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W. P. MASON
Physical Research

Barium-titanate ceramic as an electromechanical transducer

Until the early years of this century, electromechanical transducers—devices that transform electrical waves into mechanical waves and vice versa—were limited almost entirely, at least for practical application, to electromagnetic types, such as the ordinary telephone receiver. At the comparatively low frequencies of the voice band, these are still the most satisfactory for many applications. During World War I, however, there was a great need for detecting submarines by acoustic and ultrasonic waves transmitted through the water. With the higher mechanical impedance of water as the transmitting medium, and particularly at the higher ultrasonic frequencies, electromagnetic transducers were not satisfactory, and quartz and other piezoelectric crystals were employed. Because such crystals expand and contract with applied electric fields, they are inherently transducers. Since that time, and particularly since World War II, they have been used and studied extensively. Besides their use for underwater sound detection, they have been found available at very high frequencies for agitating liquids in a variety of chemical and metallurgical studies.

In these latter applications, the transducer is made in the shape of a parabolic or cylindrical radiator so as to focus the ultrasonic waves on a point or along a line. In a crystal, however, the greatest mechanical response lies along a definite axis, and thus when the crystal is cut in the shape of a parabolic radiator, for example, only a small section will be acting most effectively. If a suitable ceramic material were available, this handicap would be avoided because a ceramic is isotropic: the crystal cells comprising it are not all lined up to form a single larger crystal, and thus if it possessed transducer characteristics, a parabolic disc made from it could be made to act efficiently over its entire area.

Most ceramics made from steatite or

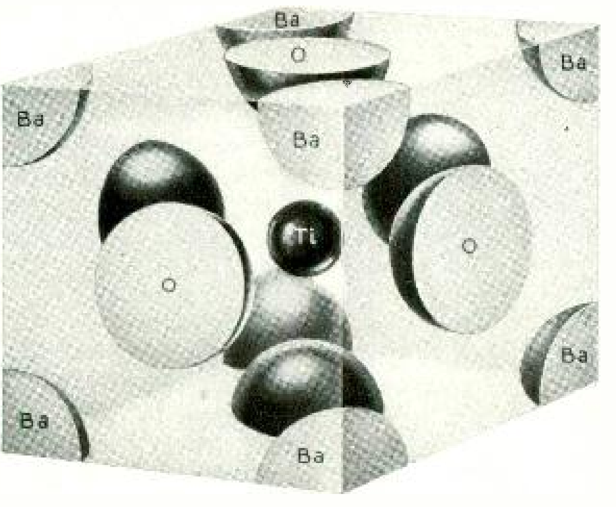


Fig. 1—Atoms in a single crystal cell of barium titanate are arranged as indicated above

silica crystals have only moderate dielectric constants and do not show any tendency to change dimension on the application of an electric field. It has recently been found, however, that ceramics fused from barium-titanate crystals exhibit very high dielectric constants, and under certain conditions can be made to change their dimensions on the application of an electric field. The amount of dimensional change is larger than that occurring in magnetostrictive materials and even exceeds that possible in Rochelle salt, which has been used for a wide variety of transducing elements. Since in addition the properties of barium-titanate ceramics do not vary much with temperature —as contrasted with the wide variation occurring in Rochelle salt—it appears likely that such ceramics may be important electromechanical transducer elements.

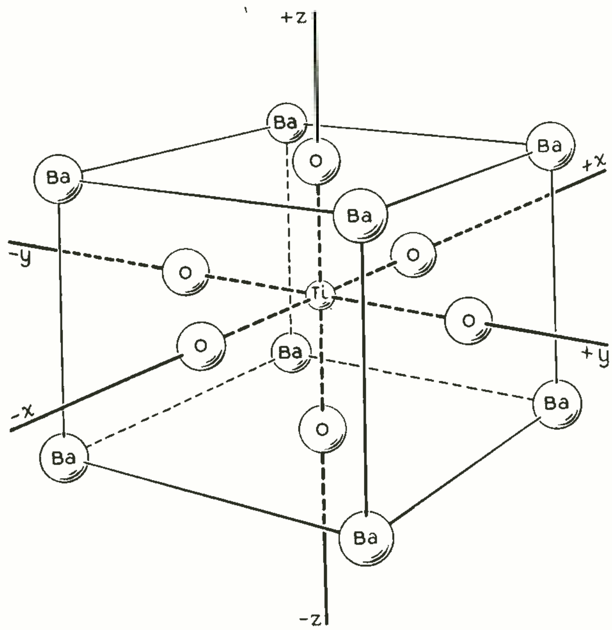


Fig. 2—Representation of barium-titanate cell showing the axes along which the cell may contract and expand

This behavior of the ceramic stems from the properties of the single barium-titanate crystal, which have been studied extensively. The arrangement of a single crystal cell of barium titanate above 120 degrees C. may be represented as shown in Figure 1, which represents the component atoms as small spheres. To represent the behavior more correctly, the spheres representing the atoms should be larger than shown—almost in contact in fact—but if they were shown so in the drawing, the outer atoms would hide the inner ones and their arrangement would not be evident. The barium atoms are at the eight corners of the cell; the oxygen atoms are at the center of each of the six faces; and the titanium atom is at the center. A complete crystal would include many billions of such cells. In a mass of the actual ceramic, the orientation of a large number of cells, called a domain as in dealing with ferromagnetic materials, are usually similarly oriented, and are considered as a unit. Such a domain is roughly the size of a one-millimeter cube, and will include a total of $16x10^{18}$ complete cells.

Although the titanium atom is shown in Figure 1 at the center, it probably makes a covalent bond with one of the oxygen atoms. When this happens, the titanium nucleus moves up to meet it. The titanium and oxygen spheres will interpenetrate, which is possible if they make a bond. Above 120 degrees C., the temperature agitation is sufficient to break up any tendency for the nuclei of adjacent cells to line up in the same direction, and any one of the six directions is equally probable. Below 120 degrees C., the temperature agitation is not sufficient to prevent adjacent nuclei from lining up in the same direction, and because of the electrical charges on the atoms, an internal field is generated by these displacements in a given domain, which causes the titanium nuclei in these domains to spend most of their time in one of the six possible positions of the axes running through the center of the titanium and the various oxygen atoms, as indicated in Figure 2. This direction is called the ferroelectric axis. The internal field lowers the potential of the equilibrium position along the ferroelectric axis and makes it more probable that the titanium will occupy this position than any of the other five. When this occurs, the four oxygens perpendicular to the ferroelectric axis move in by one-third of one per cent, while the unit cell expands two-thirds of one per cent, since the oxygens along the ferroelectric axes move out a small amount. This is the origin of the electrostrictive effect that makes barium titanate act as a transducer.

In a ceramic made from barium-titanate crystals, all directions for the ferroelectric axis are equally probable. The effect of a large d-c field is to change the direction of polarity so that more domains are lined up in the direction of the field rather than in other directions. This change is not brought about by a physical change in the orientation of the crystals, but rather by the change in the direction of the ferroelectric axis from one to another of the six oxygens. When the field is taken off, the local field caused by the lining up of the domains remains, and is sufficient to keep a large share of the domains lined up.

When a small a-c field is applied in the presence of a d-c field or remanent polarization, it is probably too small in itself to reverse any complete domain, but it can cause unit cells on the common planes of differently directed domains to change from one domain to another, and hence cause one domain to grow at the expense of other domains. If the a-c field is opposed to the d-c field, some molecules of the domains directed along the thickness will be lost to other domains directed in different directions and the crystal will become thinner. When the a-c field is added to the d-c field, these molecules and more too will be directed in the direction of the field and the plate becomes thicker. Transverse vibration is accounted for by the contraction of the domains in directions perpendicular to the ferroelectric axis, which generates a motion about half as large as the thickness motion. When an a-c field is applied at right angles to the remanent polarization, there is a tendency for domains to grow in size in a direction bisecting the two field directions and this is equivalent to a shearing motion.

Since for practical devices it is undesirable to have to supply a d-c biasing voltage, use is made of the remanent polarization induced by polarizing the ceramic by a high voltage. There is some indication, however, that this polarization may decrease with time as does the remanent magnetization of a soft magnetic material. To investigate the possibility of obtaining a remanent polarization that is really permanent, some experiments have been made on the effect of introducing impurities into the barium titanate with the thought that the ferroelectric axes might be locked into position so that they would not change, as happens in a permanent magnetic material. By introducing three to four per cent of lead in the form of lead titanate, the desired effect was found. When this mixed ceramic was

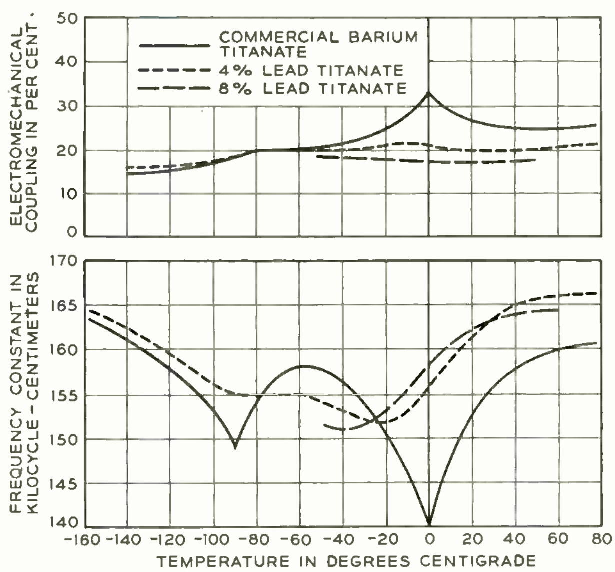


Fig. 4—Constants of the transducer as a function of temperature. All of these barium titanates are far less sensitive to changes in temperature than is Rochelle salt

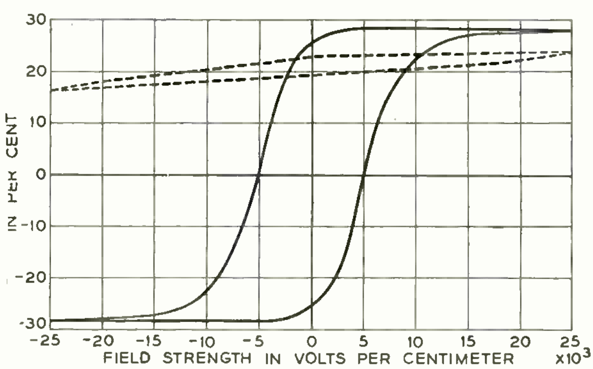


Fig. 3—Electromechanical coupling as a function of applied field: solid curve for ordinary barium titanate; dotted curve for lead-titanate mixture

poled at a high field strength at temperatures above the Curie temperature and cooled under the applied field, this remanent polarization and the concomitant electromechanical coupling could not be removed by any reversed field that could be applied to a temperature of 70 degrees C.

Figure 3 shows the electromechanical coupling factor for a radial mode as a function of the applied field. The solid line figure shows the coupling for an ordinary barium-titanate sample which shows that the coupling can be reduced to zero and the polarization reversed by putting on 5,000 volts per centimeter negative. The dotted line shows the same curve for the lead-titanate mixture; up to 25 kilovolts per centimeter negative, the coupling is only diminished slightly. It is completely restored by cycling to 25 kilovolts per centimeter positive. Hence the new material acts like a permanent magnetic material, and the remanent polarization should be stable with time. It has been found possible to radiate 100 watts per square centimeter continuous acoustic power with the four per cent lead-titanate ceramic, whereas with the untreated ceramic, a lower power causes a loss of the remanent polarization.

Although it is too early to tell for which applications the ceramic type of transducer will give better results than other competing methods, several advantages are at once obvious. Figure 4 shows the electromechanical coupling factor (which determines the percentage of input electrical energy appearing in mechanical form) and the frequency constant of a circular disc plotted as a function of temperature. The solid line is for an ordinary barium-titanate mixture while the dotted line is for the four per cent lead-titanate mixture. Two transition temperatures, at 0 degree and −90 degrees, are evident from the data. These are temperatures for which the crystal becomes ferroelectric along two directions and three directions according to present theory. The first corresponds to the titanium spending equal times along two of the six possible positions and little time along the other four, while the second transition is caused by the titanium spending most of its time at three of the possible positions lying along mutually rectangular axes, and very little time along the other three positions. The effects of these transition temperatures are somewhat curtailed for the lead-titanate modification. The constants of the transducer, as shown by Figure 4, are far less temperature sensitive than are those for Rochelle salt for example.

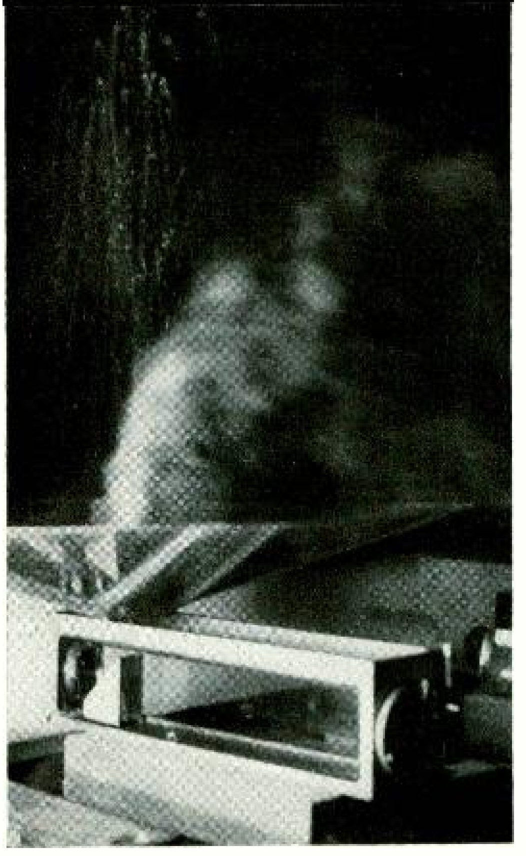


Fig. 6—A laboratory setup in which a focusing radiator under water—at the left of the narrow rectangular glass-walled tank at the bottom of the photograph—was directed toward a reflecting block. A fountain of water is projected upward from the reflecting block as a result. A collecting pan catches the falling water and drains it back into the tank

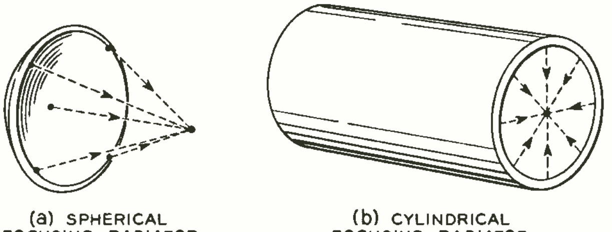


Fig. 5—Possible shapes in which barium titanates may be formed

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.

Another definite advantage of the ceramic transducer is that it can be made in any size or shape. One possible use of this is in producing focusing radiators, as shown by Figure 5a, which can concentrate ultrasonic energy in liquids in a given region. This type of transducer can be made equally efficient at all points of the surface, which is not true for a quartz transducer. Figure 5b shows a cylindrical type of transducer which can be used to produce a high ultrasonic intensity along the axis of the cylinder. This type may be of use in a continuous ultrasonic process for altering the properties of a liquid or solid. Figure 6 shows a focusing radiator which can concentrate the acoustic energy within a small spot. When this spot is directed toward the surface by a reflecting block, a fountain of water and a cold fog are produced.

Franklin Institute Honors S. A. Schelkunoff

The Stuart Ballantine Medal has been awarded to Sergei A. Schelkunoff by the Franklin Institute for "outstanding contributions to the extension of the electromagnetic wave theory, particularly his mathematically based concepts so helpful to the radio engineer." The medal will be presented to Dr. Schelkunoff at the traditional ceremonies which will be held in Philadelphia on October 19.

The double-stream amplifier

A. V. HOLLENBERG
Electronic Research

A new method of amplifying radio-frequency signals in a vacuum tube has recently been proposed and experimentally demonstrated in the Laboratories. Two streams of electrons traveling at different speeds but in the same direction and in the same space, or very close together, have been shown to amplify high-frequency signals. The signal to be amplified is impressed on the electron streams near the beginning of their travel and extracted from them near the end. In the space between, the signal on the two electron streams grows because of interaction between them without the help of any neighboring or surrounding metal structure. High gain over a broad band of frequencies may be obtained in this manner. This double-stream amplifier differs fundamentally from other amplifying tubes because of the absence of a metal structure from the amplifying mechanism. This difference may prove to be an important advantage in obtaining amplification at the highest microwave frequencies. In other known amplifying tubes, one or more of the problems of small size of elements, small spacing between elements, small clearance between elements and electron streams, and bombardment of metal elements by electron streams inevitably raise difficulties if the frequency is increased too much.

The possibility of amplification by two electron streams was recognized by J. R. Pierce and W. B. Hebenstreit of these Laboratories* during a theoretical study of noise in electron streams of different velocities. They worked out a theory believed to be valid for small signals, small differences in electron speed, and cylindrical streams that states the conditions to be satisfied in order that amplification may occur in two streams of electrons, and predicts the amount of gain to be expected. The writer, with substantial assistance from A. R. Strnad and R. E. Azud, has designed and constructed double-stream amplifier tubes in which the predicted amplification by the two streams occurs. One of them is shown in Figure 1.

The elements of a double-stream ampli-

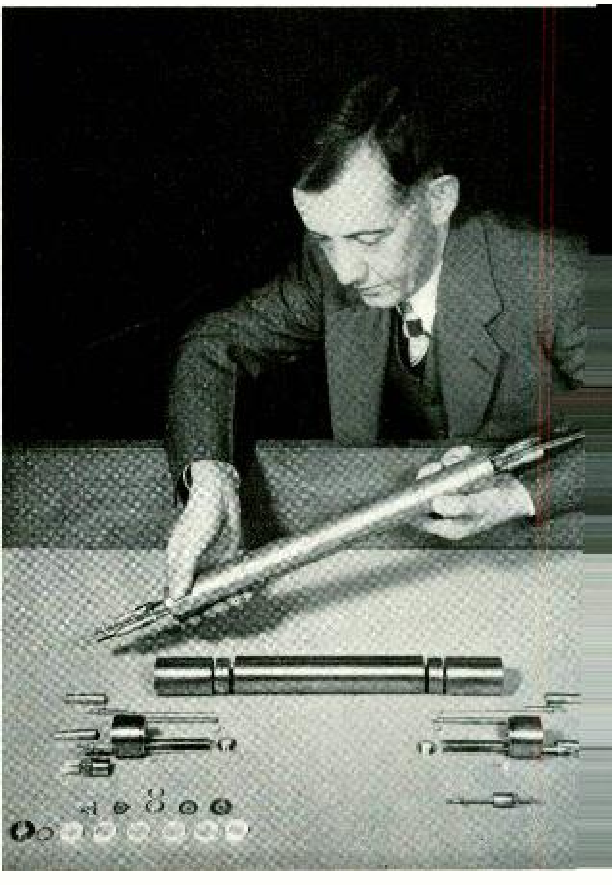


Fig. 1—The author holds one of the double-stream amplifiers above a similar one disassembled

*The possibility of amplification by the means described here and in other publications by other members of the Laboratories has also been recognized by other workers outside of the Laboratories, and described in recent technical articles by A. V. Haeff of the Naval Research Laboratories and L. S. Nergaard of R.C.A.

fier tube are represented diagrammatically in Figure 2. The two streams of electrons are emitted by the two annular cathodes, C1 and C2, which are at different potentials with respect to an accelerating grid G. After acceleration, the two streams pass down the long evacuated tube where they travel together or side by side for some distance, perhaps a foot or more. Near each end of their travel, they pass through short sections of helix. The helix at the left couples the input circuit to the electron streams, while that at the right transfers the amplified signal to the output circuit. A signal to be amplified is fed into the circuit through the left-hand helix, and modulates the electron streams a small amount. The amplitude of this signal on the electron streams grows as the streams travel down the tube because of interaction between them. The much larger signal is then transferred to the output helix shown at the right. The electron streams themselves pass to the collector C. A coil wound over the tube produces a strong longitudinal magnetic field within the tube, and holds the electron streams to a cross-section about that of the cathodes.

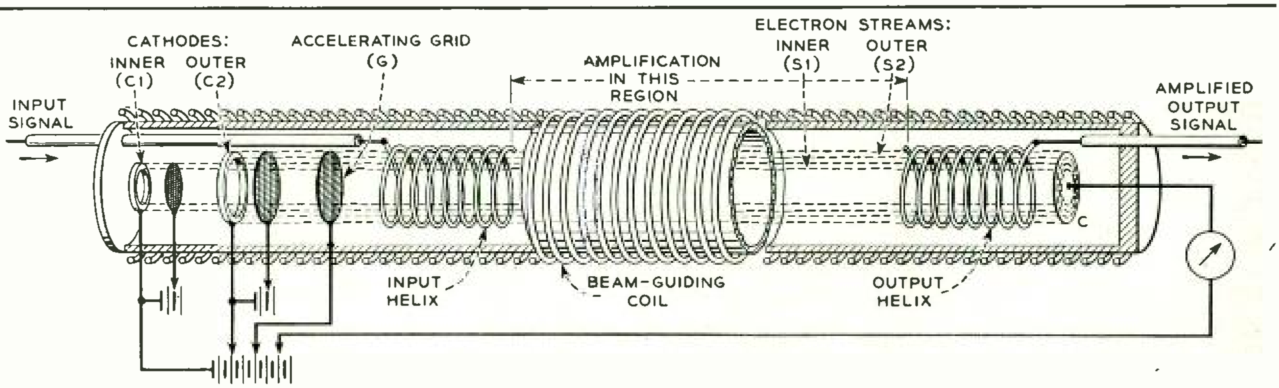


Fig. 2—Diagram of the double-stream amplifier indicating the essential elements

Like the traveling-wave amplifier,* the double-stream amplifier is able to amplify with high gain over a broad band of frequencies. The tube is many wavelengths long in terms of the wave that travels on the electron streams, and each electron participates in the amplifying process during a large number of cycles of the signal. The wavelength in the electron streams is much smaller than the free space wavelength, since the electrons are traveling at much less than the speed of light. The gain is directly proportional to the number of wavelengths in the amplifying region. The helices at the two ends are similar to the much longer helix of the traveling wave tube, and the clearance between them and the electron streams is small. Because of the shortness of the helices, however, the difficulties arising from electrons striking them are much reduced.

The results of theoretical analysis show that a wave is set up on the electron streams by the input circuit, and that it increases in the direction of electron flow if the current densities in the two streams exceed a minimum value. Below this value no amplification occurs. Above this value the gain increases rapidly at first and then approaches a limiting value as the current density is increased indefinitely. The limiting value is about 27 decibels per wavelength in the streams per unit "velocity separation." The latter term is defined as the difference in velocity between the two streams divided by the average velocity, and has small values, of the order of 0.1. For a tube 16 wavelengths long and having a velocity separation of 0.1, for example, the limiting gain would be 27x16x0.1, or about 43 decibels. The gain varies with the frequency, but slowly enough that the bandwidth of the double-stream amplification is comparable to that in the helix traveling-wave amplifiers.

*Record, *December*, 1946, *page* 439.

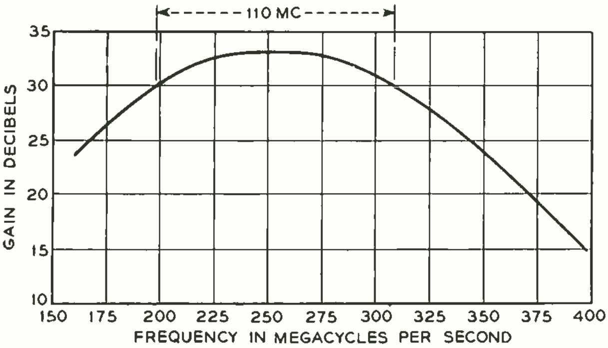


Fig. 3—Curve of the gain of the amplifier plotted against frequency

No simple physical explanation of the behavior of the double-stream amplifier has yet been devised. Its development is entirely the result of a mathematical analysis followed by experimental verification.

Although the most attractive possibilities of double-stream amplification appear to be in the microwave frequency region, it can be carried out at lower frequencies, in the range of a few hundred megacycles, and experiments showing that amplification can be obtained by the double-stream mechanism were performed in this lower range. The tube employed amplifies over the band from about 200 to 300 megacycles with maximum gain of 33 decibels. Figure 3 is a plot of gain versus frequency and shows the large bandwidth of this tube.

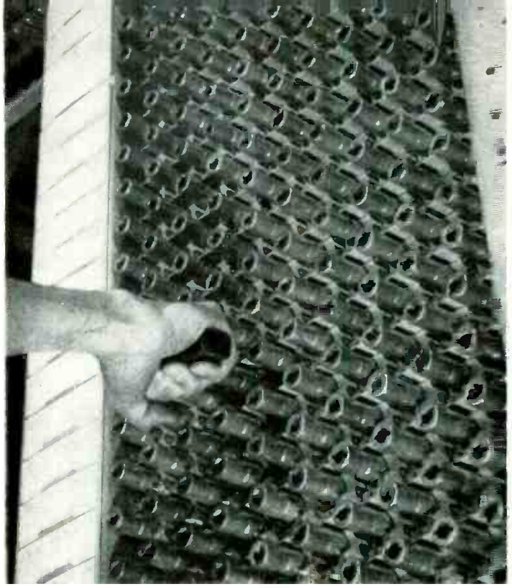
In this experimental tube, the electrons in the inner stream, shown in Figure 2, travel at approximately the same speed as the wave in the helix advances along the axis, which is about one-seventieth of the speed of light—this being the ratio of the length of the helix to the length of the wire comprising it. Because of the approximate equality of their speeds, there is coupling between the inner electron stream and the wave on the helix. The outer stream, traveling at a lower speed, does not couple to the helices, but interacts with the inner stream to produce amplification. The tube is about 16 wavelengths long in terms of the wave traveling on the electron streams.

There is almost no transmission of signal through the tube without the electron streams since the input and output circuits are separated by the long central region. With the inner stream alone turned on, signal is transmitted through the tube with little if any loss due to the ordinary traveling wave amplifier interaction of the stream and the short sections of helix. The gain of the tube appears when both streams are on and the double-stream interaction occurs. Comparison of the signals picked up by two probes inserted in the electron streams has shown that amplification occurs, as expected, in the central portion.

The 200 to 300-megacycle amplifier may be of possible use in communication systems, and could probably be adapted to use up to frequencies a few times greater rather easily. The principal reason for building the amplifier, however, has been to demonstrate the possibility of making a signal grow on a pair of electron streams, which was theoretically predicted. The principle may find much more important use in solving problems in making amplifiers and oscillators for use at the highest microwave frequencies.

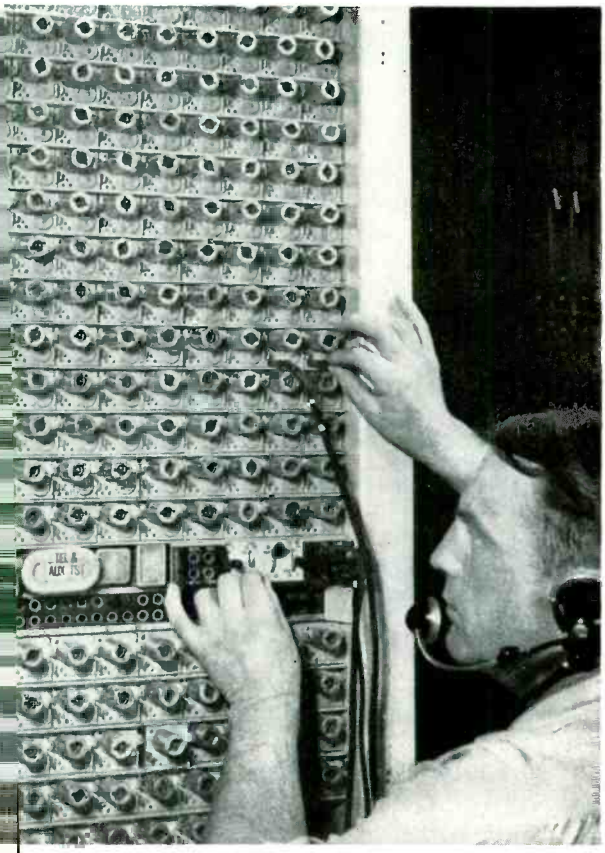
THE AUTHOR: A. V. Hollenberg received an A.B. degree from Willamette University in 1931, and the M.S. and Ph.D. degrees in physics from New York University in 1933 and 1938. He was an Instructor in Physics at Queens College from 1938 to 1942. In the latter year he joined the staff of the Columbia Radiation Laboratory where he carried on research and development work on microwave magnetrons. He joined the Laboratories in January, 1946, and has since been engaged in work on traveling-wave amplifier and double-stream amplifier tubes.

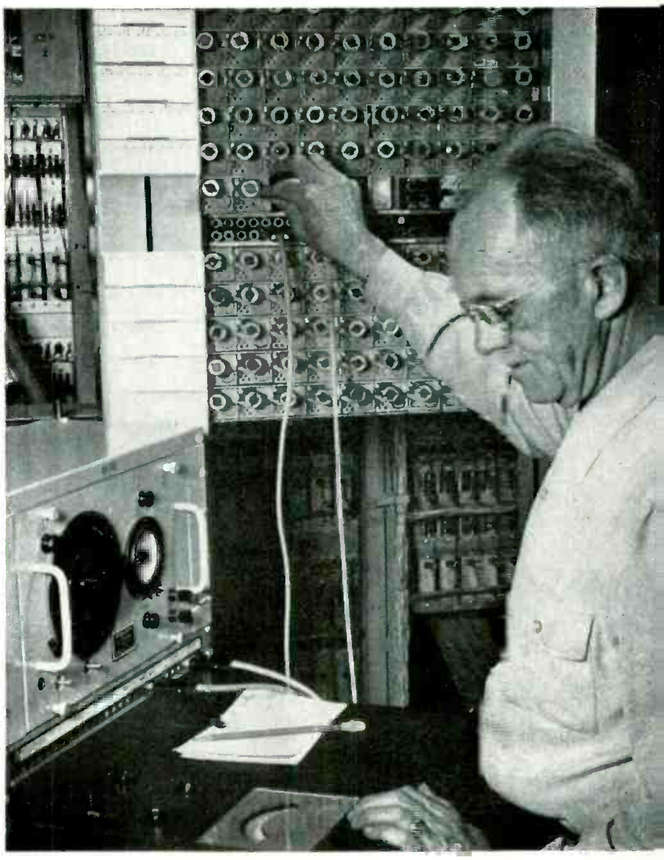
V3 Repeaters at work



One of the earliest installations of the V3 repeater* was at Framingham, Massachusetts, where the 450 amplifiers for 225 repeaters are installed in a single bay with room left for 150 more amplifiers. The illustrations show parts of this bay, and illustrate the ease with which these amplifiers are maintained. An amplifier being removed with a simple hand tool is shown at the right, above, while the illustration on the cover of this issue shows a replacement amplifier being inserted in its place. A maintenance man talking on one of the circuits is shown below, left. A 40B mobile transmission measuring set being used to adjust the gain of an amplifier that has been inserted in a test panel on the amplifier bay for that purpose is shown below.

*Record, *February,* 1949, *page* 45; *March,* 1949, *page* 94.





Alarm system for No. 5 crossbar

C. E. GERMANTON
Switching Development

To give warning of conditions that might adversely affect telephone service, Bell System telephone offices have alarm systems which indicate by both audible and visual means the equipment in trouble. The indicators are so arranged that a maintenance man, regardless of what part of the building he might be in at the time, can find his way to the equipment in trouble with a minimum of effort. Alarm systems used previously in crossbar, and in the later panel and toll offices, have achieved this objective by using a system of bells, chimes, and colored lamps strategically placed whereby the floor, the main aisle, the aisle, and finally the circuit in trouble are indicated. In the No. 5 crossbar system, the same result is achieved but with a simplicity of design that makes possible economies in manufacture, installation, and job engineering. The components for the system are fabricated in the shop, and only a minimum of cabling is required to complete the system on the job.

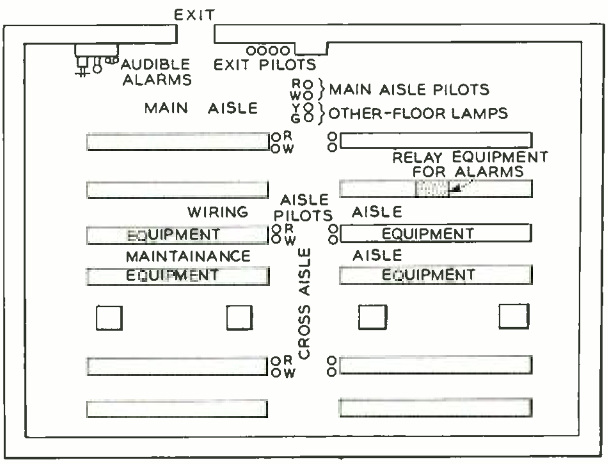
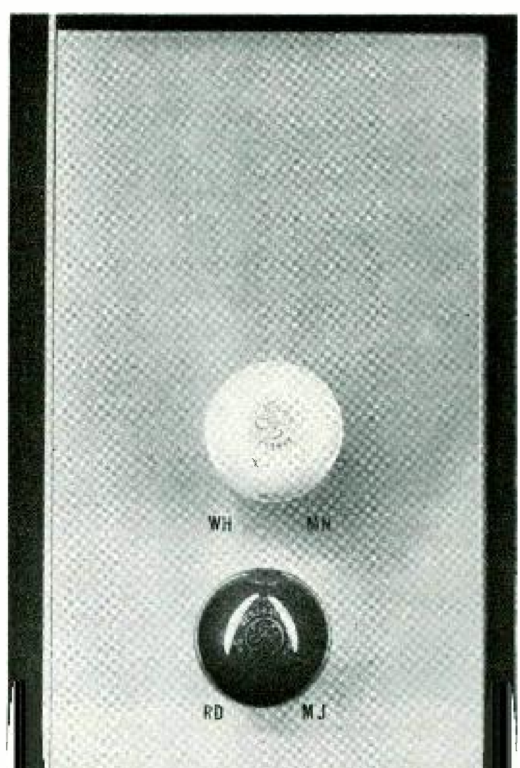


Fig. 1—Arrangement of alarm pilots in a hypothetical central office

Components do not depend on the types or number of circuits requiring alarm, and the special engineering required for each installation is reduced to a minimum. For any one building, the entire alarm equipment consists of a small aisle pilot unit having a red and a white lamp and two relays; a cluster of four lamps—red, white, yellow, and green—for each main aisle; a vertical lamp holder near the exit door having one lamp for each of the other floors in the building; a panel having a six-inch vibrating bell, two telephone ringers with distinctive gongs, and a large tone bar or chime signal; and relay control equipment consisting of one two-inch mounting plate for each floor of the building. Of the group of four lamps in each main aisle, two—the red and white—are the MAIN AISLE PILOTS that indicate trouble in some tributary aisle. The other two—green and yellow—are the

Fig. 2—The aisle pilot unit used in the No. 5



OTHER FLOOR lamps, which indicate the existence of trouble on one of the other floors in the building.

A hypothetical central office layout indicating the positions of these lamps is shown in Figure 1, and an aisle pilot unit in Figure 2. In addition to these lamps, there are individual lamps mounted on various switching and equipment frames that indicate the particular bay, panel, or circuit in which the trouble has arisen. Whenever a trouble arises that lights one of these individual lamps, an aisle pilot for that aisle, the main aisle pilot on that floor, and of the latter lamps is lighted, he will go to the exit, and the particular exit lamp lighted will indicate the floor on which the trouble has arisen. These exit lamps are arranged in a vertical row with one socket for each floor, the top representing the top floor and so on down. On each floor no lamp is in the socket for that floor, and thus the floor on which the trouble exists may be determined from the position of the lighted lamp relative to the socket that has no lamp. After he reaches the floor where the trouble has occurred, the main aisle and aisle pilots will guide him to the proper aisle, and the

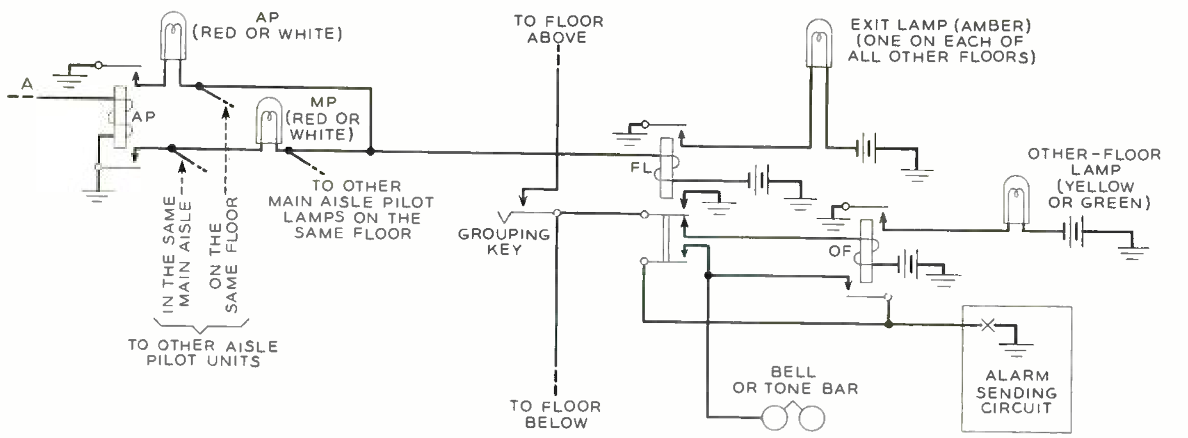


Fig. 3—Simplified schematic of the alarm circuit for No. 5 crossbar

the exit lamps on all the other floors also light, and an audible signal is sounded on the floor where the trouble has occurred. Lighting of the OTHER FLOOR lamps, and giving audible signals on other floors, is optional, and depends on whether or not a grouping key on each floor is operated. When these keys on all floors are operated, any trouble will also light the OTHER FLOOR lamps on all floors except that on which the trouble has occurred, and will sound the audible alarm on these floors. With the grouping keys all operated, therefore, a maintenance man on any floor will hear the alarm when trouble arises anywhere in the building.

By looking at the OTHER FLOOR lamps, he can tell whether the trouble is on the floor he is on or on some other floor, since an OTHER FLOOR lamp will be lighted only when the trouble is on another floor. If one lighted individual lamp on the frame will indicate the equipment causing the alarm.

The circuit by which the proper lamps are lighted when trouble occurs is indicated in Figure 3. When trouble arises, the local lamp will be lighted and battery through a resistance will be connected to lead A at the left of Figure 3. A connection to this same lead will be made for all troubles of same grade, major or minor, arising in that aisle. Battery on this lead operates the AP relay, thus lighting both the aisle pilot lamp for that aisle and the main aisle pilot lamp and operating the FL relay. The operation of this latter relay connects ground to the exit lamp multiple and thus lights all the exit lamps for that floor, sounds the audible signal on that floor and also connects ground to the grouping key. If the grouping key on any floor is operated, the audible signal will sound and the OTHER FLOOR lamp will light on the floor above. Conversely, an alarm on the floor above will sound the audible signal and light the OTHER FLOOR lamp on this floor. If all the grouping keys are operated, audible signals will sound and OTHER FLOOR lamps will light on all floors except the floor on which the trouble occurred.

Switching-trouble alarms are arbitrarily divided into two categories called major and minor alarms, and there is a circuit like Figure 3 for both types. Each circuit has lamps of a particular color associated with it. For major alarms, the individual circuit or fuse panel lamp, the aisle pilot, and the main aisle pilots are red, while for minor alarms, the corresponding lamps are all white. The OTHER FLOOR lamps are yellow for major alarms and green for minor alarms. A distinction is also made in the audible signals; for major alarms the audible signal is a tone bar operated by a relay interrupter, while for minor alarms it is a telephone ringer. The exit lamps, which are all amber, serve for both types of alarms, and are lighted by the FL relay of both the major and minor alarm circuits.

The main power supply equipment is usually all located in the basement, and since it does not require a series of locating lamps, provided by the circuit in Figure 3, it has its own alarm circuit providing both major and minor alarms. It is tied in with the Figure 3 circuit, however, to the extent that for major alarms it lights the yellow OTHER FLOOR lamp and rings a six-inch gong on all floors whether or not the grouping keys are operated. For minor power alarms, it lights the green OTHER FLOOR lamp and rings the regular minor alarm bell on one of the floors which was arbitrarily designated as the floor from which power alarms are supervised. Of course, the grouping keys will also transmit minor power alarms to the other floors. For either major or minor alarms, it lights a separate amber exit lamp on each of the switching floors.

Also not part of Figure 3 are the alarms from the fuses that supply the alarm circuits themselves. A failure of one of these fuses rings a specially toned telephone bell on each floor, but no pilot lamps are lighted except in the alarm control equipment unit, since the blown fuses might prevent the pilot lamp from lighting and thus no dependence could be placed on them. The location of the alarm control equipment is always known to the maintenance man, and thus the sounding of the specially toned bell is sufficient to indicate where the trouble has occurred.

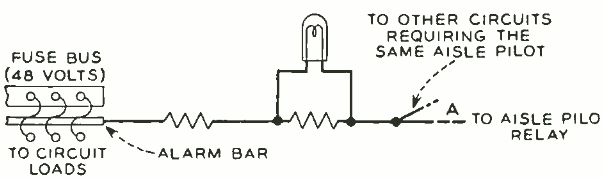


Fig. 4—The standard fuse alarm arrangement

Since in a 10,000-line central office there are about 15,000 fuses that may give an alarm, they are potentially the source of the greatest number of alarms. Experience has shown, however, that fuse alarms are of comparatively rare occurrence.

Alarm type telephone fuses connect the individual circuits to a common power bus, and when they blow, they establish a con-

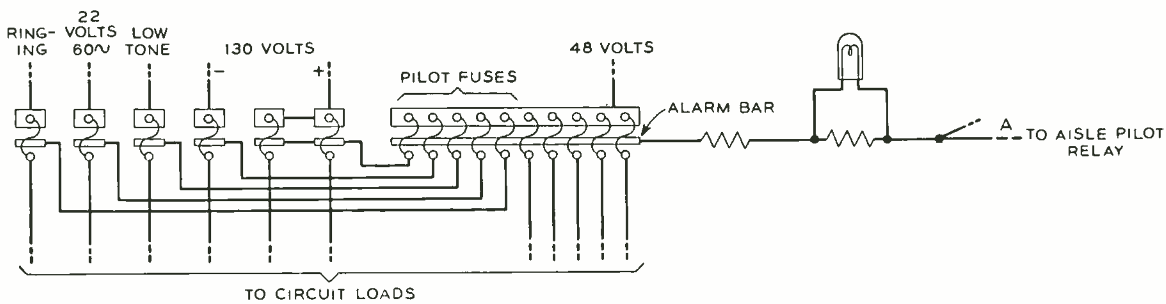


Fig. 5—Pilot fuse alarm system employed where more than one type of power supply is required

nection from the power bus to an alarm bar as has already been described in the Record.* This arrangement, together with a commonly used type of circuit to connect the alarm bar to the fuse panel lamp and the alarm system, is shown in Figure 4. Lead A connects to lead A of Figure 3. Such an arrangement has been used for many years, but it has been necessary heretofore to limit the number of fuse panels that can be connected to the same aisle pilot relay—relay AP of Figure 3. This is because with a number of simultaneous alarms, the current through the winding of the AP relay is the sum of all the individual alarm currents, and as a result with many simultaneous alarms, the relay not only overheats but may reduce the voltage across the lamps below the point for satisfactory illumination. By a careful selection of the type of lamp, the relay winding, and the two resistors in the lamp circuit, however, the permissible number of simultaneous alarms has been so greatly increased that all restrictions on the number of fuse panels have been removed. The panel lamps, indicated in Figure 4, are always red

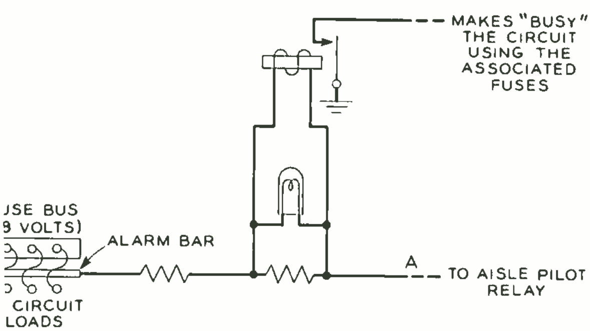


Fig. 6—A make-busy type of fuse alarm

since blown fuses in this system are arbitrarily classed under major alarms.

Telephone offices require a number of power supplies other than 48-volt battery, and heretofore a relay has been used for each panel for each type of supply since the panel lamps had to be lighted through relay contacts. For the No. 5 crossbar alarm system, however, the arrangement indicated in Figure 5 is employed. It is

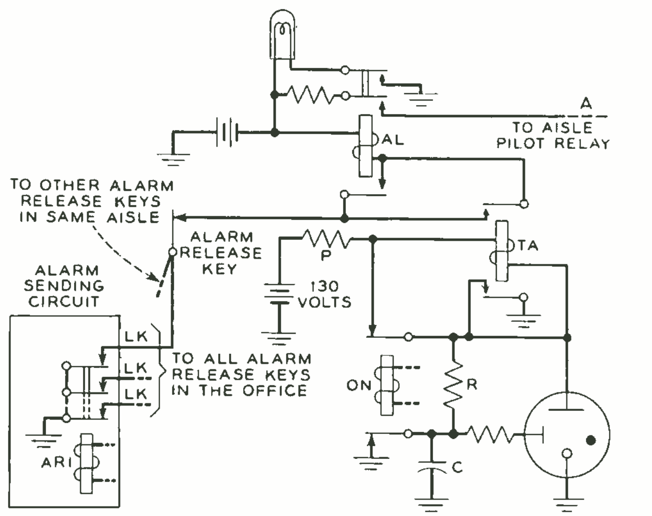


Fig. 7—A typical time alarm

known as the "pilot fuse" method since it employs a fuse in the regular 48-volt section of the panel as both a relay and indicator to give the alarm when a fuse in any other part of the panel blows. Five types of power supply besides 48-volt battery are shown in Figure 5, and the alarm contact or stud for each of the fuses in these five sections of the panel is connected to a separate pilot fuse in the 48-volt section of the panel. When a fuse blows and connects its particular power supply to its alarm stud, the pilot fuse is placed directly in series between the 48-volt battery and the other power supply. As a result, the pilot fuse blows and gives an alarm in the regular manner.

Some circuits, such as the marker or transverter, have a large number of fuses since it is not desirable to design them with a single fuse large enough to carry the entire load. However, should even one fuse blow, the effectiveness of the circuit is impaired and since the circuit is involved in a large percentage of the calls handled by the office, it is of the utmost importance not only to indicate an alarm if a fuse blows, but also to prevent the circuit from being selected for further use until the defective fuse is replaced. For such circuits, therefore, the arrangement shown in Figure 6 is employed.

A relay is connected in shunt with the

*Record, *October*, 1925, *page* 78; *September*, 1933, *page* 27; and *February*, 1939, *page* 178.

panel lamp, and if any fuse blows, not only will the regular alarm be actuated, but, in addition, the relay will operate and make this circuit busy. The relay has practically no effect on the fuse alarm, and thus does not affect the high reliability of the original arrangement. If a failure should occur in the wiring to the relay or in the relay winding, or if the adjustment of the relay is faulty, the regular fuse alarm in the system is still operated.

In addition to fuse alarms, many circuits are arranged to indicate other types of trouble, particularly an inability to complete functions within a reasonable time. To measure such time intervals, a condenser-timed cold-cathode-tube circuit is usually employed. One type of circuit is shown in Figure 7. When the circuit is selected, relay ON operates and remains operated during the entire in-use time. This removes the ground connection from capacitor C and allows it to charge from the 130-volt battery through the P resistance, the winding of relay TA, and resistance R. As the capacitor charges, the voltage between the control anode and the cathode increases. When this voltage is high enough to cause ionization, current will flow between the main anode and the cathode, thus operating relay TA. The operation of TA in turn operates relay AL, which lights a local alarm lamp and connects battery to lead A, which in turn connects to lead A of Figure 3. Through circuit components not shown in Figure 7, relay ON is then released, thus releasing TA, stopping the flow of current through the tube, and restoring the circuit to its original condition. Relay AL has locked itself in, however, and will remain operated to remember the trouble until it is manually released.

Another common source of alarms is the trouble recorder, since each time a trouble record is made, an alarm is given. These also are classified as major and minor, and light indicating lamps leading to the master test frame.

Since the No. 5 system was designed to serve small as well as large areas, it was planned to extend the alarms a large portion of the time to off-premises personnel. It has been necessary, therefore, to provide for transferring the alarms to a distant office where a maintenance force will always be available. All the alarms, therefore, are connected to an alarm sending circuit, which is indicated in both Figures 3 and 7. The alarm sending and receiving circuits, which are capable of identifying as many as seventy distinct types of trouble, will be described in an early issue.

THE AUTHOR: C. E. GERMANTON was graduated magna cum laude from Lafayette College in 1926, receiving the B.S. degree in electrical engineering. He then joined the Technical Staff of these Laboratories where, as a member of the Systems Development Department, he has since been principally engaged in the development of panel and crossbar switching circuits. During World War II he contributed also to the design of the operational flight trainers, which were built by the Western Electric Company for the Navy. Since V-E Day he has been designing circuits for the No. 5 crossbar system.

W. KOENIG
Transmission Engineering

A new frequency scale for acoustic measurements

In acoustical and telephone transmission studies of all kinds, various characteristics, such as loss, noise, sensitivity, and many others are plotted against frequency. Because of the octave relationship in music, a logarithmic scale for frequency has been most commonly employed. So far as the simple recording of engineering data is concerned, the particular scale used for frequency is of minor importance. It becomes important only when it is necessary to judge by eye the merits of changes in the response of telephone systems, reduction of noise, or the like. On a logarithmic graph for frequencies extending from 100 to 10,000 cycles, for instance, the 1,000-cycle point is half way across the chart, and thus makes the band of frequencies below 1,000 cycles appear as of the same importance as the band from 1,000 to 10,000 cycles. To avoid the overemphasis of the lower frequencies, a linear scale is sometimes used, but since on such a scale the 1,000-cycle point is only one-tenth the way across the chart, the importance of the lower frequencies is underemphasized.

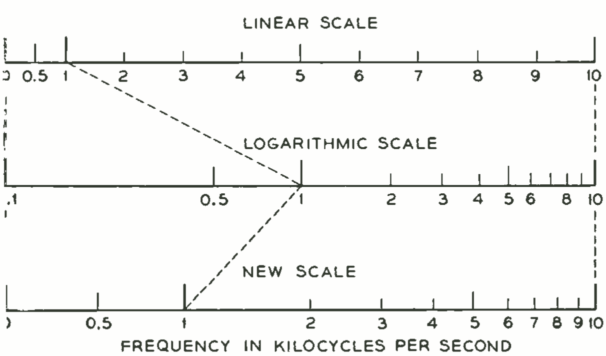


Fig. 1—The new frequency scale contrasted with linear and logarithmic scales

What has long been desired is a frequency scale that would proportion the space occupied by any band of frequencies to the importance of that band to the response of the ear, since it is this that is the criterion in all acoustical work. With this objective in view, an analysis was made of

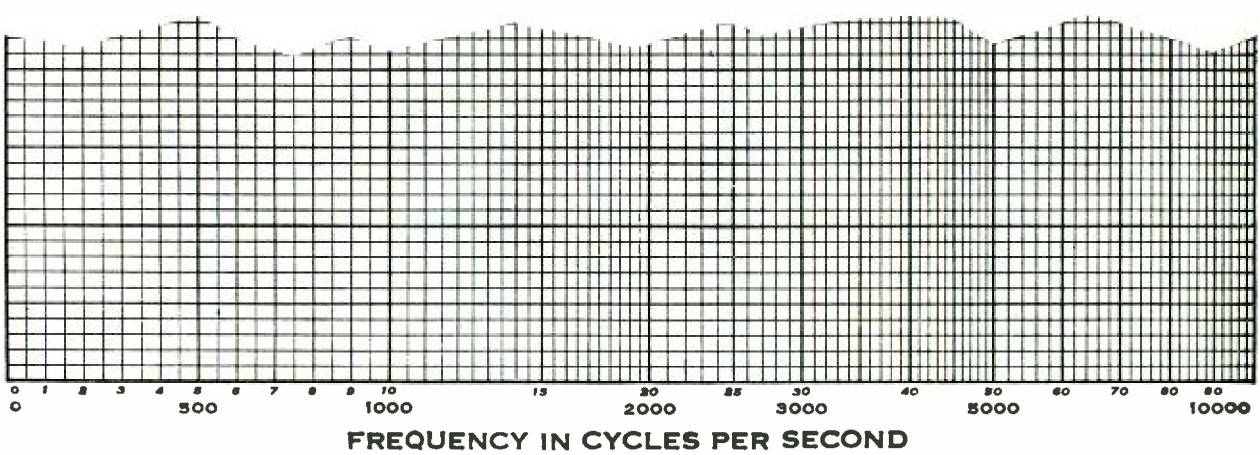


Fig. 2—A section of graph paper using new frequency scale. The actual sheets are seven large divisions high instead of the two shown above, and are stocked as E-1631-B

the various characteristics of the ear to determine what sort of a frequency scale would make them linear when plotted. Perfect linearity was not expected because the characteristics do not all vary in exactly the same manner.

It was found that if the frequency scale was made linear up to 1,000 cycles and logarithmic from there on, approximate straight lines would be obtained for all the characteristics studied. Such a scale is shown in Figure 1, together with a completely logarithmic and a completely linear scale. It will be noticed that on the new scale, the 1,000-cycle point is about one-third the distance to 10,000 cycles, which gives these two bands approximately the importance they have in telephone transmission. Moreover, there is a smooth transition at 1,000 cycles; the distance from 1,000 to 1,100 cycles is closely the same as that from 900 to 1,000 cycles. Each 100-cycle interval below 1,000 cycles, however, occupies the same distance along the axis, while above 1,000 cycles, the distances become progressively shorter in the familiar logarithmic manner. This is evident from Figure 2, which shows a portion of a standard form in use at the Laboratories for plotting responses, energy distributions of speech and noise, and the like. The vertical scale on this chart is linear, and is intended to be used mostly as a db scale, 1 db per division. Response curves for the old and present handsets with one mile twenty-four gauge loops, and a 900 ohm 9 db trunk are plotted on Figure 3 to show their appearance on the new paper.

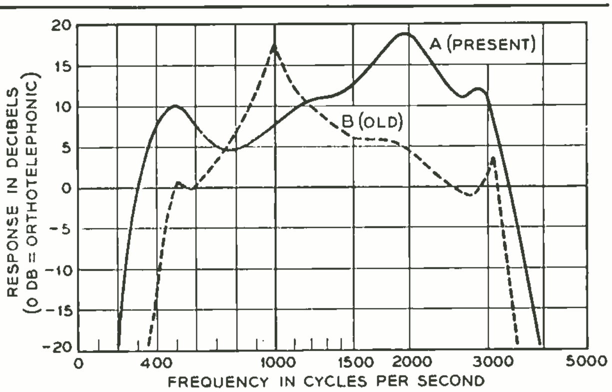


Fig. 3—Response curves for the old and present handsets plotted on the new scale

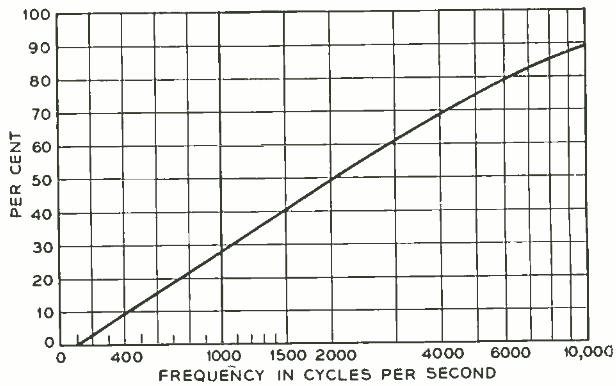


Fig. 4—A cumulative curve describing what percentage of the sensitive membrane of the ear is concerned with the perception of tones

How closely this new frequency scale represents the characteristics of the ear is shown in Figures 4, 5, and 6. Figure 4 is a cumulative curve of the number of nerve endings on the basilar membrane counting from the narrow end, and thus is representative of the response of the ear. Twenty per cent of the nerve endings, for example, are concerned with the perception of frequencies below 750 cycles, forty per cent below 1,500 cycles, seventy-five per cent below 5,000 cycles, etc.

As shown in Figure 4, this was deduced indirectly from tests of the masking effect of noises, and from tests of the minimum percentage change in pitch that can just be noticed by the ear. This curve is substantially linear over most of the frequency range, whereas it would be decidedly S-shaped on ordinary logarithmic coördinates, and highly concave downwards on linear coördinates. That it bends down slightly at the high end is not felt to be sufficient justification for departing from the familiar logarithmic scale that is used in this region.

Figure 5 is another cumulative curve. It is derived from articulation tests, and shows the importance of various frequency regions to the perception of speech sounds. The fifty per cent point, for instance, is at 1,900 cycles, and the one hundred per cent point at 7,000 cycles, which means that the region below 1,900 cycles is equal in importance to the region from 1,900 to 7,000 cycles. This curve also is not quite a

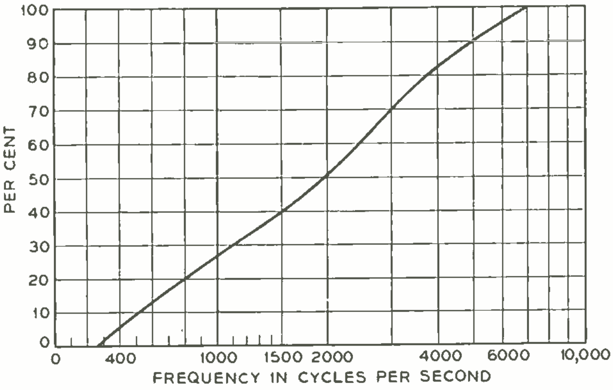


Fig. 5—Any two frequency bands showing equal percentage increments on this curve have the same inherent importance to articulation

straight line, but is much more nearly so than it would be on either a linear or a logarithmic scale.

Figure 6 shows some additional subjective data, derived from tests made to determine how much the cutoff of a high-quality telephone system could be reduced before its effect on speech could be noticed in an A-B listening test. Progressive cutoff steps were thus determined at both the high and low frequency ends. The whole frequency region from 100 cycles to 10,000 cycles is divided into thirty just-noticeable steps. The region below 550 cycles, for instance, includes five just-noticeable steps of high-pass cutoff; at the high end, there are five just-noticeable steps of low-pass cutoff above 5,200 cycles, five more between 5,200 and 2,900 cycles, etc. The dotted region was not explored, but all the data can be represented closely by the curve which again is nearly a straight line.

The new scale is easy to specify: 2 inches from 0 to 1,000, linearly divided; 4½ inches from 1,000 to 10,000, logarithmically divided. This specification has the advantage of not being tied to subjective determinations, which are subject to change, and yet corresponds closely enough to the ear characteristics for practical purposes.

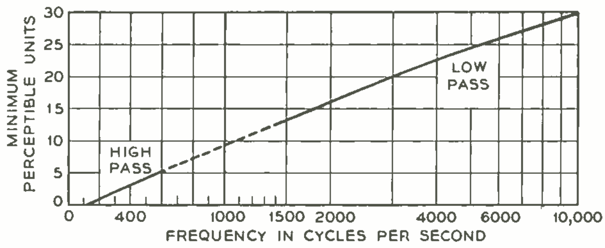
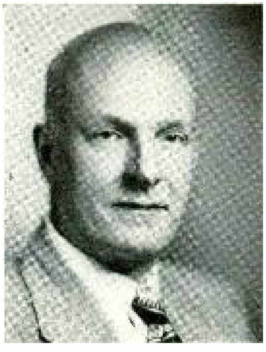


Fig. 6—If the cutoff of a high-quality telephone system is changed from one frequency to another differing by one unit on the ordinate scale, the change will be just perceptible to the average listener



THE AUTHOR: WALTER KOENIG, JR., received the A.B. degree from Harvard in 1923, and then remained for a year as instructor and research assistant. In 1924 he joined the D. & R. Department of the American Telephone and Telegraph Company, where he was associated with a group concerned chiefly with studies relating to transmission quality, including analysis of the physical characteristics of speech and the structure of telephone conversation. During the war he was associated with several projects of the National Defense Research Committee, for which he received the Army-Navy Certificate of Appreciation. The present article is a report of work begun before the war.

Helen Keller Visits Murray Hill

A decade ago after Miss Helen Keller had visited the West Street laboratories, she said, "I feel that I have visited a little city of people who were interestedly doing the most interesting things for the good of the world." On June 14, this year, she was our guest again, this time at the Murray Hill laboratory; on leaving, she confirmed with enthusiasm her earlier sentiments.

Helen Keller's life story is well known through her remarkable attainments as lecturer, writer, and particularly as champion of handicapped people. After losing her own hearing and sight at the age of 19 months, she later learned the art of vocal expression with the patient help of devoted teachers.

It was Alexander Graham Bell who obtained Anne Sullivan (Mrs. Macy) as Miss Keller's first companion-teacher. Dr. Bell was Helen Keller's firm friend, and her host on many occasions. Miss Polly Thomson, who has been Miss Keller's companion for many years, succeeded to Mrs. Macy's rôle. Miss Thomson accompanied Miss Keller on each of the visits to Bell Laboratories.

In the foyer at Murray Hill this group was photographed on the occasion of the visit of Miss Helen Keller in June. Left to right: H. B. Ely, Ralph Bown, Miss Polly Thomson, Miss Keller, T. C. Fry and R. K. Honaman

Through the acoustical and several other laboratories at Murray Hill, the guests were escorted by T. C. Fry, R. K. Honaman and H. B. Ely. Miss Keller studied a model of the building and grounds and commented accurately on the scale; she perceived the physical aspects of the free space room and heard the story on synthetic crystals. Passing her hands knowingly over crystals of various sizes and lifting them, she was able to assess the rate of their growth.

She tested the effects of acoustic lenses and sensed the rhythm of the music through her touch on a modified recorder stylus attached to a pick-up microphone. She learned of the trends in component miniaturization and the significance of the Transistor and took a short course in the relay computer. Finally she renewed acquaintance with Dr. Bell's harmonic telegraph and first telephone models, progressing delightedly from them through the desk stand and early handsets to the new combined telephone set.

Miss Keller and Miss Thomson were in constant communication during the Murray Hill tour. Miss Thomson swiftly conveys messages by means of pressure signals on Miss Keller's palm, and in some instances, Miss Keller reads Miss Thomson's lips by placing the ends of her fingers lightly upon them. Miss Keller spoke back readily or, with her sensitive touch, carried out some action suggested by the demonstrators during the tours.

Members of the Laboratories who told Miss Keller and Miss Thomson of their work were W. E. Kock, F. K. Harvey, A. C. Walker, R. S. Graham and W. C. Jones.

Following her visit to the Laboratories, Miss Keller wrote to Dr. Buckley a letter which he is happy to share with readers of the Record and which appears on the facing page.

and L. A. Weber, and *Power Supplies for Coaxial Systems*, H. H. Spencer.

Included in the Symposium on Electrical Properties of Semi-conductors and the Transistor, the papers were: *The Conductivity of Silicon and Germanium as Affected by Chemically Introduced Impurities*, G. L. Pearson; *Internal Photoeffects in Germanium*, J. N. Shive; *Theory of Transistor Action*, W. Shockley; and *Equivalent Circuits for Transistor Action and Noise*, R. M. Ryder.

In the section covering Computing Devices, E. G. Andrews presented *The Bell Computer*.

R. K. Honaman and A. R. Thompson attended meetings of the Publication and of the Transfers Committees, and a special meeting of Sections delegates devoted to a discussion of A.I.E.E. publicity. Mr. Honaman is chairman of the Committee on Public Relations.

Others who attended included D. E. Trucksess, E. I. Green, J. D. Tebo, R. C. Davis, W. Keister, A. E. Ritchie, S. H. Washburn, G. R. Frost and O. Myers.

II where he will engage in studies of design and production economy, reporting to W. L. Casper.

N. Insley will join the Switching Apparatus Development Department to take up work on relays.

P. A. Byrnes, Miss M. M. Cook, L. L. Lockrow, T. L. Tanner, Mrs. B. R. Timm and E. J. Zimany, together with their work on switchboard and resistance lamps and station equalizers, were transferred to the Electronics Apparatus Development Department.

C. A. Webber and his group who develop cords—W. S. Eno, N. C. Hazell, F. S. Kammerer, F. Lindberg and H. H. Staebner—were transferred to the Station Apparatus Development Department.

D. R. Brobst and his group—R. W. Bogumil, W. A. Bunzel, H. C. DeValve, W. J. King and J. I. Stockwell—who develop insulated wire and switchboard cable, remain in the Transmission Apparatus Development Department, reporting to P. S. Darnell.

The annual luncheon of the Bell Laboratories Club was attended by the old and new officers and representatives. Left to right, seated: T. J. Grieser, R. A. Deller, Mrs. C. A. Smith, D. D. Haggerty, D. A. Quarles, J. A. St. Clair, newly elected president, E. K. Eberhart, retiring president, F. D. Leamer, W. C. Toole and Miss Fay Hoffman, newly elected second vice-president. Standing: J. J. Harley, A. Zitzman, R. B. Miller, A. J. Kuczma, Mrs. M. H. Read, J. C. Kennelty, J. G. Whytock, R. L. Shepherd, J. Marshall, E. A. Perpall, G. E. Perreault, W. E. Grutzner, G. H. Reuble, E. K. Casey, W. H. Thatcher and S. D. White

Changes in Organization

The following changes in organization took place recently in Apparatus Development Departments I and II:

E. B. Wood took up new duties as a Consultant in Apparatus Development Department

J. H. Bower and Mrs. M. Morrissey, with their work on primary batteries, were transferred to P. S. Darnell.

O. C. Eliason and J. P. Messana were transferred to R. O. Grisdale and will continue temporarily their activities on air conditioning and sealed terminal problems respectively.

RETIREMENTS

Recent retirements from the Laboratories include W. E. Mougey, with 42 years of service; O. E. Rasmussen, 36 years; R. L. Wegel, 35 years; A. G. Eckerson, 31 years; and B. L. Leger, 29 years.


W. E. Mougey   O. E. Rasmussen

Wilbur E. Mougey

Wilbur Mougey recalls that soon after he entered the Bell System, people were saying that the 600-pair exchange area cable and the 10-gauge loaded toll cables were literally the "last word" in cable engineering. In spite of that, Mr. Mougey helped to reap quite a harvest in a supposedly worked-out field.

After graduation from Ohio State University in 1907 and two years student training at Hawthorne, Mr. Mougey came to West Street and became associated with the physical testing laboratories. In 1910 he returned to Hawthorne and took up cable engineering and development. The cable designer's art requires close contact with manufacture because there are no breadboards, no mock-ups. The production machinery is the source of all specimens of new designs required for testing and evaluation.

During the next two years at Hawthorne, Mr. Mougey specialized in the design of toll cables, which at that time utilized heavy gauge conductors in configurations suitable for obtaining phantom circuits. The Western Electric Company had a decided lead over domestic and European competitors in the field of toll cable design and through its subsidiary company, Western Electric Limited in England, had captured an order for a quadded cable between London and Birmingham. To carry out this contract, they needed the benefit of know-how in latest American toll cable practices. Mr. Mougey, being a bright and energetic young engineer, had learned his trade rapidly and was selected to go to England to assist in the design, manufacture, installation and testing of this cable. He spent nearly three years on this project, returning late in 1915 to Hawthorne.

In World War I, he was Lieutenant Mougey of the Signal Corps Research and Inspection Branch in Paris. Demobilized, as well as delighted, he reported to Western Electric's London Office in 1919 and assisted in the manufacture of the initial three submarine cables for installation between Havana and Key West. In the years following, he was sent to 10 European countries whose cable factories had contracted for Western Electric help in the engineering, manufacture and installation of toll cables for their respective governments. Mr. Mougey was the author of some of the earliest European specifications for these cables. Also during this period he had the interesting experience of participating in the laying of a submarine cable in Pacific equatorial waters between Fanning Island and Suva in the Fiji Islands.

Upon the withdrawal of Western Electric from the foreign field, he returned to the Laboratories in 1926 and shortly thereafter, in 1928, took charge of our toll and exchange area cable engineering group at Western's Kearny Works. Ten years later he rose to the position of Cable Engineer in charge of all Laboratories cable development, excepting deep sea submarine types.

A list of the cable developments in the last twenty years is impressive—it includes pulp insulation, steel and jute protection for burial in earth; unit-stranding for cable cores; use of wires as fine as 28 gauge for exchange cable; layer shields for carrier-in-cable; quadded cable suitable for the high frequencies of type J carrier; coaxial cable, video pairs and, more recently, new developments in sheath, including alpeth and lepeth which make use of mutually reinforcing layers of metals and plastics. Mr. Mougey contributed substantially in the technical phases of all of these advances and, in the course of his many years of experience, developed to a remarkable degree that sixth sense or intuition which is so important to a successful cable engineer. He also provided the leadership, encouragement and guidance which stimulated other engineers in the successful advancement of an art where the rules cannot be exactly stated and the stakes on failure or success are high.

After retirement, which is at his own request, Mr. Mougey expects for a time at least to continue to live in Summit, New Jersey, and to make use of his increased leisure time in further studies of golf, American and European history, and old firearms, of which latter he has a substantial collection.

Raymond L. Wegel

R. L. Wegel joined the Laboratories in 1914, having specialized in theoretical physics at the University of Wisconsin and spent two years at the Edison Laboratory at Orange, New Jersey. His field has been industrial physical research and his activities directed to such practical problems in the telephone art as can be helped by improved understanding of the physical processes and principles involved.

Among his early contributions were the practical rationalizations of some of the physical problems of telephone receivers and transmitters, relays, mechanical filters, and other transmission apparatus. In the field of physiological physics he contributed to the early work on theories of the mechanism of hearing and of the voice. His more recent projects were the introduction into the Laboratories of the study of internal friction in solid materials and a physical study of the various phases of the dynamics of contacts.

Mr. Wegel has held memberships in the main scientific and engineering societies. During the first and part of the second world wars, he was engaged in antisubmarine projects and during the latter part of the second, on physical problems concerned with sound ranging, at Duke University.

After his retirement, which is at his own request, Mr. Wegel plans to live with his family at his home in Putnam County, New York.

Osvald E. Rasmussen

Thirty-six years ago Osvald Rasmussen came over from Copenhagen and joined Western Electric's patent department as a draftsman. He had graduated from a technical school and continued his studies at Cooper Union, where he received his B.S. in 1917 and E.E. in 1921; he became a citizen in 1919. Eventually, he was chief draftsman; and with his transfer to the Laboratories in 1925, he became a patent attorney. During the next quarter-century he worked in a variety of fields: magnetic materials, telegraphy, rubber chemistry and telephone cables.

A. G. Eckerson

B. L. Leger

"The Telephone Hour"

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

August 8	*Gladys Swarthout*
August 15	*Ezio Pinza*
August 22	*Mixed Chorus*
August 29	*Licia Albanese*
September 5	*John Charles Thomas*
September 12	*Barbara Gibson*
September 19	*Pia Tassinari and Ferruccio Tagliavini*
September 26	*Lily Pons*

Abram G. Eckerson

Someone did the Bell System a good turn when he recommended to Abram Eckerson that the Laboratories would be a good place to work. That was in 1918; and not only has Mr. Eckerson worked here for thirty-one years, but his son was with us until the Navy claimed him in World War II.

Until 1929, Mr. Eckerson worked in stockrooms; then he transferred to the Central Instrument Bureau. His job has been to issue and receive instruments, to check their accuracy and make minor repairs, and to solicit their return when others need them. It has been an interesting job, he says, both at West Street and at Murray Hill, where he moved in 1941. During the war, things were really hectic, with greatly increased laboratory work, often in fields where new types of instruments were needed and with all instruments in short supply.

Out-of-hours, Mr. Eckerson is happiest with either a bowling ball or a paint brush in hand: he rolls in the Laboratories league and he paints houses—inside and out—for his friends.

Benoit L. Leger

When stabilized feedback was invented back in the nineteen twenties, Patent was duly notified and preparations were begun to file an application. B. L. Leger's half-dozen years on telephone repeaters indicated him for a job which was to last off and on for twenty years. The field was a difficult one; many of the ideas were best expressed in mathematics, and a clear physical picture was hard to grasp. Mr. Leger's analytical mind enabled him to prepare a series of applications which have clearly established our position in the art.

After graduation from University of Michigan in 1911, Mr. Leger was for a time with

Systems Chorus Entertains Life Member Club

The noon-hour meeting on May 13 of the Pioneer Life Member Club in the West Street Auditorium was highlighted by a concert of the Systems Glee Club under the direction of L. P. Yeaton. The first part of the concert was a piano solo, *Waltz in C Minor* by Chopin, played by Helen Herrmann, at left, accompanist; the second part, three numbers by the Glee Club: Brewer's *Alexander*, Brahms' *Lullaby* and Sullivan's *The Lost Chord*.

Following the entertainment was the annual business meeting at which C. W. Lowe was elected president of the Pioneer Life Member Club; W. J. Shackleton, vice-president; and Helen Craig, secretary-treasurer. Isabel Benedict, A. G. Hargan and E. D. Johnson were elected members of the executive committee.

General Electric, then returned to his home city of Washington, where he entered the Patent Office. After several years as an assistant examiner, he joined our Patent Department in 1920.

A bachelor and a resident of Washington Square, Mr. Leger looks forward to retirement at his own request as an opportunity to see more of his many friends and to get around the country a bit.

Change in Organizational Title

The title of the Specialty Products Development Department (8700) has been changed to Military Electronics Department. R. E. Poole, who was Director of Specialty Products Development, is now Director of Military Electronics Development.

News Notes

O. E. Buckley was in attendance at the New York Telephone Company Operating Conference on June 16 at the Seaview Country Club, Absecon, New Jersey, and gave a talk covering some recent Laboratories' developments.

M. J. Kelly attended a meeting in Washington of the Research and Development Board Committee on Navigation and a meeting at White Oak, Silver Spring, Maryland, of the U. S. Naval Ordnance Advisory Board.

J. R. Flegal, C. B. Green, W. G. Pfann, N. Y. Priessman, J. H. Scaff, G. K. Teal, and M. C. Waltz attended sessions of the I.R.E. Conference on Electron Tubes and Semiconductor Devices at Princeton.

W. M. Stuart, Jr.
1879-1949

William M. Stuart, Jr., who died on June 25, joined The Bell Telephone Company of Pennsylvania in 1906, and served first as a subscriber's station installer and later as an inspector of this work. He was subsequently transferred to inspection work on PBX installations, and before joining the Western Electric Company in 1915, was special inspector for the City of Philadelphia. He came to West Street as a member of the circuit laboratory, where he engaged in work on subscriber's station ringing circuits, for which his earlier experience had admirably fitted him. At the time of his retirement in 1944, he was a member of the dialing and ringing group of Switching Development.

News Notes

D. A. Quarles and R. K. Honaman attended the Bell System Conference on Public Relations at Absecon, New Jersey.

W. H. Brattain, J. Bardeen and G. L. Pearson attended the I.R.E. Conference on Electron Devices at Princeton, at which Mr. Pearson presented a paper, *Filamentary Transistors.*

B. T. Matthias and Elizabeth Wood presented papers entitled *New Ferroelectric Crystals* and *Barium Titanate,* respectively, at the American Chemical Society meeting in Pittsburgh. They also attended ASXRED meetings at Cornell, where Dr. Matthias presented a paper on *New Ferroelectric Crystals* and Dr. Wood presented a paper on *High and Low Temperature Forms of Barium Titanate.*

R. M. Burns spoke on *Qualifications of Chemical Engineers for Industrial Research* before the American Society of Engineering Education at Troy, New York. Dr. Burns has been elected chairman of the New York Section of the American Chemical Society.

P. P. Debye attended a symposium on *Particle Size* at the Illinois Institute of Technology, and the annual symposium on *Absorption Spectroscopy* at Ohio State University.

J. J. Lander gave a talk on *An X-Ray Diffraction Study of the BaO-NiO System* at the American Chemical Society Conference in Pittsburgh. Mr. Lander also attended the ASXRED Conference at Cornell University, where he presented a paper which was entitled *Anion Rotational Disorders in Alkaline Earth Carbonates.*

F. S. Malm and G. N. Vacca attended a meeting of the Wire and Cable Technical Advisory Committee, U. S. Department of Commerce, in connection with the evaluation of *Cold Rubber* for the wire and cable industry. Mr. Vacca has been reëlected treasurer of the North Jersey Section of the American Chemical Society.

H. F. Dienel and G. K. Teal discussed silicon carbide varistors with Western Electric engineers at Allentown.

F. H. Winslow attended the Eleventh National Organic Chemistry Symposium of the American Chemical Society held at Madison, Wisconsin.

L. A. Wooten participated in a symposium on Organic Reagents in Analytical Chemistry sponsored by American Chemical Society at Wesleyan University, Middletown, Connecticut. He served as chairman of a symposium on *Rapid Methods for the Identification of Metals,* held by A.S.T.M. Committee E-3 on Chemical Analysis of Metals, at Atlantic City.

U. B. Thomas took part in battery tests in several K carrier auxiliary stations in Nebraska.

A. V. Lewis and A. H. Lince assemble a delay lens and horn at Holmdel for test before it is put in service on the New York-Chicago radio relay route

K. G. Coutlee, I. L. Hopkins, C. L. Luke, H. V. Wadlow, H. Peters, E. K. Jaycox, L. A. Wooten, G. Deeg, A. H. Falk, J. J. Martin, G. H. Williams and E. E. Wright attended the meetings of the A.S.T.M. in Atlantic City, during which Mr. Jaycox was appointed chairman of Subcommittee V on Nickel and Copper Alloys of A.S.T.M. Committee E-2. W. Babington attended meetings of A.S.T.M. Committee B-6; F. G.

Foster, meetings of Committee E-4; and I. V. Williams, meetings of Committee B-7 and Committee A-10. H. V. Wadlow presented a paper coauthored by H. W. Hermance entitled *Electro-Spot Testing and Electrography*. J. R. Townsend presided at two sessions of the convention as chairman of meetings of Committee E-1 on Methods of Test and Committee B-6 on Die Castings. G. R. Gohn attended meetings of Committees E-1 and E-9 and presented papers, *The Creep Characteristics of Compression Molded Polyethylene*, by J. D. Cummings, W. C. Ellis and Mr. Gohn, and *A New High-Speed Sheet Metal Fatigue Testing Machine for Unsymmetrical Bending Studies*, by Mr. Gohn and E. R. Morton.

R. K. Potter presided over the symposium on visible speech and music during the Central Section meeting, June 10 in Toledo, of the Society of Motion Picture Engineers.

J. C. Steinberg attended the Physics Colloquium at the University of Iowa, where he gave a talk on *Research in Speech*.

J. R. Weeks was at Hawthorne and Archer Avenue on general problems relating to aluminum can condensers and networks.

J. R. Pierce, with Nelson Wax of the University of Illinois as coauthor, published an article, *Filter-Type Traveling-Wave Amplifier*, in the June issue of the *Proceedings of the I.R.E.*

L. W. Giles' trip to Haverhill was in relation to the manufacture of retardation coils.

F. F. Siebert and B. E. Stevens went to Haverhill regarding core material applications in power apparatus.

P. S. Darnell, L. W. Kirkwood and A. B. Haines visited the New York Transformer Company at Alpha, New Jersey, in connection with the airborne transformer development.

D. E. Cavenaugh discussed JAN requirements on power transformers and reactors at Squier Laboratories, Fort Monmouth.

A. B. Haines attended meetings of RMA Subcommittee TR 9.4 on Power and Audio Transformers in Chicago and the meeting of the A.I.E.E. Subcommittee on Magnetic Amplifiers at Swampscott.

L. W. Giles was a guest speaker on The WNBC Stamp Club meeting on June 4, which featured the Course in Philately, sponsored by the Philatelic Foundation, Inc., and conducted weekly at the Collectors' Club in New York.

"Don't be afraid of it, Joe, it's only a new cable sheath from Bell Labs"

P. S. Darnell conferred at Fort Monmouth on RDB activities on resistors.

M. Salzer visited the Towson, Maryland, and Glenolden, Pennsylvania, central offices in connection with field studies of trouble recorder perforators.

L. N. Hampton's visit to the Teletype Corporation was in connection with production status of trouble recorder perforators.

R. H. Ross and L. C. Wescoat discussed the testing of synchros at the Frankford Arsenal, Philadelphia. Mr. Ross also visited the Leese-Neville Company in Cleveland in connection with the manufacture of power equipment for radio equipment.

L. D. Fry made noise studies on the exhauster sets for the pneumatic ticketing system at the Troy office.

"She won't trust anyone else to take it to Murray Hill"

D. L. Moody and A. A. Hansen attended the cutover of the new No. 4 toll switching system at Cleveland. Mr. Hansen visited the Columbus and Mansfield, Ohio, toll offices in connection with performance studies of single frequency signaling equipment, and also the Philadelphia No. 2 toll office in connection with tests of improvements in the 2A signaling test set.

N. A. Newell was in Milwaukee and Madison in connection with the N1 carrier trial.

C. A. Dahlbom and N. B. Rowe conducted tests on single frequency signaling circuits in Philadelphia.

W. L. Betts discussed ringing machine designs with the Holtzer Cabot Company at Boston and also attended a quality survey conference on charging and ringing sets at the General Electric plant in Lynn. He recently attended a Regional delegates' conference at San Francisco as a delegate from Region 2, American Society of Mechanical Engineers.

R. H. Miller witnessed the cutover of No. 4 toll office in Cleveland.

A. E. Gerbore was in Pennsylvania in connection with the operation of the No. 5 crossbar office at Media.

Mary Pilliod and G. V. King visited Philadelphia for a day in connection with the cutover of the No. 1 crossbar of the Madison-Clearbrook office.

J. Meszar and G. Riggs conferred at Hawthorne on the development of automatic message accounting equipment; J. G. Ferguson and L. J. Purgett on No. 5 crossbar.

F. S. Farkas visited Milwaukee, where he conducted tests on signaling circuit stability tests for N1 carrier.

K. G. Van Wynen, President of the Board of Education of Ramsey, New Jersey, addressed the High School graduating class on the subject of *Investments* at the outdoor commencement exercises June 20. The class of 199 was the largest to date.

F. B. Combs visited the Radio Shop in Winston-Salem in connection with mobile radio manufacturing problems.

J. G. Nordahl attended an RMA committee meeting in Washington to discuss with FCC engineers the new FCC operating rules and their effect on equipment for the mobile radio.

The Country Gentleman

"When he said he wanted to talk with a friend, I thought he wanted to use the phone!"

G. H. Klemm and C. G. Reinschmidt witnessed the making of and inspected the first tool-made sample of the plastic antenna dome for TE-2 radio system parabolic antennae at the Steiner Manufacturing Company, in Long Island City.

V. B. Pike visited Columbus, Cleveland and Chicago to discuss matters in connection with the design of special switches.

Collegiate Degrees

Members of the Laboratories to whom collegiate degrees have been awarded recently are:

V. W. Bennett	B.M.E.	C.C.N.Y.
G. F. Clement	M.A.	Columbia
R. W. Edmonds	B.S. in E.E.	Newark Col. of Eng.
W. J. Fullerton	B.S.	Seton Hall
E. A. Hake	B.E.E.	Cooper Union
B. P. Herbort	B.A.	Brooklyn College
H. E. Kern	B.S.	Brooklyn Poly
Joseph Kocan	B.S. in E.E.	Newark Col. of Eng.
Grace Lakin	M.A.	Columbia
Stella Lawrence	B.E.E.	Brooklyn Poly
W. F. Miller	M.S.	Stevens
F. J. Osolinik	B.S.	N.Y.U.
W. J. Perry	B.S.	N.Y.U.
June Sandberg	B.A.	Upsala
W. R. Sittner	Ph.D.	Northwestern
M. V. Sullivan	B.E.E.	Brooklyn Poly
R. L. Trent	M.S.	Columbia
W. G. Turnbull	M.S.	Stevens
D. J. Van Slooten	B.S. in E.E.	Newark Col. of Eng.
E. C. Walsman	M.B.A.	N.Y.U.
C. A. Warren	M.S.	Stevens
H. R. Wilsey	M.S.	Stevens

A. H. Inglis and A. W. Hayes visited various Telephone Companies at Minneapolis, Omaha, New Orleans and Los Angeles in connection with the trial of the new telephone set. Following this, Mr. Inglis further visited St. Louis, Chicago and San Francisco.

W. G. Breivogel, at Archer Avenue, discussed problems related to manufacture of dials and A. Herckmans, the dial of the new station telephone set. Mr. Herckmans, W. L. Tuffnell and L. Vieth visited Hawthorne in connection with the dial of the new telephone set.

W. Kalin visited the Western Electric Company at Burlington on hearing aid problems.

L. R. Snoke conducted experimental spraying treatments for chemical brush control along the Reading–Wilkes-Barre "B" cable right-of-way near Hamburg, Pennsylvania.

R. H. Colley and J. Leutritz, Jr., were at the Forest Products Laboratory, Madison, Wisconsin, in connection with coöperative laboratory evaluation tests of modern creosotes.

D. C. Smith and R. C. Eggleston attended the American Society for Testing Materials Convention in Atlantic City in connection with the development of standard test procedures for evaluating the strength of wood poles.

J. G. Brearley, F. W. Horn, C. F. Wiebusch and V. T. Wallder went to Miami on matters of alpeth sheathed cable.

C. H. Amadon supervised experimental treatments of lodgepole pine poles at Denver.

H. C. Rubly, accompanied by J. D. Jensen of A T & T, visited the Ohio Bell at Columbus, the Illinois Bell at Chicago, the Southwestern Bell at Kansas City and The Chesapeake and Potomac Telephone Company at Richmond, Washington and Baltimore in connection with an improved design of stapler for use in securing JKS station wire. T. A. Durkin participated in the work at The Chesapeake and Potomac Company's locations.

W. J. Lally discussed field requirements for a high-strength drop wire with the Wisconsin Telephone Company at Milwaukee and the Southwestern Bell at St. Louis.

W. J. Anderson and C. Shafer, Jr., were in Hartford on a field study of a dehydrated compressed air system for toll cable maintenance. Mr. Shafer also discussed exchange plant maintenance at Media and Trenton.

L. S. Inskip and H. B. Brehm met with engineers of the New England Telephone and Telegraph Company to discuss details of proposed field trials of surge-resistant fuses and NC-16 distribution cable terminals. Mr. Brehm was in New Haven and Thompsonville, Connecticut, in connection with the trial installation of surge diverters by the Southern New England Company.

B. H. Nordstrom went to the Navy Department in Washington to discuss the development of fire control equipment.

C. R. Taft's trip to New London was in connection with electronic apparatus for submarines.

Engagements

*Bernice Bielecki—William F. Coughlin
*Muriel Bryer—Thomas Dandrea
*Virginia Chaya—Charles Laible
*Madeline Gabay—Robert Smith
*Joan Mellen—Edward J. Cannon
*Mary Reibel—Thomas J. Corcoran
*Mabel Samper—Frank V. Perretta
*June Sandberg—Carl Lilja, Jr.
*Gladys Singewald—Arthur E. Judd
*Margaread Ward—Ernest White

Weddings

*Carmela Arfuso—Dominick Liantonio
*Myra Brown—*Allan J. Rosselet
Patricia Collins—*Robert D. Williams
*Enid Cummings—Charles M. Hinds
Dorothy Knopf—*Roy W. Bruning
*Mary Ann O'Hearn—Daniel J. Courtenay
*Shirley Perry—Ernest J. Bittman, Jr.
*Stella Pluta—John T. Jersitz