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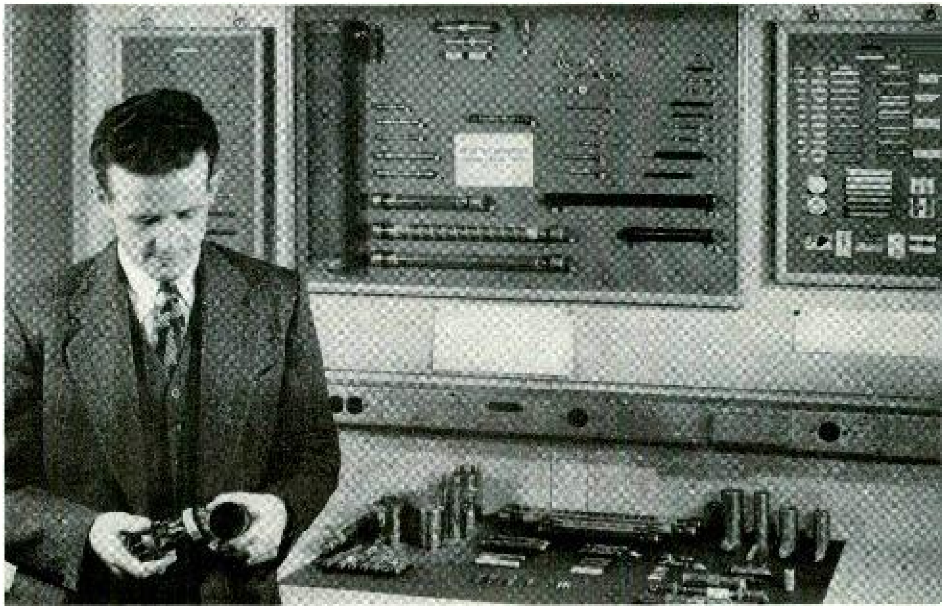
A. C. PFISTER
Transmission
Apparatus
Development

PRECISION CARBON RESISTORS

Because resistors are among the oldest elements of electrical circuits, the equipment designer has a great variety of sizes and types available. The earliest resistors and still the best for many purposes are those made of wire; they have been progressively improved through advances in metallurgy and in techniques of fabrication. However, wire wound resistors are relatively expensive and large in size so other types were naturally developed for the manifold uses not requiring wire wound accuracy and stability, and possessing the important qualities of small size and low cost. Among the latter are the well-known composition or carbon resistors employed in almost astronomical numbers in radio and other electronic equipment. In prewar planning for the Laboratories' electrical gun director* the potential supply of stable high-value resistors appeared critical. A

*RECORD, *January*, 1944, *page* 225.



A. C. Pfister holding an amplifier input network nesting several precision carbon resistors. Other carbon resistor developments are shown on the display boards

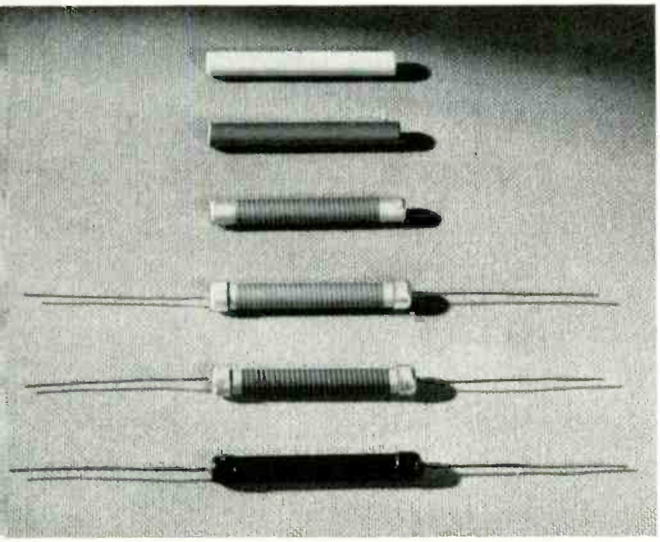


Fig. 1—Production steps for varnished resistors. The cylinders are two inches long

review at that time indicated that the facilities in this country for drawing the necessary small gauge alloy wire would have been taxed to the utmost to supply wound resistors at the necessary rate solely for this one apparatus; hence it became essential to develop a suitable substitute employing non-critical materials. Then came a special precision type of resistor, also made from carbon, in which the merits of wire wound resistors were combined with the smaller sizes and lower costs of the composition varieties. These newer deposited carbon resistors, developed by Bell Telephone Laboratories, are improved versions of similar products made in Europe prior to the war.

As the name implies, deposited carbon resistors are made by laying down very thin films of pyrolytic carbon, which is carbon obtained by the thermal decomposition of gaseous hydrocarbons at high temperatures, on the surfaces of ceramic cores. This is a process like that by which the undesired carbon deposits in internal combustion engines are formed.

Pyrolytic carbon films had previously been used in the Laboratories to produce and study carbon for microphones and, as an outgrowth of such work, to make resistors for high frequency application. Similar products made in Europe prior to the war were known to be particularly well suited for high frequencies since there is no skin effect, small reactance, and an effective resistance reasonably independent of frequency.*

By suitably controlled methods, the carbon film can be produced on cores in thicknesses as desired, ranging from 1×10^{-4} to 5×10^{-8} inches; the lower limit is of the order of the average thickness of the crystallites of which the films are composed. Though the thickness of these films is that of thin high resistance metallic films, the critical dependence of temperature coefficient on thickness, present in metallic films, is not found in them.

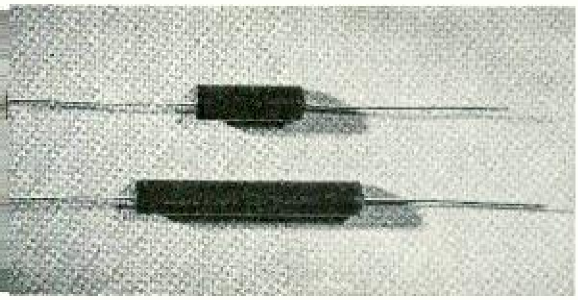
Uniform carbon films on rod surfaces have resistance values ordinarily measured

*See page 407 of this issue.

Fig. 2—To prevent contamination before and aft[er] firing, the carbon resistor blanks are careful[ly] handled. R. H. Braun, wearing a cotton glov[e] removes blanks from the end hopper of the labor[a]tory apparatus

only in thousands and tens of thousands of ohms. Greater values in the millions of ohms are obtained by grinding a helical groove through the carbon film making, in effect, a carbon ribbon wound around a ceramic core. The increase in resistance from the unspiralled to the spiralled condition on the same form can be varied over a range from about four to almost ten thousand times.

After spiralling, the ends of the resistor cores are provided with low resistance electrodes of either graphitic or special metallic paint. The electrodes are then cured by baking and metal ferrules with integral lead wires forced over them, after which a selected baking varnish is applied.



ig. 3—*Deposited carbon resistors in phenolic pro-ective shell. The barrel of the smaller unit is one ıch long*

Steps in the production of such a varnished resistor are indicated in Figure 1.

In the initial attempt to produce resistors in the megohm range, previously uncontrolled factors were found to be important in determining resistor characteristics and stabilities, paramount among these being the nature of the ceramic surface. It had been recognized earlier that the ceramic core must be nonporous to prevent deposition of carbon through its volume; also it was learned that the degree of surface perfection was directly associated with the resistance stability of the film. Study proved that direct correlation exists between the number of microscopic surface imperfections and the resistance stability, the temperature coefficient of resistance, and the random noise that is in excess of thermal noise.

Experience accumulated in the Laboratories' earlier work on microphone carbon served as a valuable guide, for the noise generated at minute porous regions or cracks is the result of loose and variable carbon contacts, on which the operation of the telephone microphone depends. It followed that the production of stable, low-noise deposited-carbon resistors having small and reproducible temperature coefficients of resistance required the elimination of such defects from the ceramic surface.

While it is true that these imperfections would be shunted by a surrounding continuous film in an unspiralled unit, in the spiralled unit they would become series

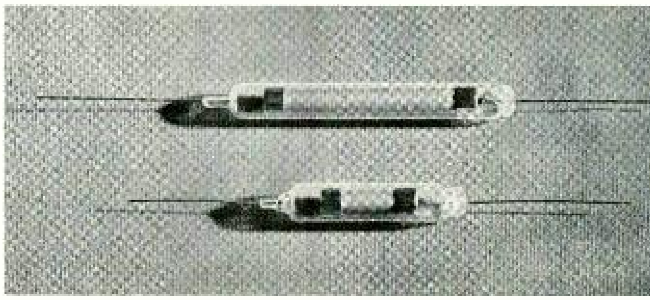


Fig. 4—*Deposited carbon resistors glass-sealed for applications requiring highest stability. The topmost container is three inches long*

or shunt elements between successive turns causing unstable, noisy resistors. Thus the requirements for physical perfection of the ceramic core were so severe that microscopic examination was in most cases of little use. One of the final tests of the suitability of ceramic cores is whether or not invisible imperfections in the core are accentuated by the deposition of carbon to a degree that they become visible.

The development of ceramics acceptable as cores* was not confined merely to the elimination of the surface defects, for it developed that not all ceramic materials with the requisite surface perfections were suitable otherwise. For example, carbon adheres very poorly to some ceramics, resulting in a lack of rigid control during the subsequent processing; and many

*RECORD, *December*, 1947, *page* 464.

ceramics exhibit undesirable electrical characteristics. It is interesting to note that the ceramic material developed specifically for resistor cores also has properties which are making it useful for an increasing number of other Bell System applications.

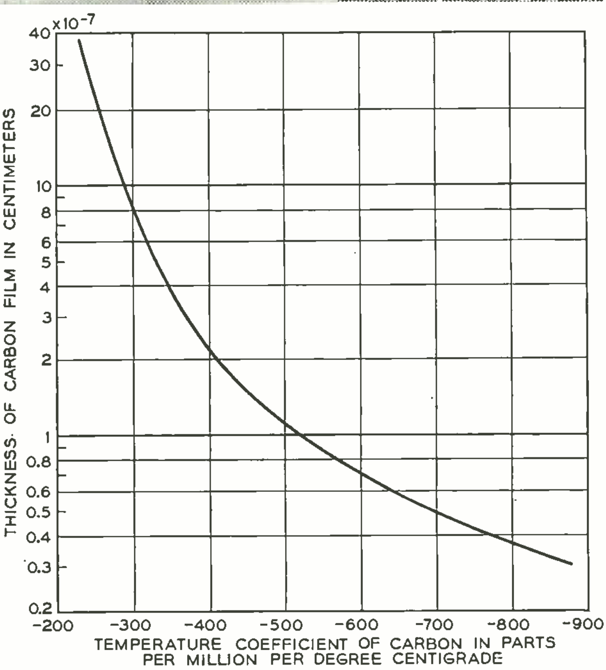


Fig. 5—Temperature coefficient of resistance versus carbon film thickness

Having devised techniques for fabricating resistor cores with requisite qualities it was learned that in addition to being physically perfect the cores had to be kept scrupulously clean. No satisfactory chemical process for cleaning contaminated cores was found, and it was necessary to prescribe special handling of the cores after the final firing in the ceramic kiln. In Figure 2, for example, the operator wears a glove in handling the blank.

Indicative of the successful solution of the problem of surface cleanliness and perfection is the fact that spiralling resistor blanks with carbon films averaging only one ten-millionth of an inch thick now yields the computed resistance value within the error of measurement. These very thin carbon films are transparent and any variation in film thickness results in alteration in the shade of gray of the reflected light, a fact which makes it possible for an experienced person to inspect the films visually for imperfections and to tell the resistance value of a uniformly coated blank with fair approximation.

Varnished resistors of the type employed in non-critical circuits in the first gun director were supplied to an initial accuracy of one per cent and, in the sealed apparatus assemblies in which they were

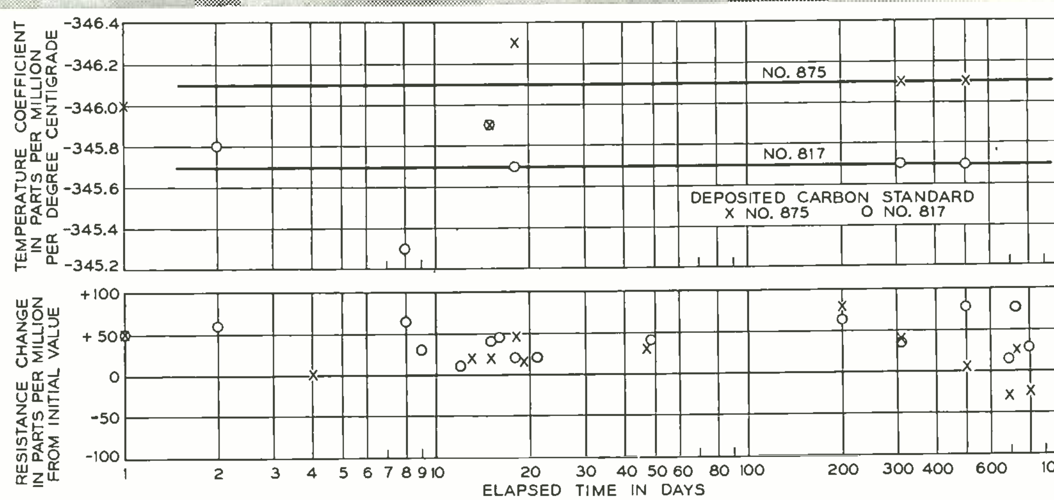


Fig. 6—Stability of two glass-sealed deposited carbon resistors used as measurement standards

employed, they were stable to about one per cent per year. This same type of resistor was later employed in high voltage equipment; one of the specifications successfully fulfilled was that a four megohm resistor should dissipate four watts on direct current for one hour without permanent change in excess of one per cent.

For general circuit use the varnished resistor was provided with a protective phenolic shell sealed with bakelite cement. This type of resistor, supplied in the two sizes shown in Figure 3, found wide use in special electronic equipment and in the terminals of Spiral-4 transmission systems as replacements for wire wound types.

With the original objective of producing resistors satisfactory for use in the gun director achieved through the varnished type of deposited carbon resistor, other potential uses for yet more stable and precise high-value resistors were considered. One principal consideration was employment in the critical networks of computers* associated with radar bombsights. In these applications the resistors had to be of high values to minimize the drain on power sources that were already loaded heavily; they had to be matched or padded to various resistance ratios with great accuracy; furthermore, they were required to "track" each other in changes of resistance with temperature to insure proper functioning of the computers under all service conditions.

By enclosing the resistor element hermetically in a glass envelope, as shown in Figure 4, a resistor of very great stability was obtained. At first the envelopes were heated and evacuated only, but since the resistors had to respond rapidly to changes in ambient temperature the envelope was filled with purified helium to achieve a tenfold increase in heat transfer from envelope to resistor element.

To produce computer "tracking" resistors of different values and all with approximately the same temperature coefficient of resistance required close control of the spiralling factor and the selection of continuous films of the same thickness. The dependence of temperature coefficient of resistance of a deposited carbon resistor on the thickness of the carbon film is shown in Figure 5. However, under closely controlled manufacturing conditions, which were no more severe than those for the manufacture of high quality wire wound resistors, the precision glass-sealed resistors

*Record, *December*, 1946, *page* 445.

THE AUTHOR: A. C. Pfister joined the service group of the Research Department in 1930. In 1935 he transferred to the Physical Research Department as a Technical Assistant in the study of microphonic materials. In 1939 he became a Member of the Technical Staff and that same year received a B.S. degree in Mechanical Engineering from Brooklyn Polytechnic Institute. During the war Mr. Pfister was concerned with the development of deposited carbon resistors for use in war equipments. Now, with Transmission Apparatus Development, he is engaged in the investigation of the properties of carbon in thin films and bulk form.

had temperature coefficients (TC's) of $-335 + 35$ parts per million per degree Centigrade (PPM/°C) and they were supplied in groups within which the variation of TC was less than 1 PPM/°C, the relative TC's of the individual resistors being determined to an accuracy of about 0.2 PPM/°C. The problem of measuring resistors in the megohm ranges to these accuracies was in itself difficult and its solution required the development of new techniques and new equipment.* The data of Figure 6 on the resistance and temperature coefficient of two such resistors employed as measuring standards indicates a stability in absolute resistance value of the order of 0.005 per cent per year, which is about the limit of error in measurements extending over such a time period.

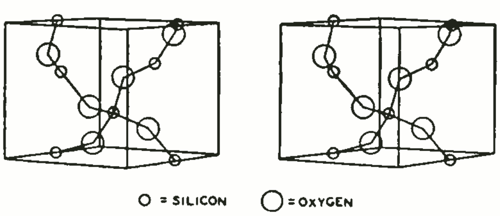
Comparison of the glass-sealed carbon resistors with the best obtainable wire wound high resistance types reveals interesting facts. First, the observed variation of ± 10 per cent in temperature coefficient is no greater than that for wire wound types although the absolute value of temperature coefficient is about four to six times larger. Secondly, the resistance stability of a ten megohm carbon resistor is greater than that of a two megohm wire wound type; the inevitable strains in the mile and one-half of fine alloy wire, which the latter contains, introduce time instability and hysteresis in its resistance temperature characteristic. Again, the glass sealed resistors are capable of dissipating from ten to twenty watts of power without permanent change in resistance value, although, because of their numerically larger temperature coefficients, their power coefficients of resistance are greater than for wire wound types.

Typical of most such endeavors in the Laboratories, the deposited carbon resistor has been brought to its present state of usefulness by the coöperative effort of many persons.

*Record, *April,* 1947, *page* 155.

STEREOSCOPIC DRAWING OF CRYSTAL STRUCTURE

From computed positions of the atoms in a crystal, W. L. Bond plots two drawings that show a three-dimensional diagram of the atom's structure when viewed in a stereoscope.



When these two drawings are viewed in a stereoscope, one sees an atomic model of a quartz crystal

These drawings consist of straight lines that connect circles which represent the atoms. The circles are of different sizes to indicate different molecules. The lines are drawn in a sheet of cellulose acetate with scribes and the circles are drawn with a special cutting tool.

In the left foreground of the illustration on the cover of this issue of the Record, there are several pairs of contact prints made from these original drawings. When mounted in the old-fashioned parlor stereoscope, shown at the left, the drawings give as clear an impression of the structure within a crystal as that obtained from a physical model. They have the advantage of greater convenience in handling and storage. This stereoscopic technique is applicable to any three-dimensional data, such as that for a room or a space curve.

W. VAN ROOSBROECK
Solid
State
Physics

HIGH-FREQUENCY DEPOSITED CARBON RESISTORS

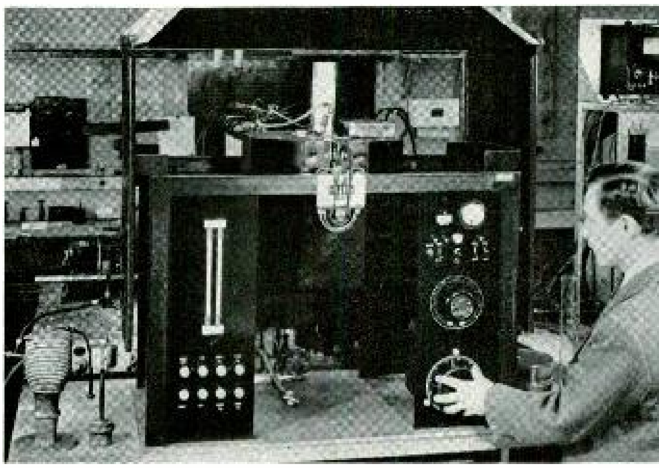
Films of microcrystalline carbon deposited on ceramic surfaces provide resistors of particular utility for high-frequency applications. These films can be made in a wide range of controlled thicknesses and a small ceramic rod coated with carbon can thus provide a resistance of tens of thousands of ohms. Still higher resistances are obtained by grinding a helical groove through the coating to make a long and narrow carbon path. The resistance is thereby increased by a factor which depends on the helix angle and the width of the groove. These thin carbon films also provide precision resistors* of high resistance and high stability.

Deposited carbon resistors are useful at high frequencies because they are characterized by small reactance and constancy of effective resistance which arise largely from their inherently small inductance and capacitance. The absence of skin effect, resulting from the relatively high resistivity of the carbon and the thinness of the films, also contributes to the independence of their effective resistance with frequency. Computation for the thickest films on large-diameter cores shows that the relative contribution of skin effect to the resistance change is negligible.

Resistors of high resistance, however, show a diminution of effective resistance with increasing frequency, which depends on the product of the frequency, resistance and total distributed capacitance. While spiralling increases inductance, the ratio of inductance to resistance remains essentially unchanged, being determined to a first approximation by the thickness of the carbon film. Since distributed capacitance is changed only slightly by spiralling, the alteration in high frequency behavior of a resistor which is spiralled to a high resistance value is largely that associated with the resistance increase alone.

Inductances of medium- and large-sized resistors of both the continuous and spiralled types can easily be calculated, but the arrangement of the leads may affect the inductance of small resistors appreciably. The capacitance is best found by measurement and is mostly distributed. This distributed capacitance is increased by the proximity of a grounded conductor, and also by surrounding the carbon film with a material of appreciable dielectric constant. The latter effect is most marked if the material is in direct contact with the carbon. For this reason, the greatest constancy of effective resistance at high frequencies is obtained with resistors not covered with a protective organic finish but rather enclosed in a glass envelope or in a plastic or ceramic shell. Dielectric power loss in the ceramic base may also

Laboratory installation, at Murray Hill, of a rocking furnace producing high-frequency deposited carbon resistors. H. E. Earl, Jr., is checking the voltage supply



*Page 401 of this issue.

result in a reduction in effective resistance, but this power loss is in general quite negligible and is not a consideration in resistor design. For applications in which high voltage pulses of ultra high-frequency power are to be dissipated at an elevated operating temperature, however, a special low-loss ceramic is necessary.

In general the only way in which requirements of small reactance and relative constancy of effective resistance can be met is to make the resistor small. However,

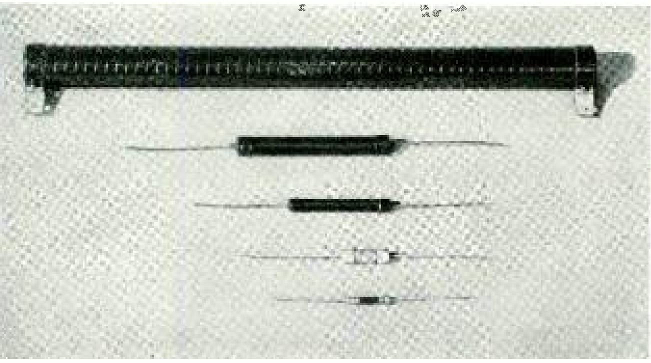


Fig. 1—Deposited carbon resistors with varnish protection of the film. Length of the middle resistor body is two inches

for a given power dissipation, a lower limit to the size of a deposited carbon resistor not completely protected from oxidation is imposed by the limitation of its operating temperature. Above 160 degrees C the oxidation of carbon becomes appreciable, but even when limited to this operating temperature, resistors with a protective organic coating are still quite small. For example, a unit 1/8 inch in diameter and 3/4 inch long can dissipate one watt continuously. Such units, as well as others even smaller, have been made for experimental use in high-frequency measurement equipment. One of the smaller type is shown at the extreme left in Figure 2.

Experimental deposited carbon resistors have been used as components for high-frequency attenuators. Some of these attenuators, with disc-shaped resistors, are shown in Figure 2. With electrodes at the center and at the outer edge, the discs are mounted in coaxial lines, and constitute lumped shunt conductances. Tee- or pi-pad

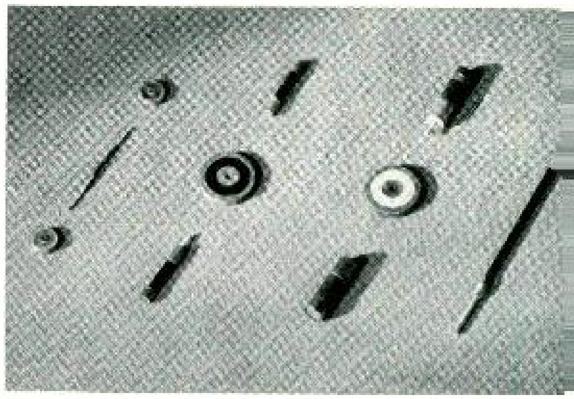


Fig. 2—Experimental deposited carbon resistors use in high-frequency attenuators. The large discs ha diameters of three-quarters of an inch

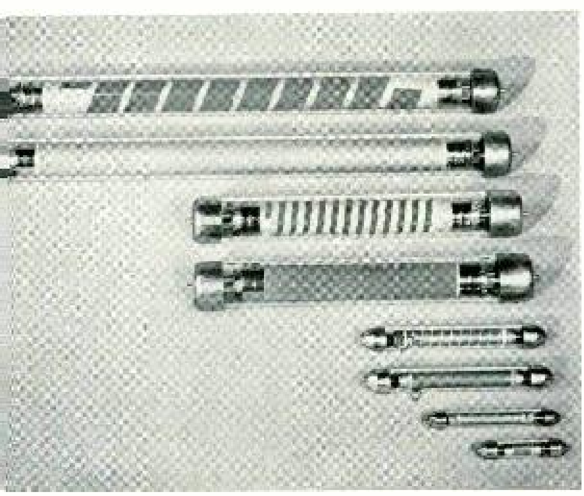
attenuators of relatively small reactance have been constructed for tests by using these disc resistors in conjunction with small cylindrical resistors mounted axially. The tests at the Laboratories on such experimental attenuators show them to be reasonably constant at least to frequencies of hundreds of megacycles. Another trial type of high-frequency attenuator consists of a long cylindrical resistor of small diameter mounted axially in a cylindrical conductor several times the resistor's diameter. By a proper choice of dimensions and resistance, a desired attenuation at a given high frequency has been obtained. Its form is shown at the right, Figure 2.

The permissible power dissipation for a given size of deposited carbon resistor is multiplied tenfold by sealing the resistive element in a glass envelope containing a neutral gas. The glass-sealed resistors are capable of dissipating relatively large amounts of power in small space, and are thus particularly useful at high frequencies. A number of these are employed in the single sideband transmitter for which they were originally developed, and they are used also as dummy antennas and in other applications where small reactance is essential. At their rated capacities, they operate with the carbon films at red heat. The first limitation to their power-handling capacity is imposed by the softening temperature of the glass envelope, if not otherwise by external conditions.

One wartime use of these power resistors was in radar to dissipate a succession of power pulses of short duration whose intensity was thousands of times the average power rating. These pulsed currents, either direct current or current modulated at ultra-high frequencies, rise to their maxima in extremely short time intervals so that a small inductance is necessary to minimize distortion. With pulses of one microsecond duration the temperature change in the carbon films during a single pulse may be of the order of 100 degrees C, the rise being determined by the heat capacity of the film and the thermal properties of the base material. Densities of pulsed currents in the carbon films are often of the order of several million amperes per square centimeter. To avoid breakdown, configurations of current path which give rise to regions of local high current density must be carefully avoided.

In this connection, spiralled resistors have silver electrodes so disposed that their edges are at right angles to the edges of the conducting path and, to eliminate the possibility of high-voltage corona between turns, they are spiralled with cuts of a proper width. Also, their envelopes are filled with purified nitrogen at approximately atmospheric pressure. With these precautions, the average power rating is the same as that for continuous loads. Spiralled resistors for use under high-voltage pulses are shown as the two largest of the spiralled type in Figure 3. Production over a very wide resistance range of spiralled glass-sealed resistors in which voltage breakdown does not occur below normal rated power is simply achieved. A single properly selected carbon film thickness suffices. This is so because in a resistor of given size spiralled with a cut of fixed width, an increase in the number of turns increases the voltage for rated power, corresponding to a larger resistance, and simultaneously increases the breakdown voltage for continuous power loads in very nearly the same ratio.

Fig. 3—Power types of deposited carbon high-frequency resistors. The topmost resistor is approximately fifteen inches long over-all



Another radar application is that in which a resistor is used as a current shunt in an oscilloscope circuit to measure high-intensity pulses. Such a resistor must have very small inductance to avoid pulse distortion and yet it must be capable of dissipating appreciable power. One designed to meet such requirements is shown assembled and disassembled in Figure 4; it consists of two internally carbon-coated ceramic tubes mounted in a coaxial structure and connected in parallel. Elements which make contact between the outer ends of the tubes and the central conductor also clamp them against an annular ring at the center of the grounded housing to which the tubes' inner ends make contact through the crimped washers.

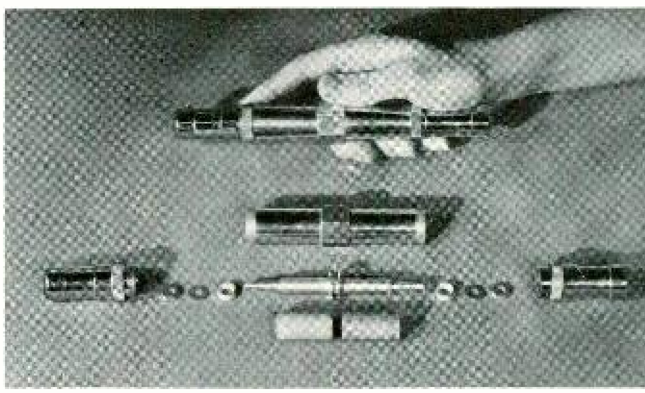


Fig. 4—Low inductance coaxial type of deposited carbon resistor

Leads are attached to the opposite ends of the assembly. This resistor, ordinarily used in resistance values from one to ten ohms, dissipates fifteen watts of average power and its measured inductance is about 0.01 microhenries.

A still further increase in the dissipative capacity for a deposited carbon resistor of given size can be obtained by use of a liquid coolant circulated in direct contact with the carbon film. For example, very compact water-cooled resistors have been used experimentally to dissipate continuously as much as three hundred times the normal rated power. They can dissipate only alternating current power because a direct potential causes anodic oxidation of the carbon film. Trial units of this type include the large deposited carbon resistor shown in Figure 5. In addition to general application in field tests of transmitters, they have been used successfully as dummy antennas for broadcasting transmitters. These large water-cooled units are generally mounted in cylindrical metal shields and by suitable choice of dimensions the reactance can be made zero at a particular frequency, and substantially so over a band such as that used for FM broadcasts.

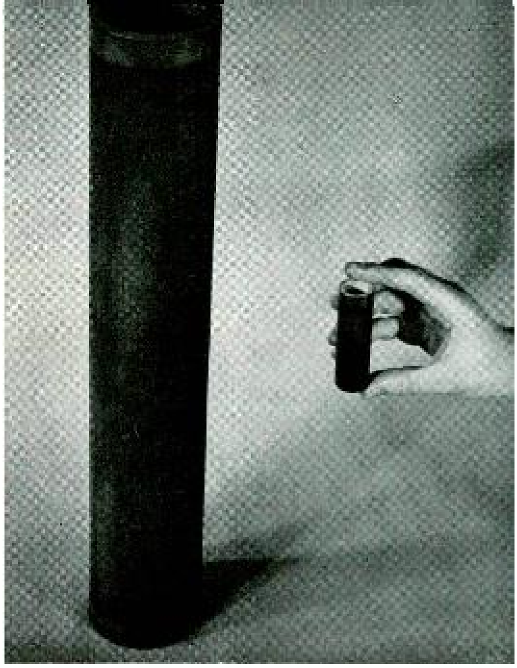


Fig. 5—Experimental high-frequency deposited carbon resistors for power applications requiring liquid cooling of the film

Recognition of the particular suitability of deposited carbon resistors for high-frequency applications increased the demand for them within the Laboratories and led to their increased use elsewhere. This development represents another coöperative effort in which many persons took part.

THE AUTHOR: W. VAN ROOSBROECK joined the Laboratories in 1937, shortly after receiving an M.A. degree in physics from Columbia University. He engaged in the work on development of the deposited carbon resistor and continued on this during the war period. He contributed also to wartime research on the infra-red bolometer. Mr. van Roosbroeck has been occupied of late with an investigation of the copper-oxide rectifier, and has recently transferred to the Physical Research Department where he is now engaged in studies in solid state physics.

R. W. SEARS
Electronic
Apparatus
Development

BEAM DEFLECTION TUBE FOR CODING IN PCM

In a pulse code modulation transmission system, a speech wave is sampled at a periodic rate, and code groups of on-off pulses representing the magnitude of successive samples are generated for transmission. The input signal range is divided into a sufficient number of steps to give the grade of transmission desired, and all signal samples falling within a particular step are represented by one group of on-off pulses. This operation is called quantizing. With time-division multiplexing of a number of channels, the codes for the samples of the various channels are interleaved, so that between successive samples of one channel, samples of all the other channels of the group are transmitted. In the experimental 96-channel system recently developed,* twelve channels are grouped in time-division multiplex with an 8,000-cycle sampling rate so that only about 10 microseconds is allowed for each code. The rapid quantizing and coding is done by an electron beam tube in which the practically inertialess two-dimensional deflection characteristic of a focussed electron beam have been combined with an unusual feedback arrangement for performing the modulation operations.

Coding is performed with the tube indicated diagrammatically in the upper part of Figure 1. The tube is similar to a cathode-ray tube with the fluorescent screen replaced by an aperture, or code plate, and an output plate. Electrons reach the output plate only when the beam is deflected to positions where apertures are cut in the code plate. An input voltage of a particular value applied to the Y deflector plates will deflect the beam to point "a" on the aperture plate as indicated. A linear sweep applied to the X deflector plates, while the input voltage on the Y deflector plates is held constant, causes the electron beam to sweep across the aperture plate along the dashed line a-b, and each time the beam crosses an opening in the aperture plate it passes through to the output plate and produces an output pulse. The openings in the aperture plate are so arranged that a different sequence of pulses is formed for each of the small ranges of values into which the complete amplitude range is divided. A seven-digit code is used for the new system, but for the sake of simplicity only a four-digit code is illustrated in Figure 1. With a four-digit code, there are sixteen (2^4) possible values that may be used to represent the sample, and in the lower diagram the sixteen ranges into which the signal range would be divided are shown bounded by dashed lines. Any amplitude falling between two adjacent lines is represented by a single code, which is shown at the right.

Quantizing is secured by producing the same code for all signal amplitudes falling between two adjacent horizontal lines, and coding is performed by the transverse sweep of the beam. If the electron beam were vanishingly small in diameter, and if the transverse motion were exactly at right angles to the vertical axis of the aperture plate, such an arrangement would always

*RECORD, *September*, 1948, *page* 364.

give the correct coding. It is, however, impossible to obtain anything approaching an infinitely sharp focus of the beam, and furthermore, it is not feasible to produce a sweep that is perfectly aligned with the aperture plate. To secure correct coding with a beam of finite size, and even when the transverse motion is not exactly at right angles to the axis of the aperture plate, a grid of wires is placed in front of the aperture plate as shown in Figure 2, and a concetion from this grid is carried back to serve as a feedback voltage for the Y deflection plates.

The grid wires are spaced and lined up

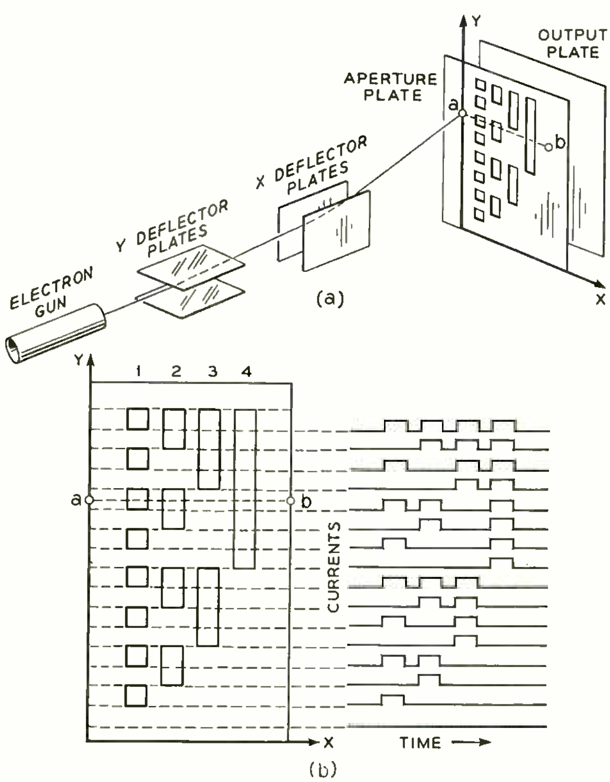


Fig. 1—Schematic of coding tube above and masking plate and coding patterns formed below

with the openings of the aperture plate exactly as are the horizontal dashed lines of Figure 1. Since the diameter of the beam is slightly larger than the opening

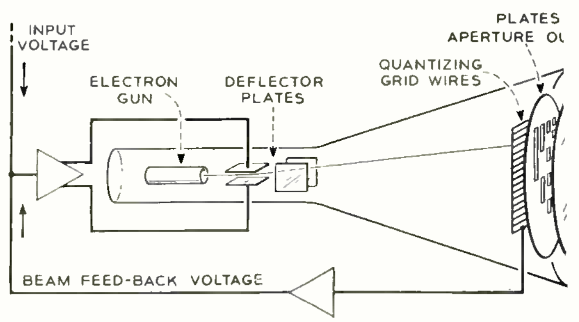
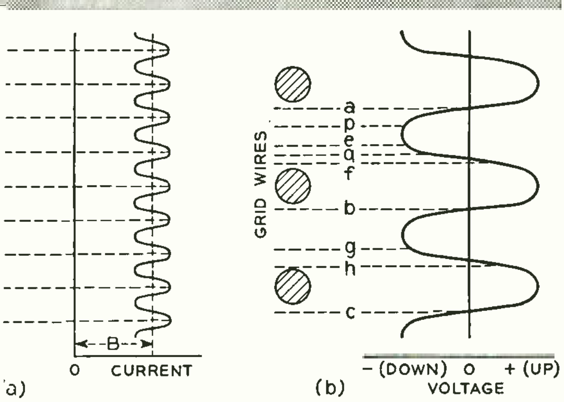


Fig. 2.—Schematic of the coding tube showin circuit arrangement

between the grid wires, there are some electrons striking the grid even when the center of the beam is halfway between the wires, but there will be many more when the center of the beam is on a grid wire. The current in the grid circuit could thus be represented as at (a) of Figure 3, opposite a cross-section of the grid shown at the left. The grid current thus varies above and below a mean value marked B, depending on the position of the beam. In returning this current as feedback, a circuit is employed that cancels this fixed bias B, and results in a voltage proportional to the varying part of the current. The feedback voltage may thus be represented as in (b) of Figure 3. It varies from a maximum positive value when the beam is directly on a grid wire to a maximum negative value when it is halfway between two wires, and this voltage is applied to the Y deflecting plates in such a way that a plus voltage tends to raise the beam and a minus voltage, to lower it.

The deflection voltage that determines the beam position is the sum of the signal and feedback voltages, and thus the position the beam assumes will differ from that it would have taken under influence of the signal alone. Suppose that the signal voltage alone would deflect the beam to position p in Figure 3b. Since the feedback voltage is negative, the beam would move down to some such position as q where the



ig. 3—Variation of the grid current with position of eam, left, and feedback voltage, right

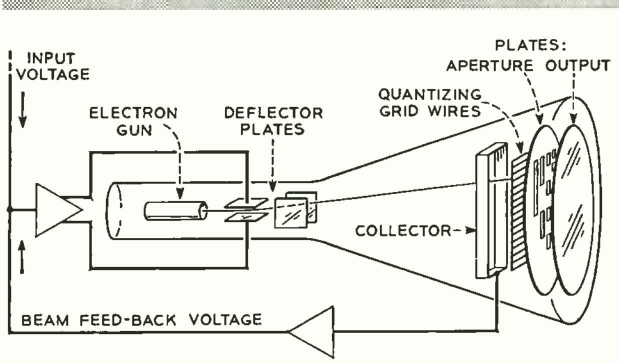


Fig. 4—In the actual coding tube a collector is used to supply the feedback instead of the grid as was indicated in Figure 2

signal plus negative feedback voltage is equal to the voltage required to deflect the beam to q. Any disturbance tending to move the beam up from q would result in a larger negative feedback voltage, which would tend to restore the beam to position q. Any disturbance tending to move the beam down from q would result in a smaller negative feedback voltage which would also tend to restore the beam to position q. Thus q is an equilibrium position. Signal voltages which would, without feedback, produce beam deflections between a and b will, with feedback, produce stable beam positions in some small range such as between e and f. Similarly, signal voltages corresponding to deflections between b and c without feedback will with feedback produce stable positions in the small range between g and h. The feedback action thus constrains the beam to a narrow range of positions near one of the grid wires for each small range of input signal voltages, and constrains the beam to a similar narrow range of positions near the next grid wire for the next range of input signal voltages. Since each grid wire is accurately aligned with a set of holes in the masking plate, the feedback produces the desired quantization of the input signal and assures production of definite output code groups. Feedback action further insures that the beam will sweep out the code group initially selected even though the beam sweep axis is tilted slightly with respect to the grid wires and code plate.

To insure that the feedback will always lock the beam in just above the proper grid wire, a definite sequence of operations of the tube is required. The input signal voltage is applied with the electron beam cut off, or blanked, by the application of a bias to the beam intensity control grid of the electron gun. This causes the beam to assume a "virtual" y position proportional to the amplitude of the signal sample. The beam is then turned on and this activates the feedback circuit which shifts the beam to the nearest position of stable equilibrium. A linear sweep is then applied to the x deflection plates and the output pulse code group is generated. Finally, the beam is again blanked during the retrace period of the x sawtooth sweep, and the tube is in the proper condition for the application of the next input signal sample. Two tubes are used in alternation to permit code groups to be generated continuously without suffering an interruption while the beam is being returned and quantized for a new signal sample. As soon as the last digit position is swept over in one tube, the sweep of the beam in the second tube begins to generate the code group for the next signal sample.

The operation of the tube with feedback resulting from the direct electron beam current intercepted by the grid is difficult

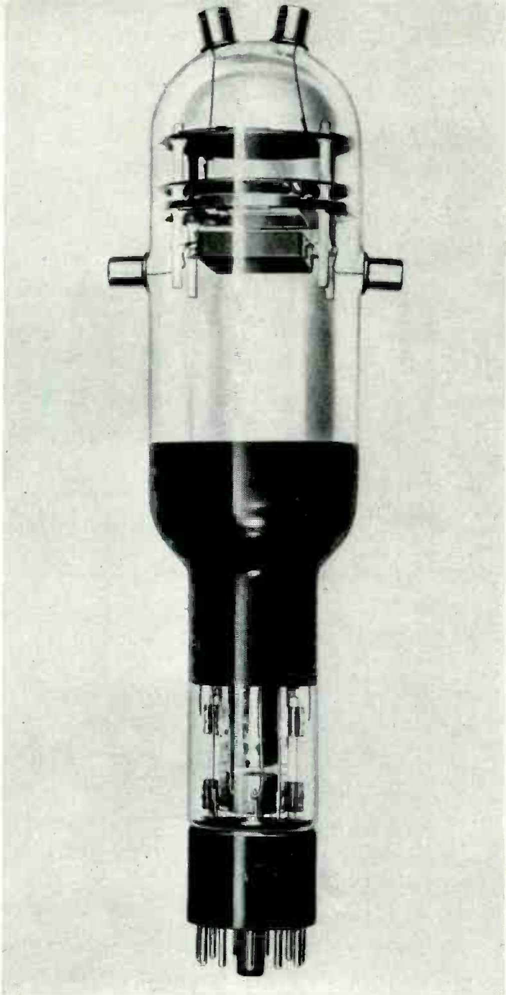
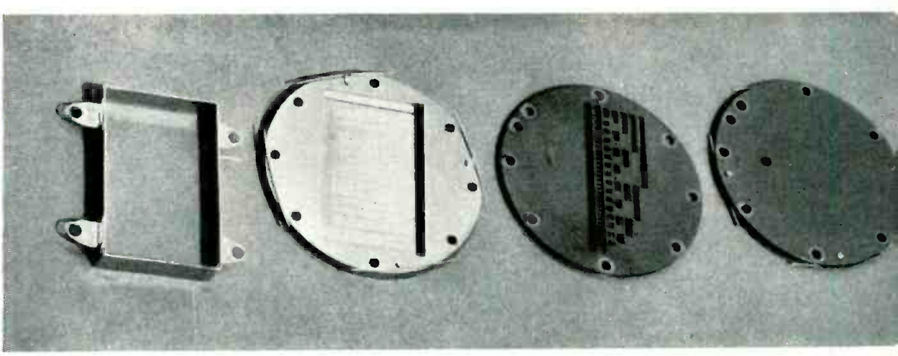


Fig. 5—The coding tube for the experimental 96-channel system

because of secondary emissions from the grid and code plate. It turns out, however, that the secondary emission which at first appeared to be so detrimental can be used to advantage. The grid is processed to have a high secondary electron emission factor, and the secondaries produced at the grid are accelerated and collected by a rectangular shaped collector located in front of the quantizing grid as shown in Figure 4. The secondary electron current to this electrode is proportional to the fraction of the primary beam striking the grid. Furthermore, potentials may be applied to the various electrodes so that most of the secondary electrons originating at other electrodes do not reach this collector. Accordingly, the quantizing current for feedback is taken from the secondary collector rather than from the grid. This results in an enhanced feedback current due to secondary electron multiplication at the grid, and a lower capacitance than if the grid connection had been used.

The coding tube developed for the experimental multi-channel pulse code transmission system is shown in Figure 5. A 7-digit binary code plate providing 128 output codes is used. A surprisingly compact tube design was obtained with an over-all length of 11-1/4 inches and a diameter of 2-1/4 inches. The electron gun sealed into the left-hand end of the tube envelope operates with a final anode potential of 1,000 volts and a beam current of approximately 10 microamperes. The electron optical design of the electron gun provides a focussed beam somewhat smaller than is usually obtained in a conventional cathode-ray tube of comparable size. The target assembly consisting of secondary electron collector, quantizing grid, aperture or code plate and output plate is assembled and aligned as a unit and sealed into the right-hand end of the tube envelope. The four electrodes of this assembly are shown in more detail spread out in Figure 6. The line-up between code plate, quantizing

Fig. 6—The four elements that comprise the anode assembly of the coding tube



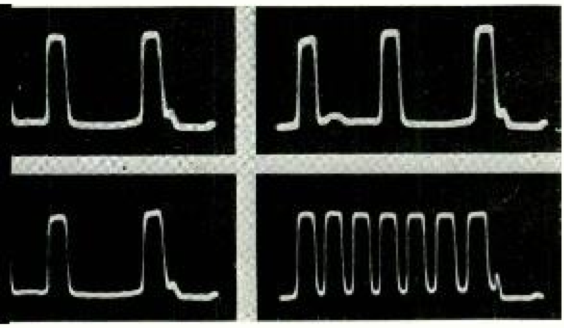


Fig. 7—Typical code groups formed by the tube

grid, deflection plates, and axis of the electron gun must be controlled to a high degree, and this is accomplished by the use of precision jigs during the assembly and final seal-in of the tube.

In addition to the usual precautions during the processing of tube parts and assembly to avoid contaminants which are detrimental to the oxide-coated cathode of the electron gun, it was necessary to process the tube for uniform secondary electron emission of the quantizing grid wires. Some idea as to the degree of cleanliness required for this may be gleaned from the fact that a single speck of dust on the grid causes a discontinuity in the secondary emission such that the electron beam will jump from one code group to an adjacent code group during the beam sweep. Such a defect is cause for tube rejection.

The four code groups shown in Figure 7, each representing a seven-digit binary number, are typical of the tube output. The sweep period of the coding tube, and thus the length in time of each of the codes, is 10.5 microseconds, while each pulse is allotted approximately 1.5 microseconds. To obtain optimum transmission characteristics in the experimental PCM system, the pulses are reshaped by auxiliary equipment after generation to completely fill this 1.5-microsecond period. Coding tubes have been operated satisfactorily for long periods of time in the present experimental multichannel pulse code system, and have required minor adjustment of potentials not more than once a day.

THE AUTHOR: R. W. Sears received the B.A. degree from Ohio Wesleyan University in 1928, and the M.Sc. degree from Ohio State University in 1929. Joining the physical research group of the Laboratories in 1929, he was engaged in fundamental research in thermionics. He continued graduate work in physics at Columbia University from 1930 to 1934 under the Laboratories' part-time post-graduate plan. In 1938, he was transferred to what is now the Electronic Apparatus Development Department, and was responsible for tube processing and material problems, and the development of oxide cathodes. During the war, he was associated with a number of electron tube developments for the Services. Since then, he has been responsible for the development of electron tubes of the beam deflection type.

TEST SETS FOR DIELECTRIC FAULTS IN COAXIAL CABLE

J. W. KITTNER, JR.
Outside
Plant
Development

One of the installation tests on coaxial telephone cable used in the Bell System is intended to detect two types of faults—low insulation resistance and points of low dielectric strength. The former may be located and cleared by methods standard in the art for many years, but the latter present a more difficult problem whose study has led to the development of two new test sets. One set, known as the "Sliver Burner" coded as the 94A test set, burns out certain of the troubles electrically and the second, the 90A test set, determines the location when the trouble cannot be burned out.

Fig. 1—The Sliver Burner is operated by P. J. Kreider in a laboratory test

Essentially the Sliver Burner comprises a means for charging a capacitor to a high voltage and for transferring this charge to the cable. If the fault consists of a fine sliver of copper, the energy from the capacitor will burn it out although sometimes several discharges of the capacitor may be necessary before this is accomplished. A photograph of this set is shown in Figure 1. The connection to the coaxial unit is by means of flexible coaxial cable terminated with a special connector designed to make contact with either 0.375-in. or 0.270-in. coaxial units, or with a coaxial terminal.

Since coaxial cable tests may be made at remote sites where commercial power is not available, the Sliver Burner carries its own power in the form of a six-volt battery of four dry cells. As shown in the circuit diagram of Figure 2, this voltage is interrupted by a vibrator and impressed on the primary of an automobile ignition coil. The secondary high voltage is rectified by cold cathode gas tubes and applied to charge a 2-microfarad capacitor. Since the rectifier tubes have a peak rating of 2700 volts and the sharp peak voltages from the ignition coil may reach a value of 10,000 volts, four tubes in series are used. The resistor R1 limits the current through the tubes to a safe value and resistors R2, R3, R4 and R5 limit the starter electrode currents. An electrostatic voltmeter in parallel with the capacitor indicates the capacitor voltage and the safety gap limits the maximum voltage of the charge.

Mercury switches S2 and S3 are used to transfer the high voltage charge from the capacitor to the cable, and to discharge the cable. They offer the advantages of low contact resistance and ability to withstand high surge currents. A lever actuating system was designed to mount the mercury tubes of the switches on standard key frames. To limit the current when discharging the cable, a resistor R6 is in series with switch S3. The complete set weighs approximately 30 pounds including batteries and is 11-5/8 inches long by 9-5/8 inches deep and 12-1/2 inches high.

In the second test set — the high voltage bridge — the conventional 3-Varley method is utilized to locate faults; schematic circuits for these standard measurements are shown in Figure 3. Figure 4 gives the bridge schematic diagram and Figure 5 pictures the assembled test set. Varley 1 and 3 measurements involve relatively low resistances in the battery circuit and they are made at a low voltage. The Varley 2 measurement requires bridge voltage applied in series with the fault, however, and where the fault is one of low dielectric strength, current will not flow through the bridge unless the bridge voltage itself is able to break down the fault.

Basically the high voltage bridge is a d-c bridge of special design operated from a high voltage source. When the high voltage breaks down a cable fault, a pulsing rather than a continuous arcing current flows because, after breakdown, the capacitances of the cable and power supply discharge through the fault until the voltage falls below the value required to maintain the arc. It then requires a finite time to recharge the cable and power supply capacitances through protective resistances inserted in the power supply. These resistances, shown as R1 and R2 in Figure 4, are necessary to limit the output current for protection against accidental contact by the operator as well as to prevent damage to the resistances in the bridge circuit.

The intermittent breaking down of the fault produces pulses of current in the galvanometer which can be considered to have a d-c and an a-c component. The d-c component, for a given current from the power supply, depends on the d-c

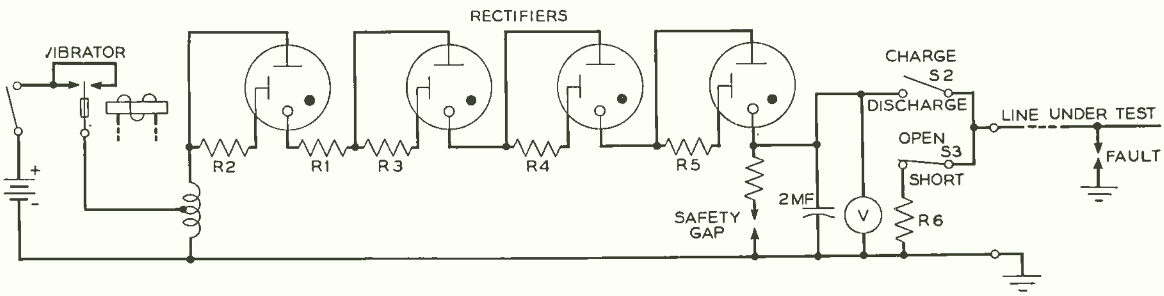


Fig. 2—Simplified schematic for the Sliver Burner

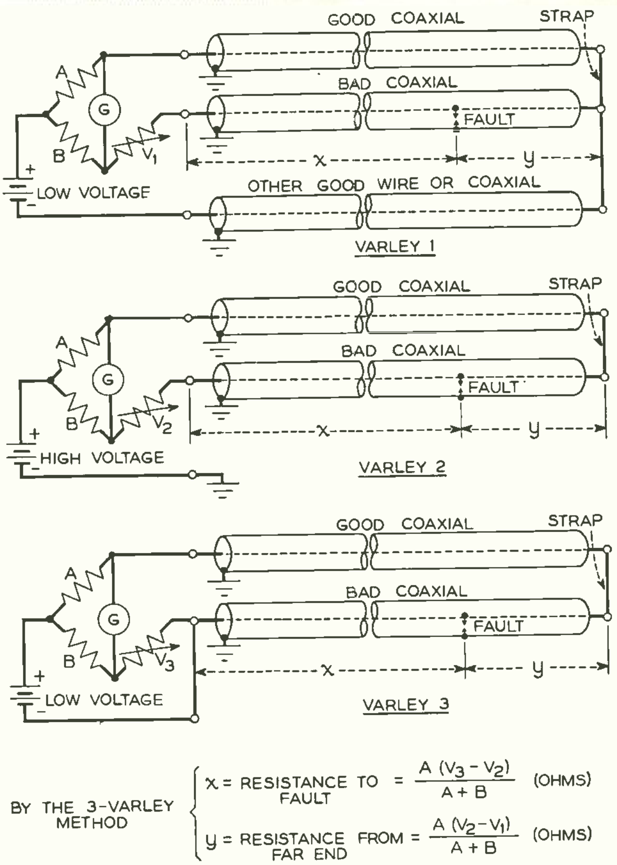


Fig. 3—Diagrams showing high voltage bridge connections to a coaxial cable

resistance values in the bridge circuit. If the galvanometer can be made to respond only to the d-c component, then the Varley 2 measurement is feasible.

Filters in the galvanometer circuit were found to be impracticable for removing the a-c component of current because of the low frequency, as low as two cycles per second. The device finally developed, descriptively named a "kick balancer," consists of potentiometer P1 shunted across the galvanometer with the movable arm connected to ground through capacitor C3. When properly adjusted, the kick balancer introduces an a-c component across the galvanometer equal in magnitude but opposite in polarity to the original a-c component. The setting of the kick balancer for neutralizing the a-c component in the galvanometer depends principally on the setting of the ratio arms A and B; the kick balancer knob is calibrated therefore in terms of the ratio arm values and may be set approximately correctly before the start of the balancing operations. During the balancing operations this adjustment is further refined.

While the kick balancer eliminates practically all visible fluctuations from the galvanometer needle, there are still some transient voltages of short duration across the galvanometer terminals of the bridge. These transients would have sufficient strength under some conditions to burn out the galvanometer and to obviate this possibility a series choke L1 is inserted. Finally, the fuse F1 is included to protect the galvanometer against damage if the bridge is improperly operated or should a secondary breakdown occur in the cable.

The power requirements of the bridge are too large to permit a dry cell source as used in the Sliver Burner. Operation is from a 110V a-c supply. Lacking available commercial power the bridge is operative from a six-volt storage battery which energizes a rotary converter whose output is the required 110 volts a-c; or, by a 110V a-c generator driven by a gasoline engine as shown in Figure 5.

As also noted in Figure 4, the bridge contains a high voltage power supply whose output is controlled by a variable auto transformer in the primary circuit of the step-up transformer. A low voltage d-c supply, consisting of a step-down transformer and a copper oxide rectifier, is provided for the Varley 1 and Varley 3 measurements. To connect either the high or the low voltage supply to the bridge circuit there are push button switches. The total resistance value of the A and B arms of the bridge is always 1000 ohms and the Varley resistance consists of four sets of decade resistors in 1000's, 100's, 10's and unit steps. All of the bridge arms are at high potential above ground and hence commensurate insulation is employed in mounting and covering the metal parts of the circuit elements.

A general view showing the arrangement of the bridge controls on the panel

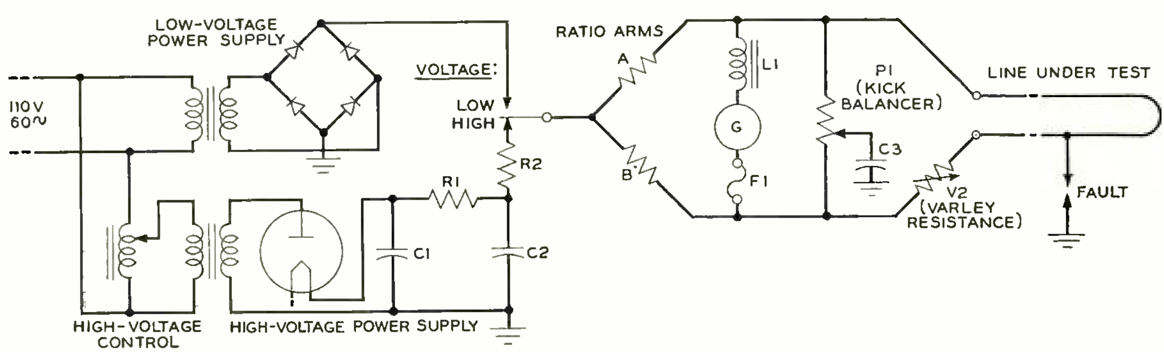
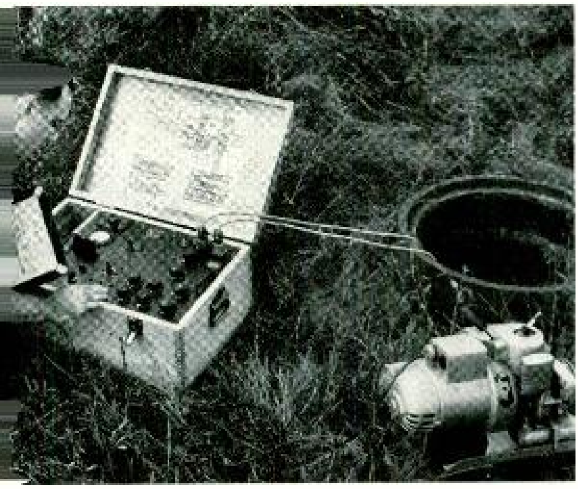


Fig. 4—High voltage bridge, simplified schematic



ig. 5—A field set-up of the high voltage bridge ith power supplied by an accessory gasoline ɿgine-driven generator. J. B. Hays, Jr., makes a arley measurement to locate a coaxial cable fault

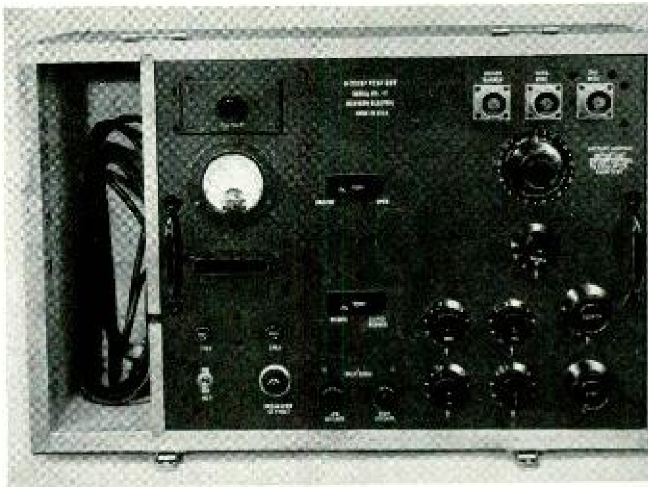


Fig. 6—The panel layout of the high voltage bridge shows the arrangement of the controls. The galvanometer scale, which has a hood to shield it from outside light, may be noted below the voltmeter

is shown in Figure 6. The transformers, capacitors and the rectifier tube are mounted on a sub-chassis. In manufacture the panel and chassis are wired separately and then assembled together. Final electrical connections between them are made at terminal strips on the chassis. The complete set weighs 80 pounds and measures 25-3/8 inches in length by 16-5/8 depth, with a height of 11 inches.

In operation the high voltage bridge is connected to the individual coaxial units of the cable by flexible cords with connectors identical with those on the Sliver Burner. The ratio arms (A and B), and the kick balancer, are set at values depending on the length of line to be tested. Voltage is increased until the fault breaks down, which is indicated by a drop in the voltage and the simultaneous flashing of the neon light on the panel. The voltage is thereupon adjusted until the breakdown rate is two to five times per second. Then the low sensitivity galvanometer key is depressed and the kick balancer and decade knobs alternately adjusted until the galvanometer deflection is steady at zero. The balance is further refined with the

THE AUTHOR: J. W. Kittner received the degree of Bachelor of Science in Electrical Engineering from Purdue University in 1939. He joined the Laboratories that year and became associated with the cable apparatus development group of Outside Plant Development where he was concerned with the development of test sets for use by outside plant field forces. During World War II he worked on similar equipment for the Signal Corps as well as submarine detection apparatus for the Navy. He then was with the plant facilities group of the Outside Plant Development Department, working on problems of exchange plant maintenance in Morristown until a year ago. Since then he has been in the plant systems group at Murray Hill.

higher sensitivity galvanometer keys. The final decade resistance V2 is recorded and after the other Varley measurements, V1 and V3, have been made at low potential the distance to the fault is computed by the formulae given in Figure 3.

In field practice, splicers who work on coaxial cables are equipped with Sliver Burners. When a splicer cannot burn out a fault a cable tester locates it with a high voltage bridge. In order that the cable tester need not carry a separate Sliver Burner in his own kit this feature has been incorporated in the bridge circuit.

HISTORIC FIRSTS: CRYSTAL CONTROLLED BROADCASTING

One of the factors in the success of commercial broadcasting, and in fact of all radio communication, is the precise control of the carrier frequency. Effective use of closely spaced channels would be impossible if the carriers were not maintained accurately at the proper position within their allotted band. There was, of course, no need for such a requirement in the early 1920's when broadcasting began, and it is interesting that the first application of quartz crystals to control the carrier was not made to prevent deviations of the carrier from causing interference with programs in adjacent channels. It was applied in June, 1924, to the transmitter of Radio Station WEAF—then operated by the American Telephone and Telegraph Company – to prevent the oscillating circuit from being frequency modulated by the amplitude modulation of the carrier.

Broadcasting by the Bell System was initiated in the summer of 1922 with Station WBAY at the Long Lines building, then referred to as the Walker-Lispenard building but now known as 32 Avenue of the Americas. The great height of the antenna – about 500 feet – was soon found to be unsuited to the particular frequency assigned, however, and in August of that year the WEAF transmitter and antenna at 463 West Street was taken over and operated over a program line from the studio at the Walker-Lispenard building. WEAF used a 500-watt transmitter as did WBAY. It had been operated by the Engineering Department of the Western Electric Company – a few years later incorporated as Bell Telephone Laboratories, Inc. – since 1919, originally under

THE MURRAY HILL BUILDINGS FROM MOUN

the experimental station call letters 2XB.

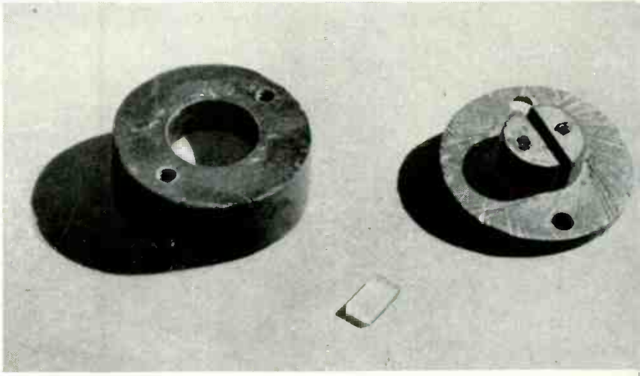
Although reception was improved by the change to West Street, it was soon found that in certain areas of the receiving territory severe fading and distortion were being encountered for which no obvious reason could be found. Extensive transmission tests were undertaken by D. K. Martin under a number of controlled conditions of the transmitters. The region of bad reception in Connecticut was found to lie in the radio shadow of a group of tall buildings just below Central Park. The effect of these buildings combined with frequency modulation of the carrier which the tests had also shown to exist were found responsible for the distortion experienced.

The use of a piezoelectric crystal to control an oscillator had already been demonstrated by the Laboratories,* and Professor W. G. Cady at Wesleyan University had recently extolled the merits of quartz crystals for stabilizing the frequency of an oscillator in a paper before the Institute of Radio Engineers.† A new 5-kw transmitter had been installed at WEAF late in 1923 under the direction of F. M. Ryan, and on June 19, 1924 – it having been established by that time that the frequency modulation of the oscillator circuit was largely responsible for the difficulties encountered – W. A. Marrison was asked to cut a 610-kc crystal for controlling the new WEAF transmitter.

*Record, *November,* 1944, *page* 601.

†Proceedings of the I.R.E., *April,* 1922, *Volume* 10, *page* 82.

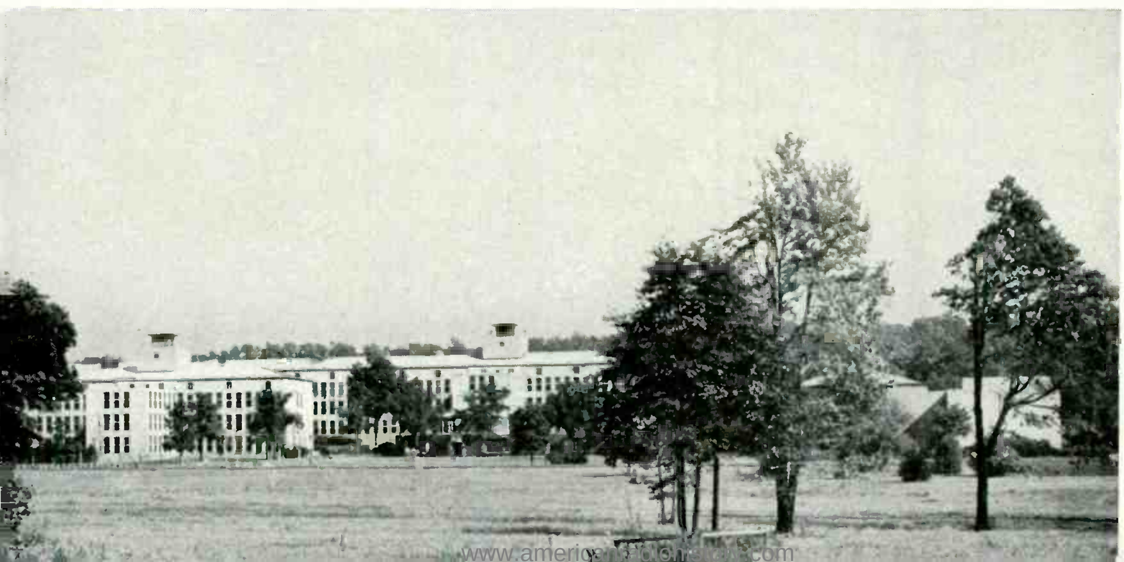
Marrison had been preparing quartz crystals for some time to be used as frequency standards, and proceeded at once to cut a 610-kc crystal and to build a suitable oscillator circuit. The original



Original crystal and its holder used for the first crystal controlled broadcast transmission

crystal and its holder are shown in the accompanying illustration. A "bread-board" model of the crystal controlled oscillator was prepared and tried out with the WEAF transmitter at first when no program was being broadcast. An improvement in reception in the critical area was observed in these tests, and as a result, crystal control was developed for regular use. Arranged in more permanent form, the crystal controlled oscillator was put in service by the WEAF staff in 1925, and WEAF has remained crystal controlled from that time on, more recently under the call letters WNBC.

-NUE. THE NO. 2 BUILDING IS AT THE LEFT



NEWS AND PICTURES OF THE MONTH

CLIFTON W. PHALEN

VICE-PRESIDENTIAL CHANGES IN A T & T AND WESTERN ELECTRIC

Clifton W. Phalen, formerly vice-president of the New York Telephone Company, has been elected vice-president of the American Telephone and Telegraph Company in charge of Public Relations, succeeding Keith S. McHugh. Mr. McHugh, in turn, has become vice-president in charge of Finance. Charles P. Cooper has retired as vice-chairman of the Board of A T & T; he continues as a member of the Board of Directors.

Mr. Phalen, who was born in Washington, D. C., and graduated from Yale University, began his Bell System career 21 years ago in the plant department of the New York Telephone Company at Syracuse. Following work as a lineman, cable splicer, installer and repairman, he was made a district plant chief in 1929. He rose to the position of assistant vice-president of the New York Company in 1943 and in 1944 was elected vice-president, Personnel. The following year he became vice-president, Public Relations. Mr. Phalen is succeeded in the New York Company by Wellington Powell, formerly vice-president and general manager of the Company's upstate area.

George L. Best, vice-president in charge of patent licensing activities of the Western Electric Company, has been named vice-president, Finance, to succeed T. Kennedy Stevenson. Mr. Stevenson, vice-president, Finance, since 1941, will retire on November 30 under the Company's age retirement rule and Mr. Best's appointment will become effective at that time. Mr. Best will continue to be responsible for patent licensing in addition to duties associated with his new post.

NEW TRAINING COURSES START

Beginning with the week after Labor Day, some fifty of Bell Telephone Laboratories' younger engineers started on a training program in communication development. Some will attend a course of in-hours lectures and apply the rest of their time in rotated sched-

Veronica Salis and E. J. Thielen confer on the administration of the Communication Development Training program recently inaugurated ules of work in the technical departments of the Laboratories. Others will attend one or more lecture courses while continuing their present work assignments. Included in the program are field trips to nearby Bell System operating organizations and to the shops of the Western Electric Company.

Courses for the first semester, with the instructors, are: *Transmission Systems—Introduction*, R. A. Shetzline; *Design for Production and Service*, James G. Ferguson and W. W. Werring; *Fundamentals of Switching*, John Meszar and W. Keister; *Design Principles of Electromechanical Switching Apparatus*, H. N. Wagar; *Communications Engineering Materials*, A. G. Ganz; *Probability and Statistics*, R. I. Wilkinson and H. F. Dodge; *Outside Plant*, T. C. Henneberger; and *Development Economics*, J. W. Emling. These instructors will be assisted from time to time by lecturers on special topics.

Communications development training is a function of the Personnel Department, under the charge of Morton Sultzer. Curriculum, preparation of texts and selection of instructors has been handled by the Program Committee, of which H. M. Trueblood is chairman; members are P. W. Blye, A. G. Ganz, T. C. Henneberger, S. B. Ingram, John Meszar, F. F. Romanow and Mr. Sultzer. E. J. Thielen is in charge of operations, with Veronica Salis, registrar of the training program.

BELL SYSTEM OPENS MID-WEST TELEVISION NETWORK

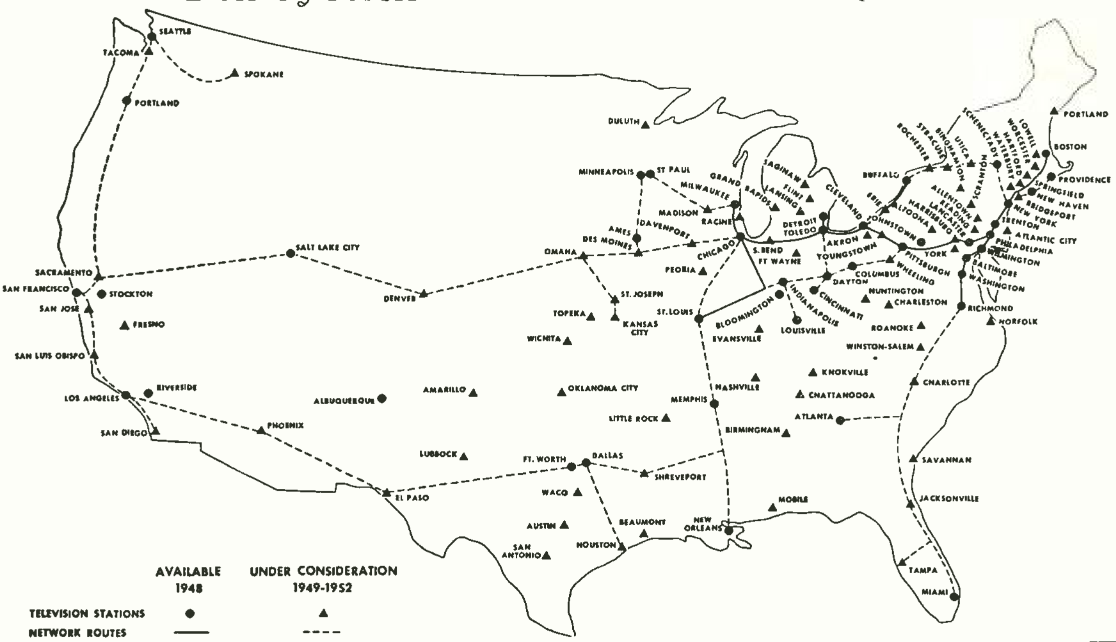
Network television arrived in the Mid-West on September 20 when Bell System engineers completed tests which cleared the way for video service between St. Louis, Chicago, Milwaukee, Toledo, Detroit, Cleveland and Buffalo. By the end of the year, this Mid-Western network will be linked to the East Coast network, making it possible for one program to be broadcast by stations on a hook-up from the Atlantic Coast to the Mississippi River.

Service is provided in both directions between St. Louis, Chicago, Toledo, Detroit and Cleveland, and branches carry programs to Buffalo and Milwaukee. The television channels are furnished by coaxial cables, with the exception of the Toledo-Detroit and Chicago-Milwaukee links where radio relay systems are employed.

Bell System coaxial cables and radio relay systems are built primarily to meet the needs of long distance telephone service. But provision is made at the same time for video channels and other communication services.

Work on the coaxial cables in the Mid-Western network—part of the large post-war construction program of the Bell System—was

Bell System Television Network Routes



begun in May, 1946, with the laying of the Buffalo-Cleveland coaxial cable. The Terre Haute-St. Louis coaxial cable project was started before the war but its completion was delayed until 1945.

Work on the Chicago-Terre Haute and Cleveland-Toledo sections was begun in February, 1947. In August of that year, the Chicago-Toledo segment was started. All cable segments have been in use for long distance telephone service for some months, while additional channels were being equipped for television transmission.

Construction of the radio relay systems in the network was begun during the spring of this year. Three intermediate towers were built between Chicago and Milwaukee, and two between Toledo and Detroit. Terminal equipment was installed at the Michigan Bell Telephone Company building in Detroit, The Ohio Bell Telephone Company building in Toledo, the Illinois Bell Telephone Company's long distance center in Chicago, and at the Wisconsin Telephone Company toll building in Milwaukee.

The Mid-Western and Eastern networks will be linked by a coaxial cable between Cleveland and Philadelphia. The Bell System will then have a total of some 5,000 miles of video channels, linking fourteen major cities from Boston and Richmond to St. Louis and Milwaukee.

Personnel Director F. D. Leamer congratulates W. B. Bachmann, one of the young men who completed the Drafting Assistant Course during the past year and received his certificate on August 18. All Laboratories drafting departments were represented among this year's twenty graduates, most of whom carried their studies to completion despite an interruption of more than three years due to military service during World War II

DRAFTING ASSISTANT COURSE GRADUATION

The presentation of Drafting Assistant certificates took place at a luncheon attended by the graduates and representatives of the Personnel and Drafting Departments. Left to right, seated—J. W. Woodard, H. P. Franz, H. B. Ely, F. D. Leamer, H. W. Gillette, H. J. Delchamps, W. L. Heard, W. J. Adams, and graduates R. L. Norton and J. B. Kennedy. Standing—V. W. Bennett, A. A. Roetken, and graduates F. R. Misiewicz, W. B. Bachmann, D. W. Graham, R. C. Benkert, R. M. Oppenheimer, G. Chabra, P. G. Nolan, R. S. Yerden, J. A. Ce-nzo, L. B. Jones, R. E. Haggerty, E. Miritello, H. J. Fischer, C. H. Dalm, W. V. Hoshowsky, G. J. McArdle, and C. M. Voss. Graduate J. H. Devereaux, Jr., was unable to attend the luncheon

W. H. Harrison Leaves B.T.L. Directorate

At a special meeting of the Board of Directors of the Laboratories on August 30, the resignation of William H. Harrison, as Director, was accepted. General Harrison was initially elected to the Board on March 3, 1937, resigned to enter military service on December 8, 1941, and on his return was reëlected to the Board on September 27, 1945. He is now president of the International Telephone and Telegraph Company.

Part-Time Postgraduate Study Plan

Individuals interested in undertaking postgraduate work under the Part-Time Postgraduate Study Plan may obtain detailed copies of the announcement pamphlet, application forms, and other information from the Personnel Department, Section 4-H of the West Street building, on Extension 628.

Any employee of the Laboratories who has been regularly employed for a minimum of approximately one year and who holds a bachelor's degree in arts, science, or engineering is eligible to make application under the Part-Time Postgraduate Study Plan.

Candidates who wish to enroll under the plan should discuss the question of their enrollment with their immediate supervisors.

It is expected that prior to application for enrollment under this plan, consideration will have been given to equivalent instruction available outside of working hours, that is, Laboratories' Out-of-Hour Courses, evening or extension courses in metropolitan colleges, and courses offered for postgraduate work on other than scheduled working days.

MOBILE TELEPHONE AIDS COSMIC RAY RESEARCH ON MOUNTAIN PEAK

This converted Army trailer has a new mobile telephone, believed to be the highest telephone in North America

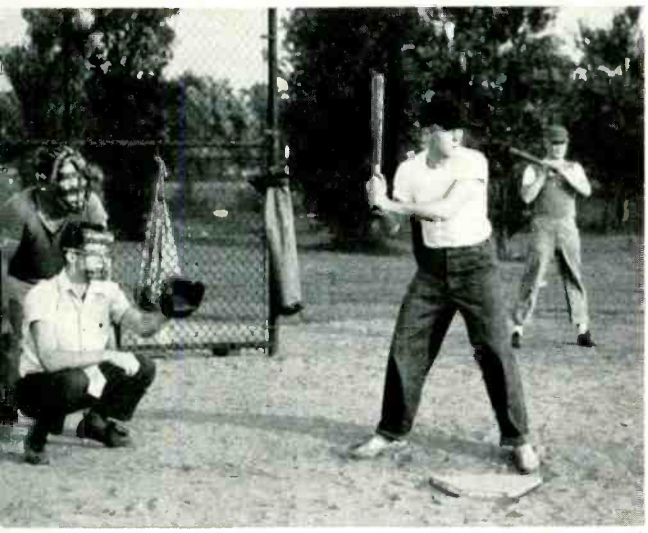
The mobile radio telephone system is getting up in the world.

Probably the highest telephone of any type in all North America—exclusive of those in aircraft—is the one that was recently installed for the Department of Physics of the University of Denver in a trailer which spends considerable time atop 14,260-foot Mount Evans in Colorado.

The mobile telephone was recently placed in service by The Mountain States Telephone and Telegraph Company for the use of university scientists who are engaged in a program of cosmic ray research and who had been handicapped by lack of communication with the outside world. Tests conducted by the telephone company revealed that, because the research station could be reached by Denver's urban service transmitter, installation of a mobile radio telephone was practicable under the conditions that would be encountered at this location.

Installed in a converted Army trailer, the mobile set is surrounded by an intriguing array of nuclear research equipment and a number of white rats used in experiments. It enables the scientists, who are from widely scattered institutions, to keep in touch with their colleagues, and to arrange for necessary supplies. The Denver switchboard permits prompt connection with most of the 36 million telephones in the country.

WINNING TEAM OF NEW YORK SOFTBALL LEAGUE



Systems Drafting won the West Street Softball League trophies against Graybar and the combined Apparatus Drafting and Building T Shop teams. Lined up, rear row, left to right, are G. B. Clark, Jr., J. J. Cebak, R. C. Nance, G. J. Wieland, Jr., W. Bergmann, Anthony Majlinger and T. J. Landis; second row, A. W. Luhrmann, G. W. Fiederowicz, R. P. Erbig, Jr., J. M. Marko and, center front, J. B. Seiders

Umpire D. F. O'Sullivan and catcher J. A. Kotaski of Apparatus with R. C. Nance at the plate, G. J. Wieland, Jr., warming up at bat

F. J. H. Colclough ready to swing a home run at Lincoln Park, Jersey City, with, left to right, J. H. Mogler, A. W. Luhrmann at first base, D. F. O'Sullivan, umpire, J. B. Seiders, catcher, G. C. Irwin and H. A. Cubberly onlookers and J. J. Cebak pitching

Laboratories Men Honored by I.R.E.

Ralph Bown, director of research, has been named to receive the annual Medal of Honor awarded by the Institute of Radio Engineers. He is the fifth Bell System man to be so honored by the Institute.

The medal was awarded "in recognition of distinguished service rendered through substantial and important advancement in the science and art of radio communication." It will be presented at the Institute's convention in March, 1949.

Herman A. Affel, director of transmission development, has been elected a Fellow of the Institute.

Traveling Telephones and Displays

Public telephone service and exhibits of general interest are combined in this new telemobile trailer, one of two which toured the county fair circuit in New York State during the summer. The trailer has five acoustically treated booths equipped for service in either dial or manual exchanges. A directory library, seats and a water cooler are provided for the public. An attendant makes change at the entrance. Fresh air is circulated throughout the trailer by blowers.

The main display shown in the center of the trailer's side is a large operating model of the transmitter and receiver of a telephone handset designed by H. J. Kostkos of the Laboratories. Other displays include coaxial cable, the replacement of crank-type telephones with handsets, and a chart showing how much rural telephone progress has been made.

One of the two telemobile trailers which toured the county fair circuit in New York State during this past summer

More A T & T Stock Available to Employees

Directors of the American Telephone and Telegraph Company on September 15 voted to proceed with a second offering of shares of capital stock to employees of the company and its subsidiaries under the employees' stock plan authorized by stockholders in October, 1946. Under the plan a total of not more than 2,800,000 shares may be sold to employees.

The new offering will be made by a prospectus which it is expected will be sent to employees early in December, 1948.

Employees with three months or more service on November 30 will be eligible to participate. Officers of A T & T will not be eligible. The purchase price will be $20 per share less than the market price when payment is completed, but not more than $150 nor less than $100 per share.

Under the new offering, eligible employees may elect to purchase one share of stock for each full $500 of their annual basic rate of pay on November 30, 1948. These shares may be in addition to the shares which employees are buying under the first offering, except that no employee may purchase a total of more than 50 shares under both offerings. Payment will be made by payroll deductions at the rate of $5 per share per month. Interest will be credited on installment payments at the rate of 2 per cent per year compounded semi-annually.

Proceeds from the sale of the stock will be used to provide funds for extensions, additions and improvements to the plant of A T & T and its subsidiary and associated companies and for general purposes.

Heading up the Doll and Toy Committee at three locations are, left to right, Marion Merck, Whippany; Mary Upton, New York; and Peggy Anderson, Murray Hill; with Mildred Read, second vice-president of the Club, during a conference on toy purchases and institutional requests

Doll and Toy Committee Needs Your Help

Thousands of youngsters in greater New York institutions, boarding homes and hospitals begin to dream of Santa and Christmas about this time of year. The dreams of many are inspired by the memory of the beautifully dressed dolls, archery sets, books and baseball paraphernalia distributed to them through the generosity of Laboratories members and their Doll and Toy Committee last year. This year the project is headed by Mrs. Mildred Read of Murray Hill, second vice-president of Bell Laboratories Club, with Peggy Anderson chairman of the Murray Hill Committee, Marion Merck, the Whippany Committee, and Mary Upton, the New York Committee. They will need departmental representatives to contact those interested in contributing to the Committee, Laboratories girls and wives of Laboratories men to dress dolls, and men to help with displays and with packing cartons. Will you volunteer your services?

"Crystal Clear," a New Bell System Film

The new technique of growing synthetic crystals in the laboratory in a few months' time is shown in a new Bell System motion picture entitled "Crystal Clear." The movie was recently released to Associated Companies by the Film and Display Division of the A T & T for showing to Bell System employees and the general public.

"Crystal Clear," filmed in Kodachrome by Bell Telephone Laboratories, depicts the various stages of the crystals' growth from seed to final crystal bar. The picture tells something of the part crystals play in the transmission of many long-distance telephone conversations over the same pair of conductors. Two versions of the film are available: a popular one for the general public, and a longer one which has additional technical detail for scientific groups.

The picture was filmed in 16mm color at Murray Hill by J. J. Harley in collaboration with A. C. Walker of the Chemical Laboratories and his associates.

Bell Musicians to Make Carnegie Hall Debut

The Metropolitan Bell Symphony Orchestra will present a concert at New York's Carnegie Hall on Friday, November 12, at 8:30 p.m. Marisa Regules, Argentine pianist, will play the Chopin F-Minor Concerto with the orchestra. Designed to demonstrate the versatility of Bell musicians, the program will include music by Rossini, Haydn, Schubert, Bach, Elgar, and an arrangement of Stephen Foster melodies by conductor Michel Gusikoff.

Open to members of Bell System companies in metropolitan New York and New Jersey, the orchestra now includes the following members from the Laboratories:

H. H. Abbott	R. V. Hatch
R. E. Anderson	A. F. Hughes
B. P. Bogert	F. A. Johnson
R. N. Breed	W. A. Krueger
E. Callahan	W. R. Lundry
G. F. Critchlow	P. E. Mills
P. G. Edwards	Bernice Potwin
R. D. Fracassi	J. A. Weller
J. C. Gabriel	H. C. Green
A. L. Whitman	

Additional application blanks for tickets to the November 12 concert may be obtained in Room 177, West Street.

Franklin Institute Honors E. H. Colpitts

The 1948 Elliott Cresson Medal has been awarded by Franklin Institute to Edwin H. Colpitts, formerly vice-president of the Laboratories and presently director of the Engineering Foundation.

Founded in 1848, the Elliott Cresson Medal is one of the highest honors of the Institute and is given "for discovery or original research, adding to the sum of human knowledge, irrespective of commercial value." Dr. Colpitts will receive it for his pioneering achievements leading to the development of practical systems of long distance communication, both by wire and radio.

H. T. Killingsworth Named General Manager of A T & T Long Lines

Henry T. Killingsworth has been appointed General Manager of the Long Lines Department of the American Telephone and Telegraph Company. The appointment became effective August 11, on the retirement of Laurance G. Woodford, General Manager since 1943. Having joined the Long Lines Department as a technical employee at Atlanta in 1919, Mr. Killingsworth came to New York in 1925 as an engineer for the A T & T. He was transferred three years later to Cleveland.

From 1936 to 1940, Mr. Killingsworth was division plant superintendent in Denver. He then returned to New York as general plant supervisor. With the creation of Long Lines' Southern Area in 1945, he was promoted to area plant manager.

Toll Dialing Points Increased

Operator dialing of long-distance calls took another step forward recently with the opening of a new tandem central office in New York City which permits operators in more Eastern cities to dial New York numbers directly.

In addition to thirteen nearby cities already having one-way toll dialing circuits into New York, the new office, known as Gotham Tandem, ties in Chicago, Miami, Baltimore, Wilmington, Del., Atlantic City, and seven upstate New York cities. Washington, Philadelphia and three additional New York State toll centers will be added later in the year. Thirty-four suburban toll points in Long Island, New Jersey, nearby Westchester County and Connecticut will also be served.

Distinguished Visitors at Murray Hill

Recent visitors to Murray Hill were Sir C. Venkata Raman on August 9, and Dr. Geoffrey Gee on August 27. An outstanding physicist, internationally known for his discovery of the Raman effect, Sir Venkata spoke in the Arnold Auditorium on *Molecular Vibrations in Diamonds*, during his visit, and Dr. Gee, who is director of the laboratories of the British Rubber Producers' Research Association, on *The Nature of Polymer Solutions.*

Registration for Selective Service

New York Laboratories members required to register under the Selective Service Act of 1948 were registered from 9 to 5 at West Street on September 7 and 8 by Clarence Anderson, W. A. Bollinger, Anne Pluta and Ruth Robinson, chief registrant. Ninety-nine employees availed themselves of the facility. Shown directly below are Miss Robinson and Alfred Briganti; and in the other photograph, Miss Pluta and F. X. Sullivan.

RETIREMENTS

H. G. Rife

W. S. Boerckel

C. E. Lane

Among the recent retirements from the Laboratories are W. S. Boerckel, with forty-two years of service, H. G. Rife, thirty-eight years, and C. E. Lane, twenty-seven years.

Harry G. Rife

Graduating from Beloit College in 1908, Harry G. Rife joined the Western Electric Company at Hawthorne in 1910. After a little over a year in the Production and Inspection Departments, he transferred to the Engineering Department, which later became the Laboratories. As a member of Outside Plant Development, he remained in Hawthorne until December, 1929, when he was transferred to Kearny.

Mr. Rife has been associated almost continuously with the work on lead-covered cable development and design for both associate and non-associate use.. As improvements in the design of telephone cable have been made for the Bell System, it has been his responsibility to acquaint the non-associate field with them. He has been responsible for and has engineered special cables required by non-associate users such as railroads, municipalities, and the U. S. Government, for the past quarter of a century. During World War II, he was active in the design of the vast amount of cable that was used by the Armed Forces.

In retirement, Mr. Rife expects to continue his residence in Westfield and to find more time for his hobby, contract bridge.

Winfield S. Boerckel

Entering Western Electric while its eastern works was still in our present West Street building, W. S. Boerckel learned the drafting art and practiced it until 1913, when he transferred to the Transmission Apparatus laboratory. There he worked on carbon-button repeaters and transmitters, on train dispatching and early loud-speaker systems. In 1922 he returned to drafting in Apparatus Development, specializing in keys, jacks, and plugs. He became a supervisor in 1927.

In his home town of Valley Stream, where he has lived for 30 years, Mr. Boerckel has been captain of a volunteer fire company and later fire commissioner. A home craftsman, he is looking forward to making further improvements in his home.

Clarence E. Lane

Near the beginning of our intensive work in acoustics, C. E. Lane entered the Laboratories in 1921 with A.B. and M.S. degrees from the University of Iowa. His first five years

October Service Anniversaries of Members of the Laboratories

45 *years*
George Dodd

40 *years*
G. A. Locke
A. H. Sass

35 *years*
G. D. Edwards
J. D. Hubbell, Jr.
R. E. Ottman
L. W. Parker

30 *years*
Bartow Koopman
C. C. Munro

25 *years*
Aniello Arcella
G. E. Atkins
I. H. Baker
L. J. Barker
C. W. Carter, Jr.
W. F. Clemency
F. A. Hoyt
E. A. Krauth
J. A. Krecek
Andres Llorente
W. J. Means
J. D. Sarros
E. S. Savage

20 *years*
F. M. Burelbach
Harry Hansen
A. H. Hearn
W. F. Hoover
E. H. Jones
R. E. Long
Arthur Ludwig
S. N. Markocki
W. H. McAuliffe
J. A. McHugh
R. H. Ross
J. J. Scanlon
W. J. Szmeikal
W. A. Tracy
H. E. Vaughan
J. W. Wolek

15 *years*
T. F. Rogan

10 *years*
J. H. Craig
H. L. Rosier
O. E. Stelter

were occupied with studies of auditory masking of one tone by another; in the development of loud-speakers; and on the artificial larynx. In 1926 Mr. Lane transferred to Transmission Networks and had charge of the development of crystal filters. Early in 1942 he was given charge of all filter work in Transmission Apparatus Development.

Among Mr. Lane's notable personal contributions to the art is the duplex low-frequency crystal, described in the RECORD in February, 1946. His mechanical model of the band-pass filter, using pendulums and springs, is in the Franklin Institute Museum in Philadelphia; it enables one to see the actual functioning of a wave filter. Eleven patents and fifteen published papers in various technical publications record his original contributions to the communications art.

A prize winner in Laboratories' Flower Shows, Mr. Lane has put up a small greenhouse near his home in Terre Haute, where he plans to continue his experiments in the field of horticulture.

This reception desk in Women's Employment at West Street has incorporated a number of excellent features, such as a personal drawer under the typewriter, built-in files on the left, sections for stationery and a sliding tray in the center drawer. It is being given final inspection by Frank Schuler, right, the cabinetmaker who built it. On the left is Thomas Smith, who gave the desk its finish and polished it. Credit for designing the desk goes to H. W. Aschinger of the Apparatus Drafting Department

American Institute of Electrical Engineers

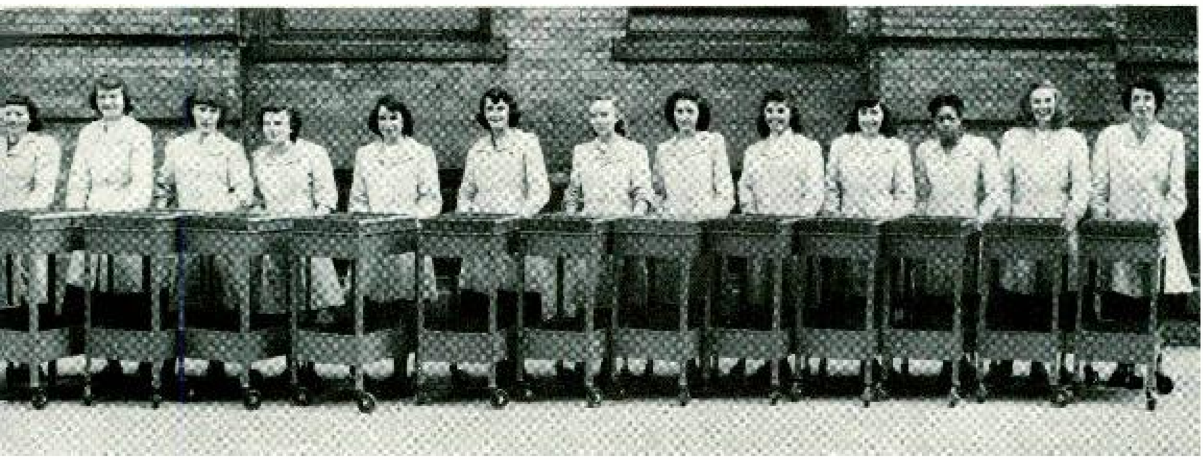
Members of the Laboratories serving as members on general committees of the A.I.E.E. for the 1947-1948 year include: *Board of Examiners,* F. J. Scudder and H. M. Trueblood; *Constitution and Bylaws,* R. L. Jones; *Planning and Coördination,* R. L. Jones and J. D. Tebo; *Publication,* R. K. Honaman; *Institute Publicity,* R. K. Honaman, chairman; *Research,* M. J. Kelly; *Safety,* L. P. Ferris; *Standards,* R. L. Jones, chairman; *Technical Program,* J. D. Tebo; and *Membership,* Charles Clos, District Vice-Chairman.

Members of professional group committees include: *Professional Group Coördinating Committee,* D. A. Quarles; *Charles Le Geyt Fortescue Fellowship,* R. I. Wilkinson; *Edison Medal,* O. E. Buckley; *Lamme Medal,* D. A. Quarles; *Management,* D. A. Quarles; and *Award of Institute Prizes,* J. D. Tebo.

Technical committee memberships include: *Carrier Current,* J. M. Dunham and R. H. Miller; *Protective Devices,* P. A. Jeanne; *Protective Devices Subcommittees,* P. A. Jeanne and A. H. Schirmer; *Transmission and Distribution* and *General Systems Subcommittee,* H. M. Trueblood; *Metallic Rectifiers Subcommittee* (of *Chemical, Electrochemical, and Electrothermal Applications Committee*), N. Y. Priessman and D. E. Trucksess;

Communication and Science Coördinating Committee, J. D. Tebo, chairman; *Basic Sciences,* J. A. Becker, W. H. MacWilliams and J. D. Tebo; *Electric Circuit Theory Sub-*

"I can't quite agree that the deuteron possesses an electric quadrupole moment such that it appears as a spheroid prolate along the spin axis"



Work of the mail girls at West Street and Murray Hill has been lightened by these aluminum carts, piloted here by Misses Lillian MacNeill, Marion Eich, Pat Lampeter, Catherine Lenzinger, Thelma Cordon, Anne Rubenstein, Evelyn Albers, Anita Garcia, Betty Sprissler, Joy Forno, Betty Hall, Betty Kaeser and Dorothy Fertsch

committee, R. L. Dietzold and E. B. Payne; *Energy Sources Subcommittee,* J. D. Tebo; *Electrical Properties of Solids Subcommittee,* J. A. Becker, chairman; *Subcommittee on Magnetics,* R. M. Bozorth;

Communication, L. G. Abraham, H. A. Affel, A. J. Busch and G. A. Locke; *Communication Switching Systems Subcommittee,* A. J. Busch; *Wire Communication Systems Subcommittee,* H. A. Affel, chairman, and L. G. Abraham; *Record Communication Subcommittee,* G. A. Locke; *Computing Devices,* W. H. MacWilliams;

Electronics, D. E. Trucksess; *Hot Cathode Electronic Power Converters Subcommittee* (of *Electronic Committee*), D. E. Trucksess; *Instruments and Measurements,* E. I. Green, chairman; *Subcommittee on High-Frequency Measurements,* E. P. Felch; and *Joint Subcommittee on Electronic Instruments,* W. H. Tidd.

Retired But Active

F. B. Jewett has been appointed to the Board of Directors of the American Standards Association, according to an article on Dr. Jewett in the September, 1948, issue of *Industrial Standardization.*

R. D. Parker, who served with the War Department in Japan for a year after retiring from the Laboratories, is now a member of the National Security Resources Board where his job concerns communications and, in particular, laboratory matters relating to communications, electronics and allied subjects that are all in the Office of Production of the Utilities Group of the N.S.R.B.

News Notes

A. B. Clark, R. I. Wilkinson, G. A. Hurst and A. J. Engelberg observed the general performance of new central office equipment at Philadelphia and discussed maintenance matters. Later, Mr. Clark, Mr. Wilkinson and Mr. Hurst went to Media with J. W. Gibson for a discussion on traffic studies being made on the No. 5 crossbar office installation and to review the maintenance situation.

E. I. Green, H. Nyquist and J. R. Pierce, who sailed August 13 on the *Nieuw Amsterdam,* spent ten days in London at various technical institutions and universities before visiting Holland, where their two-week visit included conferences at the N. V. Philips Company, Eindhoven.

Lloyd Espenschied is the author of the guest editorial in the August, 1948, *Proceedings of the Institute of Radio Engineers,* and J. R. Pierce of an article entitled *Effect of Passive Modes in Traveling Wave Tubes.*

R. K. Honaman visited The Southern New England Telephone Company on August 11 to discuss publication questions.

H. J. Miller has been appointed Field Engineer in the Mountain States territory, with headquarters in Denver. For several years, field work in this case has been handled by J. W. Van der Water, stationed in Omaha, but the growing number of new telephone projects and the expanding usefulness of the field engineers have made it necessary to split the territory and to assign two Field Engineers to it. Mr. Van der Water will continue to cover the Northwestern Company's areas from the Omaha headquarters.

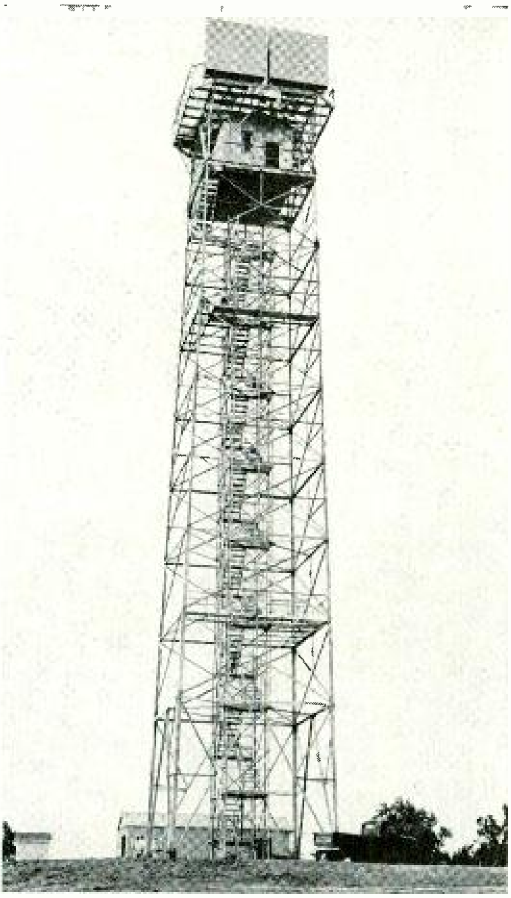
H. Peters visited the Simplex Wire and Cable Company in Boston in connection with submarine cable.

C. H. Amadon inspected Douglas fir and lodgepole pine installations in the far West. He also made a special study of lumber quality in relation to material requirements for crossarms.

G. Q. Lumsden and C. R. Brearty made a survey in Kansas on the behavior of unseasoned poles shipped into dry territories.

J. B. D'Albora made an investigation at Allentown of magnetron problems.

B. E. Stevens visited the Western Electric plant at Haverhill in connection with manufacturing problems on voltage regulators.



Microwave radio relay tower near LaSalle, Michigan, on the link which will bring Detroit into the television network

C. A. Chase, N. C. Youngstrom and J. J. Gilbert were at Key West in connection with a survey of landing places for the projected Key West-Havana cables.

J. R. Weeks visited Hawthorne in connection with metallized paper condenser problems, and J. R. Bardsley to discuss questions of loading coil case design.

C. M. Hill conferred at the General Electric Company, Pittsfield, on various rubber compounding materials.

J. J. Lander attended the Conference on *Transitions in the Solid State* held by the National Research Council at Cornell University.

W. J. Kiernan was appointed a member of A.S.T.M. Committee E-12 on Appearance.

G. R. Gohn visited the Canadian Bureau of Mines, Ottawa, to discuss methods of testing creep and fatigue, and the Aluminum Laboratories, Kingston, Ontario, to discuss methods of fatigue testing.

J. D. Struthers attended the Symposium on Nucleonics and Analytical Chemistry at Northwestern Technological Institute.

T. A. McCann, H. W. Hermance and T. F. Egan discussed with the Illinois Bell Company in Chicago a proposed relay contact field study. Relay design problems and adjustment procedures were also discussed with Western Electric and Illinois Bell engineers in conferences at which P. W. Swenson, H. O. Siegmund and B. F. Runyon were present.

F. F. Shipley and C. E. Brooks, together with W. Rupp and W. O. Turner of the A T & T, spent a few weeks in California with the Pacific Telephone and Telegraph people in connection with the preparation of cost studies for the Southern California area and a program for additional studies to help in the determination of the proper direction for the central office switching program. Some time was also spent in San Francisco discussing local tandem and toll switching problems.

H. W. Bode presented a paper, *Mathematics in Communication Research,* before the Mathematics Institute at Duke University.

W. P. Mason sailed for Europe on August 28 aboard the *Mauretania* to participate in the meeting of the Seventh International Congress of Applied Mechanics in London. Mr. Mason will also visit Holland, Switzerland and France.

A. B. Reynolds studied a quality survey of reissued combined telephone sets at the Pittsburgh, Cleveland and Detroit Distributing Houses of Western Electric.

Mary Kitchell, left, and Madeline Kessler are handling the issue and reissue of many telephone system circuits. By thus relieving regular circuit engineers of the work, they are making available more engineers for new development projects. Miss Kessler is as we say "third generation Bell System" and has an A.B. in physics from Barnard while Miss Kitchell was the first woman to be graduated with a B.E. in E.E. degree from Pratt Institute

W. L. Bond, C. J. Calbick, R. O. Heidenreich, A. N. Holden, W. P. Mason, B. T. Matthias, A. C. Walker and Elizabeth Wood attended the first meeting of the International Union on Crystallography at Harvard University on August 2. Mr. Calbick presented a paper, *Electron Micrographic Study of the External Form of Crystals of Carbonyl Nickel,* and contributed a display of electron micrographs under the title *Electron Micrographic Study of the Sintering of Nickel-Manganese Oxide.* Mr. Walker presented a paper, *Growing of Quartz Crystals,* coauthored by E. Buehler. He also showed the movie, *Crystal Clear,* on the growing of EDT crystals. He repeated this talk and showed the same movie on August 24 to the New England Association of Chemistry Teachers at the University of Maine.

Engagements

*Enid Cummings—Charles Hinds
*Carolyn Dour—Edwin R. Blake
*Florence Doyle—Edward R. Hartung
Shirley Griffiths—*W. S. Ballantyne
*Jeanne Hankinson—Richard Bird
Mary Montelero—*Robert Funck
*Elizabeth O'Brien—William Brady
Theresa Scognio—*Gunther K. Hetzel

Weddings

*Evelyn Doucet—Harold F. Burr, Jr.
*Mildred Hoogstraat—*W. Thornton Read, Jr.
*Josephine Kaiser—*Edward J. Zillian
*Catherine Loeffel—James Bellotti
Josephine Loume—*Harry L. Christie
*Corrinne Marky—Ralph Hann
*Eleanor Scheuch—James Moran
*Lillian Voss—Francis J. Eberle

*Members of the Laboratories. Notices of engagements and weddings should be given to Mrs. Helen McLoughlin, Room 803C, 14th St., Extension 296.

D. G. Blattner, at Hawthorne, participated in discussions on wire connections to central-office apparatus.

P. T. Higgins visited four telephone exchanges in Connecticut to discuss maintenance problems of step-by-step equipment.

R. F. Mallina and J. H. Mogler participated in crossbar switch development conferences at Hawthorne during August.

H. O. Siegmund, B. F. Runyon, T. H. Guettich and H. M. Knapp visited Hawthorne on contact and relay developments; O. Mohr, on problems concerning polar relays.

W. A. Marrison and P. F. Weaver attended the National Instrument Conference in Philadelphia on September 16. Mr. Marrison also participated in the Science Forum Broadcast over Station WGY, Schenectady, on the evening of September 8. His subject was, *The Crystal Clock.*

J. E. Ranges went to Winston-Salem plant of the Western Electric Company in connection with pulser networks.

M. W. Bowker visited Baltimore and Richmond in connection with improved apparatus for locating gas leaks in toll cable.

J. B. DeCoste's visit to the Western Electric Company at Hawthorne concerned extrusion problems related to Alpeth cable.

W. K. Oser witnessed trial installations of a new type of wire at Langhorne, Pa., and Poughkeepsie, N. Y.

K. K. DARROW presided at the International Union of Pure and Applied Physics at Amsterdam, Holland, from July 8 to 10, as vice-president of the Union and as chairman of the United States delegation. He also attended a Physics and Metals conference at Amsterdam and the summer conference of the Physical Society of London at Oxford. Dr. Darrow also visited laboratories in England and France.

R. H. GALT and M. B. GARDNER have been elected Fellows of the Acoustical Society of America.

H. M. SPICER conferred with the Allen Bradley Company, Milwaukee, on control equipment.

W. L. TUFFNELL, at Point Breeze, discussed jacketed cords for the station handset.

H. F. HOPKINS attended a regular meeting in Cleveland of the Loudspeaker Committee of the Radio Manufacturers' Association.

F. L. CRUTCHFIELD went to Archer Avenue in connection with problems encountered in the manufacture of telephone receivers.

M. E. CAMPBELL, B. DYSART, R. W. MARSHALL and L. W. MORRISON have been in St. Louis, Chicago, Cleveland and Buffalo in connection with the television network being set up between these points.

J. P. KINZER has been measuring L1 cable characteristics near Dallas.

W. H. C. HIGGINS and G. G. SMITH went to the Brooks and Perkins Company, Detroit, to discuss the procurement of trailers for the transport of military apparatus.

J. W. SMITH, C. R. TAFT, H. A. BAXTER and N. W. BRYANT attended conferences at the Portsmouth Navy Yard in New Hampshire. Mr. Baxter and Mr. Taft also made a trip to General Mills, Minneapolis, in connection with naval submarine projects.

J. LEIGHTON and J. J. JOHNSTON investigated production problems at Winston-Salem of fire-control equipment.

H. M. CLEVELAND, E. A. THURBER and F. J. BIONDI spent several days at Allentown discussing electron tube problems. Mr. Biondi and J. P. AHRENS visited the Corning Glass Works regarding glass solder.

J. P. GUERARD and E. E. WRIGHT observed a demonstration of a new universal testing machine at Massachusetts Institute of Technology.

W. BABINGTON consulted with the Canadian Bureau of Mines, Ottawa, and the Western Electric Company, Chicago, on die casting of aluminum and zinc.

H. W. HERMANCE and T. F. EGAN conferred at Hawthorne on relay contact studies.

G. RODWIN and F. A. HUBBARD visited Burlington on type LE radio equipment.

T. J. GRIESER, during the first two weeks of August, supervised the installation of microwave path test equipment in the neighborhood of Salt Lake City.

D. E. THOMAS, N. C. YOUNGSTROM and J. J. GILBERT were at the Simplex Wire and Cable Company, Cambridge, in connection with submarine cable manufacture.

J. W. GEILS, with F. R. James of the Western Electric Installation Department, observed the installation at 32 Avenue of the Americas of the first A3 channel banks shipped from the shop on standard cable duct type bays.

AT WINSTON-SALEM, R. F. LANE, E. L. NELSON and R. C. NEWHOUSE were concerned with the production of aircraft radio-telephone equipment; J. B. D'ALBORA and J. H. HERSHEY, with an investigation of testing problems of fire control equipment; and E. H. JONES, with standardization matters.

ABC of Fire Prevention

P*ut out lighted matches and cigarettes before disposal.*

R*eplace electric cords when worn or frayed.*

E*liminate all rubbish and unnecessary combustibles.*

V*ertical openings in buildings must be cut off to prevent spread of fire.*

E*ducate school children in the simple rules of fire prevention.*

N*ever smoke in bed.*

T*rain everyone on what to do when fire breaks out.*

F*lameproof decorations in all public places.*

I*nspect frequently all places where fire may occur.*

R*eplace wooden shingle roofs with fire-retardant roofings.*

E*xamine and maintain all fire appliances.*

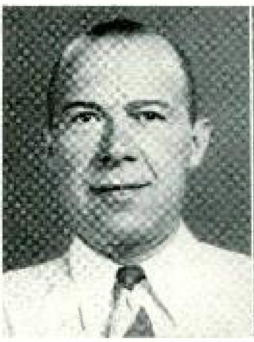
S*afeguard all heating equipment from surrounding combustibles.*

RECENT DEATHS

Alfred Kaufmann, August 17

A veteran of World War I, Mr. Kaufmann's Bell System service began in 1909 when he entered the American Telephone and Telegraph Company as a messenger. He became a member of the D & R when that department was formed in 1919, and in 1920 was promoted to cashier, a position he held until 1934 when the D & R consolidated with the Laboratories. His first work at West Street was in the Financial Department, from which he transferred in 1936 to the Accounting Department. During World War II he transferred to the Plant Department where, as a staff assistant, his work had to do with the admission of citizens to the main building and with checking on citizenship requirements as required by government security regulations. At the close of the war, Mr. Kaufmann transferred back to the Accounting Department.

Mr. Kaufmann had been a member of The White Church of Brooklyn, the Aurora Grata Masonic Lodge, the Eastern District Turnverein and the St. George Society. He was buried at Pinelawn Military Cemetery with full military honors.



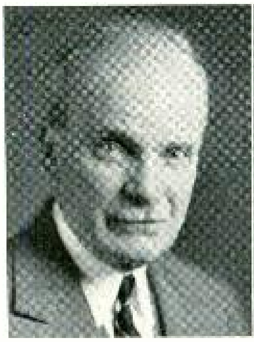
Alfred Kaufmann
1894-1948

C. G. Spencer
1882-1948

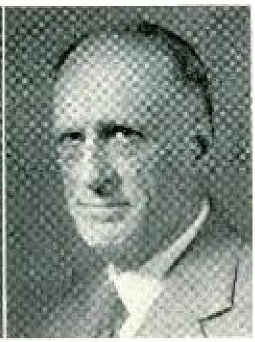
Charles G. Spencer, August 8

Mr. Spencer's long telephone career began in 1899 when he joined the Western Electric and ended in 1946 when he retired from the Laboratories. His work included six years with the manufacturing organization of Western and an equal length of time in the inspection group of the Engineering Department. In 1911, Mr. Spencer entered upon apparatus design work at Hawthorne, where he remained until 1918 when he joined System Development in New York and became concerned with developments which took him to Sweden in 1921. This work, in connection with the installation of the cable connecting Stockholm with Goteborg, kept him abroad two years. Upon his return to West Street, he was engaged in developing all types of systems for manual central offices until his retirement.

A. A. Schwinn
1879-1948



H. G. Eddy
1878-1948



Alfred A. Schwinn, August 9

Mr. Schwinn's service at the Laboratories dated back to 1908, when he began work on the construction of models of early semi-mechanical switching systems. Three years later he transferred to the Model Shop, where he specialized in the construction of models for the panel system, then under development, and in this connection he went to Hawthorne for half a year to assist in the production of the equipment and to Newark to take part in the installation of panel equipment in various exchanges. Returning to the Model Shop, he worked on vacuum-tube construction during World War I and later transferred to the Research Department. Mr. Schwinn retired from the Laboratories on July 1, 1945.

Herbert G. Eddy, September 11

Mr. Eddy, who retired from the Laboratories on July 1, 1936, was a graduate of Rutgers and a member of the Technical Staff. He was in charge of systems inspection engineering in what is now the Quality Assurance Department when he retired after serving thirty-five years in the Bell System. In his early years with Western Electric, he supervised central office inspection and later became one of the veterans of the development of dial systems, having had a prominent part in the creation of the panel-type semi-automatic system first set up in Newark in 1914 and 1915. His Bell System career also included duties as engineering representative at various installations in Dallas, Omaha and Kansas City as well as in New York at the Metropolitan Toll installation and a period when he was in charge of the dial system's circuit laboratory.

News Notes

R. H. Colley's article on *Wood Pole Standards* was published in the August issue of *Industrial Standardization.*

The Laboratories were represented in interference proceedings before the Primary Examiner at the Patent Office in Washington by W. J. O'Neill.

A. R. Thompson and H. J. Kostkos conferred with the Illinois Bell Telephone Company and officials of the Chicago Museum of Science and Industry in that city on the displays which are being developed for the Museum. Mr. Thompson and Mr. Kostkos were in Allentown on arrangements for the Bell Laboratories displays that will be included in the Western Electric open house exhibit in October.

here are a quarter of a million tracings in what known at West Street as The Vault, actually the ystems Tracing File, used mostly by engineers and raftsmen. Elaine Golding, shown checking tracings elow, has been a member of the Files staff for a ear now, having been promoted from junior clerk n the messenger force

M. W. Bowker visited the General Electric Company plant at Schenectady in connection with newly developed apparatus which has been proposed for use in locating leaks in pressurized cables.

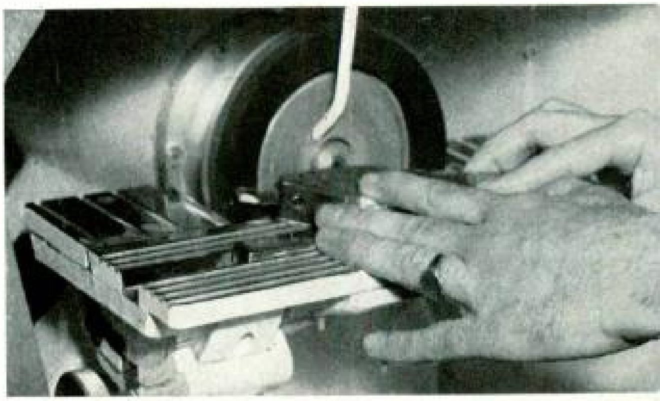
A. H. Hearn inspected test poles undergoing periodic examination at Stamford and Mineola.

R. L. Lunsford, J. E. Greene, Jr., F. A. Korn and O. J. Morzenti discussed manufacturing schedules for No. 5 crossbar equipment at the Hawthorne plant.

R. C. Eggleston investigated checking and bleeding of creosoted pine poles on a recent trip to Nashua, N. H.

J. G. Brearley, A. L. Richey and V. J. Albano were in Trenton in connection with Alpeth sheath studies.

P. W. Swenson, H. O. Siegmund, B. F. Runyon, H. W. Hermance, T. A. McCann and T. F. Egan visited the Western Electric at Hawthorne in connection with the study of open contacts caused by dirt.



Close-up of the new carboloy grinder in the Development Shops Department, Section 4-B, at West Street showing a carboloy tool bit on the mount being ground by the diamond impregnated composition wheel

H. E. Noweck and A. A. Hansen visited Rochester on MF key pulsing in the No. 1 toll switchboards used in conjunction with the rotary switching system being installed by the Federal Telephone and Telegraph Company.

W. E. Grutzner and H. W. Heimbach studied vacuum tubes for No. 5 crossbar offices at Allentown.

N. J. Eich and L. Pedersen with V. F. D'Agostino of Kearny conferred at Hawthorne on methods of mass soldering and solder spraying in connection with the N1 carrier telephone development.

J. J. Lander is author of an article published in *The Physical Review*, August 15, 1948, entitled *Measurements of Thomson Coefficients for Metals at High Temperatures and of Peltier Coefficients for Solid-Liquid Interfaces of Metals.*

H. W. Heimbach visited the Western Electric Company at Duluth where, with O. J. Morzenti and Western Electric engineers, he discussed manufacturing schedules concerning the test equipment for No. 5 crossbar offices.

H. J. Fisher was appointed to the A.I.E.E. Related Activities Committee, Communications Division, New York Section, and W. H. Tidd, Secretary of the A.I.E.E. Joint Subcommittee on Electronic Instruments.

R. H. Colley, K. G. Compton and J. Leutritz, Jr., visited the Forest Products Laboratory at Madison, Wisconsin, in connection with a coöperative project being carried out there to standardize methods for the evaluation of wood preservatives.

A. W. Dring and M. W. Bowker discussed gas tightness requirements for coaxial cable terminals at Point Breeze.

Carolyn Wright, graduate of Cranford High, and a member of the Stenographic Department at Whippany, came to her present position like so many other girls at the Laboratories by promotion from the messenger group. Carolyn has two skills now, for in addition to being a typist she is also able to run the hectograph machine in her department

J. M. Hardesty, with E. W. Lloyd of Western Electric, visited conduit plants in Aultman and Haydenville, Ohio, and Brazil, Indiana, on matters of manufacture and inspection of clay conduit.

S. C. Miller and R. J. Kent witnessed trials in Schenectady of proposed designs of a corner cable jack and cable shifting tools.

W. E. Mougey consulted with engineers at Hawthorne, where he particularly observed their manufacture of Alpeth sheath.

"The Telephone Hour"

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

October 11	*Maggie Teyte*
October 18	*Gladys Swarthout*
October 25	*Clifford Curzon*
November 1	*Tagliavini and his wife, Pia Tassinari*
November 8	*Polyna Stoska*
November 15	*Jussi Bjoerling*
November 22	*Marian Anderson*

C. E. Brooks discussed with the Illinois Bell in Chicago their studies on panel alternate routing and short and long-term tandem switching studies. Mr. Brooks also made a visit to the relay manufacturing and equipment wiring shops at Hawthorne.

M. B. McDavitt spent some time at Media with G. A. Hurst discussing maintenance studies, and with E. S. Gibson discussing traffic studies.

H. H. Staebner consulted with the Western Electric at Point Breeze about problems connected with the design of retractile cords.

J. A. Becker gave a lecture and demonstration on *The Transistor—a New Semiconductor Amplifier*, at Houston, Texas, under the auspices of the National Association of Police Communications Officers and the local Institute of Radio Engineers.

John Landers went to Watertown, Wisconsin, to bring East one of the trucks used in connection with carrier test equipment.

"John, the bridge game isn't over. Will you get dinner started?"

P. A. Byrnes was in the Allentown plant of the Western Electric Company in connection with equalizer development.

L. G. Kersta is a co-author of one of the recently published M.I.T. Radiation Laboratories series of books entitled *Pulse Generators*. Mr. Kersta visited the University of Michigan at Ann Arbor, Mich., in connection with the visible speech project.

L. L. Lockrow conferred at the Allentown Electronic Shops on the proposed manufacture of a new equalizer.

M. A. Froberg discussed rectifier designs for teletypewriter applications with the Lorain Products Corporation at Lorain, Ohio. Mr. Froberg also visited the Pennypacker Office in Philadelphia where noise measurements in the switchboards were made.

C. S. Knowlton observed operations of the newly designed rectifiers used with the 301C power plants at Cincinnati and the voltage variations that occur in the operation of motor generator sets at Cleveland.

N. H. Thorn, A. A. Burgess and J. Meszar discussed post cut-over changes in new equipment with The Bell Telephone Company of Pennsylvania in Philadelphia.

G. Rodwin and F. A. Hubbard visited Burlington on July 27 and discussed manufacturing problems in connection with types LD and LE radio equipment.

V. T. Callahan conferred on Diesel engine problems with New York Telephone Company engineers at Syracuse. He also discussed small engine designs with members of the Signal Corps at Fort Monmouth.

SPLITTING THE INFINITIVE

[*This is reprinted in its entirety from the* Chemical Digest *of Foster D. Snell, Inc., who admitted that it was written by some author whose name they could not ascertain.*]

One of the most closely guarded secrets of the era can now be told, how an anonymous group of grammarians, working in secrecy in a remote section of the country, have finally succeeded in splitting the infinitive.

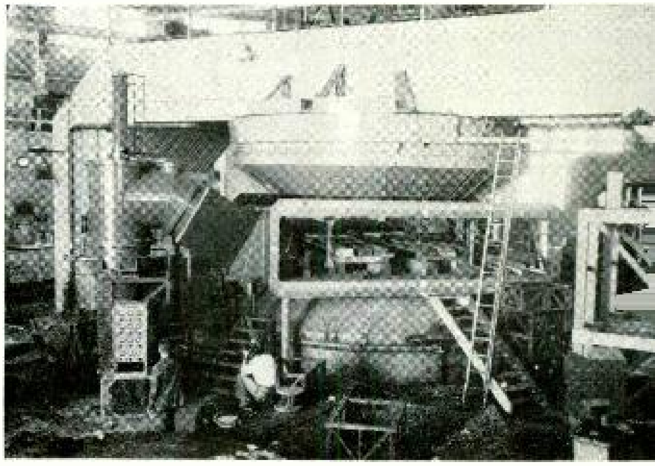
The so-called "Bronx Project" got under way in 1943, with the installation of a huge infinitron specially constructed for the job by Cal Tech philologists. Though the exact details are still withheld for reasons of security, it is possible to describe the general process.

From a stockpile of fissionable gerunds, encased in leaden clichés to prevent radio-activity, a suitable subject is withdrawn and placed in the infinitron together with a small amount of syntax. All this material must be handled with great care as the slightest slip may lead to a painful solecism. Once inside the apparatus, the gerund is whirled about at a great speed, meanwhile being bombarded by small particles. A man with a Gender Counter stands always ready to warn the others if the Alpha-Betical rays are released in such high quantities as to render the scientists neuter.

The effect of the bombardment is to dissociate the whirling parts of speech from one another until at length an infinitive splits off from its gerund and is ejected from the machine. It is picked up gingerly with a pair of hanging clauses and plunged in a bath of pleonasm. When the infinitive cools, it is ready for use.

The question is often asked: can other countries split the infinitive? I think we can safely answer "No." Though it is true that Russia, for one, is known to have large supplies of thesaurus hidden away behind the Plural Mountains, it is doubtful if the Russians have the scientific technique. They have the infinitive but not the know-how.

And that is something on which to congratulate our own brave pioneers in the field of grammatical research. Once it was thought that the infinitive could not be split—at least, not without terrible repercussions. We have shown that it is quite possible, given the necessary skill and courage, to unquestionably and without a shadow of a doubt, accomplish this modern miracle.



Acme

Prototype of the infinitron while under construction

BELL LABORATORIES CLUB ACTIVITIES

Activity	*Chairman*	*Meeting Place*	*Time*
Archery	W. G. Laskey (West Street)	Washington Irving High School	Tuesdays and Wednesdays 7:00
	C. A. Bengtsen	Whippany	Noontime
	W. D. Goodale	Murray Hill	Noontime
Arts and Crafts	F. Frampton (New York Area)	Building T	To be announced
Bowling	Mary Upton (West Street)	Village Recreation Center, N. Y. C.	Fridays 5:45
	E. W. O'Hara (West Street)	National Bowling Recreation Arena	Wednesdays and Fridays 5:45
	H. K. Meyer (Whippany)	O'Dowd Bowling Alley, Pine Brook	Fridays 6:15
	H. Watkinson (Murray Hill)	South Orange	Thursdays 6:30
		Plainfield	Mondays 6:45
Bridge	E. G. Walsh (West Street)	1-H Game Room	Mondays 6:00
	Dorothy Thom (Murray Hill)	Murray Hill Restaurant	Mondays 5:45
Chess	H. G. W. Brown (West Street)	1-H Game Room	Noontime and Evenings
Glee Club	Phyllis Taylor (Murray Hill)	Summit Y.M.C.A.	Wednesdays 8:00
	J. Kovac (Whippany)	Whippany Lounge Room	Noontime
Golf	W. F. Malone	Essex County Country Club	Saturday, Oct. 2, 8:00 a.m.
Horseshoe Pitching		Bethune Street	Noontime
		Whippany	Noontime
International Club	H. W. Dudley	Murray Hill	Monday Luncheons
Model Railroading	P. Mallery (West Street)	West Street	Meetings as announced
	V. T. Wallder (Murray Hill)	Murray Hill	Meetings as announced
Model Railroading (*Cont'd*)	W. L. Rohr (Graybar-Varick)	West Street	Meetings as announced
	D. W. T. Cotte (Whippany)	Whippany	Meetings as announced
Motion Picture Camera Club	D. F. Hoth (West Street)	West Street Auditorium	2nd Wednesday 5:45
	J. J. Harley (Murray Hill)	Murray Hill	Noontime a Evenings as announced
Orchestra	L. E. Melhuish (West Street)	West Street Auditorium	Tuesdays 6:
	R. R. Galbreath (Murray Hill)	Murray Hill Auditorium	Tuesdays 5:
Photo Forum	E. Alenius	West Street Auditorium	3rd Wednesday 5:45
	W. L. Filmer	Whippany	As announce
Rifle Club	R. E. Strebel (New York Area)	W. E. Co. Range Kearny	Tuesdays 7:
	G. Benson (New Jersey Area)	Summit	Thursdays 8:00
Stamp Club	P. W. Blye (New York Area)	West Street Conference Dining Room	Monday Luncheons
	A. N. Holden (Murray Hill)	Murray Hill	Noontime ar Evenings as announced
Swimming Classes	W. C. Buckland (Murray Hill)	Plainfield Y.W.C.A.	Wednesdays 6:00
Swimming and Gym for Men	A. J. Kuczma (New York Area)	Textile High School	Thursdays 5:30
Table Tennis	J. V. Elliott (New York Area)	Building T and Graybar-Varick	Noontime an Evenings
	Dorothy Clothier (Whippany)	Whippany	Noontime
	T. Ong (Whippany)	Whippany	Noontime
Volley Ball	H. Rosier (Whippany)	Whippany	Noontime
	Betty Engstrom (Whippany)	Whippany	Noontime