. I. McCullagh, O. L. Michal, W. H. Scheer and H. O. Siegmund.

E. I. Green, F. J. Given, P. S. Darnell, A. J. Christopher and D. A. McLean, accompanied by C. A. Purdy and E. W. Ertner of Hawthorne, visited the paper mill of Peter J. Schweitzer, Inc., at Mt. Holly Springs, Pennsylvania. Paper-making operations were observed and capacitor paper problems discussed.



In the Development Shop at Holmdel, Fred Moller puts the finishing touches on electromagnetic horn for microwave research.

Joseph Romeo returns to "Pat" Rooney, Whippany Doll and Toy chairman, the first of 125 dolls dressed by girls and wives of engineers.

G. F. Heuerman appeared before the Board of Appeals at the Patent Office relative to an application for patent.

R. O. Covell was at the Patent Office in Washington during October relative to patent matters.

J. W. Smith, C. R. Taft and H. A. Baxter inspected submarine equipment at General Mills, Minneapolis.

J. W. Smith, C. R. Taft, R. J. Philipps and P. H. Smith went to Washington to discuss features of proposed Navy equipment.

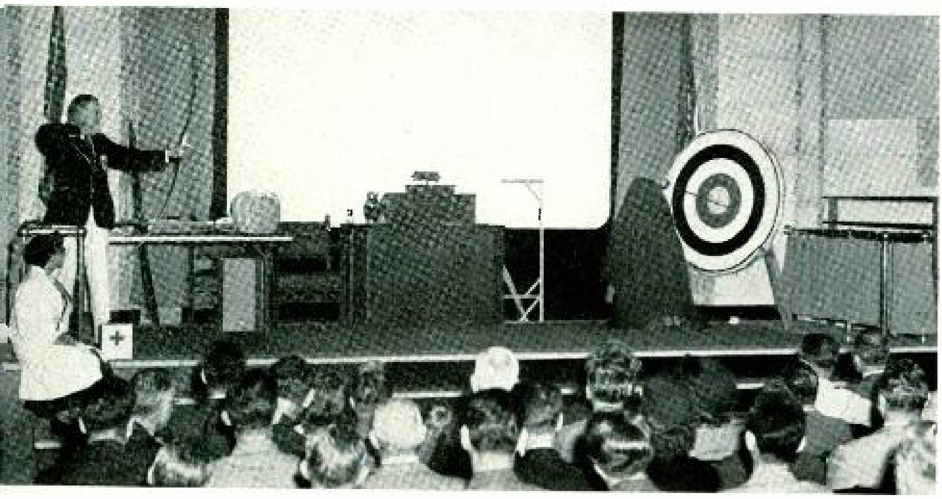
C. C. Houtz and M. Whitehead visited the Fansteel Metallurgical Corporation in North Chicago to discuss matters relating to tantalum electrolytic capacitors.

At Point Breeze, W. L. Tuffnell and C. A. Webber discussed cords, and J. B. Dixon, conductors for insulated wires.

"The Archery Hour"

"The Archery Hour," presented under the auspices of the Bell Laboratories Club, brought to a close a six-week campaign by the Archery Club to bring to the attention of all the fascination of archery as a sport. C. N. Hickman, chairman of the Club, after brief orientation remarks, introduced Mrs. E. B. Miller, who talked on *What, Why and How of Archery*, and Wendel Cernik, a member of the Club who started shooting last fall, and who, in his first season of shooting, won over thirty prizes.

The program ended with a modernized version of the William Tell episode, shown above. Dr. Hickman shot an apple three inches in diameter off the head of Helen Smith, secretary of the Club. After placing the apple on her head and taking his shooting position, Dr. Hickman complained that he could not concentrate on the apple on account of her pretty face and beautiful dress. Being very resourceful, he placed a large black cloth over her. He was assisted by Mildred Samek, who had come to the stage dressed in a nurse's uniform and equipped with a stethoscope and first-aid kit. He then placed the apple on Mrs. Smith's head and, after removing his jacket, started to shoot. He asked her if she had any last request. She said, "Yes, don't miss the apple." He then called for some soft music, and, with the strains of Chopin's Funeral March as a musical background, he shot the apple. The arrow went straight through the apple. Then he slowly removed the cloth and, as it was being lowered, it was observed that her hair had turned white. Remarking that she had evidently been badly frightened, he lowered the cloth still further, and those who were alert noted that Mrs. Smith was sitting in the box instead of on it, and that the lid of the box had been raised and acted as a shield. A cross-member had also been raised which concealed a false head and shoulders. Pretending that he had revealed the trick by accident, he quickly raised the cloth and when lowered again she was again sitting on the box, the dummy having been folded down so that it was inside the box. The audience was delighted with the program and about twenty new members have been recruited for the Club.



C. N. Hickman's William Tell trick with Helen Smith "victim" and Mildred Samek "nurse" caused a sensation at "The Archery Hour."

News Notes

W. C. Ball, J. H. Harding and P. A. Jeanne coöperated in recent tests in the Philadelphia area to determine the noise influence of a new type of electric locomotive.

P. G. Edwards spoke on *The Compandor—Its Principles and Applications* at a meeting presided over by R. B. Shanck of the New York Section, A.I.E.E., Communication Division.

C. D. Lindridge and W. R. Steeneck with W. R. Scherb and C. J. Stolp of Western Electric visited the Doehler-Jarvis Corporation at Pottstown, Pennsylvania, to discuss die-casting designs for the N1 carrier telephone system.

Harvey Fletcher was presented with the 1948 Progress Medal Award by the Society of Motion Picture Engineers for outstanding achievement in motion picture technology, at the Convention of the Society in Hollywood on October 12. He was also awarded Honorary Membership by the Audio Engineering Society for outstanding accomplishments in the broad field of audio engineering.

L. G. ABRAHAM, J. R. BRADY, M. E. CAMPBELL, A. C. DICKIESON, H. A. LEWIS and L. W. MORRISON assisted in tests of television at Washington, D. C.

R. D. HEIDENREICH has written an article on *Electron Microscope and Diffraction Study of Metal Crystal Textures by Means of Thin Sections* which appeared in the *Journal of Applied Physics.*

K. K. DARROW attended a meeting in Philadelphia of the Bartol Committee of Franklin Institute on October 6 and visited the University of Pennsylvania. Dr. Darrow witnessed the 75th anniversary celebration of Smith College at Northampton and later attended the New England Section meeting of the American Physical Society.

Hot Water Heating System

To provide comfortable temperatures in the West Street building during the heating season, heated water is circulated through radiators in the building. Important units of the hot water heating system are three heaters which receive heat from the steam system and transfer it to the water through numerous tubes inside the heater.

The water temperature is automatically controlled by a thermostat on the outside of the building which regulates the steam valves on the steam supply to the heaters; the water temperature varying according to the rise or fall of the outside temperature.

Tubing inside the heaters is subject to severe strain during normal operation and has to be replaced when leaks from the steam to the water compartments occur in the heater. The picture below shows the tubing being replaced by Erlund Johnson of the Building Shop.

J. F. Morrison, in flying gear, had just returned to Warner Robins Air Force Base at Macon, Georgia, from a flight on which he had conducted tests on newly developed Air Forces equipment.

News Notes

WILLIAM SHOCKLEY spoke on *Elementary Plastic Processes* at a Conference on the Solid State at the Brooklyn Polytechnic Institute. R. M. BOZORTH presided at one of the sessions.

G. H. WANNIER has become an adjunct associate professor of mathematics and physical science, and J. T. MULLER a lecturer in mechanical engineering at the Graduate School of Stevens Institute of Technology at the opening of the fall term.

H. E. IVES, retired, is the author of an article on *The Lorentz-Type Transformations as Derived From Performable Rod and Clock Operations* published in *The Journal of the Optical Society of America*, September, 1949.

DR. EUGENE WIGNER, Thomas D. Jones Professor of Physics at Princeton University, was at the Murray Hill Laboratory on November 4. During his visit, he spoke on *The Rôle of Conservation Laws in Physics.*

W. L. Black, as chairman of the Awards Committee of the Audio Engineering Society, presented awards at the Society's annual meeting to a number of persons, including an honorary membership to Harvey Fletcher. During the Society's convention, Mr. Black presided at a symposium on audio frequency measurements and delivered the first paper.

C. J. Calbick and R. D. Heidenreich attended the meeting of the Electron Microscope Society in Washington.

E. K. Jaycox was at the thirty-fourth annual meeting of the Optical Society of America in Buffalo; he also attended a meeting of the Advisory Committee of A.S.T.M. Committee E-2 there.

H. F. Dienel and G. K. Teal discussed the 312A silicon carbide varistor with Western Electric engineers in Allentown.

P. P. Debye visited Johns Hopkins University's Cryogenic Laboratory in Baltimore.

A. C. Walker gave a talk on the *Growing of Crystals* before the Summit Rotary Club on October 3 at a luncheon meeting. He also talked on the same subject before the Men's Club of the First Presbyterian Trinity Church of South Orange. A motion picture on growing crystals was shown at both of these meetings.

At the meeting of the American Institute of Mining and Metallurgical Engineers held in Cleveland, two papers, *P-Type and N-Type Silicon and the Formation of the Photovoltaic Barrier in Silicon Ingots,* by J. H. Scaff, H. C. Theuerer and E. E. Schumacher, and *Microstructure of Silicon Ingots,* by W. G. Pfann and J. H. Scaff, were presented.

J. H. Scaff has been appointed chairman of the Membership Committee of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers.

H. Peters visited the Simplex Wire and Cable Company at Cambridge, Massachusetts, to discuss submarine cable splicing.

I. L. Hopkins addressed the Polymer Group of the North Jersey Section, American Chemical Society, on *Polymers Under Complex Stress.*

W. O. Baker spoke on *Properties of Synthetic Rubber* at the Summit Lecture Series of the North Jersey Section of the American Chemical Society.

F. G. Foster attended the meetings of the American Optical Society in Buffalo.

L. E. Abbott attended meetings of the American Welding Society in Cleveland and also discussed welding methods at Hawthorne.

"The Telephone Hour"

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

December 12	*Lorne Munroe and Carroll Glenn*
December 19	*John Charles Thomas and Mixed Chorus*
December 26	*Zino Francescatti*
January 2	*Lily Pons*
January 9	*Clifford Curzon*
January 16	*Ferruccio Tagliavini*
January 23	*Ezio Pinza*

R. M. Burns was in Chicago, where he visited Hawthorne and attended meetings of the Industrial Research Institute and the Electrochemical Society.

I. V. Williams read a paper on *The Use of Thin Sheet Metal Gauges* before the Company Member Committee of the American Standards Association.

J. R. Townsend visited San Francisco in connection with the selection of corrosion exposure sites, the A.S.T.M. West Coast convention, and Stanford Research Institute. During the convention of the American Society for Metals in Cleveland, Mr. Townsend led a panel discussion on *Economy-in-Production Through the Use of More Precise Castings or Formed Shapes.*

K. G. Compton visited The Pacific Telephone and Telegraph Company during October. While in San Diego, with Milo M. Squires of The Pacific Company, he terminated the LaJolla corrosion tests of the A.S.T.M. and shipped the test specimens to New York. In the company of Mr. Squires, he inspected cable, strand and hardware along the coastal area between San Diego and Los Angeles. With Mr. Calderwood of the San Francisco Office, he visited the proposed test site at Monterey. Later they were joined by J. R. Townsend for a visit to another proposed site at Point Reyes north of San Francisco, where the A T & T has a trans-Pacific receiving station. While in San Francisco, arrangements were made for the exposure of new items proposed for use in a severe coastal location.

G. H. Williams visited the Mack Molding Company in Arlington, Vermont, in connection with central office battery equipment.

R. Burns addressed a joint meeting of A.S.T.M. and A.S.Q.C. at Franklin Institute, Philadelphia, on Quality Control in Materials Procurement.

G. DEEG visited Rohm & Haas Company, Philadelphia, in connection with optical plastics for military applications.

G. DEEG, J. J. MARTIN, G. H. WILLIAMS and E. E. WRIGHT attended meetings of A.S.T.M. Committee D20 on Plastics in New York.

R. L. HANSON gave a demonstration lecture on transistors before the Communications Section of the Association of American Railroads, Portsmouth, New Hampshire, on September 29. This same lecture was repeated for 3,000 students of the Brooklyn Technical High School on October 18 and for an additional 3,000 students of the school on October 19.

A. G. JENSEN attended the Radio Fall Meeting of the RMA Engineering Department and the Institute of Radio Engineers at Syracuse.

R. R. RIESZ spoke on *Low Frequency Spectography: Some Applications in Physiological Research* before the second annual joint I.R.E.-A.I.E.E. Conference on Electronic Instrumentation in Nucleonics and Medicine, and Nucleonic Manufacturers' Exhibit.

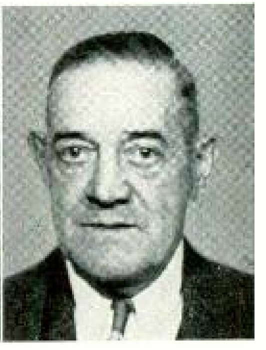
W. E. KOCK and F. K. HARVEY have written on *Refracting Sound Waves;* O. O. GRUENZ and L. O. SCHOTT on *Extraction and Portrayal of Pitch of Speech Sounds;* H. T. O'NEIL on *Theory of Focusing Radiators;* R. C. MATHES, A. C. NORWINE and K. H. DAVIS on *The Cathode-Ray Sound Spectroscope* in the September *Journal of the Acoustical Society of America.*

W. M. GOODALL selected the topic *Television by Pulse Code Modulation* for his talk before the Princeton Section of the I.R.E.

RECENT DEATHS

S. T. CURRAN
1894-1949

HERBERT OLDHAM
1884-1949



G. F. VOEHL
1886-1949

STANLEY T. CURRAN, October 24

After attending Cornell University and Massachusetts Institute of Technology, Mr. Curran joined the Laboratories in 1919 as a member of the Technical Staff. His early work was as a design engineer and, later, editor in the specifications group. Following that, he transferred to Station Apparatus, and, for many years, engaged in the design and development of telephone sets. With the war in 1941, he transferred to Whippany to engage in the development of radars. His experience as a Navy flier in World War I was of assistance in his work on airborne types. In 1945 he transferred to station apparatus development work at Murray Hill, and was engaged there for three years. Returning to Whippany in 1948, he again was concerned with the development of airborne radar.

Mr. Curran was active in civic affairs, having served as councilman for several terms and chief of the fire department for fifteen years in his home community of Mountain Lakes. During the war he was the local official responsible for civilian defense activities.

GUSTAV F. VOEHL, October 30

Shortly after joining the Laboratories as a toolroom clerk in 1918, Mr. Voehl transferred to the 4C Development Shop stockroom at West Street as a storekeeper. With the exception of a short time when he returned to the Development Shop as a machine hand, all the rest of his Bell System service was as a storekeeper. For a time he was assigned to Basement D storeroom, but his longest service was at Graybar-Varick, where he was in charge of the self-service storeroom on the 13th floor.

HERBERT OLDHAM, October 11

Mr. Oldham, a retired member of the Laboratories, joined the Engineering Department of Western Electric in 1918 as a photostat operator. He became a supervisor of the group operating the photostat machines in 1944. The following year he was retired.

W. E. Thacker won first prize, portrait class, for this picture of Isabel Armstrong and Gil Chandler.

Whippany Photographic Contest

The second annual photographic contest of the Whippany Camera Club was held October 27-28 in the main lounge, with 52 prints entered by 28 members, and 57 color slides entered by 19 members. The Morris County Camera Club judged the show. In the black and white contest, four groups of pictures were shown. These were classified as Portrait, Landscape and Architecture, Children and Pets, and Miscellaneous. The winners in the various classes were as follows:

Portrait: W. E. Thacker, first; J. P. Swart, second; C. J. Halvorsen, third; L. W. Lott, fourth; and R. R. Cordell, fifth.

Landscape and Architecture: A. L. Johnsrud, first; P. H. Thayer, second; H. R. Wilsey, third; A. L. Johnsrud, fourth; and R. R. Cordell, fifth.

Miscellaneous: W. E. Thacker, first; A. L. Johnsrud, second; L. W. Lott, third; and R. R. Cordell, fourth.

Children and Pets: L. W. Lott, first; J. P. Swart, second; J. P. Swart, third; and C. J. Halvorsen, fourth.

The color slides were classified as Indoor Pictures and Outdoor Pictures. The winners were as follows:

Color Slides–Indoors: H. R. Wilsey, first; H. R. Wilsey, second; F. E. Nimmcke, third; and R. R. Stephenson, fourth.

Color Slides–Outdoors: R. R. Stephenson, first; R. R. Stephenson, second; A. B. Anderson, third; and R. E. Coram, fourth.

First prize photograph in the landscape class went to A. L. Johnsrud.