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THE TRANSISTOR

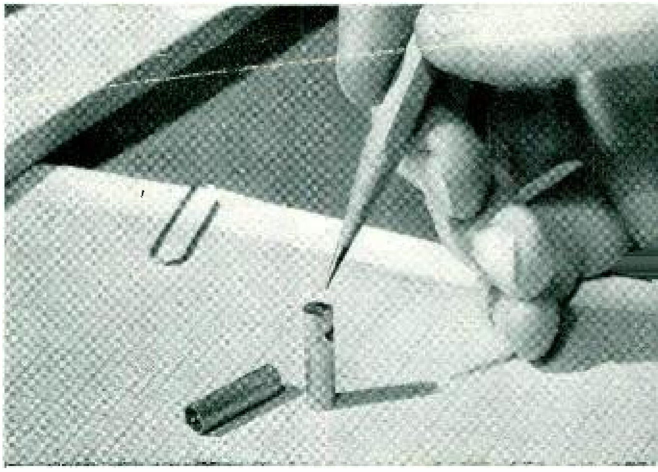
An amazingly simple device, capable of performing efficiently nearly all the functions of an ordinary vacuum tube, was demonstrated publicly for the first time on June 30 in our West Street auditorium.

Known as the Transistor, the device works on an entirely new physical principal discovered in the course of fundamental research into the electrical properties of solids. Although the device is still in the laboratory stage, it is expected to have far-reaching significance in electronics and electrical communication.

Two hair-thin wires touching a pinhead of a solid semi-conductive material soldered to a metal base are the principal parts of the Transistor. These are enclosed in a simple metal cylinder not much larger than a shoe-lace tip. It has no vacuum, no glass envelope, no grid, no heated cathode. It will serve as an amplifier or an oscillator—yet it bears almost no resemblance to the vacuum tube now used to do these basic jobs. More than a hundred Transistors can easily be held in the palm of the hand.

Since the device is still in the experimental stage, no data on cost are available. Its essential simplicity, however, indicates the possibility of widespread use, with resultant mass-production economies. When fully developed, the Transistor is also expected to find new applications in electronics where vacuum tubes have not proved suitable.

Tests have shown that the Transistor will amplify at least 20 decibels (100 times). Some test models have been operated as amplifiers at frequencies up to ten million cycles per second. Because of the basically



Contained in a small metal cylinder, the Transistor consists of two extremely fine wires whose points rest on a small square of a semi-conductor simple structure of the new units, stability and long life are expected.

While many scientists and engineers have been associated with the work during the project, key investigations which brought the Transistor to reality were carried out by John Bardeen and Walter H. Brattain. The general research program leading to the Transistor was initiated and directed by William Shockley. All three are with the solid state physics group.

Preceding a demonstration to the press, the Transistor was demonstrated by Ralph Bown to executives of A T & T, Western Electric, and the New York and New Jersey companies. Members of our own executive staff acted as hosts. Noting that the Transistor was the first real challenge to the vacuum tube in its forty-year-life Dr. Bown explained its name as a reference to the *trans*fer of signals through a var*istor*. In his first demonstration he talked through a telephone handset to individual receivers used by the audience, inserting and removing a Transistor amplifier. Next, he showed on an oscilloscope a wave-form with and without Transistor amplification. He then brought down to the audience an audio-frequency oscillator, using Transistors, which was assembled with a small loudspeaker in a transparent plastic case. This demonstration showed that no time was required for warm-up as with vacuum tubes.

A television receiver was arranged to pick up a local program. In its video circuit was an attenuator; Dr. Bown inserted enough loss to make the picture all but invisible. He then broke the circuit and plugged in a two-stage Transistor repeater, housed completely in a box only a few inches each way. At once the picture was restored to its original brightness.

To emphasize the Transistor's possible role in radio reception, Dr. Bown exhibited a popular make of portable receiver whose vacuum tubes had been entirely replaced by Transistors. Reception was excellent. A superheterodyne type of radio receiver for larger output was also shown; its final stage had two Transistors in push-pull, and volume on a W. E. speaker was ample.

At the demonstration, Ralph Bown described the Transistor using this 100-*to*-1 *model*

In the Transistor, two point contacts of the "cat's whisker" or detector type, familiar to radio amateurs, are made to the semi-conductor only two thousandths of an inch apart. Input power delivered to one of these contacts is amplified at least 100-fold and transmitted to the other terminal where it is delivered to an output circuit. The Transistor is energized by voltage supplies, such as batteries, which apply bias voltages to the two points. The power actually consumed in the Transistor is less than a tenth that used by an ordinary flashlight bulb.

The amplification process can be understood in terms of the discovery made by Dr. Bardeen and Dr. Brattain that the input point is surrounded by an "area of interaction." Within this area the electronic structure of the semi-conductor is modified by the input current. Now, if the output point is placed in this area, the output current can be controlled by the input current. This control of output current by input current is the basic mechanism of amplification.

Semi-conductors have for many years been regarded as an ideal field for research at Bell Telephone Laboratories because of their practical possibilities and rich scientific interest. These materials, whose electrical properties are intermediate between those of metals and insulators, offered particular promise of useful electrical applications, since their ability to carry electrical current can be changed over wide ranges in various ways.

These materials, like any having the ability to conduct electrical currents, rely for conductivity on the presence of current-carrying electrons. In metals, which are good conductors, there is a ratio of approximately one current-carrying electron to every atom. In insulators, there are practically no such electrons and therefore little conductivity.

In semi-conductors, such as silicon and germanium, some metallic oxides and other compounds, there may be as few as one current-carrying electron for every million atoms. But — and this is the significant feature — this number of carriers may be varied 1,000-fold or more by changing the electronic structure of the materials. Hence the current flowing through the semi-conductor can be controlled.

Prior to the invention of the Transistor, varying conductivity in semi-conductors was employed in rectifiers, such as the copper oxide and selenium rectifiers, and the silicon detector. Bell Telephone Laboratories have for a long time been active in the development of semi-conductor rectifiers. Before the war they had developed silicon detectors for use in microwave radio apparatus and these were supplied for use in early wartime radars. Largely as a result of radar interest, research and development on semi-conductor point-contact rectifiers and the phenomena involved in their operation have been stimulated at other industrial and several university laboratories.

After Dr. Bown's talk the audience inspected his demonstrations

In critically examining the implications of the prevailing theory of electrical conduction in semi-conductors, Dr. Shockley was able to predict that it should be possible to control the meager supply of electrons inside a semi-conductor by influencing them with an electrical field imposed from the outside without actually contacting the material. Realizing the practical implications of such a possibility he devised some experiments to test his hypothesis but was unable to secure positive results. The electrons seemed to get trapped in the surface of the material and did not behave just as anticipated.

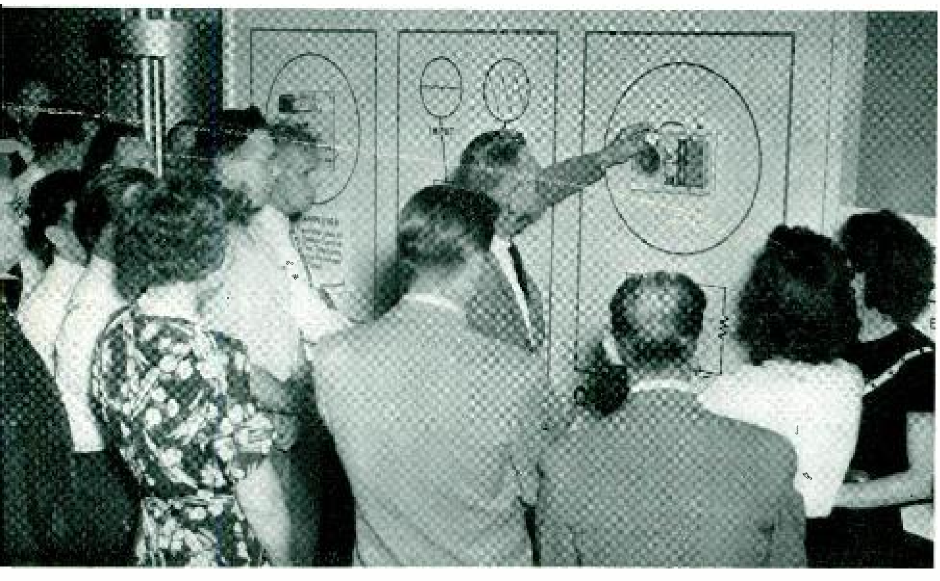
This part of the problem was tackled on a theoretical basis by Dr. Bardeen. He developed a theory of what happened at the surface which was able to explain satisfactorily many of the observed facts and which led to further experiments carried out in collaboration with Dr. Brattain. In the course of these experiments they invented the Transistor.

Transistor action depends upon the fact that electrons in a semi-conductor can carry current in two distinctly different ways. This is because most of the electrons in a semi-conductor do not contribute to carrying the current at all. Instead they are held in fixed positions and act as a rigid cement to bind together the atoms in a solid. Only if one of these electrons gets out of place, or if another electron is introduced in one of a number of ways, can current be carried. If, on the other hand, one of the electrons normally present in the cement is removed, then the "hole" left behind it can move like a bubble in a liquid and thus carry current.

In a Transistor made of semi-conductor which normally conducts only by the extra electron process, current flows easily into the input point, which is at a low positive voltage, and out of the output point, which is at a higher negative voltage. The area of interaction is produced by "holes" introduced by the input current and collected by the output point.

In announcing the Transistor, the Laboratories pointed out that scientific research is coming more and more to be recognized as a group or teamwork job. This is true not only in industrial research but, to a rapidly increasing degree, in academic research. There continues within the group structure, however, ample opportunity for individual work. The Transistor represents an outstanding example of brilliant individual achievement and emphasizes the value of basic research in an industrial framework.

Scientific publications relating to the Transistor appeared in the Letters to the Editor section of *The Physical Review* for July 15.



To inform the entire Laboratories personnel, a bulletin was distributed on the day of the demonstration. As a follow-up, the Transistor was demonstrated in the West Street restaurant during the lunch periods on July 7 and 8, and at Murray Hill later

O. R. GARFIELD
Transmission
Development

A DISTRIBUTION ANALYZER FOR LENGTHS OF IMPULSES

It is frequently desirable to know the lengths and relative frequency of occurrence of irregularly recurring phenomena that affect electrical transmission. In speech, for example, the greater part of the energy appears in certain syllables, and the rate of occurrence of syllables with an amplitude greater than an established value frequently affects the design of transmission apparatus. Other examples are the duration of fades below a given depth occurring over short wave radio paths, and the "holding" times of senders in telephone switching systems. To make it easy to secure such information, a pulse-length distribution analyzer has been developed which records the number of pulses longer than each of ten given times on ten groups of message registers and neon lamps marked from 0 to 9. The zero register records the number of pulses greater than 50 microseconds; the No. 1 register, the number longer than L, where L is an adjustable basic time interval; the No. 2 register, the number longer than 2L and so on, and thus the analyzer supplies data from which a ten-point cumulative distribution curve may be plotted.

A dial on the face of the panel permits the basic interval L to be set at any of fourteen values increasing in multiples of 2 from 1.56 milliseconds to 12.80 seconds. With the dial set at the lowest position, pulses varying in length from 50μs to 14 milliseconds are counted, while when the dial is on its highest point, the pulse lengths counted may be as long as 115.2 seconds, or nearly two minutes. A row of ten messages registers across the top of the panel, associated with from one to five neon lamps in the vertical columns beneath them, evident in Figure 1, add up the pulses of the various lengths.

Since the message registers require an interval of about 150 milliseconds between successive operations, and would thus not be satisfactory for counting short pulses in rapid succession, the circuits associated with the neon lamps are employed to act as sub-totalling devices to make it unnecessary for the message registers to operate on every pulse. Associated with the zero message register, for example, there are five lamps marked 1, 2, 4, 8, and 16, respectively. The first pulse lights the No. 1 lamp, the second puts out the No. 1 and lights the No. 2, the third lights the No. 1 again and leaves the No. 2 lighted, while the fourth puts out both 1 and 2 and lights No. 4, and so on. Thus the sum of the numbers opposite the lighted lamps indi-

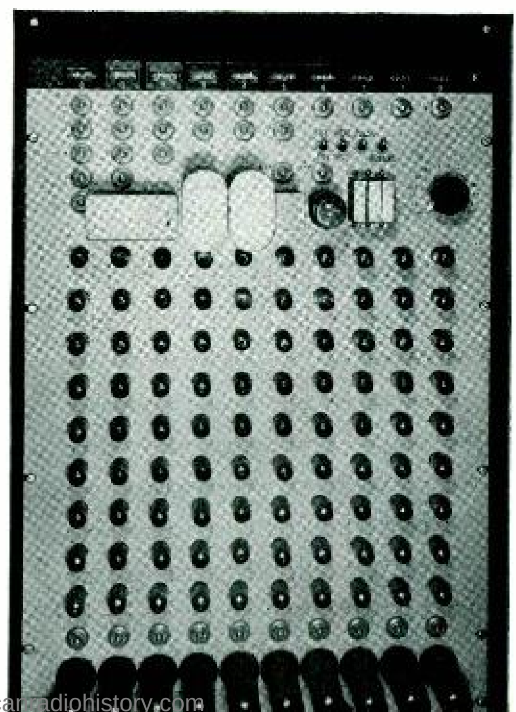


Fig. 1 — The analyzer panel with message registers above and the driving tubes below

cates the number of pulses which have been received up to 32. At the end of the 31st pulse, all five lamps will be lighted, thus showing 1 + 2 + 4 + 16 = 31 + 8 pulses. The 32nd pulse will extinguish all five lamps and operate the message register. The number of pulses that have been recorded is thus the difference between the readings of the message register at the beginning and end of the test multiplied by 2^n, where n is the number of lamps below the register, plus the sum of the numbers opposite the lighted lamps.

With the dial set for the desired value of L, and with the set turned on for an analysis, the arrival of a pulse lasting over 50 μs will light the No. 1 lamp of the zero register circuit; if the pulse lasts longer than L, the No. 1 lamp of the No. 1 register circuit will be lighted. Successive No. 1 lamps will light after successive L intervals: the No. 1 lamp under the No. 9 register lighting after the pulse has endured 9L, thus indicating that a pulse of at least this length has been received. Successive pulses are measured and recorded in a similar manner, lighting the lamps under the registers and operating the registers after the proper number of pulses have been received.

To operate the lamps and registers at the proper intervals, there is required, in addition to the ten circuits controlling the ten registering groups, a frequency divider circuit that provides timing pulses at intervals corresponding to the fourteen possible values of L, and a counting circuit that measures the pulses in terms of the value of L selected, and after each interval sends a pulse to one of the registering circuits. At the end of a pulse, the counting circuit restores to normal ready to measure the length of the next pulse, and the frequency divider circuit stops, since its excitation is cut off.

A block diagram for the circuit is shown in Figure 2. Basic timing is derived from a 1280-cycle oscillator whose output is blocked by the losser except while a pulse is being measured. On the receipt of a pulse, the losser is made to pass the oscillator output, and at the same time a short pulse is sent to the No. 0 register group to record the arrival of a pulse. The limiter, which directly follows the losser in the path of the oscillator output, converts the 1280-cycle current into a train of pulses, one pulse for each cycle. These oscillator pulses, spaced 0.78 ms apart, are passed to the frequency divider, which from them derives a sequence of pulses for each of the fourteen values of L; one sequence spaced 1.6 ms, one spaced 3.1 ms, and so on, up to 12.8 seconds. These pulse sequences are connected to the fourteen points of a dial, evident at the upper right of Figure 1,

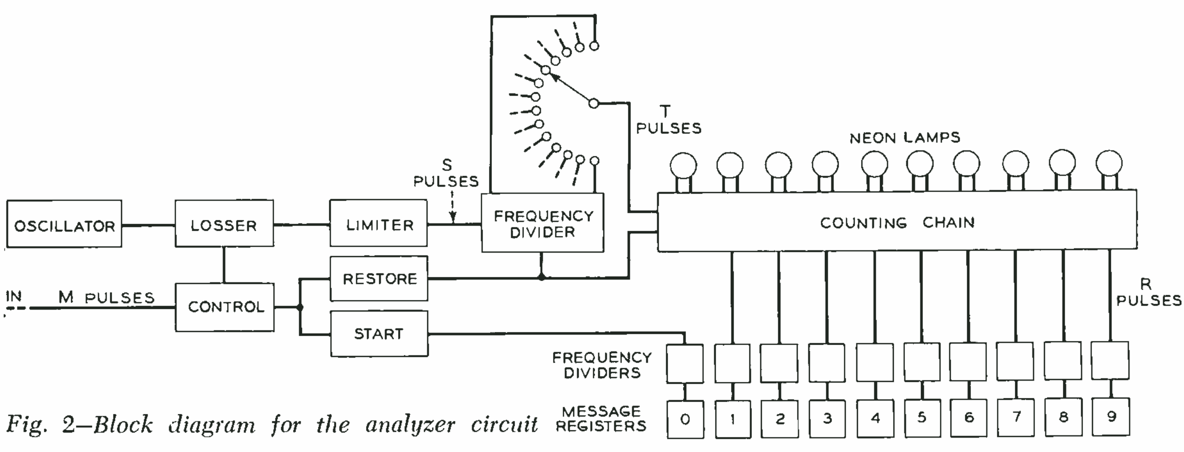


Fig. 2—Block diagram for the analyzer circuit

which selects the one to be used for the analysis in hand. From the dial, the particular sequence of pulses selected is passed to the counting circuit, which sends pulses to the various register circuits at successive intervals. A neon lamp is associated with each of the ten stages of this circuit, evident at the bottom of the panel of Figure 1, and these lamps light and go out successively as counting progresses.

Since there are several different types of pulse sequences, it will avoid ambiguity to tie a tag on each to identify it. Hereafter, therefore, the pulses to be analyzed will be called M pulses; the sequence derived from the oscillator and spaced 0.78 ms apart will be called the S pulses; and those used for measuring the duration of the M pulses will be called the T pulses. The frequency divider circuit derives fourteen sets of T pulses from the S pulses, and one of these fourteen available sets is selected for use in each analysis. The pulses sent from the counting chain to the registering circuits will be called R pulses. The pulses being measured — the M pulses — will vary widely in duration, but all other pulses are short spurts caused by a capacitor charge.

Each of the three major types of circuits —the frequency divider that provides the sets of T pulses, the counting chain that counts the T pulses after the arrival of an M pulse and supplies R pulses to the registering circuits in the proper sequence, and the registering chain that counts the R pulses, lights the proper neon lamp, and ultimately operates the message register — all consist of chains of trigger circuits of the general type shown at the left of Figure 3. This is essentially a multivibrator circuit*, shown at the right of Figure 3, but with the control of the transition removed from internal timing elements and placed in an external circuit. In both of these circuits, one tube and only one tube is conducting at a time. If the tube that is conducting is made to cease conducting, the other tube will start to conduct, while if the tube that is not conducting is made to conduct, the other tube will cease conducting. In the multivibrator circuit, transition from one tube to the other occurs automatically and at regularly spaced intervals controlled by the capacitances C and the resistors in series with them. In the circuits used in the analyzer, however, the capacitances C are made much smaller and are shunted by a resistance. Control of the transitions is thus removed from the internal circuit and is exercised by pulses from an external circuit applied either to the cathode or the grid of the conducting tube.

*RECORD, *September*, 1943, *page* 17 and *March*, 1948, *page* 114.

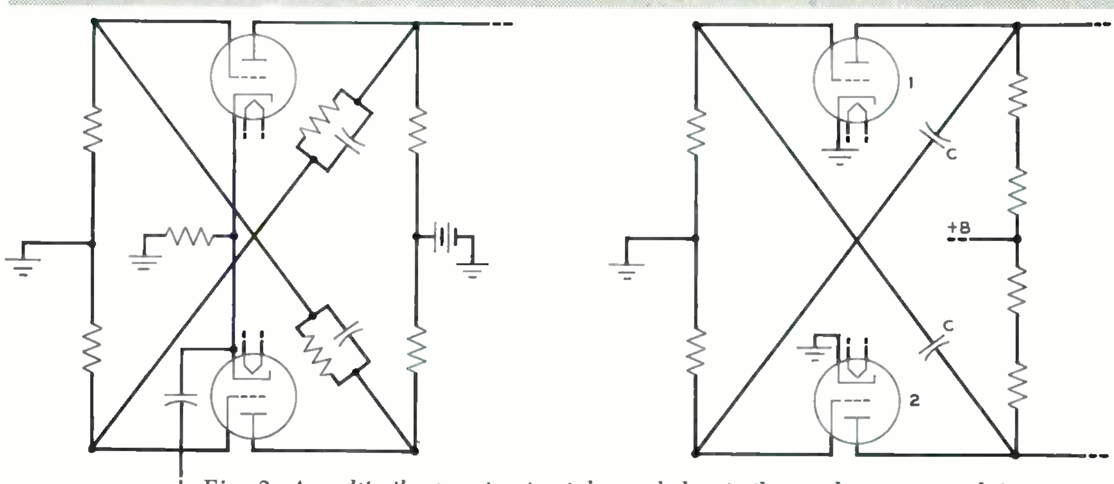


Fig. 3—A multi-vibrator circuit, right, and the similar analyser circuit, left

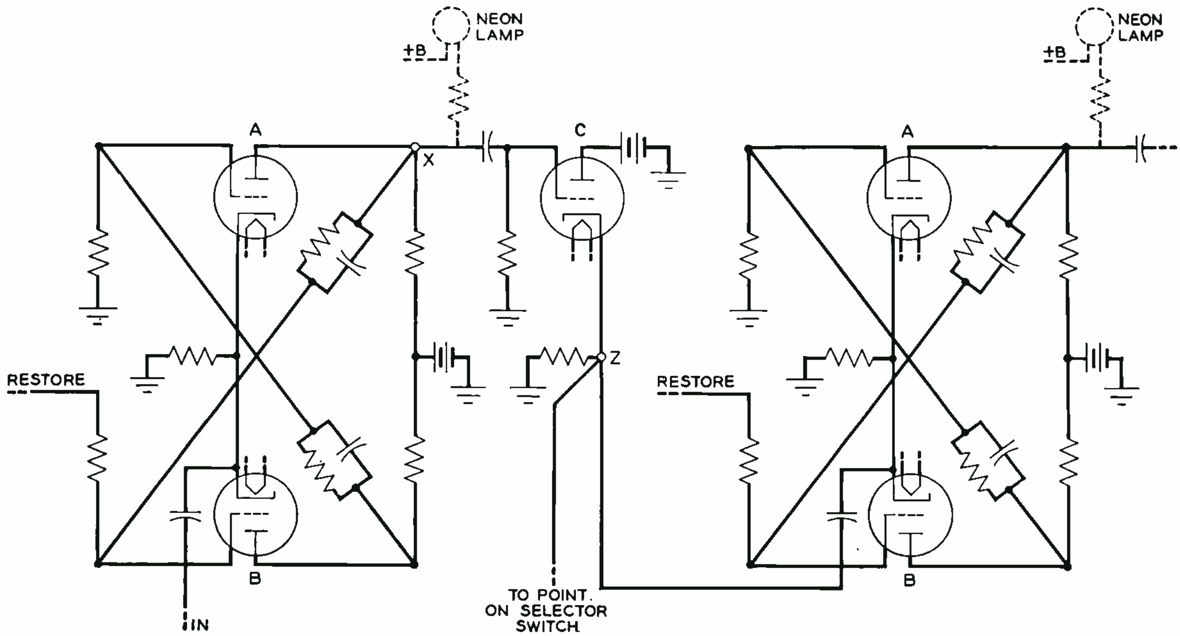


Fig. 4—Two stages of the frequency dividing circuit. A similar circuit is also used for registering with neon lamps as indicated in dotted lines above

For frequency dividing, two adjacent stages of this circuit are arranged as indicated in Figure 4. At the beginning of an analysis, or at the end of the preceeding M pulse during an analysis, all the B tubes have been made conducting by the application of a positive pulse to a "restore" bus. The first S pulse arriving in the IN lead will block the B tube and thus make A conducting. In starting to pass current, A will lower the voltage at point X, and the resulting negative pulse to tube C will have no effect since C is normally non-conducting. The next S pulse arriving will block the A tube and make the B tube conduct. As A blocks, the voltage at X rises, and the resulting positive pulse to the grid of C causes current to flow in it and the voltage at Z to rise, thus passing a positive pulse to the cathode of the next stage – blocking B and allowing A to pass current. This continues with successive S pulses throughout the fourteen stages.

From the point maked Z at the output of each stage, a lead is carried to one point of the selector switch. If the stage at the left of Figure 4 is that immediately following the limiter, there will be a plus pulse on the IN lead every 0.78 ms, or for each S pulse. At the second S pulse, however, a pulse will appear at point Z of the first stage, and the lead running from Z will appear on the 1.6 point of the selector. A pulse will appear at this point for every second S pulse thereafter, and thus the first point of the selector will receive pulses every 1.6 ms. At every second pulse appearing at Z_1, a pulse will appear at Z_2 of the next following stage, and also on the second point of the selector. The separation of the pulses at the Z point of any stage is twice as great as that of the preceding stage, and thus the L values appearing on successive steps of the selector increase in multiples of 2.

Typical stages of the counting chain are shown in Figure 5. The basic circuit is the same, but the control of the transition differs somewhat because of the different results desired. At the beginning of an M pulse, the A tubes of all ten stages but the first, or zero stage, are conducting while the B tube of the zero stage is conducting, and the neon counting lamp associated with it is lighted because of the lowered voltage at point Y.

The bus to which the cathodes of all B tubes are connected is supplied through the cathode resistor of a tube which has its grid connected to the arm of the selecting switch, and which thus passes current at each T pulse. This cathode resistor is of such a value that only one B tube can be conducting at a time, and at each T pulse the voltage of the bus is raised sufficiently to extinguish the B tube that is conducting. At the first T pulse, which appears approximately one L interval after the arrival of the M pulse, the B tube of the zero stage is blocked, the A tube of that stage passes current, and in doing so sends a negative pulse to the grid of the No. 1 stage. This blocks the A tube of the No. 1 stage, makes the B tube conduct, thus lighting the neon counting lamp associated with it, and puts the second stage in condition to transmit a pulse to the No. 1 registering circuit. As the B tube of the zero stage stopped passing current, the voltage at Y rose, thus extinguishing the neon counting lamp for that stage. No pulse is sent to the registering circuit for the zero stage of the counting chain, since the latter gets a pulse each time an M pulse is received.

On the second T pulse, this same process is repeated for the No. 1 stage, and as the neon lamp of No. 1 stage goes out, a positive pulse is transmitted to the No. 1 registering circuit to indicate that an M pulse at least L long has been received. This action continues down the counting chain until the end of the M pulse.

Each of the registering circuits employs a chain of the type indicated in Figure 4 with the addition of a neon lamp connected to the point X (indicated dotted in Figure 4) in the plate circuit of the A tube. These are the lamps shown below the registers in Figure 1, and the associated circuit will have as many stages as there are lamps:

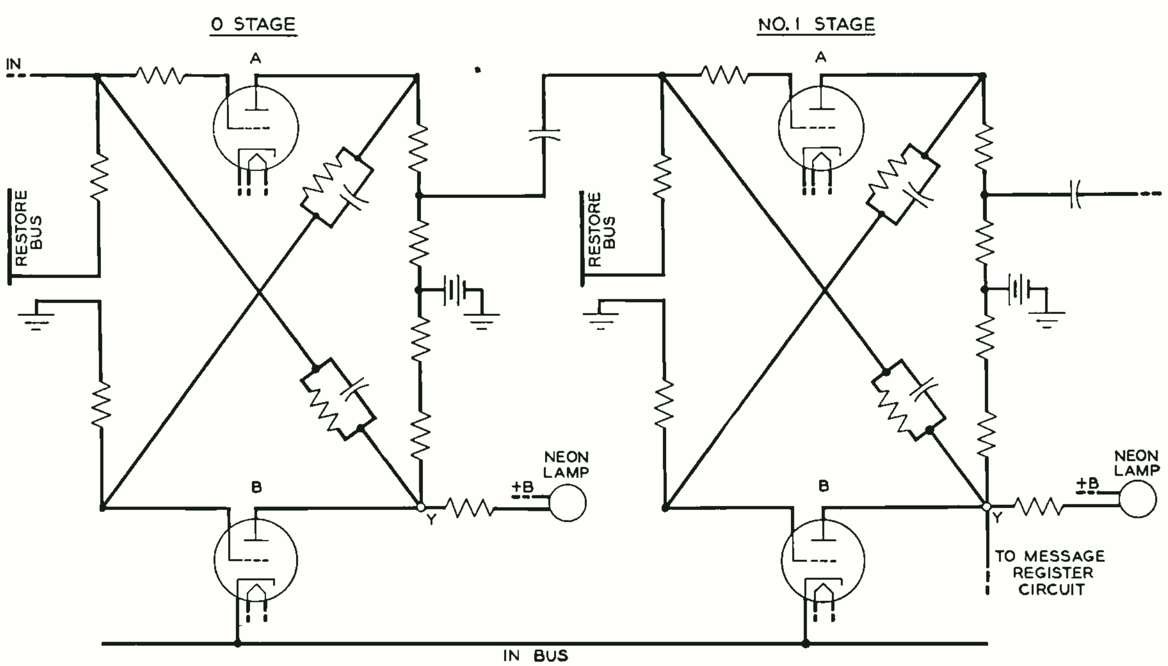


Fig. 5—Two stages of the counting chain

five for the zero stage, four for the No. 1 stage, three for the No. 2 stage, two each for the 3, 4, and 5 stages, and one each for the 6, 7, 8, and 9 stages. The zero stage receives its operating pulse each time an M pulse is received, while the other stages receive their pulses from the correspondingly numbered stage of the counting chain.

Before the arrival of an M pulse, all the B tubes of the registering chains are passing current. At the first T pulse received, the B tube of the first stage is extinguished, and as A passes current as a result, the neon lamp associated with it — the No. 1 lamp — lights. The next pulse, in reversing the No. 1 stage, extinguishes the No. 1 neon lamp, reverses the second stage, and lights the No. 2 lamp. The third pulse lights the No. 1 lamp again. The fourth pulse extinguishes both the No. 1 and No. 2 lamps and lights the No. 4 lamp, which is associated with the third stage. At the pulse that extinguishes the lamp of the last stage, a pulse is transmitted to the message register.

Two of the analyzer panels, such as shown in Figure 1, are mounted in a seven-foot cabinet with associated power supplies as shown in Figure 6. Approximately 1 kw of 115-volt a-c power and a source of 130 volts d-c is required for operation. The input terminals associated with each panel appear as coaxial jacks on a strip at the back of the cabinet.

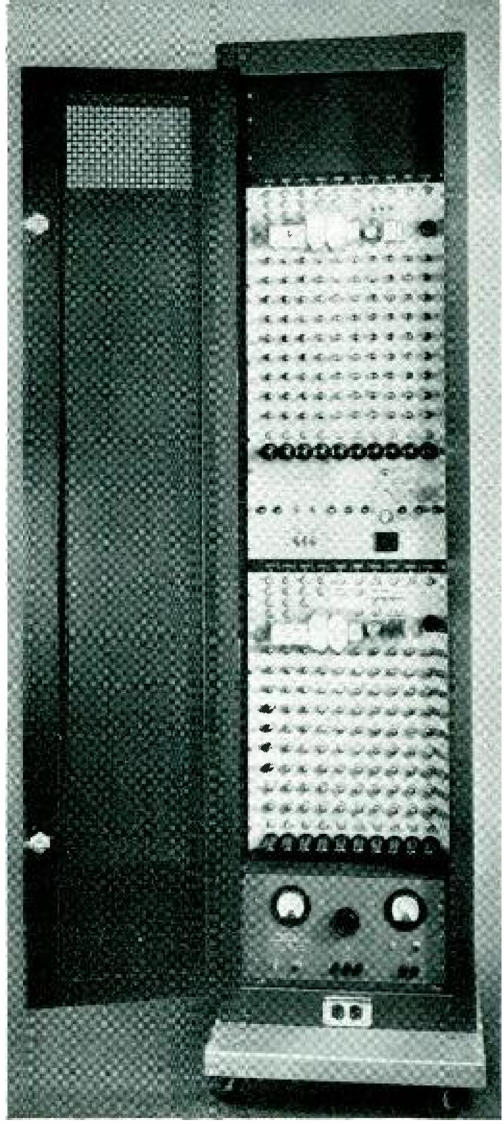


Fig. 6 — Two analyzer panels are mounted with their power supplies in a single cabinet

THE AUTHOR: O. R. GARFIELD graduated from Massachusetts Institute of Technology with an M.S. degree in 1930, and at once joined the Technical Staff of Bell Telephone Laboratories. Since that time he has worked in the Transmission Development Department on voice-operated devices, radio control terminals, privacy systems, and short-haul carrier systems. During World War II, he was engaged in underwater sound projects for the Navy.

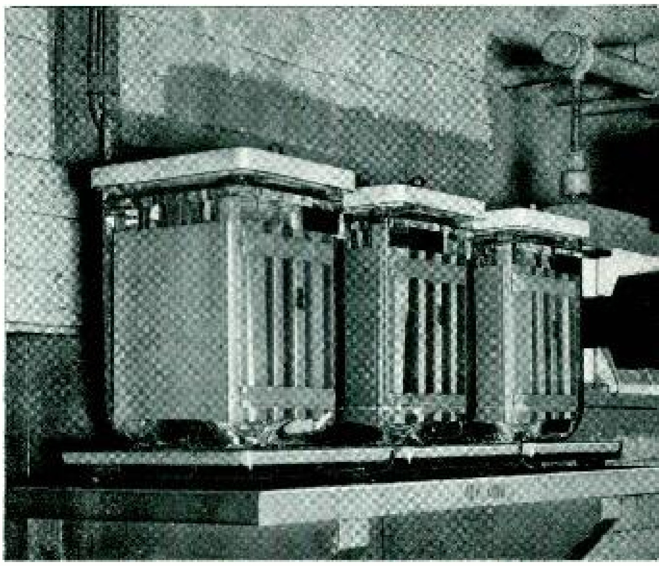
HISTORIC FIRSTS: THE ELECTROLYTIC CONDENSER

When the first installation of the panel system was made in Newark in 1919, the M-type generator had already been used over a quarter of a century for charging central-office storage batteries. It had been especially designed with a surface-wound armature, very narrow commutator bars, and copper-gauze brushes to provide a reasonably quiet supply of power for telephone batteries, since the ordinary generator with its slot ripples and commutator disturbances would have been much too noisy. The M-type generator, however, was large, costly, and expensive to operate, and since dial offices require much larger batteries than manual, its expense appeared even more formidable in view of the extensive program of dial installations that rapidly took shape following the success of the panel system. Within a few years, however, it became possible to overcome this excessive cost of battery charging through the development of the electrolytic condenser.

It had been known for a long time, of course, that the much less expensive standard generator could be used in place of the M-type generator if filters were connected to its output to reduce the commutator disturbances and the ripples in the generated voltage caused by the armature slots. With any type of condenser available at the time, however, the cost of the filters would be great enough to wipe out the savings from the use of standard generators. Filtering, therefore, had seemed to offer no solution.

Since a less expensive charging system seemed essential for panel offices, however, the Apparatus Department was asked to develop an economical condenser that could be used for filtering purposes. H. O. Siegmund, who had recently joined the Engineering Department of the Western Electric Company, was assigned to this task. It was known that large values of capacitance could be obtained at low cost from aluminum cells of the type long used by power companies as lightning arresters. Up to that time, however, no such condensers had been produced that were capable of operating continuously and of providing the long life and constant value of capacitance required of the filters for a common-battery charging system.

Because of the great possibilities of cost reduction by the use of such condensers, however, Siegmund undertook development



Electrolytic condensers installed in connection with a 48-volt battery supply in Reading, Pa.

work that continued for over two years. With the assistance of the Chemical Laboratories, he found means of controlling the chemical action of the electrolyte so that corrosion of the anodes was eliminated, and satisfactory life and performance was obtained. A patent was applied for in May, 1921, and patent No. 1,514,736 was issued in November, 1924. Some eleven subsequent patents were issued between then and 1936. With satisfactory electrolytic condensers available, heavy-duty retardation coils were developed for use with them to provide suitable filters, and these became standard central office equipment from this time on.

These condensers and their application, and the change to commercial type generators their use permitted have already been described.* In a typical filter installation, each electrolytic condenser provides a capacitance of 1,000 microfarads at 24 volts or 600 microfarads at 48 volts. Their life is of the same order as that of the batteries with which they are used.

Although the condensers have changed in form since that time, the use of commercial charging machines in combination with filters employing them has become universal, and the old M-type generators have become little more than a memory. The large capacitances obtainable in small sizes has also led to their almost universal adoption for radio receivers.

*Record, *April,* 1927, *page* 276; and *December,* 1927, *page* 113.

"AND THE TRUMPETS BLOW"

In the mail a clipping from a suburban newspaper came to our desk. It was an editorial, in humorous vein, about the telephone business. Here is part of it:

"Being somewhat familiar with the Bell System's relations with the public, we can only say that we know of no other private—or public—organization more determinedly solicitous of its clients' welfare. Subjected to its persuasive charm long enough, every telephone user would get the idea that when he picks up the receiver, a hush comes over the Bell domain, thousands of technicians spring to their posts, trumpets blow somewhere in the distance, massive gears begin to grind, and a million units of electrical energy are spent just so you can say: 'Hello, dear. Will you bring a loaf of bread on the way home?' "

Well, that's a bit fanciful, all right. But we appreciated it – and got a chuckle out of it. Then, as we thought it over, we realized that in fact it comes closer to the truth than you might at first suspect.

Every telephone call you make is custom-built. There is no mass production in this business. There's no way to manufacture calls in advance, and store them up for future use. It's a matter of individual service, on the spot.

Each time you pick up the telephone—your order is taken, the call is tailored to your exact specifications and delivered to you, at any hour, day or night. At the same time, the Bell System stands ready to provide this very personalized service to millions of others.

The knowledge that skilled people and highly-developed facilities are always standing by, waiting to help – this quality of ever-readiness, is one reason why you cannot measure the full value of your telephone service in terms of how much you pay for it.

From "The Telephone Hour," June 14, 1948.

L. O. SCHOTT
Transmission
Research

A PLAYBACK FOR VISIBLE SPEECH

With the development of apparatus for producing visible speech,* a new tool became available for studying the characteristics of speech. A clear and compact picture showing most of these characteristics could now be made. One more step was needed, however, to take full advantage of this new form of presentation. Although the visible patterns showed much of what is known to be important, techniques were needed to determine the relative values of the various physical attributes which bear on the interpretation of speech. One such technique would employ playback apparatus that would reproduce speech from the visible patterns. With such apparatus, the patterns could be modified at will to determine the importance of each characteristic on the overall interpretation. To make studies of this kind possible, the pattern playback system shown in Figure 1 was developed. This apparatus deals with spectrograms as indicated in Figure 2.

In the form here, the apparatus includes a turntable carrying a frosted lucite drum twenty-four inches high and thirty-six inches in diameter resting on a lower section that houses the control units. Black paper strips representing the elements of speech are fastened on the outside of the drum. and light from a fluorescent lamp mounted vertically just inside the drum passes through the drum wall and falls on a bank of thirteen photoelectric cells in a rack just outside the drum. The light reaching these cells is modulated by the opaque patterns as the drum is rotated so that varying currents are generated in the cells, thus accomplishing a translation from the visible patterns into related information-bearing electric signals. These electric signals then pass into a synthesizer where they control the flow of certain synthesizing energies which are suitable for operating a loud speaker and producing the audible sounds represented by the visible patterns.

Fig. 1—*The playback apparatus for visible speech*

*Record, *January*, 1946, *page* 7.

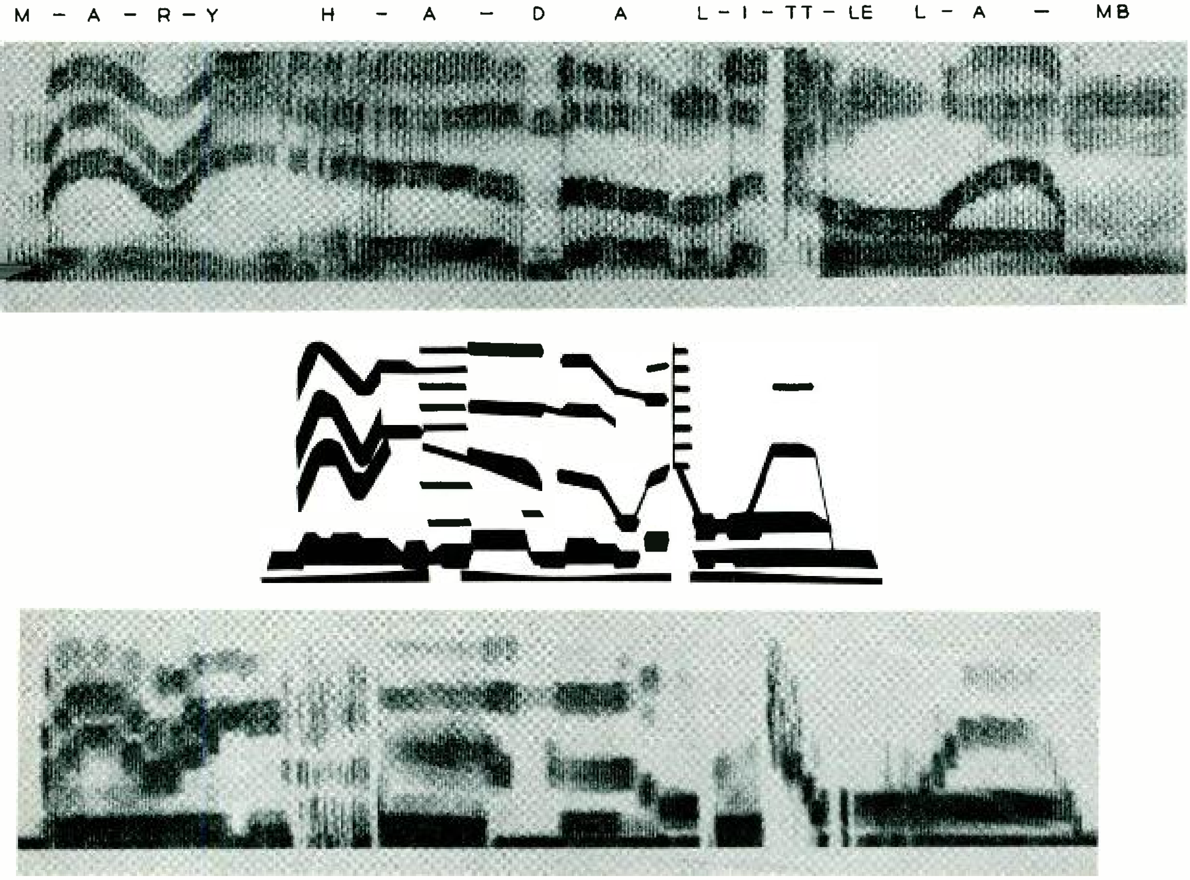
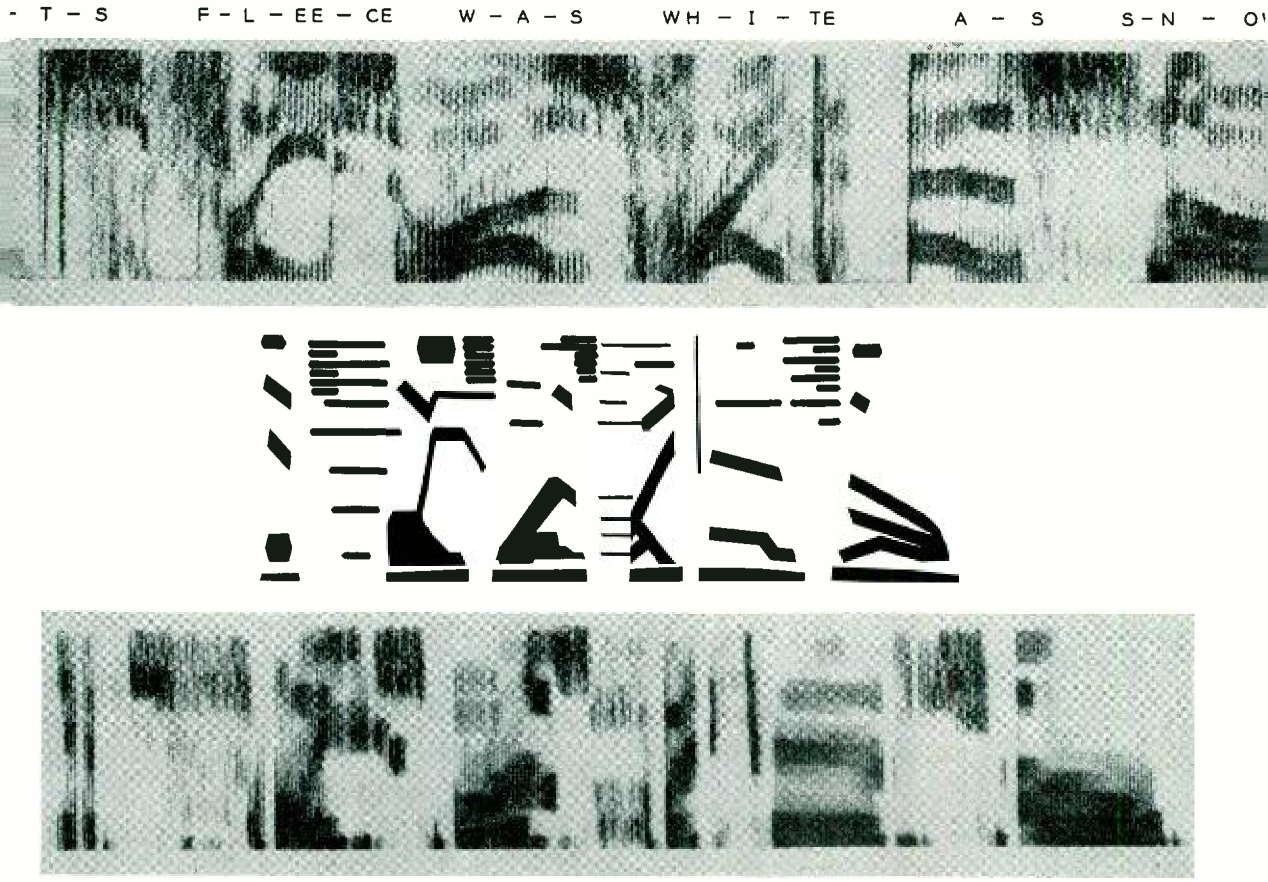


Fig. 2—A real-speech spectrogram above; a corresponding playback pattern in the mid

This procedure corresponds in its broad outlines to the production of speech by the voice. As one talks, speech is produced by controlling in a number of ways the pressure energy of the breath stream. One type of sounds, termed "vocal or voiced," is produced when the vocal cords vibrate in the breath stream, setting up a "buzz" tone which has a fundamental frequency, or pitch, and a rich content of harmonics, or overtones. In ordinary speech, the pitch has a range from about 90 to 200 vibrations or cycles per second for men and from about 150 to 300 for women. The pitch of an individual voice may be varied from instant to instant and this is used to produce inflection effects. The harmonics, of course, vary with the pitch, and for present purposes, only those which fall within the frequency range below 3600 cycles will be considered. Thus, with the lowest pitch of ninety cycles there are forty usable harmonics in this range, while with a pitch of 300 cycles there are only twelve. A particular voiced sound is usually formed by selecting three or four groups of certain harmonics, and suppressing the unwanted harmonics. The selecting and suppressing processes take place in the resonant cavities of the throat, mouth, and nose, where the several articulators—lips, jaw, teeth, tongue, and soft palate—act as the controls. Different voiced sounds require different groupings of the harmonic energies.

The other type of sounds, the "whispered or unvoiced," employs the breath stream more directly, depending for its audible effects on the turbulences set up as the breath flows through the various small openings or constrictions which may be formed by the articulators. This turbulence energy sounds like ordinary "hiss" noise



a spectrogram made from the playback synthesized speech, below

because it is composed of a great many random frequency parts which are not harmonically or systematically related. Covering the 3600-cycle range as it does, this hiss energy is subjected to the same general processes of selecting, grouping, and suppressing, i. e., to the resonance effects of the vocal cavities, as described above for the harmonic energies. Consequently, sounds like the vowels may be whispered as well as voiced. Certain other sounds, like the "s", are always of the whispered type, while still others, like the "v", are made from a combination of both buzz and hiss energies. Whispered speech does not have interesting characteristics like those produced in voiced sounds by the pitch, inflection, and the harmonics. These, in large part, bear on the quality and also very considerably on voice identification; but in both types of sounds there are the characteristics of tempo and of stress which, of course, bear in other ways on quality and identification.

All of these important attributes of speech sounds are dealt with through the features of the playback system. The black paper strips on the drum, which may be seen in Figure 1, are arranged to portray each of the several variables separately and independently. The smooth-shaped strips along the bottom-most section of the visible pattern mark the intervals where voiced sounds occur, and therefore when buzz energies are to be employed. Along the horizontal or time scale, the vertical width of the strip at any point represents the pitch of the buzz at that instant, with variations of width representing changes of inflection for the voiced sound being made — widening for rising inflection, and narrowing for falling inflection. Where there is a gap in the pitch markings, the indication is that, instead of buzz, the hiss energy is to be used for producing an unvoiced or whispered type of sound. No provision is made in the present playback system for using buzz and hiss energies simultaneously as for sounds like the "v" mentioned above, since for our purposes so far, a similar and satisfactory effect is produced by switching from buzz to hiss at a particular instant during the interval allotted for such a combination sound.

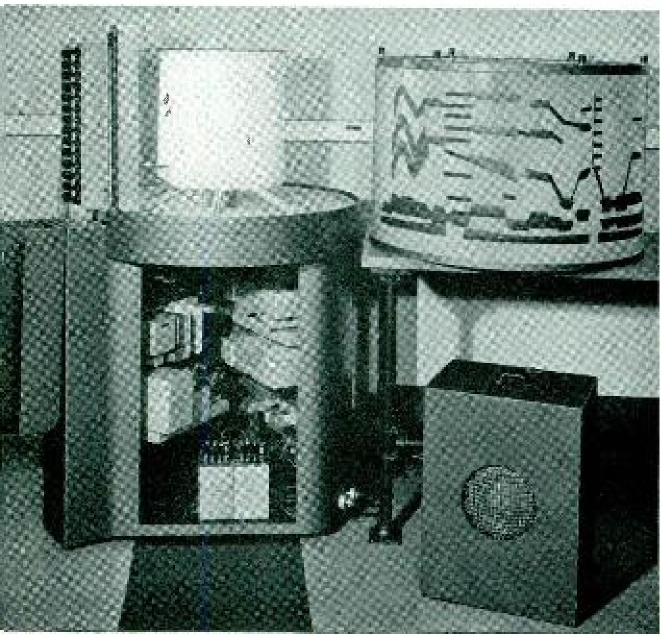


Fig. 3—The speech playback apparatus with drum removed exposing the fluorescent light arrangement, the hood for the photoelectric cell rack lowered, and a panel below taken off exposing the synthesizing units

All of the black strips above the pitch markings represent what is known as the speech spectrum. This part of the visible pattern is essentially a frequency-time-amplitude graph, displaying which frequency groups or components from the buzz or the hiss energies are to be used, when those components are to be used, and how strong each should be. Frequency is indicated vertically and time horizontally. Although the amplitudes of the energy components might be represented by the denseness of the graph at particular frequency and time locations, the synthesizing process, described later, represents them more conveniently by the vertical widths of the black strips. A narrow strip simulates a low density in that section of the graph, and consequently a weak contribution of energy from that particular frequency region, while a wider strip simulates a higher degree of density, and consequently a stronger contribution from the energy. Although the visible pattern is hand-tailored and appears quite artificial, from a broad view it is like a spectrogram of real speech, as will be pointed out later.

The construction of the playback apparatus is more clearly evident in Figure 3, which shows the drum removed exposing the fluorescent light arrangement, the hood for the photoelectric cell rack lowered, and a panel below taken off exposing the synthesizing units. The housing for the fluorescent lamp has a narrow slit running the full height of the drum through which the light passes toward the inner wall of the drum, through this translucent wall, and thence to the photoelectric cells. Figure 4 shows these arrangements in greater detail, with a part of the fluorescent lamp housing removed, with the photoelectric cell rack tipped back, and the cover for the cells raised. When the cover for the photoelectric cells is closed each of the thirteen cells is in a separate compartment and receives light through a narrow window from only that section of the drum immediately opposite it. There are thirteen amplifiers and associated sensitivity controls for the photoelectric circuits mounted on the back of the rack. The fluorescent lamp housing is supported from a fixed central shaft rising up through the center of the turntable, and the photoelectric circuit rack is fastened to the outer frame. With the drum in place on the turntable, its cylindrical wall passes between the lamp housing and the photoelectric rack. An inner translucent cylinder, enclosing a bank of incandescent lamps, plays no part in the process, and was added merely to display the drum and its patterns better during demonstrations.

A block schematic of the overall system is given in Figure 5, which shows the fluorescent lamp with its slit housing, the drum wall, the thirteen photoelectric cells, associated sensitivity controls and amplifiers, the synthesizer, a speech sound equalizer, an output amplifier, and the loud speaker.

The synthesizer portion of the system is the same as that used in the vocoder.* The two synthesizing energies are generated in separate units shown at the bottom of Figure 5. A relaxation oscillator with its output containing all harmonics up to 3600 cycles supplies the buzz, and its fundamental frequency is adjustable to cover the range of pitch from low voices of men to high voices of women. The hiss energy is produced by a random-noise generator, and its output is about evenly distributed over all the frequencies in the 3600-cycle speech range. These energies are controlled in accordance with the pitch markings on the drum by way of the bottom photoelectric cell, designated P, with which those markings are aligned. Current from the cell is amplified, and then controls a switch to select either the buzz or the hiss as required at the moment, and it also controls the frequency of the relaxation oscillator, and thus the pitch of the reproduced vocal parts of speech.

Speech sounds are distinguished from one another by their energy content at different frequencies. From early experiments, which led to the vocoder development, it was learned that speech sounds could be constructed out of combinations of groups of energy from twelve contiguous bands of frequencies 300 cycles wide covering the spectrum range up to 3600 cycles. This means that, whereas real speech sounds are composed of different frequency groupings of energy with generally smooth and continuous shadings between the selected and suppressed energies, a close approximation of the overall effect is accomplished by utilizing the frequency constituents in a number of discrete blocks with the constituents in each block treated as a unit and varying in amplitude as a unit. For the present, twelve 300-cycle bands seem sufficient.

Currents from the twelve spectrum photoelectric cells control twelve bands of synthesizing energy, regulating their flows and combinations in specified amounts in accordance with the spectrum patterns. The No. 1 cell controls energy in the band up to 300 cycles; the No. 2 in the band from 300 to 600 cycles; and so on up to the No. 12, which controls energy in the band from 3300 to 3600 cycles. Output from the energy source is carried to a row of twelve band-pass filters, each 300 cycles wide and together covering the range up to 3600 cycles. The output from each filter is carried to a similarly marked copper-oxide modulator to which the corresponding photoelectric circuit is also connected. These modulators act as valves and release energies in proportion to the

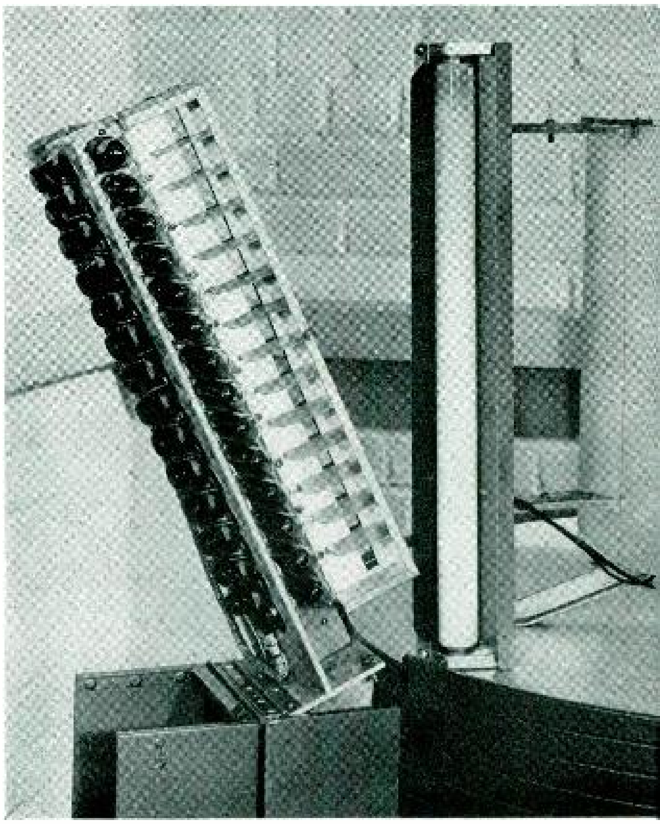


Fig. 4—Light unit of the playback with the cover for the photoelectric cells raised. When the cover for the photoelectric cells is closed, each of the thirteen cells is in a separate compartment and receives light through a narrow window from only that section of the drum immediately opposite it

*RECORD, *December,* 1936, *page* 98 and *December,* 1939, *page* 122.

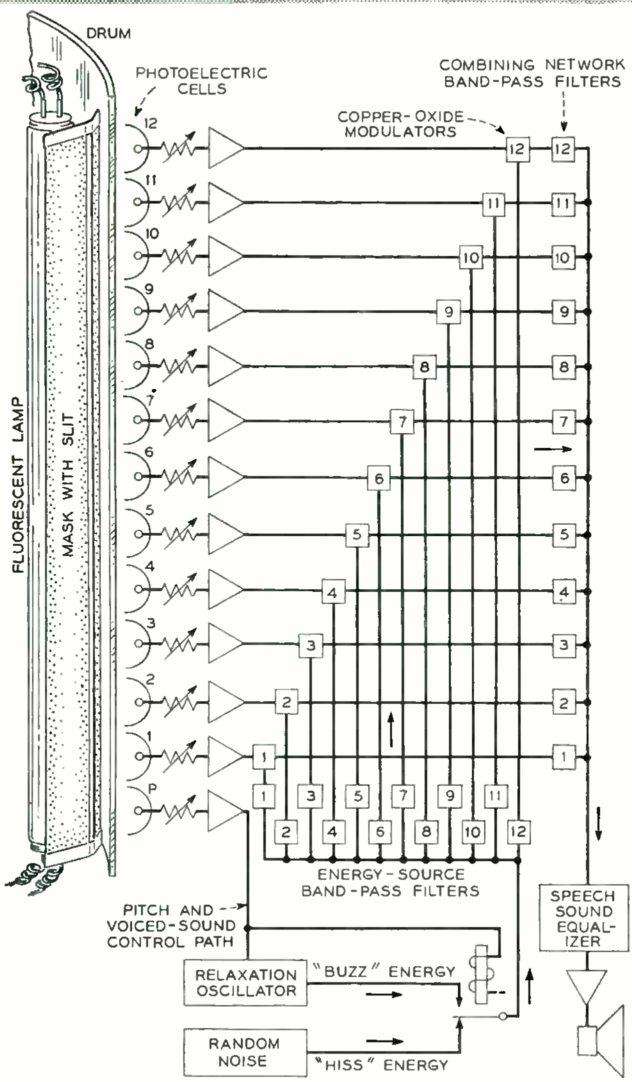


Fig. 5—Block schematic of the playback circuit showing the fluorescent lamp with its slit housing, the drum wall, the cells and the associated equipment

control signals received from the photoelectric circuits.

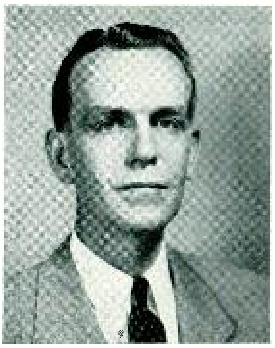
Outputs from the modulators, as controlled by the photoelectric circuits, pass to a combining network consisting essentially of twelve band-pass filters like those in the supply to the modulators, and the combined output is carried to a speech sound equalizer. In ordinary speech, the levels of the component energies decrease somewhat with frequency. Since it is advantageous to operate the copper-oxide modulators with fairly even levels of synthesizing energy, the required shaping is derived by passing the combined output energies through the speech-sound equalizer, which provides attenuation proportional to frequency at a rate of roughly 4 db per octave. The synthesized speech energies are next amplified and then passed to the loud speaker where the sounds are produced.

A visible pattern of the sentence, "Mary had a little lamb; its fleece was white as snow," is shown in the upper part of Figure 2. This is a spectrogram of real speech as made with the Sound Spectrograph. From a broad view, the playback pattern shown next below is a similar kind of picture representing the same sentence, allowing that the horizontal time scale here is somewhat compressed. Pitch markings, like those along the bottom of the hand-tailored pattern, are not shown in the real speech pattern, although they could be included if desired. Other evidence of the pitch is shown on the real-speech pattern in the form of fairly regular vertical striations which appear to run from top to bottom in those intervals of the pattern where voiced sounds are portrayed. The spacing of these striations is related inversely to the pitch, the wider apart the lower the pitch, and vice versa. This form of pitch indication has not been particularly useful because the markings are obscured in some places and are difficult to read and interpret. Except for this, the playback apparatus could have been built to operate from a real-speech pattern instead of the artificial one, for in most of the important respects these two patterns differ only in fairly minor details. The pattern elements were tailored to the physical dimensions of the drum and to the electrical dimensions of the photoelectric and synthesizing circuits and certain convenient substitutions were made.

How closely the playback system produced sounds of speech type is shown in the lower line of Figure 2, which is a spectrographic pattern of the sounds produced from the artificial pattern. Broadly, this pattern compares fairly well with the real-speech pattern in the top line. The "blockiness" and the "stairstep" glides show the effects from using the twelve bands in the synthesizing process. To the listener, the synthesized sounds sound like speech and are intelligible, although not like the original real speech referred to above. The departures are due, for the most part, to factors like differences in tempo changes, stressings, pitch, and such – conditions injected quite intentionally when this particular artificial pattern was constructed.

In this ability to modify any part of the pattern as desired lies the great advantage of this playback as a research tool for studying speech. As formed by mouth, the resonance or prominent energy regions are necessarily inter-related, but it is not known that the resulting effects are all essential or even helpful to the ear. It is quite conceivable that artificial patterns, or perhaps even more direct devices, might be designed that would produce speech more easily interpreted than that from the mouth. Also, in spectrograms of connected speech sounds, glides and influences of consonants on preceding and succeeding vowels are always prominent features. These are very helpful in reading spectrograms, but are they essential to intelligibility or merely an incidental feature imposed by the fact that we cannot move our speech articulators instantly from one position to another? In hand-tailored patterns, the glides can be made to occur at any desired time rate, and influences may be eliminated to observe the resulting effect on intelligibility. One interesting feature of the playback is that changing the speaking rate, by changing the rotating speed of the drum, has no other effect – pitch and inflection, for example, are not altered. Another feature is that, with a given pattern, the speech sounds may be produced in any pitch range, as from a low bass voice or from a high soprano.

The manipulations afforded by the playback system give wide scope for studies in the essentials of speech. While further work and developments may suggest some practical applications, it is expected, at least in the immediate future, that the playback system will be used primarily for the fundamental studies of speech carried on in the Laboratories.



THE AUTHOR: LIONEL O. SCHOTT graduated from the University of Missouri in 1928 with a B.S. degree in Electrical Engineering. He then joined the D & R of the A T & T, where he was engaged principally in development and research on voice-operated devices for application to wire and radio circuits. After 1934, when the D & R was merged with the Laboratories, these activities continued until 1937, when he began concentrating on toll transmission studies. In 1942 he returned to development and research on devices in speech transmission systems, and this led, in 1943, to his connection with the visible speech program.

THE EA RELAY

D. D. MILLER
Relay Engineering Development

An important factor in keeping down the cost of dial switching was the development of the E relay in 1910. Using cores and armatures punched from metal sheet, this development not only greatly reduced the cost of the relays that were required in very large numbers for dial switching, but reduced their size so that many more could be mounted in the given space. So well conceived was its design that the E relay has remained essentially unchanged to the present day. The R relay,* which came out in the 1920's, is essentially an E relay, but with its core swaged to an oval shape. Although the R took over some of the applications of the E, its somewhat thicker winding makes it unable to compete in some services.

In 1938 a number of important modifications were proposed for the E relay to decrease its production cost, but the rapid growth of war production discouraged changes at that time. Faced with a large production of types E and R relays at the end of the war, however, the Western Electric Company requested the Laboratories to complete the design changes suggested in 1938, since they would permit very substantial savings in winding machinery alone.

The cores of the E relay – as were those of many other Western Electric relays prior to the U relay† – were larger at the ends than within the coil, and the windings were wound on each relay individually. The U relay, however, had a uniform cylindrical core, and the coils were wound seven at a time on a common mandrel, and then cut off and slipped over the cores.

The core of the E relay is shown at the left of Figure 1, and the proposal was to cut off the excess width at the front end in order that coils could be wound and then slipped in place over the core. Coils of this type are called "filled windings" because they are made of alternate

*Record, *November,* 1926, *page* 83.

†Record, *May,* 1938, *page* 300.

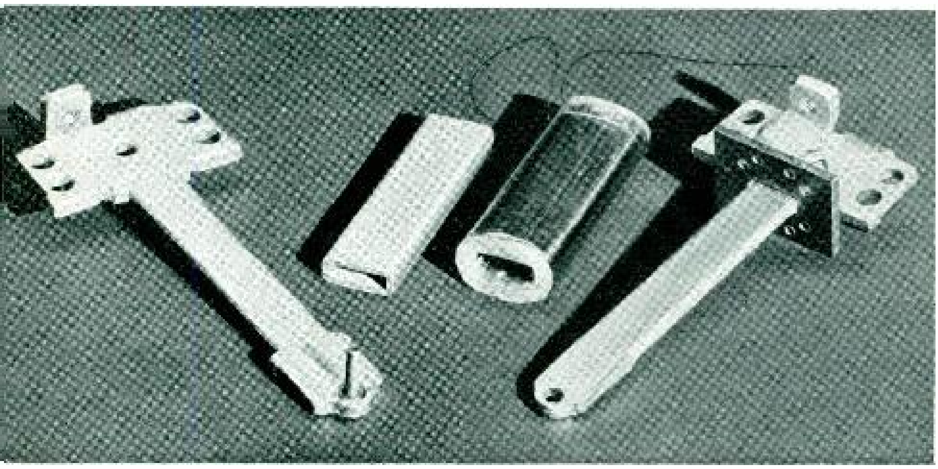


Fig. 1—A core of the E relay at the left, and one of the EA at the extreme right. Between the two cores is a short-circuiting sleeve and a "filled" winding such as is used with the EA-type relay

lays of wire and thin insulating sheets. and the insulation filling gives the coils stiffness so that they are self-supporting. Such a filled winding is also shown in Figure 1. In narrowing the front end of the core, the pole-face area – where the armature meets the core – is decreased. Careful investigation showed, however, that this change alone would not prevent this modified E relay—known as the EA—from serving successfully in practically every application. This effect, however, would prevent extending this construction to the R relay. The rounded core of this latter relay would offer too narrow a pole-face if its expanded end were narrowed to core width.

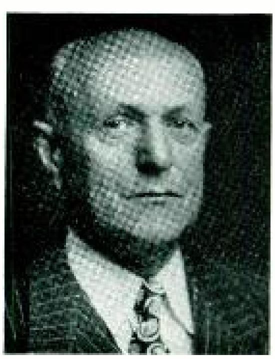
Another advantage of the EA relay, and one permitting still greater economies, is that it allows a conducting sleeve to be slipped over the core under the winding to act as a short-circuited winding. Such a sleeve of aluminum is also shown in Figure 1. To secure proper timing of the cut-off relay, a non-inductive resistance winding is placed in parallel with the regular winding, but since the regular winding of the cut-off relay occupies all available space, this additional resistance winding is placed on the associated line relay – both of these relays being of the R type. With the EA relay, a simple aluminum sleeve slipped over the core of the cut-off relay gives the desired characteristics, and saves the cost of an entirely separate winding and the additional wiring to it.

So far, this new construction has been applied chiefly to the line and cut-off relays because of their large production and relatively simple spring and contacting arrangements. As shown in Figure 2, some nine codes of EA relays have been designed, and they have a prospective production of almost 3-1/2 million a year.

NEW CODE	SPECIFIC PURPOSE	SYSTEM USED	RESISTANCE COIL	SPRING COMBINATION
EA1	LINE	* 1X-BAR	1000 SHORT COIL	TOP
EA2	LINE	* 5X-BAR	500 SHORT COIL	TOP
EA3	REGISTER	* 5X-BAR	650 SHORT COIL	TOP & BOTTOM
EA4	SENDER	* 1X-BAR	1050 LONG COIL	TOP & BOTTOM
EA5	LINE	SXS	550 550 LONG COIL	TOP & BOTTOM
EA6	CUT OFF	SXS	1150 LONG COIL	TOP & BOTTOM
EA7	LINE	PANEL	1000 LONG COIL	TOP BOTTOM
EA8	CUT OFF	PANEL	615 1985 LONG COIL	TOP & BOTTOM
EA9	CUT OFF T.P.M.R.	PANEL	615 LONG COIL	TOP BOTTOM

Fig. 2—The nine codes of present EA relays with information pertaining to them

THE AUTHOR: D. D. MILLER joined the Western Electric Company in 1909 following his graduation from the University of Tennessee. The next year he transferred to the Engineering Department in New York, and participated in the design and the earlier installations of the Western Electric Company's train dispatching systems. In 1917 he was given direct charge of the design of wound apparatus such as relays, ringers, resistors, message registers, and electromagnets, and also of the engineering work on precious-metal contacts. In 1937, current engineering on panel central office apparatus, and in 1938, current engineering on step-by-step central office apparatus were added to the responsibilities of his group. During World War II, he worked on rockets and mine control apparatus. Since then he has resumed development and design work on electromagnetic apparatus in Switching Apparatus Development.



AREA MANAGEMENT OF STAFF SERVICES

By G. T. Selby
Staff Manager, General Staff Department

During the late 1920's, because of the need for more space, the Laboratories had to lease quarters at several locations in New York City. Since that time, staff services such as mail, messenger, transcription, stockrooms, project planning and shop work have been provided by units at these locations reporting to supervision at West Street. This principle was also followed when Murray Hill I was occupied.

Studies of staff operations had indicated that many advantages would accrue through a decentralization of selected staff activities which would make the three Areas (West Street, Murray Hill and Whippany) more or less autonomous. At the same time, there should be means provided at headquarters for coordination to keep the three Areas in general conformance in the provision of staff services.

On January 1, 1947, staff services at Whippany were set up on an Area basis, thus providing opportunity to observe actual operations with local autonomy. Operations at Whippany during the past eighteen months have produced encouraging results.

On July 1, 1948, Area Management for staff services at West Street and Murray Hill was announced and will become effective on a step-by-step basis, as rapidly as the Murray Hill Project Group (the organization responsible for the erection and occupancy of the second Murray Hill unit) makes space available. As members of the technical department are moved from West Street, staff personnel requisite to the enlarged scale of operations at Murray Hill will also be moved and will be properly placed in the new Area organization. During the same interval, staff personnel at West Street will be shifted within the General Staff Department into the new organization.

In the following description of the changes in organization, it should be emphasized that some of those named are still actively engaged in the Murray Hill Project, and this has been indicated in the organization change notices. In these instances the new assignments will not become effective until the progress of the building project permits.

So far as plant services are concerned, the new form of organization transfers the Building Shop from the Plant Department and consolidates it with the Development Shops organization. It segregates Plant Engineering in a new headquarters organization to be discussed later. Under the Area Managers will be consolidated the former General Services, Commercial Relations as related to Project Planning and Procurement, and certain of the staff services formerly reporting to Staff Engineers. A Technical Department Staff Representative with a group of aides has been set up for each of the technical departments. Dealing with staff engineers and project engineers, these groups will provide case cost, budget, commercial and certain other services required by the technical departments in the pursuit of their research and development efforts.

Coincident with these changes, plant engineering has been separated from plant operation which continues as a part of the Area organizations. Under S. H. Willard as General Plant Engineer will be the Plant Engineering groups formerly located at West Street and Murray Hill. In addition, he will provide space planning and layout services for all departments, this function having been transferred from the Staff Engineer Organizations.

The Manager of the New York Area will be H. C. Atkinson who has heretofore been Manager of Developments Shops. Reporting to him as Plant Operation Manager will be L. P. Bartheld after his present work is completed where he is in charge of occupancy, design and space allocation in the Murray Hill Project Department. Mr. Bartheld's staff will be W. C. Somers, in charge of New York building operations and Miss Elizabeth Ink, restaurant supervisor.

Also reporting to Mr. Atkinson will be F. Cowan as General Service Manager; Mr. Cowan was formerly Service Operation Manager at Whippany. His staff will include F. Keeling, Technical Department Staff Representative for Apparatus Development I; F. R. Wheeler, Technical Department Staff Representative for Systems Development; J. F. Lewis, Order and Local Service; E. J. Reilly, General Service; F. Haese, Reproduction; C. T. Boyles, Traffic, Central Instrument Bureau and Stockrooms; J. Cameron, Mail and Messenger Service, TWX and Central Files; and Miss Vivian Kilpatrick, Transcription.

Reporting to A. H. Sass, Shops Manager, and W. B. Vollmer, his assistant, will be J. W. Tengstrom, Building Shop Superintendent; G. Scott, Development Shop Superintendent; and A. I. Heitzman, in charge of shop planning at West Street.

G. F. Fowler, who continues as Plant Relations Manager, will also report to Mr. Atkinson.

The Manager for the Murray Hill Area will be R. H. Wilson, formerly General Service Manager of the Laboratories. On his staff will be A. F. Leyden, who continues as Plant Operation Manager at Murray Hill, and will have reporting to him T. J. Crowe, as Building Operation Superintendent, and F. E. Dorlon, as Restaurant Supervisor.

Also reporting to Mr. Wilson will be H. Schmitt, General Service Manager, and his staff will include the following: L. W. Stengel, Technical Department Staff Representative for Research; A. J. Akehurst for Apparatus Development I; J. H. Hart for Apparatus Development II; L. W. Mackey for Systems Development; C. A. Charity in charge of Order and Local Service; E. Van Horn, Reproduction; E. H. Kampermann, Traffic, Central Instrument Bureau and Stockrooms; and V. D. Gallagher, Transcription, Mail Service and Central Files.

H. J. Wallis will be Shops Manager at Murray Hill, reporting to Mr. Wilson. Previously Mr. Wallis was in charge of the Assembly and Wiring Shop at West Street. His staff will be D. R. Pope, Building Shop; A. E. Emerson, Development Shop Superintendent; and F. W. Brunnengraber, Shop Planning. Mr. Wilson will also have charge of General Service at Deal and Holmdel. At Holmdel, the Research Department has turned over is maintenance and shop force to Area Management.

J. G. Segelken, currently Staff Representative in the Murray Hill Project Department, will become Plant Relations Manager after the Project is completed.

The Whippany Staff Department remains under O. M. Glunt, Director of Whippany Staff, and is functionally changed only in that the Development Shop now located at Whippany becomes a part of the Whippany Staff Department and will be under the direction of W. W. Schormann, Service Operation Manager, who will be responsible for shops and services at Whippany.

The headquarters organizations will consist of six units. Mr. Fondiller continues as Treasurer with G. A. Brodley as Assistant Treasurer. A. O. Jehle continues as Comptroller and G. T. Selby as Staff Manager. S. H. Willard, formerly Plant Manager, will become General Plant Engineer. G. H. Bogart, formerly Plant Operations Manager in New York, will become Plant Engineer in New York, with C. W. Lowe and J. E. Conwell responsible for space and facilities requests, layouts, moves and telephone installations; and D. J. Hendrick responsible for Buildings and Facilities Engineering and Construction Supervision.

J. G. Motley, currently Construction Engineer in the Murray Hill Project Department where he will continue until the Project is completed, will be Plant Engineer at Murray Hill. His staff will be L. S. Hulin, responsible for space and facilities requests, layouts, moves and telephone installations; and P. V. Brunck responsible for Buildings and Facilities Engineering and Construction Supervision. M. M. McKee, now in the Murray Hill Project Department, later will report to Mr. Willard as General Occupancy Engineer; his staff will be I. W. Whiteside and R. H. Kendall.

Also reporting to Mr. Fondiller is B. B. Webb who continues as Commercial Relations Manager. Reporting to him are J. A. Sherwin, who continues as Case Systems Supervisor, and C. R. McConnell as Commercial Relations Supervisor.

H. W. Dippel, Purchasing Agent, now reports to Mr. Fondiller with E. G. Conover and W. F. Halloran as Assistant Purchasing Agents. A small purchasing unit is being established at Murray Hill.

Area management of staff services will assign an increased degree of local autonomy to the staff groups at New York, Murray Hill and Whippany. It is believed that this will better serve the needs of the Technical Departments. The three areas will be closely correlated by a small coordinating group and by supervision at the New York headquarters. The work done in the areas will also be supplemented by functional groups at headquarters, as has already been mentioned, for such matters as Plant Engineering, Purchasing, Accounting, etc.

The present changes to Area Management should be looked upon as simply a step, although a significant one, in the evolution of the organization of the Laboratories. Such changes bring to its members new opportunities for experience and achievement. As times and seasons pass, it is natural that changes come, and this will be true in the future just as it has been in the past.

Walter S. Gifford Addresses Executive Conference

Throughout the years, the older members of the Laboratories have been in a favorable position to watch the development of the Bell System not only in technology – which has been their particular concern – but in other respects such as finance and public relations which have contributed so much toward the present size and stability of the System as a whole. A panorama of these latter developments through the eyes of the chief actor in them was unfolded when Walter S. Gifford addressed an executive conference in the West Street auditorium. Mr. Gifford was president of the American Telephone and Telegraph Company from 1925 until February of this year when he became chairman of the Board of Directors.

Introducing Mr. Gifford, President Buckley noted that the present corporate form of Bell Telephone Leboratories was largely due to Mr. Gifford. Telling of his personal relations Mr. Buckley said that Mr. Gifford, who in a real sense had been his immediate superior, was "a good boss to work for"; no matter how busy, Mr. Gifford was always accessible and ready to listen to Mr. Buckley's problems and quick to understand them. Outstanding in Mr. Gifford's personality was his good common sense and his accurate perception of human reactions together with a shrewd feeling for the relative importance of particular elements in the problem.

In concluding his talk, Mr. Gifford summed up his philosophy for today's problems as follows:

"The one thing that disturbs me most – it isn't in the telephone business but in the country at large – is the sense of defeatism that seems to have come over our country growing out perhaps of the depression and other things, some of them political. I see no reason for it and I think it's a very dangerous thing to have people apologizing for free enterprise. Great heavens, the very system in the world that is not on trial is free enterprise. It's silly to talk about the free enterprise system on trial, the system that supplied munitions to all the Allies in World War II and is now supplying the whole world, that will take it, with help of one sort or another. I keep hearing people talk about the dreadful conditions in this country. Of course they're not perfect and they never will be here or anywhere else but they are better here than anywhere else. We have every reason, I think, to be optimistic and I say this in spite of the threat of international difficulties. Come what may, I think we can do as we've done in the past – surmount them. We hope we won't have to but if the spirit of optimism that runs in the Bell Telephone System today could be widespread throughout our country, we'd get a lot of our troubles behind us and get a lot more fun out of life."

A T & T Names C. F. Craig To Head O & E

Cleo F. Craig, vice president of the A T & T, has been placed in charge of the Department of Operation and Engineering, succeeding William H. Harrison, who has resigned to become president of International Telephone and Telegraph Corporation. Mr. Craig will also be responsible for advice and assistance to the Associated Companies and the Long Lines Department on rate and revenue matters.

In charge of the Personnel Relations Department at A T & T since April 1941, Mr.

Craig had previously had many years of experience in the Company's Long Lines Department, starting as an equipment man in St. Louis in 1913 and rising through the ranks to become general manager of the department in 1933 and Long Lines vice president in 1940. He was elected Director of the Laboratories in March 1941.

Mr. Harrison leaves the Bell System after 39 years of service, during which he rose from repairman for the New York Telephone Company in 1909 to operations vice president of the Bell Telephone Company of Pennsylvania in 1933 and vice president of the A T & T in charge of operation and engineering in 1938. He was elected Director of the Laboratories in March 1937 serving until December 1941 when he resigned to enter military service. He served his country with distinction, rising to the rank of Major General as chief of the Signal Corps' Procurement and Distribution Service. In September, 1945, he was again elected a Director of the Laboratories.

William C. Bolenius, president of the Wisconsin Telephone Company, was elected A T & T vice president in charge of personnel relations, succeeding Mr. Craig.

C. N. Hickman and H. E. Ives Awarded Medals for Merit

The Medal for Merit, the President's highest award to civilians, has been conferred on C. N. Hickman and on H. E. Ives who retired from the Laboratories on July 30, 1947. Presentation was made in joint Army-Navy ceremonies on June 22 at Governors Island. Following remarks by General Courtney H. Hodges, First Army Commander, the medals were presented by Admiral Thomas C. Kinkaid, Commander of the Eastern Sea Frontier. Citations, signed by President Truman, were as follows:

"Dr. Clarence N. Hickman, for exceptionally meritorious conduct in the performance of outstanding services to the United States from July, 1940, to June, 1946. Dr. Hickman, Chief of Section H of the Division of Rocket Ordnance of the National Defense Research Committee, Office of Scientific Research and Development, foresaw, with rare vision and with remarkable accuracy, at the outset of European hostilities and before the United States was involved in the war, the role of the rocket in modern warfare. As a rocket enthusiast since the days of the First World War and as a scientist, with experience in the field of rocketry and knowledge of how the relatively crude, early rockets might be improved, he was able to grasp their tremendous potentialities as weapons, and he was instrumental in persuading the National Defense Research Committee that a program of rocket research should be initiated. He displayed great enterprise and scientific acumen in his direction of the work of the Atlantic Coast group of investigators at the Allegany Ballistics Laboratory whose studies led to the development of powerful new weapons: the small rocket to be used by infantrymen which was effective against tanks; the jet-accelerated armor-piercing bomb; the target rocket to be used in the training of anti-aircraft gunners; the recoilless gun; and a high-velocity aircraft rocket. That the rocket weapons of the United States were among the most vital and successful types of ordnance is the result in no small part of Dr. Hickman's vision and planning."

Signal Corps Photo

Admiral Thomas C. Kinkaid presents Medal for Merit to C. N. Hickman for his leadership in the development of rockets during World War II

"Dr. Herbert Eugene Ives, for exceptionally meritorius conduct in the performance of outstanding services to the United States from December, 1940, to June, 1946. Dr. Ives, as Consultant for the study of blackout lighting, member of the Camouflage section and of the Division of Optics, Chief of the section of Nocturnal Logistics, and member of the Division of Physics of the National Defense Research Committee, directed important phases of the war work in the field of optics. In the scientific race against the ingenuity of the enemy, he devoted his talents to such purpose that our military equipment was superior. He directed the development of equipment which made night driving of our trucks possible under blackout conditions. He enabled ships in the presence of the enemy to signal each other without showing visible light or breaking radio silence. He developed the 'Snipascope,' a device by which our soldiers could detect an enemy in the dark, with which it is estimated, one-third of the Japanese casualties in the early engagements on Okinawa were caused. Dr. Ives' achievements were brilliant and his contribution to the war effort was outstanding."

Pioneers Gala Moonlight Sail

With the ship's orchestra playing *Anchors Aweigh*, the *Bear Mountain* eased out of her berth at the Battery on June 15 at 7:40 P. M. with 550 Pioneers of the Frank B. Jewett Chapter of the Telephone Pioneers of America, their friends and families aboard for a moonlight sail up the Hudson. The open decks were crowded by those who had come early to secure chairs and settle down to enjoy sunset and skyline views while having box-lunch suppers; couples hugged the rails watching twilight descend over the City; cameras were everywhere in evidence as fans pitted their skill and technique against the fast diminishing light. As the *Bear Mountain* passed Laboratories headquarters at West Street, her horn blew a dozen blasts which were acknowledged by rivercraft and docked vessels in the vicinity. On the roof of the building were a few of those working late who wanted to see the Pioneers sail by.

Beyond Riverside Drive, most people left the open decks, some to have a snack in the dining room, others to visit friends, renew acquaintances or meet co-workers' families. A few began to play bridge, but the majority gathered around the dance floor either to watch or to participate in the evening's fun. A Paul Jones or two helped to make people better acquainted, and then square dances were called. Four couples who were expert at square dancing volunteered as leaders and the Caller began directing. For a while the pace was slow, a fellow or girl would swing the wrong partner, or be left stranded for a moment; but before long the men had their coats off, petticoats and full skirts with the New Look were swirling prettily, and the orchestra looked pleased playing for a group who enjoyed themselves so much.

Just above Ossining, the *Bear Mountain* turned for home. The moon came up beautifully and couples went off in twos to the open decks, some with portable radios to enjoy their favorite programs. Chairman L. P. Bartheld began the drawing for gangplank prizes, the first, won by Loretta Farrell, being a ten-dollar gift certificate on a New York department store. Two other similar prizes were awarded to holders of lucky numbers, as well as candy, cigarettes, and miniature handsets. Dancers competed for prizes in the waltz, tango, and the foxtrot. Many a retired Pioneer, like L. Montamat, scarcely missed a dance all evening.

Meanwhile river currents were bringing the *Bear Mountain* downriver faster than she was scheduled to return so a surprise, a sail out to the Statute of Liberty, majestically flood-lighted in the dark harbor, was added. In several cases that part of the trip was most enjoyable, particularly for C. F. Blackwelder and his family. On their farm at Cheyenne Wells, Wyoming, is one of the terminals of the Bell System's first rural radio link. In appreciation of their hospitality during the field trials, S. B. Wright brought them to the Pioneers' party. Guests of Harvey Fletcher, retiring president of the Chapter, were Ivor Sharp, manager of Station KLS at Salt Lake City, and his family.

Committee members to whom success of the moonlight sail is due are Joyce Thompson, secretary of the Pioneers Entertainment Committee who selected the prizes, E. G. Andrews, R. E. Coram, C. A. Conrad, A. G. Jensen, D. R. McCormack, R. J. Nossaman, R. E. Poole, J. A. St. Clair, E. F. Watson and I. W. Whiteside.

Changes in Organization

In anticipation of retirements which will occur in the Outside Plant Development Department within the coming year, the following changes in organization became effective on July 1:

R. J. Nossaman was appointed Assistant Director of Outside Plant Development and is now associated directly with R. A. Haislip, Director of Outside Plant Development.

J. W. Kennard, Assistant Cable Engineer, is now associated directly with W. E. Mougey, Cable Engineer.

T. C. Henneberger was appointed Plant Systems Engineer, succeeding M. Nossaman in this position.

A. L. Richey was appointed Cable Systems Engineer and in this capacity will report to Mr. Henneberger.

On the Moonlight Sail

.—A. G. Jensen presents Loretta arrell with first prize for holding ıe lucky ticket for gangplank rizes as J. A. St. Clair, left, and ,. P. Bartheld look on. B—The pen deck was crowded with ioneers enjoying the river breezes. '—R. A. Haislip, extreme right, is ıe president for 1948-49 of the '. B. Jewett Chapter. D—Reering Pioneer President Harvey 'letcher's party included Mrs. and)r. J. C. Fletcher, Sally Sharp, Iarvey, Jr., Mrs. H. Fletcher, Mrs. oor Sharp and Dr. Fletcher himelf. E—S. B. Wright's party ıcluded Phyllis Blackwelder, Mrs. . B. Wright, H. S. Wright, Ir. and Mrs. C. F. Blackwelder, Ir. Wright, Glenda McFie and tephen Duma. F—Mr. and Mrs. C. Osten-Sacken and Mrs. and Ir. A. Burkett. G—An Accounting)epartment group—Thomas Corey, Iary White, Miriam Van Gelder, 'leanor Dunn, Maryalice Corey, Iarian Haggerty, Ethel Sauter ıd James Foley

August Service Anniversaries of Members of the Laboratories

40 years

H. N. Bowman

35 years

N. M. Anderson
G. E. Bailey
W. G. Freeman
Arthur Kenner
W. J. Turney

30 years

Fred Broome
W. A. Drake
R. C. Kraft
R. H. Mills
G. F. Voehl

25 years

M. T. Diaz
C. D. Hanscom
R. R. Hopkins
A. G. Kobylarz
R. K. Potter
E. F. Smith
J. G. Walsh
B. S. Woodmansee

20 years

D. M. Black
F. E. Blount
M. E. Brandin
B. A. Fairweather
N. V. Firth
R. J. Fluskey
C. A. W. Grierson
Harry Grutzner
R. J. Guenther
Harriet Hoffman
J. O. Israel
Henry Kahl
M. L. Martin
Hugh McCaffrey
James McDonald
C. Erwin Nelson
C. G. Reinschmidt
Kieran Rohan
W. F. Sills
P. H. Smith
M. A. Specht
V. J. Weber
Fred West

10 years

J. A. Burton
W. J. Gallagher
J. A. Lang
F. J. Skinner

C. C. Lawson was appointed Assistant Wire Development Engineer. In this capacity he will report to C. S. Gordon, Wire Development Engineer, and is in charge of the wire development group.

O. B. Cook was appointed Cable Apparatus Engineer and reports to S. C. Miller, Plant Products Engineer.

Changes in other Departments effective July 1 were:

H. B. Ely was transferred from the Research Staff Department to the Publication Department. Until F. L. Hunt's retirement in October, Mr. Ely will also function as Murray Hill representative reporting to L. S. O'Roark.

P. J. Keenan of the Research Staff Department was appointed Executive Assistant to the Director of Research, reporting to R. Bown, Director of Research.

L. G. Rector was transferred from the Research Staff Department to the Apparatus Staff Department, reporting to H. J. Delchamps, Specifications and Staff Engineer.

C. H. Haynes, together with the mechanical design and drafting group now under his supervision, was transferred from the Research Staff Department to the Electronic and Television Research Department, reporting to A. A. Roetken.

Effective August 1, A. F. Bennett was appointed Director of Station Apparatus Development. Until further notice, W. H. Martin, Director of Apparatus Development II, continues to supervise directly the activities of Station Apparatus Development relating to Specialty Products. C. F. Wiebusch was appointed Station Apparatus Development Engineer, succeeding Mr. Bennett.

Highly specialized drafting, with requirements to comply with the U. S. Patent Office procedures, is done by these men and women in the Laboratories Patent Department drafting room at the Davis building under the supervision of H. F. Beck, in the foreground, second row. In the first row, front to rear are Elizabeth Whitley, S. Terry and O. Kimmel; second, Mr. Beck, G. T. Lewis, Virginia Merrill and C. J. Meden; third, C. C. Ward, W. A. Von Glahn, T. B. Horton and C. F. Campagna; fourth, T. A. Ayvazian, P. Pace, E. A. Lichtenberger, W. T. Gerbe and W. S. Gunnarson; and in the fifth row, Emily Callagy, H. J. Fischer and S. Cunningham

The Metropolitan Bell Symphony Orchestra gets ready to play a new number for invited guests at first performance on June 17 following formal organization of the Society in May

Metropolitan Bell Symphony Society

Under the baton of Michel Gusikoff, the Metropolitan Bell Symphony Society presented its first program to an audience of invited guests in the auditorium at 195 Broadway on June 17. Although the program was an ambitious one, climaxing in the Haydn symphony, "Militaire in G Major", it was well handled. The skill that was shown by players of widely diversed background promises well for next winter's performances. Nicolas Alexander, baritone singer, rendered a number of songs.

Membership in the orchestra is open to all members of the Bell System in and about New York. The following members of the Laboratories participated in the concert: R. E. Anderson, R. N. Breed, H. D. Doane, J. V. Domaleski, R. D. Fracassi, R. N. Larsen, W. R. Lundry, Bernice Potwin and J. A. Weller, violins; G. F. Critchlow and P. G. Edwards, flutes; H. C. Green, clarinet; J. C. Gabriel, P. E. Mills and A. L. Whitman, violas; F. A. Johnston, percussion; W. A. Krueger and H. M. Spicer, bassoons.

Bell System Radar School

The Bell System Radar School, under the direction of J. F. Wentz, opened its first training course in radar for Army personnel since the close of the war, on June 28 at Whippany. This course, intended to train Army officers in the maintenance of new radar equipments now being manufactured in the Western Electric Company Shops at Winston-Salem, will run for thirteen weeks. E. T. Mottram is in direct charge of the curriculum, assisted by the following Laboratories members who are instructors, H. H. Bailey, W. L. Cowperthwait, F. E. DeMotte, F. A. Goss, G. Head, E. H. Sharkey, J. F. Sweeney and J. E. Tarr. Assisting in the course are J. G. Beard, J. Schisel and H. Bacon from the Western Electric Field Engineering Force who will conduct additional courses at an Army Base following the completion of the Bell Laboratories sessions.

I. R. E. Awards for 1948

Among the recipients of 1948 I.R.E. Awards pictured in the June issue of the Institute's *Proceedings* were four members of the Laboratories who received Fellow Awards. They were M. W. Baldwin, "for his fundamental investigations of the quality of television signals;" H. S. Black, "for his work on the negative-feedback amplifier and for his application of pulse technique to radio communication systems;" L. A. Meacham, "for his contributions in the fields of radar range measurement and pulse-code modulation;" and J. R. Pierce, "for his many contributions to the theory and design of vacuum tubes."

Telephone Hour

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

August 2	*Gladys Swarthout*
August 9	*Claudio Arrau*
August 16	*Ezio Pinza*
August 23	*Blanche Thebom*
August 30	*Jascha Heifetz*
September 6	*Bidu Sayao*

H. M. Yates — *A. E. Hague*

Two of the many foursomes at Essex County. Above, R. D. Fracassi, H. S. Winbigler, D. K. Gannett and R. M. Chamberlin. Below, E. L. Fisher, H. T. Reeve, J. P. Griffin and R. L. Shepherd

C. H. Swannack — *H. J. Brennan*

Essex County Golf Tournament

Jersey golfers of the Laboratories participated in a tournament under the sponsorship of Bell Laboratories Club on Saturday, June 19th, at the Essex County Golf Course. Winners in the various classes at the tournament were: A. Jankowski, low gross; H. M. Yates, low net; E. F. Ennis, second low net; and W. J. King, kicker's, all Class "A"; F. H. Graham, low gross; C. W. Christ, low net; and W. L. Whinn and G. H. Baker, tied second low net, in Class "B" with kicker's, V. J. McCarthy, C. G. Arnold, J. P. Griffin and W. F. Malone. In Class "C", winners were G. Palladine, low gross; F. J. Ochs, low net; J. B. Kelly, second low net; and kicker's, W. L. Paterson and H. P. Chamberlain.

Institute of Radio Engineers

Members of the Laboratories serving as officers or members of general committees include: F. B. Llewellyn, senior past president and a member of the *Board of Directors;* R. A. Heising, a member of the *Board of Directors; Board of Editors,* A. E. Bowen, Ralph Bown, G. W. Gilman, F. B. Llewellyn, J. W. McRae, L. A. Meacham, E. L. Nelson, W. C. Tinus, E. K. Van Tassel, E. C. Wente and G. W. Willard; *Education,* F. R. Stansel; *Constitution and Laws,* R. A. Heising and F. B. Llewellyn; *Admissions,* F. A. Polkinghorn, vice chairman; *Sections,* R. A. Heising; *Nominations,* F. B. Llewellyn; *Tellers,* J. W. McRae, chairman; *Papers Procurement,* Eginhard Dietze, W. P. Mason, Pierre Mertz, J. R. Wilson and W. E. Reichle; and *Papers Review,* H. A. Affel, P. H. Betts, H. S. Black, F. W. Cunningham, R. L. Dietzold, I. E. Fair, W. M. Goodall, A. E. Harrison, J. J. Kreer, Jr., W. P. Mason, G. G. Muller, J. R. Nelson, A. F. Pomeroy, L. Vieth and W. T. Wintringham.

Members of Technical Committees include: *Annual Review,* H. S. Black and Eginhard Dietze; *Antennas,* A. G. Fox, W. E. Kock, S. A. Schelkunoff, J. C. Schelleng and P. H. Smith; *Audio and Video Techniques,* R. A. Miller and L. W. Morrison; *Circuits,* E. H. Perkins; *Electroacoustics,* Eginhard Dietze, chairman, and W. D. Goodale, Jr.; *Electron Tubes,* S. B. Ingram, J. A. Morton and R. M. Ryder; *Electronic Computers,* E. Lakatos; *Facsimile,* Pierre Mertz; *Modulation Systems,* H. S. Black, chairman; *Piezoelectric Crystals,* R. A. Sykes, vice chairman, W. L. Bond and W. P. Mason; *Radio Transmitters,* A. E. Kerwien; *Radio Wave Propagation,* Marion

Gray; *Standards*, H. S. Black and Eginhard Dietze; *Symbols*, A. F. Pomeroy, vice chairman; and *Television*, A. G. Jensen, vice chairman.

Members of Special Committees are: *Finance*, F. B. Llewellyn; *Editorial Administrative*, H. S. Black and F. B. Llewellyn; *Policy Development*, R. A. Heising and J. W. McRae; and *Professional Groups*, W. H. Doherty, R. A. Heising and F. B. Llewellyn.

W. S. Suydam Honored

W. S. Suydam won the "Print of the Year" award at the Ridgewood Camera Club's contest on May 12 with his night scene looking south from Central Park. This photo was taken during a Bell Laboratories Camera Club field trip, and won second prize in its group in our recent Annual Contest. The print will be hung in a permanent exhibit in the Pease Memorial Library. It has also been selected by *The Camera* as one of the fifty-two best pictures of the year. Six other pictures by Mr. Suydam were hung in the Ridgewood show. Six pictures by J. F. Neill were hung; one of these placed in the ten best of the show.

Edward Alenius of the Laboratories was one of the judges, together with Norris Harkness of the New York *Sun* and William C. Bowman of New Jersey Bell.

Plans Set for Installing First Connector Units for Voice Recorders

Final arrangements have been completed for customer-owned voice recording machines to be connected to telephone lines under conditions prescribed by public regulatory authorities. The telephone companies of the Bell System have filed tariffs effective August 2 and expect to begin filling orders on that date for the necessary connecting equipment, including an automatic tone device.

Recent issuance of government regulations on the use of voice recording equipment in connection with telephone service followed several years of hearings before the Federal Communications Commission, with the telephone companies and manufacturers of recording machines participating. The regulations require that the telephone companies install and maintain the connecting equipment, including the tone apparatus which produces a "beep." This lets the person at the other end of the line know a record of the conversation is being made.

A subscriber's recording machine will be connected with his telephone line by a connector unit embodying the tone device and contained in a black box slightly larger than the standard telephone bell box. The subscriber will be able to switch his recording machine on or off or connect or disconnect the machine from the telephone line at will.

When the recording equipment is in use, the automatic tone device produces a distinctive signal – a brief, high, almost musical note – which is repeated at regular intervals of about 15 seconds as a reminder that the telephone conversation is being recorded. Private-line telephone subscribers who cannot be connected with the general telephone exchange and toll system need not use the automatic device. In such cases the protective connecting equipment, without the tone device, is provided by the telephone company.

J. J. Reif's miniatures in glass won a prize in the last Bell Laboratories Club hobby exhibit. Mr. Reif is responsible for a group of glass blowers in the Electronic Apparatus Development Department who are engaged in the construction of experimental tubes

While the connector unit will be used initially to connect a recorder to only one line, work is actively under way on arrangements to permit switching a recorder to telephones on different lines, or to enable a telephone which picks up more than one line to use the recorder on any of them.

A Praying Mantis Visits West Street

Genuflecting insect, say,
Come you here to scoff or prey,
Or in homage bend the knee
To some learned Ph.D.?
Frankly, such a reverent mood
Generates disquietude.
Does the offering of prayer
Speak approval or despair?
If our not infrequent woes
Cause that ultra-pious pose,
Then, I beg, remember our
Human lack of mantic power.
Don't just sit there on the sill—
Teach us that prophetic skill.
But if your intrepid flight
Was induced by appetite,
Look around; without a doubt
You'll find "bugs" somewhere about.

RUFUS JENNER

The charge for installing the connecting equipment is $5, and the monthly rate is $2.

Circuit development of the connector unit was carried out by E. L. Owens and mechanical design was by E. G. Fracker, both of Acoustic Products Development; R. R. Galbreath of Telephone Instruments also participated.

Two New Occupational Classification

New occupational classifications with the designations "Technical Staff Associate" and "Laboratories Staff Associate" were recently established by the Laboratories. These classifications are to serve as a means for giving appropriate recognition to the employees who carry out the more difficult assignments formerly included in the Technical Assistant, Staff Assistant, and Accounting Clerk A classifications.

In common with most other large businesses, the Laboratories classifies jobs and their holders according to the work and responsibilities. Classification designations do not necessarily reflect the individual employee's training experience, or potential ability beyond his or her capacity to perform the work of his or her assignment. The new classifications apply to those jobs which involve planning and performance of laboratory or office operations with the exercise of considerable initiative and judgment and the application of advanced knowledge and skill. In general, Technical Staff Associate assignments require versatility in handling experimental, mathematical, or mechanical design projects, while Laboratories Staff Associate positions demand analogous qualifications for the business of the various staff and accounting departments. The departments of the Laboratories have reveiwed the duties of their Technical Assistants, Staff Assistants, and Accounting Clerks A and, with the assistance of the Technical Aide Sub-Committee, have selected those whose jobs properly fall in the new classifications. Those so selected were reclassified accordingly.

F. A. Polkinghorn Goes to Japan

F. A. Polkinghorn of Systems Development has been appointed Chief of the Research Branch, Civil Communications Section, Tokyo, by the War Department to take the place of R. D. Parker, who has held the post since his retirement from the Laboratories in February, 1947. On personal leave of absence from the Laboratories, Mr. Polkinghorn is a member of the Bell System group in Japan who, at the request of the Army, are habilitating communications. He will be responsible for the direction of all Japanese communications research in government agencies, educational institutions and private industry. The post was originally held by K. E. Gould who was assigned to Tokyo in 1946.

Laboratories Recieve Award from Garden Club of New Jersey

In recognition of the attractive appearance of our Murray Hill grounds as seen from the public roads, the Laboratories have received an award by the Garden Club of New Jersey in its second annual Highway Beautification survey. Fifty-eight other commercial and industrial establishments throughout the State received awards, based on general attractiveness, landscaping, absence of unsightly signs

'Maybe it's a new type of wave trap"

and conformity to State standards of health and safety. Present to receive the awards at a meeting in Elizabeth on July 7 were M. L. Wilson, Personnel Manager, New Jersey, and A. F. Leyden, Plant Operation Manager, at the Murray Hill Laboratories.

News Notes

O. E. BUCKLEY, who is President of the Board of Education, School District of South Orange and Maplewood, N. J., addressed the Columbia High School 1948 graduating class on the evening of June 23; and the next morning talked to the graduating classes of the South Orange and the Maplewood Junior High Schools.

AT THE BELL SYSTEM CONFERENCE on public relations held at Absecon, N. J., June 22-25, R. K. HONAMAN represented the Laboratories. O. E. BUCKLEY and R. L. JONES attended some of the sessions. Dr. Buckley addressed the Conference and discussed some of the new developments of the Laboratories.

D. A. QUARLES attended a meeting in Washington of the Committee on Electronics of the Research and Development Board on June 8. The following day he spoke on *Ordnance Electronics* before the thirtieth national meeting of the American Ordnance Association in Detroit. Mr. Quarles visited Hawthorne on June 10 and from June 21 to 25 was in Mexico City attending the Summer General Meeting of the A.I.E.E.

PAPERS PRESENTED at the American Physical Society meeting at Madison, Wisc., by Laboratories members were *Cathode Emission Processes in Townsend Discharges* by J. P. MOLNAR and J. A. HORNBECK; *Sorption of Gases by Metals at Low Pressure – A Study of Getters* by L. A. WOOTEN; and *Secondary Emission from Thoria on Platinum and Tantalum*, by H. E. MENDENHALL.

B. MCMILLAN, W. H. DOHERTY and S. P. MORGAN, JR., attended the I.R.E. Electron Tube Conference on June 28 and 29 at Ithaca.

W. W. MUMFORD spoke on *Maximally Flat Filters in Waveguides* and J. R. PIERCE on *A New Microwave Filter* before the meeting on June 16 at Red Bank of the Institute of Radio Engineers, Monmouth County Subsection of the New York Section.

S. O. MORGAN presented a paper on *Principles Determining the Structure of Complex Ionic Crystals* during a symposium on crystal chemistry at Rutgers University.

M. J. KELLY and R. BOWN surveyed the research programs of the Departments of Electronics and Electrical Engineering at M.I.T. on June 1 and 2, with Professors J. A. Stratton and H. L. Hazen.

R. M. BURNS, who was appointed a member of the National Council Scientific Advisory Committee on Prevention of Deterioration, attended a meeting of that Committee in Washington. At the Pittsburgh International Conference on Surface Reactions, Dr. Burns presented the introductory address, entitled *Properties of Metallic Surfaces*.

B. S. BIGGS spoke before the Trenton Section of the American Chemical Society on *Some Factors in the Stabilization of Plastics and Rubbers*.

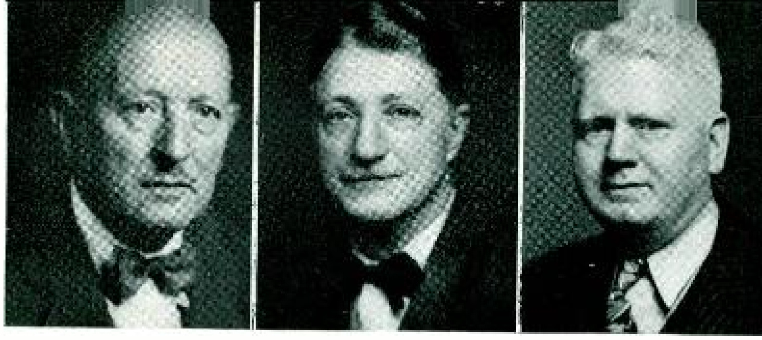
W. E. CAMPBELL's paper on *The Tarnishing of Silver and Copper* was presented at the International Conference on Surface Reactions held in Pittsburgh in June. Mr. Campbell also attended the Conferences on Wear held June 14-17, at M.I.T.

There are still many mechanical operations too delicate for any but the human touch. Here Carol Ozmac winds wire as fine as a human hair onto the smallest non-linear coil now in production, used as a harmonic generator

A. MENDIZZA and S. M. ARNOLD discussed corrosion testing facilities with engineers of the Signal Corps Laboratory at Fort Monmouth.

C. J. CALBICK attended the Symposium on Optical and Electron Microscopy sponsored jointly by the Armour Foundation and the Illinois Institute of Technology in Chicago.

RETIREMENTS



C. D. RICHARD S. S. A. WATKINS MARTIN JOHNSON

Recent retirements from the Laboratories included S. S. A. Watkins and Martin Johnson with thirty-five years of service and C. D. Richard, twenty-nine years.

CHARLES D. RICHARD

One of the few engineers of the Laboratories of foreign birth, Mr. Richard was educated in Les Ecoles des Arts et Metiers near Belfort, France. While an engineer for the Peugeot Automobile Company, he became interested in registering apparatus and invented a change-making cash register. This device made a favorable impression on an American manufacturer; while Mr. Richard was in New York to assist in putting it into production, World War I broke out, and plans were shelved. Mr. Richard remained as an engineer of the company and in October 1918 entered the Laboratories. His first activity was on telephone dials; later he worked on other dial apparatus. In 1922 he entered the Patent Department. During the next 26 years he handled patent applications in various fields, including subscribers' station and central office equipment. His own name appears as inventor on 27 patents. Of these, a number are in the fields of push-button and "repertory" dialling as a result of work done on his own initiative while in the Patent Department. During World War II Mr. Richard handled patents relating to antenna driving mechanisms and other radar apparatus.

STANLEY S. A. WATKINS

Stanley Watkins was born in England and received engineering degrees in 1908 from London University and from the Imperial College of Science where he taught physics and electrical engineering for the next three years. In 1911 he joined the Western Electric Engineering Department where he worked on development of such devices as ringing systems, public address systems, and, during World War I, anti-aircraft directors and gun ranging systems.

In 1919, with the return of the Laboratories to peaceful pursuits, he joined a group which was pioneering in the electrical recording and reproducing of sound. His practicality joined with his engineering training, made him a useful member of the team; and being of pleasant voice, he made many of the early records himself. When by 1925 the Warner Brothers' interest had been aroused, and studio trials were in order, Mr. Watkins was put in charge of the Laboratories' group which handled the sound at the Vitaphone Studio in Brooklyn. Success indicated that movie sound was here to stay and Mr. Watkins was given a leave of absence to set up the producer's engineering staff. By 1927, the sound picture business was so considerable that Western Electric set up a subsidiary, Electrical Research Products Inc., to handle it, and Mr. Watkins became director of recording engineering. For two busy years he was responsible for the layout of sound studios and their recording installations.

In 1929 he began a seven-years' sojourn in England as European technical director of ERPI with responsibilities that included supervision of engineering, recording, installation, maintenance, merchandising, and local manufacturing departments. In this post Mr. Watkins' British birth and his artistic nature were most helpful.

In 1937, Mr. Watkins returned to the United States and the Laboratories. Responsibility had been given to Publication for the Bell System's exhibits at the San Francisco and New York World's Fairs and the Voder was to be one of the highlights of both shows. It was a speech synthesizer, in which oscillators, filters and volume regulators were to be controlled by a keyboard. Mr. Watkins' knowledge of voice production, of the piano, and even of teaching techniques were to stand him in good stead. It was necessary first to learn how to "talk with the fingers" himself, then to select young women who would have the ability and perseverance to learn, and finally to train them. Success of the Voder as an entertaining and instructive show was no less due to Mr. Watkins than to the engineers who designed it. After experiments in visible speech and research on disc recording, World War II brought him back to electrical gun directors, this time to write textbooks and organize instruction courses in their use. Recently he has been concerned with the preparation of displays for museums.

Through all the years a loyal subject of the King, Mr. Watkins has retained his love of British soil, and with his wife and four children he will return to England to live.

Martin Johnson

Engineers who have needed fine woodwork have become well acquainted with Martin Johnson, who during the past quarter-century has been a supervisor in our Cabinet Shop at West Street. A craftsman in his own right, Mr. Johnson developed great skill in rounding out many rather vague ideas and embodying them in actual woodwork. A quiet, even-tempered man, Mr. Johnson was known among his associates also as an artist in oils and pastels. He came to this country from Kristiansand, Norway, in 1904, and joined Western Electric in 1907.

News Notes

P. P. Debye attended the Symposium on Molecular Structure and Spectroscopy held at Ohio State University.

E. K. Jaycox was elected chairman of the Society for Applied Spectroscopy.

L. E. Abbott, during visits to the Simplex Wire and Cable Company, Cambridge, and Thomas Gibb Company, Lynn, Mass., discussed welding of copper conductors. He also visited the Donnelly Electric Company, Boston, on aluminum brazing problems.

W. F. Jannsen conferred at the Stupakoff Ceramic and Manufacturing Company, Latrobe, Pa., on problems connected with metal-ceramic terminals. At the Saxonburg (Pa.) Potteries, he observed the manufacture of resistor cores.

J. R. Townsend participated in a conference at Hawthorne on proposed new designs for crossbar switches. Mr. Townsend and F. F. Farnsworth visited the Forest Products Laboratories at Madison, Wisconsin, on wood preservation problems.

W. O. Baker attended the A.S.T.M. Advisory Committee meeting for the Army-Navy Plastics Research Program at Princeton University.

J. H. Heiss *attended a polymer research* conference of the Office of Rubber Reserve, Reconstruction Finance Corporation in Chicago.

G. R. Gohn participated in conferences on methods of creep testing at the University of Illinois.

J. H. Scaff, A. G. Ganz, J. A. Ashworth, E. P. Felch and K. S. Dunlap attended the Magnetic Materials Symposium in Washington sponsored by the Naval Ordnance Laboratory. Mr. Ganz, R. A. Chegwidden, V. E. Legg and J. A. Ashworth attended conferences at Hawthorne on problems related to magnetic materials.

J. D. Struthers participated in a course on radio-active tracer techniques given by the Atomic Energy Commission at Oak Ridge, Tennessee.

K. G. Compton, A. Mendizza and S. M. Arnold inspected corrosion specimens at Kure Beach, North Carolina. Mr. Compton and R. C. Platow visited the General Motors and Chrysler Research Laboratories in Detroit on finish and adhesive problem, and the Minnesota Mining and Manufacturing Company in St. Paul on adhesives and magnetic recording media. Mr. Compton also attended the International Conference on Surface Reactions in Pittsburgh.

Trial of new equipment for corrosion testing on the Catskill-Albany underground cables. Robert Pope at the instruments, T. J. Maitland (Long Lines) and J. H. Harding in foreground

G. R. GOHN and W. C. ELLIS presented a paper on *The Effect of Small Percentages of Silver and Copper on the Creep Characteristics of Extruded Lead* during the 51st A.S.T.M. annual meeting in Detroit. J. A. ASHWORTH presented a paper at a *Symposium on Magnetic Testing* entitled *Core Loss Test for Narrow Silicon Steel Strip*. During the meeting's Exhibition, F. G. FOSTER received second award for his exhibit *Metallography in Color*. Mr. Foster was appointed a member of Committee E-4 on Metallography. E. K. JAYCOX attended meetings of Committee E2 on Spectrochemical Analysis of Materials. I. V. WILLIAMS was reelected chairman of Committee B-7 on Light Metals and Alloys. Others who attended the meetings were J. R. TOWNSEND, L. E. ABBOTT, W. BABINGTON, G. J. HERBERT, H. PETERS, H. A. BIRDSALL, F. E. HAWORTH, K. G. COUTLEE, K. G. COMPTON, C. C. HIPKINS and R. C. PLATOW.

With coils of rope on his shoulder, Albert Stark prepares to leave the rigging loft on the second floor, a small room where mechanical jacks, dollies and hydraulic lifts are kept ready for use in repairing elevators, moving machinery and laboratory equipment

R. D. HEIDENREICH attended a Symposium on Light and Electron Microscopy at Chicago, June 9-11, at which he presented a paper entitled *Electron Metallography*.

C. S. FULLER was a guest of the Chemical Corps at a meeting held at the Army Chemical Center, Edgewood, Maryland, where *Military Aspects of Colloids* were discussed.

W. A. MARRISON spoke on *The Development of the Quartz Crystal Clock* on June 7 before The Horological Society of New York.

LLOYD ESPENSCHIED gave the third of a series of pre-dinner talks on little-known early electrical history, illustrated with slides of the original literature, at the regular dinner meeting in June of the New York Section of the Institute of Radio Engineers.

S. D. ROBERTSON and A. E. BOWEN attended the I.R.E. Electron Tube Conference at Cornell University, Ithaca, where Mr. Robertson presented a paper on *The Input Admittances of Close-Spaced Diodes at* 4,000 *Megacycles*.

L. E. HUNT has been elected chairman of the Monmouth County Subsection of the New York Section of the Institute of Radio Engineers for the 1948-49 term.

E. I. GREEN and F. J. GIVEN conferred at the International Resistance Company, Philadelphia, on resistor problems.

J. L. GARRISON consulted the General Electric Company at Pittsfield in regard to plastic encasement of coil apparatus.

W. L. FILMER conferred at the R.C.A. plant at Camden on coil designs, and G. A. BOECK, on a ground vehicular project in which Signal Corps representatives participated.

W. M. KNOTT spent three weeks at the Naval Air Technical Training Command, Memphis, where he assisted in the instruction of Navy personnel in the use of aircraft radiotelephone equipment.

A. M. GARBLIK and H. L. ROSIER are currently located at the Patuxent River Naval Base, Maryland, where they are associated with a group of engineering representatives of several radio manufacturing concerns in the investigation of the efficiency of radio communication from aircraft.

J. J. SCANLON, F. C. WARD and H. A. WHITE are assisting in the establishment of production, inspection and test procedures for Navy aircraft radio equipment being produced at Winston-Salem.

W. H. C. HIGGINS attended the meetings of the American Ordnance Association, June 9-10, in Detroit and also visited the Brooks-Perkins plant there relative to a military project. •

F. E. NIMMCKE and H. A. BAXTER consulted the Bureau of Ordnance in Washington on the lubrication of fire control equipment.

L. G. FITZSIMMONS, G. E. BAILEY and H. A. SHEPPARD discussed pneumatic tube installations at toll offices of the New England Telephone and Telegraph Company in Boston, Taunton and Malden.

R. H. MILLER and G. A. BENSON visited Chicago to discuss problems in connection with the installation of the Chicago No. 4 toll crossbar office.

H. E. MARTING, J. M. WILSON, A. MENDIZZA and S. M. ARNOLD, and representatives of the Western Electric Company discussed the packing of equipment with representatives of the U. S. Signal Corps Laboratories at Fort Monmouth, N. J.

J. D. TEBO went to Washington to attend a conference at the National Research Council relating to the formation of a nucleonics glossary committee.

F. A. KUNTZ received the honorary degree of Master of Science from his alma mater, the Catholic University of America, in Washington on June 9. On the previous day he addressed those graduating at their Class Day ceremonies.

J. F. WENTZ participated in a Radar Panel Conference at the General Electric Company in Syracuse. Mr. Wentz, C. FLANAGAN and J. F. MORRISON visited the Coles Signal Laboratory at Fort Monmouth.

D. E. TRUCKSESS attended a session of N.E.M.A. at Cleveland in regard to the standardization of metallic rectifiers.

Finishing their lunch are these attractive members of the General Service Department at Murray Hill: clockwise, Jean Esposito, Cynthia Mick, Constance Carlson, Barbara McGowan, Jean Bausmith and Joan Baxter

J. H. WADDELL's visit to the Bell Laboratories installations at Bryan and Wauseon, Ohio, had to do with discussions and the inspection of a recording photographic installation for microwave measurements. Mr. Waddell also visited the Naval Proving Grounds at Dahlgreen, Va., in conjunction with high-speed photography, and the Navy Department in Washington to discuss a proposed recording camera.

W. W. WERRING attended the M.I.T. summer conference on mechanical wear.

F. W. CLAYTON and W. R. SCHLEICHER made resistance measurements on step-by-step solderless banks at Savannah and Jacksonville.

M. SALZER, at the Teletype Corporation, discussed production problems related to the KS-13834 perforator.

H. M. SPICER discussed new relay designs with the Struthers Dunn Company, Philadelphia, and motor-driven emergency cell switch designs at the Albert & J. M. Anderson Company, Boston.

L. D. FRY discussed power supplies in Washington with engineers of the C. & P. Company for the 1A key telephone equipment in government buildings where only d-c power is available.

H. T. LANGABEER and W. V. FLUSHING tested the initial installation in Cincinnati of the 301C power plant using 100-ampere rectifiers.

W. H. LICHTENBERGER conferred at Hawthorne and at the new plant in Duluth regarding the engineering and manufacturing of various frame equipments and interconnecting arrangements of the No. 5 crossbar system.

RECENT DEATHS



H. R. JEFFCOAT 1900-1948 | D. T. MAY 1882-1948 | A. C. L. HEITNER 1895-1948

HARRY R. JEFFCOAT, July 10

Mr. Jeffcoat, Assistant to the Executive Vice President, died suddenly while visiting friends in Lynbrook, L. I.

During the latter part of World War I, Mr. Jeffcoat inspected wind-driven generators for airplanes made by the Crocker-Wheeler Company for the Western Electric Company. Following this he joined the group developing power equipment for central offices. From 1919 to 1921 he attended evening classes at Pratt Institute. In 1922 he transferred to the Commercial Relations Department to handle the commercial phases of trial installations to which was shortly added similar work in connection with the manufacture of vacuum tubes. During 1926 he was associated with the special research group working on the New York-Azores-Emden high-speed telegraph project. Upon completion of this project he returned to his former work. During the F.C.C. investigation, Mr. Jeffcoat acted as one of the commercial contacts for the F.C.C. men at the Laboratories.

Mr. Jeffcoat transferred to the Research Staff Department in 1937 as Research Laboratory Service Manager, and was placed in full charge of that Department in 1939. Since 1945 he has been Assistant to M. J. Kelly, Executive Vice President.

DAVID T. MAY, June 23

Mr. May, Mechanical Apparatus Engineer in the Switching Apparatus Development Department, had completed thirty-eight years of Bell System service when he retired in 1943. He joined the student engineering group of Western Electric in Chicago in 1905 upon graduation with a B.S. degree from the University of Illinois and spent four years in various departments before coming to West Street's Physical Laboratory. In 1911 he became interested in electrical protection apparatus and most of the twenty-five patents granted in his name were in this field. During his early years at West Street he was engineer in charge of work involving the development of protective devices, transmission tests on long telephone cables and investigations of inductive interference from electrified railways. During this period he made important contributions to the development of the porcelain-frame protector block now in general use throughout the telephone system.

While continuing his responsibilities in matters relating to electrical protection apparatus and inductive interference studies he also was placed in charge of groups engaged in electrical and mechanical analysis of telephone apparatus. By 1929 this analysis work had grown to include mechanical and dial central office apparatus as well as station apparatus. Later on he took over, in addition, the supervision of materials investigations. In 1935 Mr. May as Mechanical Apparatus Engineer became responsible for the development and design of manual switchboard apparatus. Before his retirement he directed the development of a number of coaxial connectors and special multiple conductor plugs and sockets for the Armed Forces.

Mr. May had been a member of various technical societies including the A.I.E.E. and A.S.T.M. He had served as Laboratories' representative on the Electrical Protection Subcommittee of the Association of American Railways and also on project committees of the Joint Subcommittee on Development and Research of the Edison Electric Institute and the Bell Telephone System. For a time he also represented the Laboratories on A.S.T.M. and A.S.A. Committees. He was a member of the Telephone Pioneers.

ALFRED C. L. HEITNER, June 15

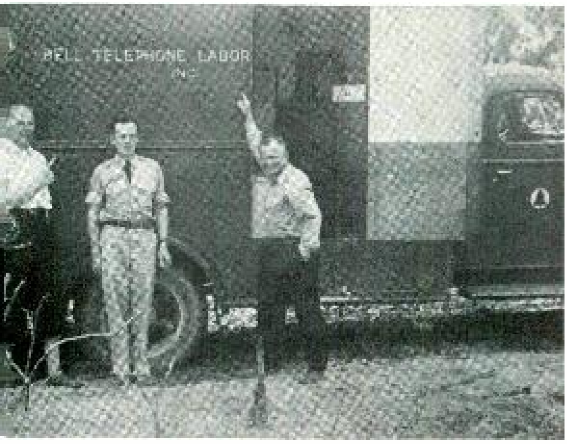
A Member of the Technical Staff in the Switching Development Department, Mr. Heitner joined the Engineering Department at West Street in 1912, shortly after he had completed the electrical engineering course at Pratt Institute, and for a year was concerned with various inspection phases of the installation work done by the Installation Department, later transferring to that department to install and test central office equipment. Mr. Heitner then left the company, but in 1917 returned to the drafting group of the Systems Development Department. Following this he transferred to the methods of operation group and then to the group preparing individual central office key sheets. From 1923 to 1932 he was concerned with analyzation of non-standard orders placed on the Western Electric Company by the Associate Companies. In 1932 Mr. Heitner transferred to the standardization group of the Switching Development Department and remained a member of the group until his death. During World War I, he served with the 209th Field Signal Battalion.

News Notes

J. J. De Buske participated in the N-1 carrier trial activities at Watertown, Wisconsin, replacing E. H. Perkins who returned to New York. E. K. Van Tassel made a brief visit to Watertown in connection with the extension of the trial. R. M. Hawekotte and M. T. Dow are also in Wisconsin obtaining noise and crosstalk data on the N-1 cable pairs.

P. T. Haury witnessed the trial installation at Nashville and nearby K carrier auxiliary stations of equipment designed to improve telephoto transmission on K2 carrier systems.

W. L. Tuffnell, L. J. Cobb, R. R. Stevens and D. T. Eighmey paid individual visits to Archer Avenue on station handset and kindred matters.



'. S. Boeck, C. S. Daugherty (Long Lines), and 1. M. Bower during pulse echo tests on new oaxial cable near Columbia, S. C.

R. W. Lange made envelope delay measurements at Philadelphia trying out a new relay measuring set on the coaxial television circuits which were installed for the Democratic convention. O. D. Engstrom operated the measuring set at the New York end of the circuit.

E. J. Howard was at Burlington for consultations on production of radio receivers.

F. H. King and G. B. Thomas, Jr. have been testing on the N-1 trial in New York City and Mount Vernon.

L. G. Abraham has been appointed to the Committee on Communication of the A.I.E.E.

F. R. Dickinson discussed die cast parts for amplifiers at the Doehler Jarvis Corporation, Pottstown, Pa.

L. R. Snoke made observations at Washington, Pa., on the use of a chemical spray to keep down underbrush below toll lines.

C. T. Wyman inspected recent cable installations in the Cape Cod region.

D. C. Smith and J. M. Hardesty attended the A.S.T.M. meetings in Detroit and while there discussed underground conduit problems with the Michigan Bell Telephone Company.

R. H. Colley, K. G. Compton, F. F. Farnsworth and J. R. Townsend visited the Forest Products Laboratory at Madison, Wisconsin, for conferences on cooperative investigations of methods for evaluating wood preservatives. Dr. Colley and Mr. Farnsworth continued the study of modern pole treating methods of producers' plants in Minneapolis and St. Paul.

A. H. Hearn inspected representative creosoted southern pine pole lines in the Carolinas, Maryland, Virginia, Georgia, Kentucky and Tennessee.

G. Q. Lumsden investigated supply production and treating problems in the locust pin industry in Virginia and West Virginia.

R. C. Eggleston investigated checking and bleeding of southern pine poles at Spartanburg, S. C.

R. E. Alberts of the Pt. Breeze group visited Kearny to confer on various cable matters.

J. W Schmied and E. B. Cave appeared before the Board of Appeals at the Patent Office relative to applications for patent.

The Laboratories were represented in interference proceedings at the Patent Office by C. Baraff before the Primary Examiner.

At the Western Electric Company in Chicago, A. W. Treptow discussed the development of a vitreous enamel number plate for the new handset; W. R. Neisser, the design of a new network for subscriber equipment; J. R. Weeks, condenser problems of the new combined handset and contact protection networks for the wire-spring relay; H. A. Frederick, A. C. Keller, C. N. Hickman, W. J. Wirth, C. C. Barber, R. F. Mallina and J. H. Mogler, new switching apparatus developments; D. G. Blattner, J. F. Baldwin and R. A. Hecht, switchboards, station plugs, and jacks; C. C. Barber, crossbar switch developments; H. O. Siegmund and C. W. McWilliams, relay and crossbar switch developments; W. C. Slauson, UA relay problems; E Von Der Linden, W. K. St. Clair and G. J. Maggi, current engineering problems; and F. T. Meyer, the stamping of equipment designations on No. 5 crossbar equipment and certain standardization matters.

The Green Team, winner of the Laboratories Assembly and Wiring Bowling League, comprised of W. Mailly, and Captain N. V. Mansuetto, seated, and C. O. Tuttle, P. Heinlein and J. A. Sarich, standing, tied for first place with the Orange and Blue teams after 89 *games of a* 90*-game season. The Greens defeated the Blues in their last game and then defeated the Oranges in the first-place roll off*

H. H. Spencer made tests on the K2 power supply at Franklin, N. H.

R. Marino was at the Patent Office in Washington during June relative to patent matters.

Engagements

Mary Boyle—Patrick G. Nolan*
Jane Conlon*—George J. Ulrich, Jr.
Anne Connell*—Anthony Sprink*
Genevieve Connolly*—James Calleary
Mary Gargiulo*—Arthur Leva
Frances Johnson*—John O. McCarty
Josephine Kaiser*—Edward J. Zillian*
Ethel Kallmann*—Rev. R. W. Manns
Rosemary Kennedy*—Daniel J. Lane
Margery McHale*—Harry F. Brewer, Jr.
Marion Nieder*—Edward R. Baldwin
Irma Ostel*—James P. Brady
Lillian Sangberg*—Howard A. Mullen
Lillian Voss*—Francis J. Eberle
Dorothy Washburn*—John J. McGowan
Doris Wolek*—William A. Vanderputten

Weddings

Lillian Bernard*—Peter Freytag
Marjorie Boin*—Frank R. Campbell
Margaret Brownlie*—William V. Hanzalek
Shirley Frey*—Robert D. Caporaso
Catherine Gilburn*—Thomas F. Ackerson
Helen Karban*—John A. Smith
Patricia Menken*—Clifford Wilson
Margaret Moore*—K. Schoolcraft*
Jean Mosier—Fred J. Herr*
Jeanne Mundy*—Walter C. Savacool
Anita Patti*—Domenic J. Galdieri
Joan Pisano*—Henry Bruni
Mabel Roche*—Walter L. Benz
Margaret Sweeney*—Philip J. Crowe*
Elizabeth Thayer*—Malcolm D. Rushin
Eleanor Wolfe*—John C. Jobst

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

Corrections

In the item, "Changes in Organization," in the July Record, the name of a new Switching Development Engineer was misspelled — it should, of course, have been "F. A. Korn." The Editors regret that among the 587 names in that issue, the mischance should have fallen on Mr. Korn.

In the article, "A High-Precision Test Set," on page 301 of the same issue, the third sentence should read: "The set is capable of measuring capacitances from 0.002 micromicrofarad to 1.1 microfarads, and conductances from 0.00003 micromho to 1110 micromhos over a frequency range from 200 cycles to 150 kilocycles."