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The Laboratories in Monmouth County

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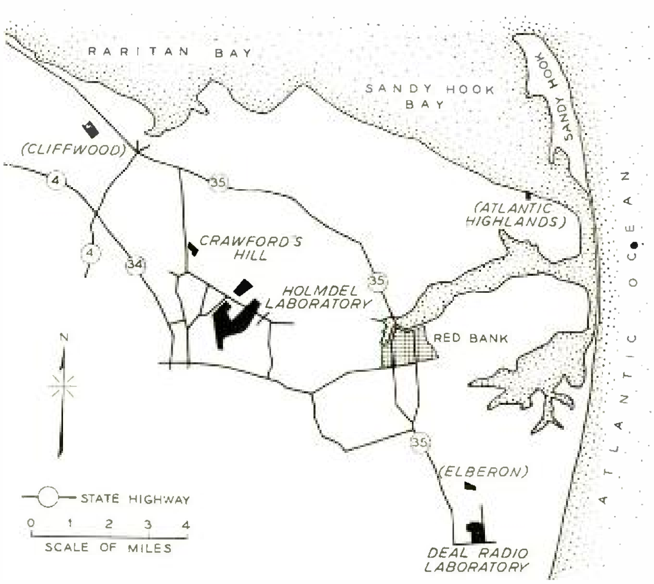
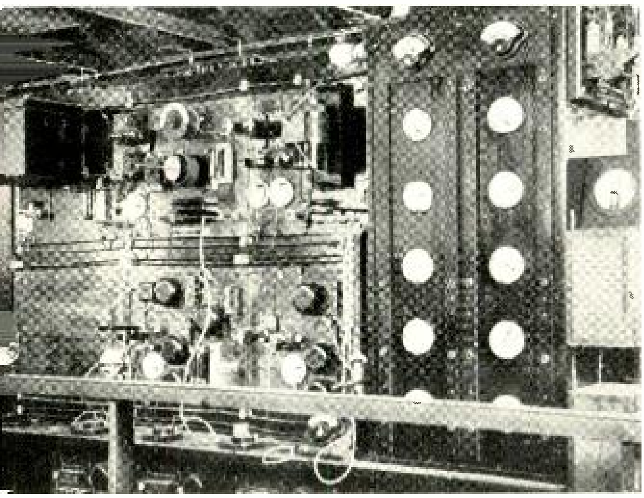
Editor
Bell Laboratories Record

About thirty years ago, the time seemed ripe for the Bell System to begin development looking toward extension of telephone service to ships at sea. During World War I, which had just ended, the Laboratories—then the Engineering Department of the Western Electric Company—had developed successful two-way radio systems for subchasers and for airplanes. On this foundation the new system was to be built by a team under the late H. W. Nichols.

From New York's Lower Bay and the North Jersey Coast, the rolling country of Monmouth County sweeps inland. Here was to be found an appropriate site for the radio station. In the summer of 1919, representatives of Western and of the Department of Development and Research of A T & T surveyed the area between Perth Amboy, Long Branch and Lakewood. They recommended a location near Cliffwood, which was bought. So was established a foothold in Monmouth County from which were to proceed great advances in radio.

Work was begun promptly at Cliffwood by putting up a temporary building and starting work on the scale model of an antenna. In September, 1919, a site near Deal was bought, and three 165-foot towers were erected. By February 1920, an experimental transmitter was "on the air" with speech and music, and listeners were reporting on the signals received at distant points. A third plot, near Elberon, was rented and receiver testing was started. Tests with coastwise ships were made successfully during 1921, and the following year apparatus was installed on the transatlantic steamer *America*. Test calls were made from Bell System telephones when the *America* was as much as 300 miles offshore. Then the post-war depression arrived and steamship lines showed no enthusiasm for telephone service, so the receiving station at Elberon was discontinued, and the Deal location was turned to other uses.





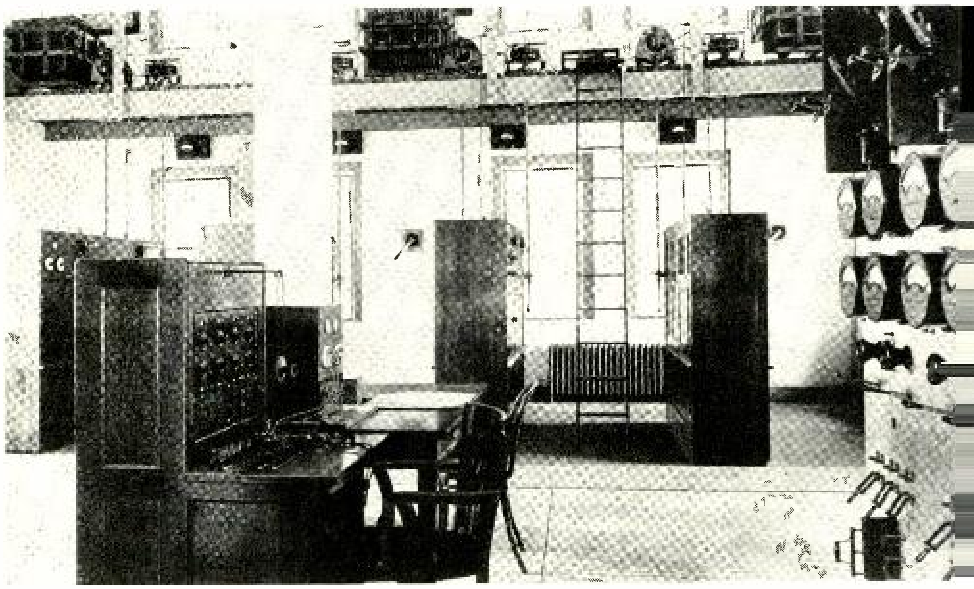
Development model of the first ship-to-shore radio transmitter in 1920. It was set up in a temporary building at Deal. Tests with coastwise ships were successfully made and, in 1922, apparatus was installed on the America and calls were made from Bell System telephones when the ship was as much as 300 miles offshore.

the development of sets for improved measurement of the strength of radio fields, particularly at those new "high" frequencies. Some of these sets gave the first clear picture of the effect of steel-frame buildings in cities on broadcast transmission and indicated the practicality of transatlantic radio.

Further improvements of receivers also appeared at Cliffwood. The automatic gain-control circuit which dates back to 1923, was the forerunner of similar circuits now in general usage and the same is true of the automatic frequency-control circuits which appeared a few years later in connection with short-wave work.

Meanwhile, a 20-kw amplifier operating at frequencies in the range from 2700 kc to 22000 kc, was evolved at Deal, to be followed shortly by another in which the power was pushed up to 80 kw. These are believed as a matter of history to be the first high-power amplifiers to be developed anywhere for use in this frequency range; they demonstrated the feasibility of stable amplification under extreme conditions. The development of transmitters continues to be one of the important contributions which Deal makes.

Starting merely as an alternate to the long-wave London circuit during the difficult summer months, the original 20-kw transmitter was used from 1927 to 1929 to supply the first commercial short-wave radio



Operator's control desk of the ship-to-shore transmitter of 1921.

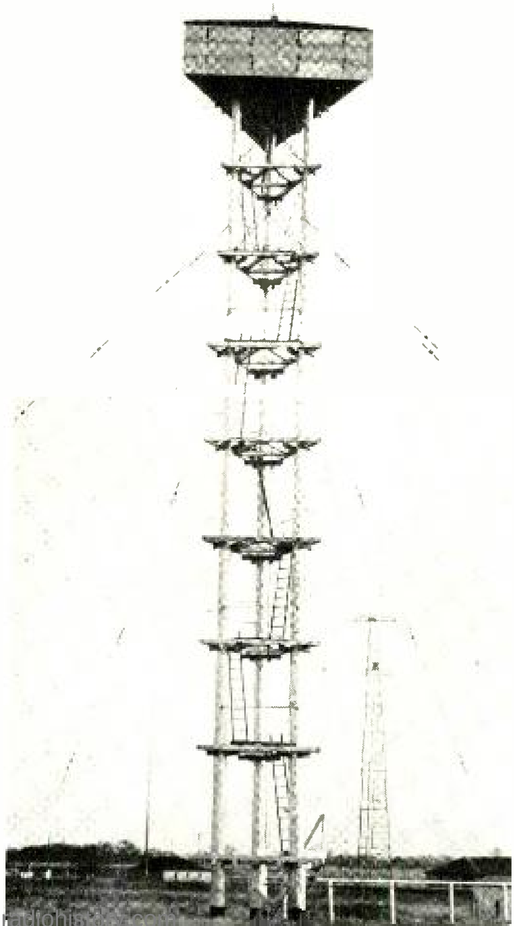
At Cliffwood the development of receivers employing the double detection principle with amplification at intermediate frequencies culminated in the famous 4A radio receiver, which demonstrated the practicality and simplicity of the system which is now almost universally used in radio reception. Another early project was

The main building at Deal, erected in 1921 to house the ship-to-shore transmitter. On the tall steel towers was hung a prototype of the original, or curtain, antenna used for a time at Lawrenceville.

telephone circuits between this country and England. Later, before the new station at Ocean Gate was equipped, it was also used to open the first telephone service to ships at sea. Thus for a while Deal became a commercial station staffed by operators from the Long Lines Department of A T & T. Finally, however, transmitters were installed at Lawrenceville and Ocean Gate which were patterned after the original 80-kw transmitter at Deal as were also those installed at Dixon, California, and at Buenos Aires.

In the years which followed, theory and experiment advanced side by side in the field of radio wave propagation. Extensive studies were made to map the frequency range to show what frequencies would best serve transmission to any distance at any time. On the geophysical side important contributions were made to the knowledge of the structure and behavior of the ionosphere, the reflecting region which makes long distance propagation possible. A theory pointing out the relation of the earth's magnetic field to radio wave propagation was developed. The effect of solar activity was studied both in regard to secular effects and in relation to the prediction of transmission conditions. The effect of meteors as contributors to atmospheric ionization was demonstrated by a crucial experiment. Contributions of great importance to the design of receiving systems and apparatus were made

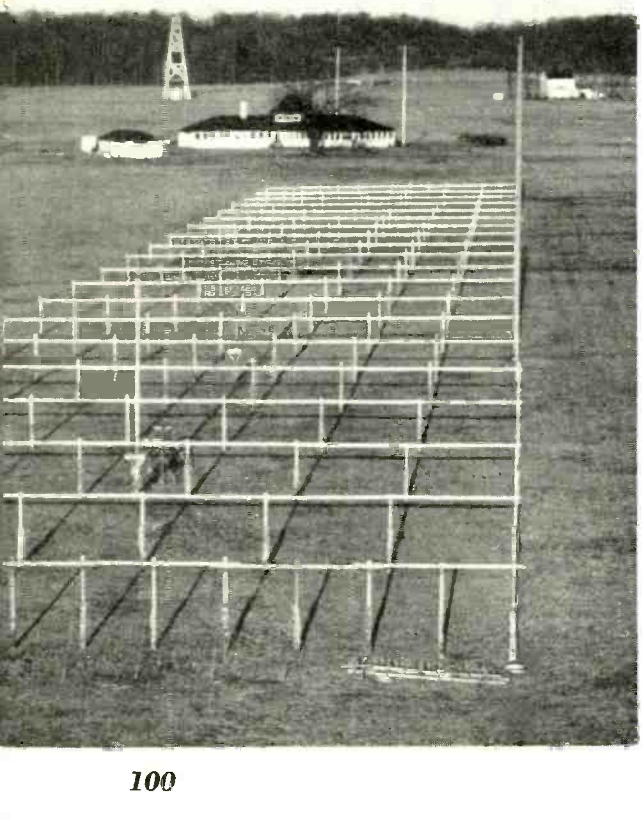
Forerunner of the radio relay stations which are rising across the country, this unit was set up at Deal in 1936 for experiments in 180-cm radio transmission.



One of the more recent Deal buildings. It houses microwave and high-power development work. One of the original ship-to-shore towers is at the right.

by studying minutely the properties of radio waves as received from long distances. Much was learned about the multiplicity of paths over which signals might travel with correspondingly different times of transit and different directions of arrival at the receiver. That fading of short-wave signals is largely due to variable interference between these wave components was early demonstrated, and the clear picture thus provided was of inestimable service in determining what to do about it. Representatives of the Laboratories who had gone to Britain and South America for this purpose contributed to this program, and effective cooperation was given by foreign communications organizations which were vitally concerned.

Several successful types of antenna array were developed at Cliffwood and at Deal and installed at Lawrenceville and Netcong for use in commercial operation. First use of coaxial lines as the transmission system between antenna and receiver was made at Cliffwood, an antenna accessory which was



Built just after the Civil war, the "Roberts House" at Holmdel is a fine example of American architecture. The house on pillars in the foreground dates only from World War II, when it was used for various radar antenna studies.

Taken in 1937 this picture shows a net of wires a few feet above the earth, used in studies of artificial grounds. Just behind it is the main Holmdel laboratory; in the distance is the caretaker's house.

borrowed and given a major role in wire transmission.

The temporary quarters at Cliffwood had never been more than a makeshift, and were becoming so crowded that in November, 1929, the Laboratories bought three farms a mile or so northeast of Holmdel. There were three houses on the property, one of which is still used as a laboratory. Another, "the Dutch house," was built in the early seventeen hundreds and with its large fireplaces and old-fashioned kitchen is one of the architectural treasures from the history of Monmouth County. In addition, a one-story temporary building was soon erected for laboratories and offices, and a few small buildings were later added for special purposes. On this tract of land have germinated and flowered several of the important communications developments of recent years.

At Holmdel a strong emphasis has always been placed on antenna development. Among important projects which might be mentioned is the work on long-wire antennas for short waves which led to the "rhombic" antenna which is now almost universally used. Another started with extensive measurements of the angles of arrival of radio waves and finally led to the combination of several rhombics with phase-changers to form the versatile MUSA, a "multiple unit steerable antenna" which could be trained electrically in any desired direction, or in several simultaneously. Important to this antenna development program was the investigation at Holmdel of the influence of the ground on radio transmission and accordingly on the performance of radio antenna systems.

At Cliffwood, studies of the absolute sensitivity of radio receivers and its limitation by "thermal agitation" noise eventually led to the present "noise figure" rating of receivers in common use today. The investigation of noise and noise sources was continued at Holmdel where studies of the direction of arrival of short-wave interferences led unexpectedly to the discovery of a source outside the earth; in fact the culprit was found to be in the Milky Way itself. On this beginning has developed the new science of "radio astronomy," a field now being actively investigated by astronomers and physicists the world over.

Toward the end of the Twenties the radio group, realizing the number of additional channels which higher frequencies would open to their rapidly growing art, were really treading on the heels of their colleagues in Electronics. Eventually tubes were forthcoming that would function in the meter range, and work was begun, first at Cliffwood and later at Holmdel and Deal on the propagation of these waves. One discovery of many that might be mentioned was the importance of atmospheric refraction and the fact that under many conditions propagation might be expressed in terms of an effective earth radius equal to four-thirds the actual radius.

The main building at Holmdel has a central foyer from which radiate two wings housing laboratories and offices, and a third wing for shops and services.

Stretching a quarter-mile from the Roberts House are Holmdel's first two wave-guides.

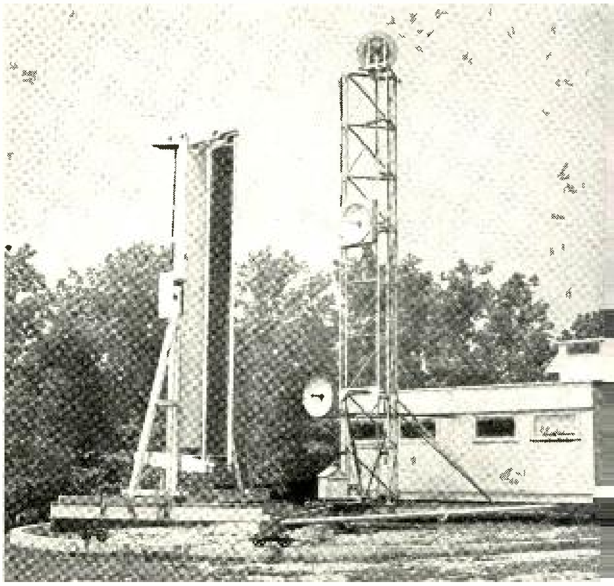
The use of ultra-short waves in mobile radio was naturally not neglected. It was now possible to build effective antennas, transmitters and receivers which could be mounted in automobiles. Some of the earliest mobile radio tests and field strength surveys were made by Deal engineers in and around Boston. In another project, an antenna and radio equipment mounted on a single pole made practicable an unattended radio station which occupied almost no real estate. After tests between Holmdel and Deal, a 75-mc channel was set up for service trial between Provincetown and Green Harbor, Mass. That system provided the only telephone contact after the 1938 hurricane.

Later a 12-channel unattended system was engineered for the gap between Cape Charles and Norfolk; the antennas and transmitters were developed at Deal. This employed envelope feedback to suppress cross-modulation, a method which had been developed for short-wave transmitters years before at Deal and which has since been widely used to reduce distortion in broadcast transmitters.

With continued pressure toward higher frequencies, one of the Holmdel engineers turned back to the crystal detectors of fifteen years earlier. By the end of the Thirties he was successful in using silicon and other materials to handle frequencies up to 2800 mc, and further development during the war made this point-contact device the best detector for radar.

In the early Thirties during an exploratory survey of the field of guided waves so much of interest was found that in 1934 a group was set up at Holmdel for a more intensive study of this field. They measured and experimented and invented, and when the war came their accumulated output became a veritable stock pile in the new field of radar. The new wave-guide means of transmission was found to be a "natural" for wavelengths of a few centimeters, with transformers, hybrids, phase shifters, filters, and so on corresponding to analogous devices in the older art of transmission.

Outbreak of the European War in 1939 found Holmdel at work on microwave radio repeater systems. In June of that year, at a demonstration for various officials of the Bell System, exhibits and lectures by Holmdel engineers showed that research models of the different components, such as wave-guides, oscillators, amplifiers, converters and antennas, required for microwave repeaters, were in an advanced stage of development. Microwave repeaters did not reach installation until 1947-48, but the techniques be-



Mounted on a turntable atop Crawford's Hill at Holmdel, this microwave set can be pointed at various objectives—some of them reflectors which allow the transmitting and receiving ends of the path to be operated in the same room.

came extremely valuable to the development of radar during the war.

No attempt will be made to cover in detail the work of the Monmouth Laboratories during the war, but a few of the high spots will be mentioned. In 1940 it was decided that except for some work on short-wave direction finders, Holmdel engineers would work on radar only. Things started humming and before a year had passed Holmdel had supplied complete microwave receivers and measuring equipment to the new government-sponsored Radiation Laboratories at the Massachusetts Institute of Technology and information on all of our techniques was freely given. Deal developed several radar transmitters and radar antennas, among the latter the Cutler antenna feed which by the end of the war had become almost universal in airborne radars.

Wartime needs prompted the purchase of a fourth home for our Monmouth County activities. This was a waterfront test station at Atlantic Highlands. On high ground overlooking the Lower Bay was erected a frame building with a long platform in front, on which were tested a score or more radars which were to leave the mark of their guns on our enemies. At the end of the war our radar work was concentrated elsewhere and the property was disposed of.*

One outstanding contribution from Holmdel was the polyrod antenna array for a shipborne radar. Its indications were so accurate that at one time it was used on all large ships to direct the fire of the main batteries. Another Holmdel development, the so-called "Rocking Horse" antenna, was used in another main-battery radar about which the following statement was made by Rear Admiral G. F. Hussey, Chief of the Bureau of Ordnance:

"While Fleet experience with this radar equipment is limited to only a few ships, reports from these ships indicate that it is considered the best radar equipment yet installed on shipboard."

In citing examples, however, the historian is embarrassed by the number from which he must choose and by the impossibility of doing individual justice.

Nineteen-forty-five brought reorientation toward Bell System's peacetime needs. Research was resumed on microwave electronics, the development of new short-wave transmitters, and a wide variety of new and in some cases spectacular developments.

The radio research group has made lasting contributions† in the areas of long waves, broadcast waves, short waves and finally centimeter waves. The centimeter waves, now well established on radio relay systems, are being tentatively joined by millimeter waves and even by long optical waves in the service of communication. The outcome obviously belongs to the future, but our Monmouth County laboratories will undoubtedly meet these new challenges as they have those of the past.

*Record, *May*, 1946, *page* 203.

†Embodied in more than 200 published papers as well as countless memoranda.

THE AUTHOR: Editor of the Record since its inception, P. B. Findley's name has seldom appeared in its pages as an author. Of this article he says, "It started out as a description of Monmouth County and of the Laboratories' work there. Eventually the latter part grew so big that it became the whole story. The article unites the contributions of a good many people, of whom K. G. Jansky, H. T. Friis and J. C. Schelleng should be mentioned particularly."

With degrees from Princeton in physics and engineering, the author went to work for Bell of Pennsylvania in Pittsburgh. While there he wrote an article for "The Telephone News." Since then he has been a literary man, observing and telling about the science and engineering of others.

Incoming register circuits for No. 5 crossbar

R. K. McALPINE
Switching Development

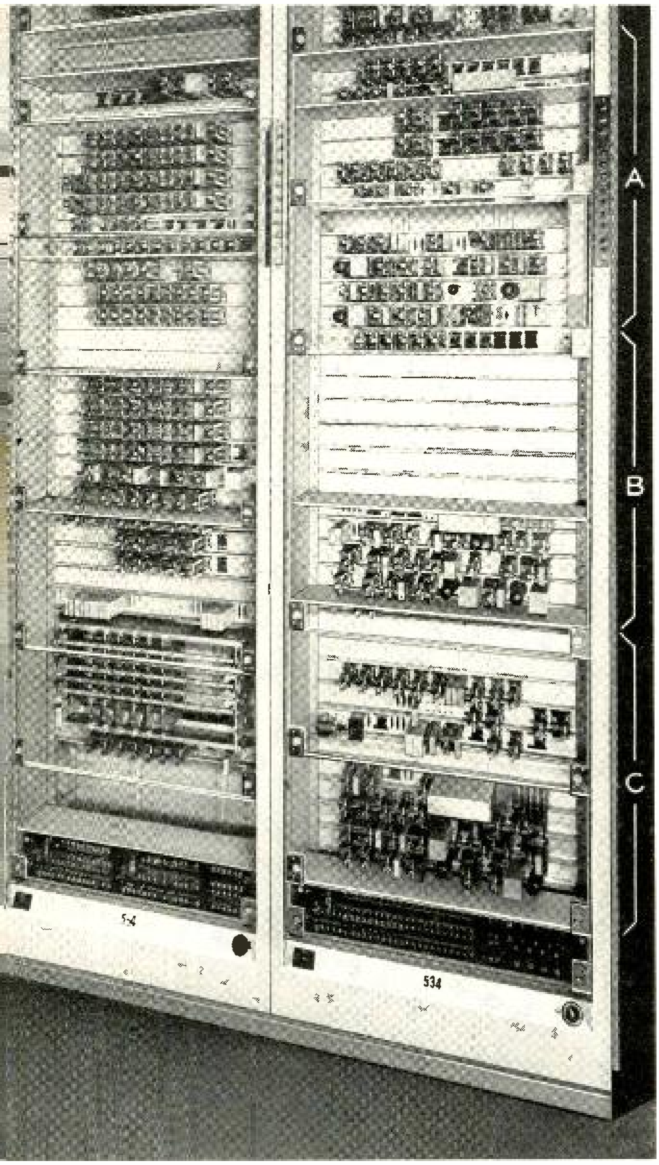


Fig. 1—A frame of incoming registers installed in the Laboratories for test: a dial-pulse register at A; a multi-frequency register at B; and a revertive-pulse register at C.

In a No. 5 crossbar office, a call coming in from another office can be completed to the called line by a marker in a fraction of a second. A much longer time is usually required, however, to receive from the incoming trunk the number of the called line, since the several digits of the number are pulsed one at a time over the two wires of the trunk. To avoid holding the marker during the pulsing time, a circuit is required to receive and remember the various digits, and then to transmit all of them to the marker at once, using as many paths as needed. Such circuits are called incoming registers. In general function and purpose, they are thus like the originating registers.*

When an incoming trunk receives a call from its distant end, it signals a link circuit, which connects it to an idle incoming register. The link transmits to the register a trunk class signal, a frame number, and, for tandem trunks, a number-group location. Class indications give such information as whether the register should send dial tone over the trunk; the number of digits to be received; whether the trunk is arranged for local, tandem, or toll service; any restrictions which may apply to the trunk in completing to various groups of lines; and whether the trunk is of a special purpose type used by certain operators or test men. Some of these items will affect register functions, but most of them are merely recorded to be passed on to the marker after the line number has been received. The frame number is the number of the trunk-link frame where the trunk appears. It is required by the marker in connecting the trunk to a local subscriber. The number group location is used by the marker to obtain the line-link frame location of a

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*Record, *January,* 1950, *page* 7.

tandem or toll trunk. Such trunks appear on both the trunk-link and line-link frames. The latter connection is used when the call is to pass through the office, and the former when it is to be completed to a local subscriber. The register records this information, checks for any possible double connection in the link, and then signals the trunk that pulsing may commence.

Incoming registers may receive pulses from a step-by-step subscriber's dial, from a sender, or from an operator's dial or keyset. Three types of pulsing are encountered: dial pulse, from a dial or sender; revertive, from a panel or crossbar sender; and multi-frequency, from a keyset or sender. Other types may be added as required without affecting the marker. A separate type of register is used for each type of pulsing. A frame with the three types of registers is shown in Figure 1 as installed in the Laboratories for test purposes.

Each dial-pulse digit is a train of from one to ten open-circuit pulses sent from the calling office; each revertive digit is a train of shunting pulses sent from the called office and stopped by a signal from the point of origin when the correct number has been sent; each multi-frequency digit is a single pulse containing two out of five frequencies in the audible range. A dial-pulse register need merely count pulses and recognize the end of each digit, while a revertive register must generate pulses, count them, and recognize an open circuit signal which marks the end of a digit. These functions are performed by relays within the registers; pulse generation as described in connection with revertive pulsing,* and counting as described for the originating registers.† Multi-frequency registers are not at present equipped with relays to sort out the a-c frequencies contained in their pulses, but instead employ an electronic multi-frequency receiver, shown in Figure 2, which amplifies the pulses, limits their amplitude, checks for spurious and missing frequencies, separates and detects the frequencies, and furnishes the register with d-c pulses on two at a time out of five leads. A sixth frequency and its associated lead are used only for start and stop signals and not for numerical digits.

As each successive digit is received, the register records it for future reference. Dial-pulse and multi-frequency registers use five relays to record each digit, two relays operating for each numeral from 0 to 9. This scheme matches both the two-out-of-five arrangement of frequencies in multi-frequency pulses and the pattern of grounded leads by which the digits will be transferred to the marker. Its main advantage is that it is self-checking, since ordinary trouble conditions would result in one or three out of five instead of two—a difference easily recognizable. These registers may be equipped for from four to eleven digits, depending on traffic requirements. In a single-office unit with only local incoming traffic, four digits are sufficient, while a No. 5 unit used as a combined local office and toll center may require eleven digits to accommodate a three-digit national dialing code, a three-digit local area code, four numerical digits and a party letter. Revertive pulse registers at present re-

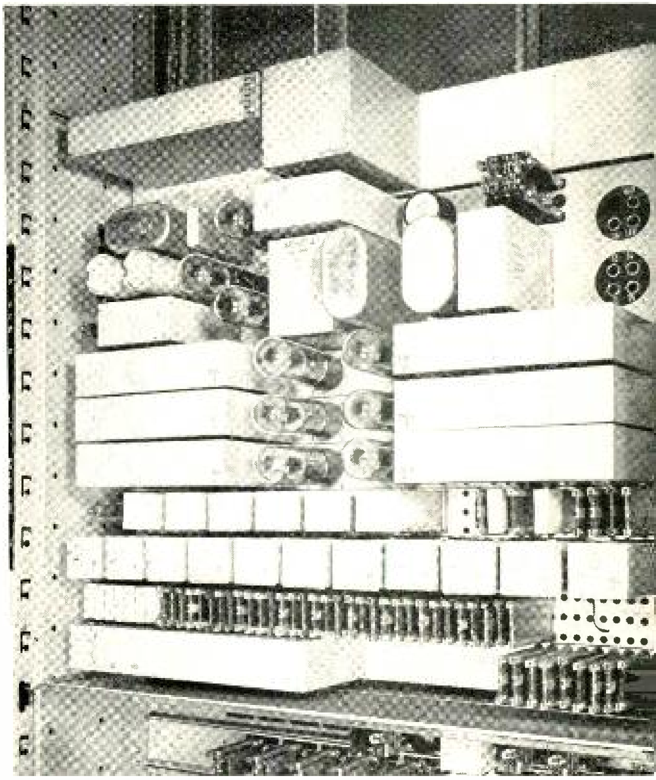

Fig. 2—A receiver for the multi-frequency register.

*Record, *August*, 1943, *page* 448.
†Record, *January*, 1950, *page* 7.

cord only the pulses designating the four digits of a line number, although plans envisage additional digits for tandem operation in the future. Instead of recording the digits on sets of two-out-of-five relays as in the other types of registers, however, the revertive-pulse registers record them on a crossbar switch, using apparatus and circuits essentially the same as those used in terminating senders of the No. 1 crossbar system.

To determine when the last digit has been received is no problem for revertive and multi-frequency registers, since the former are arranged for a fixed number of digits, and the latter always receive an end-of-pulsing signal after the last digit. Dial-pulse registers, however, may receive any number of digits from three to eleven and do not receive any end-of-dialing signal from the trunk. Dial-pulse registers, therefore, must look for every possible clue as to the number of digits to be received. On calls from local trunks, the trunk class indicates the expected number of digits—either four or five depending on the class. On tandem and toll trunks, an office code always precedes the line number. However, there may be both two and three-digit codes within the numbering area, and some offices reached by tandem may have some lines with party letters. Still more variation occurs on toll calls, since they may be directed to either subscribers or toll operators in either the local area or some distant area.

To take care of these variations, the dial-pulse register has facilities for looking at the first one or two digits of the office code, which may indicate the number of digits in the code and also identify the code sufficiently to tell whether the called office has party letters. If it has or may have, there is still no assurance that a letter will be dialed on this particular call, but the register will allow time for a possible additional digit. On toll trunks, the code may be either a local area code or a toll code. The register can recognize the difference by looking for a toll-indicating zero or 1 in the first or second position. Local-area codes are treated as are those received on tandem trunks, but most toll codes may be followed by an indefinite number of digits. When such a toll code is recognized, therefore, the register times after every digit received, and recognizes the last digit by the lack of dialing within the succeeding few seconds. An exception is made for certain toll service codes that are never followed by any digits. Such codes, recognized by 1's in certain positions, indicate the end of pulsing without timing after the third digit.

When the register is satisfied that all digits have been received, it must pass them to a marker. The register signals a marker connector circuit, which seizes an idle marker and connects it to the register by a large number of wires. Using these many paths simultaneously, the register is able to tell the marker in a few milliseconds all the information which it has accumulated in perhaps as many seconds. Trunk class, frame location, number-group location, and the several digits go into the marker all at once, enabling it to complete the call immediately and to free itself so quickly that it can handle thousands of calls per hour.

THE AUTHOR: R. K. McAlpine joined the Laboratories in 1925 immediately after receiving his B.S.E.E. degree from Purdue University. He engaged first in the analysis and testing of panel system senders and associated circuits, but later worked on the design and testing of circuits for the No. 1 crossbar system. He also undertook circuit design for crossbar tandem and crossbar toll offices. Prior to our entry into World War II, he worked on a secret Navy project but in February, 1942, joined the Signal Corps—serving in Australia and New Guinea until July, 1944. From then until the end of the war he was with the Army Security Agency from which he received the Legion of Merit award in 1947. Since then, he has been engaged in the design and testing of circuits for the No. 5 crossbar system.

An impulse generator for lightning studies

J. J. MAHONEY, JR.
Transmission Engineering

Whether or not a telephone cable is likely to be damaged by lightning depends upon a variety of factors such as the size and length of cable, the presence of open-wire extensions, the distribution and resistance of sheath and subscriber grounds, the location of protective devices, and the local earth resistivity. Because of the many variables involved, neither field studies of natural lightning damage nor experimental studies using simulated lightning current on working cables reveal the relative importance of the various factors. As a guide in providing improved lightning protection, an experimental cable was recently installed that would permit the various conditions encountered in the working telephone plant to be set up as desired. It is thus made possible to study the effects of lightning surges under a wide variety of preselected conditions. Through use of an adjustable wave-forming circuit, surges having the wave shapes of natural lightning as measured in the field but with amplitudes too low to damage the cable may be applied as often as desired. Information in terms of volts per ampere for a given wave shape may be obtained for as many wave forms and test conditions as desired.

Since lightning surges are of very short duration—ordinarily only a very small fraction of a second—it is uneconomical to wait for actual disturbances to occur or even to measure artificial surges applied to a line one at a time. To provide a more satisfactory method, the recurrent impulse generator, shown in Figure 1, was developed. It generates a continuous train of impulses, recurring at a fairly rapid rate, which may be observed as a stationary pattern on suitable oscilloscopes connected at various points along the line.

As shown in Figure 2, the generator consists essentially of a capacitor which can be periodically discharged through a wave-forming circuit from ten to sixty times a second. The capacitor is charged during a positive half-cycle of the sixty-cycle supply voltage, and is discharged by a thyratron when the supply voltage enters a negative half-cycle, thus producing formed impulses sixty times a second. To obtain higher peak power in the impulse at lower average

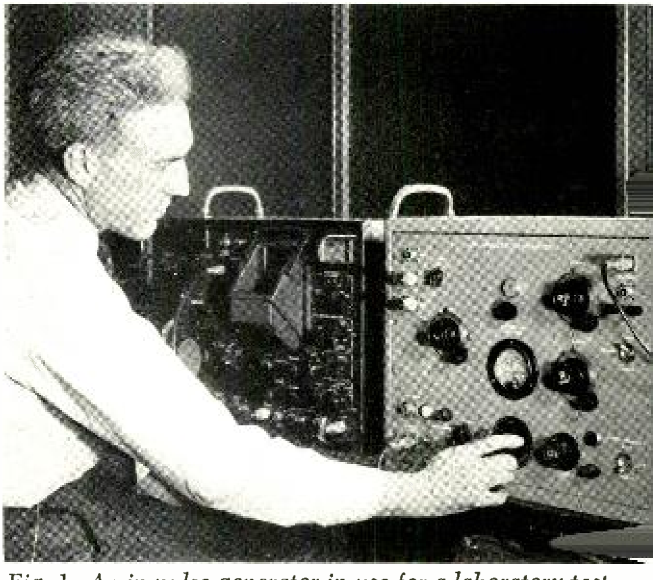

Fig. 1—An impulse generator in use for a laboratory test.

power, the control circuit is also arranged to permit operation at a base rate of twenty per second. A counting circuit is included to permit the condenser to discharge at half rate, either thirty or ten times per second, so that if an oscilloscope is caused to sweep every cycle, and the test impulse is formed only every other cycle, a zero-line trace will appear along with the impulse voltage trace.

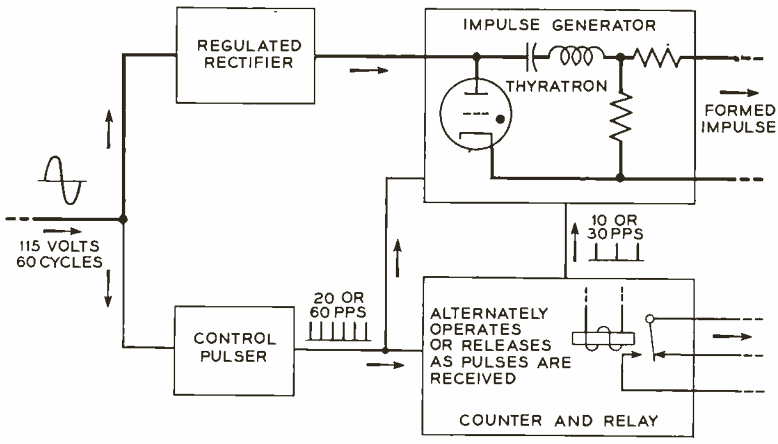

Fig. 2—Block schematic of the impulse generator circuit.

A relay is included which is operated by the counter circuit in such a way that its contacts are in one position when one impulse is formed, and in the other when the next impulse is formed. Thus two quantities can be compared directly if the relay is used to switch the oscilloscope from one test point to another. Similarly, one quantity can be observed for two test conditions when the relay is used to change test conditions. Figure 3 indicates the type of results that can be obtained by use of this relay. The upper oscillograms represent the impulse voltage obtained at two test points by using the relay to switch from one to the other. The lower curves show the voltages at a single test point when the conditions are changed by the relay.

The generator operates from a 115-volt, 60-cycle power source, and because the impulse is synchronized with it, and a phase shifter is provided, the effects of an interfering power-frequency voltage found on the cable under test can be minimized. Three values of capacitances—½, 1, or 2 microfarads—may be selected for the generator capacitor by a switch on the front panel. A fourth position of this switch is arranged so that any value of capacitance may be connected across binding posts at the rear of the generator and used as the generator capacitor. The voltage to which the capacitor is

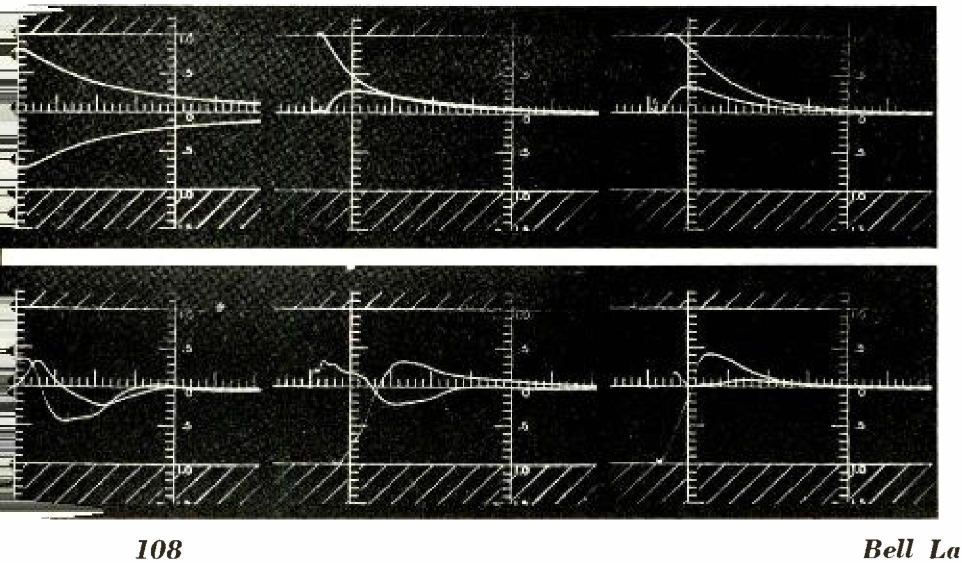

Fig. 3 – Typical oscillograms obtained with the impulse generator. The upper oscillograms show the voltages at two points resulting from similar impulses under the same test conditions, while the lower oscillograms show the voltages at a single point resulting from similar impulses but under different test conditions.

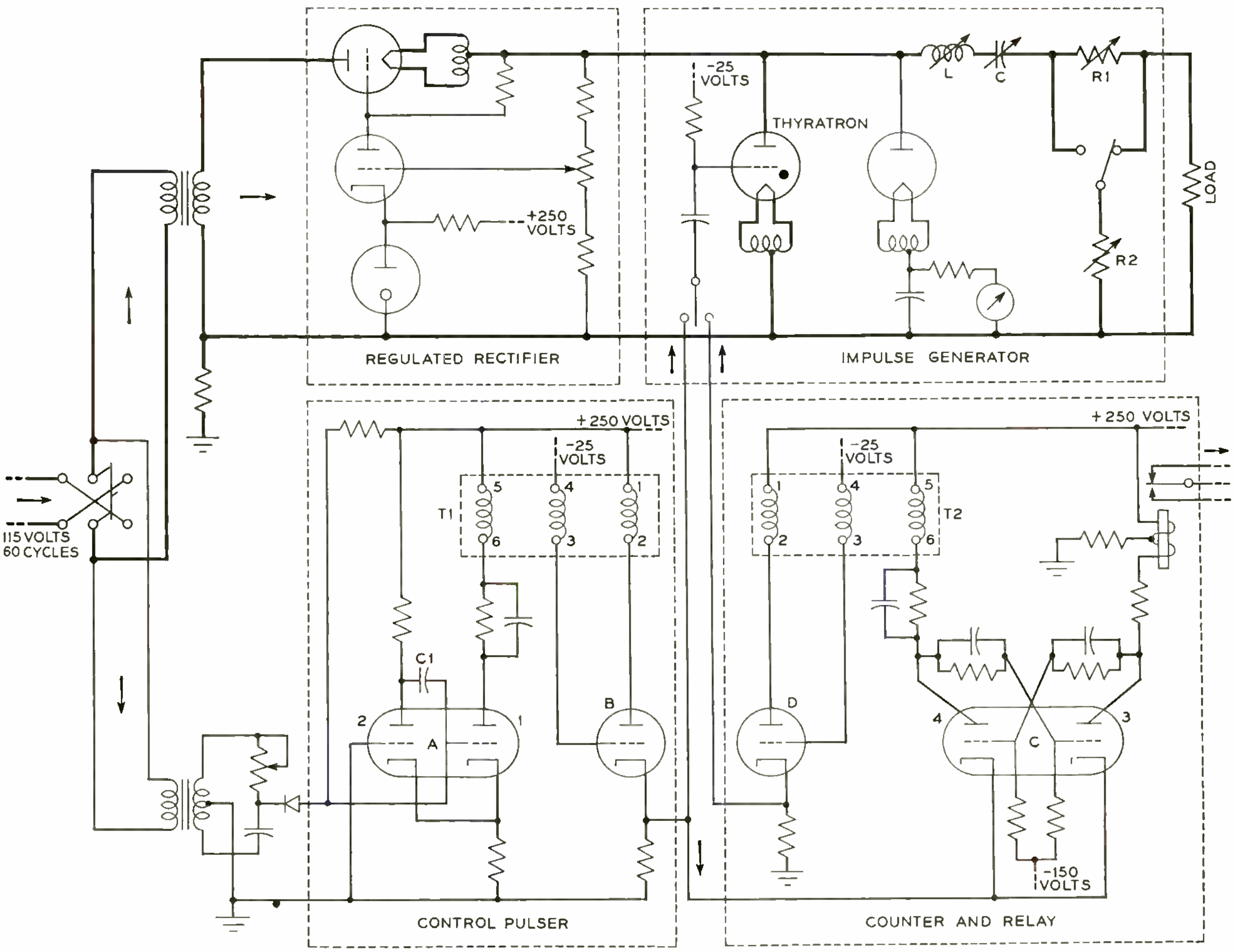

Fig. 4—Circuit schematic for the impulse generator.

charged is controlled by a vacuum-tube regulator. It is thus substantially independent of line voltage, and can be regulated at values between 500 and 2000. Current taken from the 115-volt power source depends on the average power in the impulses, but is between one and three amperes in any case.

The basic generator circuit is shown in the upper part of Figure 4. A regulated rectifier at the left charges the capacitor C during each positive half cycle—the thyratron being blocked by its negative grid bias. As the supply voltage turns negative, the thyratron is unblocked by a short positive control pulse applied to its grid, thus allowing the capacitor to discharge rapidly and yield a formed impulse at the output terminals. Adjustment of the values of the capacitor C and the resistances R1 and R2 controls the duration of the impulse and determines generator output impedance. Further adjustment is obtained by switching R2 to either end of R1 or by disconnecting it entirely. The steepness of the front of the impulse may be varied by adjusting the inductance L.

Control pulses for application to the grid of the thyratron are taken either from the control pulser circuit at the lower left of the diagram or from the counter circuit at the lower right. The control pulser generates five microsecond positive pulses at rates of either sixty or twenty per second, while the counter circuit, taking positive pulses from the control pulser, provides pulses at half the original rate, and thus at rates of 30 or 10 pps. Control voltage for the pulser is taken from the generator power source through a phase shifter so that the occurrence of the test impulse may be adjusted to a desirable point on an interfering wave.

Pulses in the control pulser are formed by triode B under control of the double triode A acting through the transformer T1. Normally, B is held blocked by its high negative grid bias, and will pass current when and only when the current in winding 5-6 of the transformer is suddenly interrupted, which occurs when triode 1 of A ceases to pass current. Current flows in triode 1 during the positive half cycles of the 60-cycle supply because at this time its grid bias is zero, while the grid of triode 2 is negative. As the supply voltage changes from positive to negative, triode 1 blocks, and triode 2 starts to pass current because of the change of their grid voltages. The sudden stopping of the current in winding 5-6 of the transformer momentarily unblocks triode B, and thus provides the desired positive control pulse to trigger the thyratron in the generator circuit. As triode 2 passes current, the grid of triode 1 is driven further negative by the voltage applied through C1, and triode 1 cannot again pass current until the charge on this condenser has been dissipated.

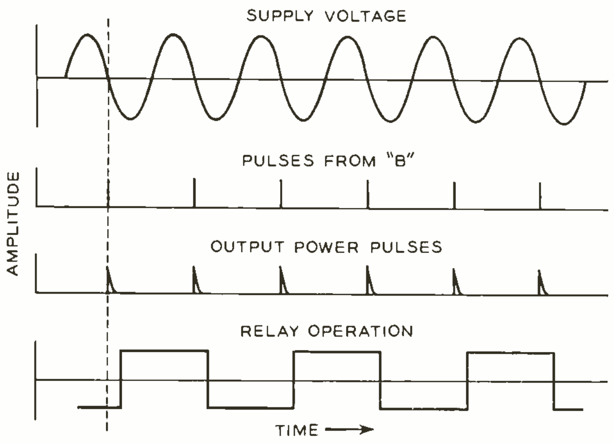

Fig. 5—The timing of the pulses and relay operations for Figure 4.

Triode 2 continues to pass current during the negative half cycle. The grid of triode 1 remains negative until the charge on C1 has been neutralized, at which time triode 1 again passes current and blocks triode 2 in doing so. By means of a rate switch on the front panel, capacitance C1 may be made either of two values. With the smaller capacitance, the charge is neutralized early in the cycle, and thus triode 1 is ready to cause another control pulse at the next following negative half cycle. By using a larger capacitance for C1, however, the grid of triode 1 is held negative long enough to prevent current flow in triode 1 until the third following positive half cycle. With this latter capacitance in the circuit, therefore, the control pulses occur at a rate of only twenty per second instead of sixty.

Pulses generated in tube B of the control pulser are also used to trigger the multivibrator C of the counter circuit. This tube is a double triode, and is associated with a transformer T2 and triode D. This latter tube, like tube B of the pulser circuit, passes current only for a short period when the current in winding 5-6 of the transformer is suddenly interrupted. At each pulse from tube B, the side of C that was passing current ceases to pass current, and the other side begins to pass current. When triode 4 of C ceases to pass current, the voltage pulse generated in winding 5-6 of T2 causes D to initiate a pulse of current. At the next pulse from B, triode 4 passes current and triode 3 blocks and no pulse is generated by D. At every other pulse from B, therefore, a pulse is generated by D, and thus the series of pulses from D occur at half the rate of those from B. With one setting of the rate switch, therefore, pulses at a rate of either sixty or thirty per second are available for the impulse generator, while with the other setting of the rate switch, pulses at rates of either twenty or ten per second are available.

Current through triode 3 operates a switching relay, which is held to one set of contacts when triode 3 is passing current and to the other set when it is not. Since triode 3 passes current and does not pass current for equal intervals under control of pulses from B, the relay it controls switches from one position to the other in step with the pulses from the impulse generator. Multivibrator C is triggered at the instant the test impulses are generated, but because of the operate time of the relay, the contacts do not change until a few milliseconds later. Thus the relay is always in one position or the other as each test impulse is formed, and the contacts are not required to initiate or interrupt current. The relative timing of the various pulses and the relay operation is indicated in Figure 5.

Besides the main circuit shown in Figure 4, there is an auxiliary power supply that furnishes various positive and negative d-c voltages required for the tubes of the main circuit. A separate source of 60-cycle power not necessarily synchronized with the impulse generator may be used for this auxiliary supply.

Although this system has been designed specifically for artificial lightning tests on aerial exchange cable in the field, other uses have suggested themselves. Transmission line properties, such as surge impedance and velocity of propagation, are conveniently measured by this equipment in combination with a pulse type oscilloscope. A measurement of velocity of propagation, in turn, provides a good indirect measure of dielectric constant—a property of cable insulation difficult to determine because insulation usually consists of an indeterminate mixture of air and insulating material. The equipment might be used, also, in determining the voltage drop across a circuit element carrying heavy surge currents, in connection with studies of impulse characteristics of apparatus. Another use is in setting up circuits for high power or destructive impulse tests. Its use for this purpose would save considerable time and labor by avoiding experimental circuit adjustment involving repeated discharges of a high power generator.

This repeating impulse method could be developed to considerably higher voltages and currents by using high power thyratrons or triggered gaps. Although the average power required might become impracticable, high power tests could be made at a much lower repetition rate, say two per second. Even at this rate, visual study of impulses is still conveniently possible.

THE AUTHOR: J. J. MAHONEY, JR. entered the Development and Research Department of A T & T in 1926. About a year later he was transferred to the Test Station at Walker Street where he remained until 1938 in various capacities from messenger to laboratory mechanic. He attended Pratt Institute evening classes for several years. In 1938 he transferred to the Protection Development Department where he was assigned to standard protection studies as a Member of the Technical Staff. This work included the development of instruments and techniques for natural and artificial lightning tests. During World War II he was engaged in the design of test oscilloscopes for use in the development and maintenance of radar systems. For the past year he has worked on exchange area transmission problems. At present he is concerned with the transmission engineering aspects of coaxial systems.

Multifrequency power supply for reed signaling

H. M. PRUDEN
Switching Development

For the tuned-reed signaling system* now being given preliminary trial for the mobile radio system,† there is required a reliable source of 32 frequencies spaced 15 cycles apart and lying between 350 and 830 cycles per second. Some consideration was given to using independent oscillators controlled by tuned reeds for obtaining these frequencies. Such a system appears to be economical to build but offers some difficult maintenance problems. If an isolated central office, for instance, has an oscillator intended to generate a frequency of 577.5 cycles and to maintain its frequency with an accuracy of one part in 20,000, there is no conveniently available method of making routine tests to make sure that the frequency has not changed. The cost of developing and providing a system for testing the accuracy of all frequencies in the 32-frequency group appeared to be prohibitive. It was therefore decided to use a crystal oscillator and harmonic generator system so that all of the frequencies would be directly related to each other, and an accurate test on any one frequency would insure that all frequencies would be correct.

A block schematic of the 32-frequency power supply that has been developed and placed on trial in the Richmond, Virginia, telephone office is shown in Figure 1. The base frequency for the entire system is provided by a 1920-cycle laminated-crystal¶ oscillator indicated at the left. This oscillator is connected to a wave squarer to provide 1920 pulses per second. The output of this squarer is connected to an eight stage trigger circuit, one stage of which is illustrated in Figure 2. Each stage divides the number of impulses by two, and thus the

*Record, *February,* 1950, *page* 72.
†Record, *April,* 1947, *page* 137.
¶Record, *February,* 1946, *page* 59.

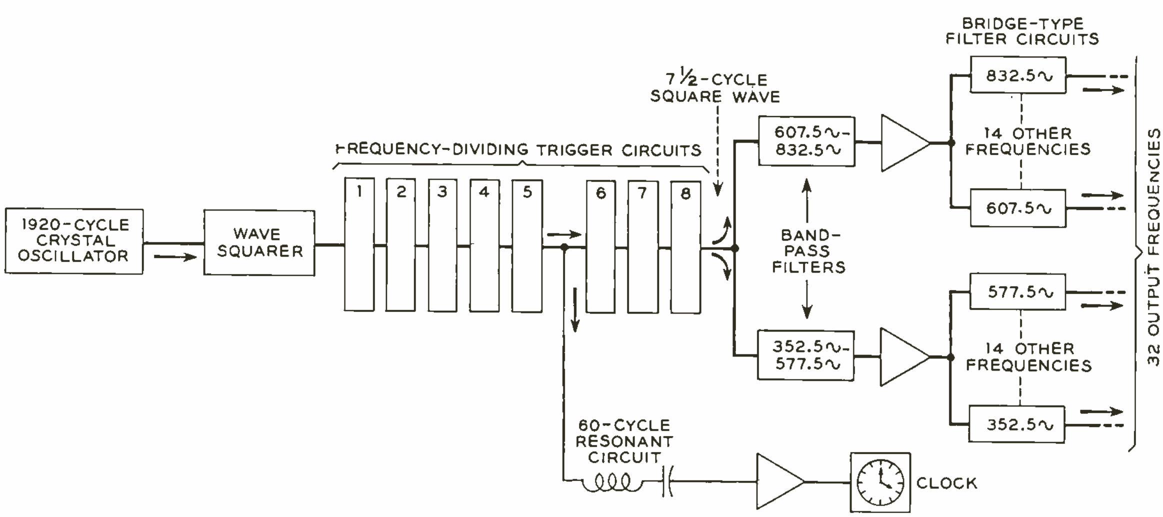

Fig. 1—Block schematic of the reed signaling circuit for mobile radio service.

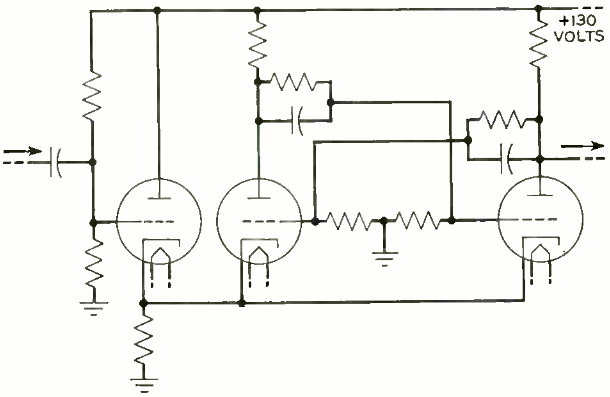

Fig. 2—One stage of the eight-stage trigger circuit.

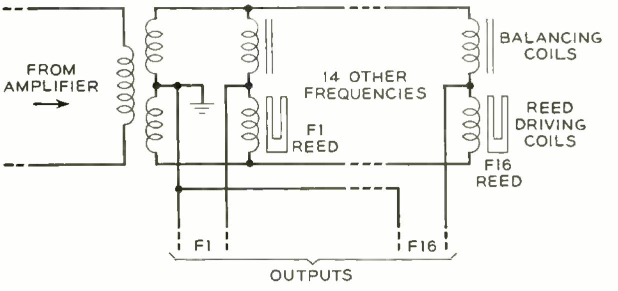

Fig. 3—Each of the bridge type filter circuits comprise sixteen bridge-reed filters similar to the two indicated above. These are connected to the balanced windings of the output transformers of the amplifiers.

output of the eighth stage is a 7½ cycle square wave which contains all odd harmonics of 7½ cycles and very little energy in the form of even harmonics.

The output of the eighth trigger circuit, which will include the desired thirty-two odd harmonics from the 47th to the 111th inclusive of 7½ cycles, is connected through two band-pass filters to two amplifiers. One band-pass filter passes the upper 16 frequencies required, and the other passes the lower 16 frequencies. These band-pass filters serve to protect the amplifiers from being overloaded by the unwanted harmonics. Each amplifier output is connected to sixteen filter circuits, each capable of identifying and passing one of the required harmonics.

These filters consist of bridge circuits, as shown in Figure 3, connected to the balanced windings of the output transformers of the amplifiers. One coil contains a vibrating reed tuned to one of the frequencies to be passed by the filter, and the other coil contains a core to permit the impedance of the two coils to be made the same. No output voltage is obtained unless the tuned reed vibrates. In the presence of its critical frequency, the tuned reed vibrates and thus unbalances the bridge circuit, allowing that frequency to pass to the output terminals of the power supply.

The frequency of all outputs of this power supply can be checked to a high degree of accuracy by means of the clock shown in Figure 1. This is an ordinary electric clock connected through a 60-cycle resonant circuit and amplifier to the output of the fifth trigger circuit, which operates at 60 cycles.

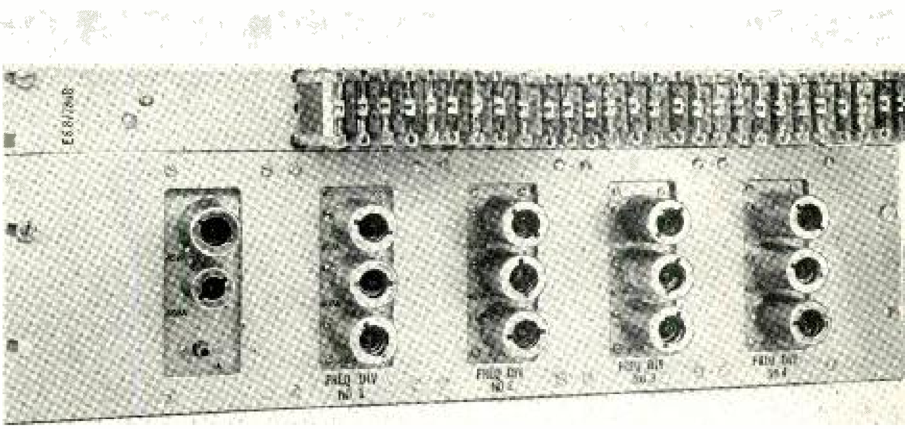

Fig. 4—Front view of the panel carrying the oscillator and frequency divider circuits.

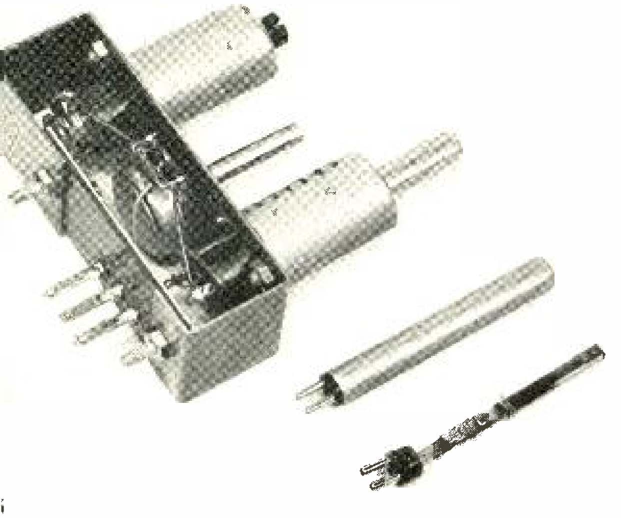

Fig. 5—A preliminary model of one of the bridge-reed filter circuits.

Should any frequency drift of the base oscillator occur, it may be determined by comparing the clock with radio time signals.

All the apparatus indicated in Figure 1 from the oscillator through the final stage of step-down is mounted on the panel shown in Figure 4. Here the two tubes at the left are in the oscillator and squarer circuits, while the four sets of three tubes to the right each comprise two divider circuits. The crystal for the oscillator is on the rear of the panel behind the squarer circuit. A model of the bridge-filter circuit is shown in Figure 5. The two similar cylindrical cans enclose the two coils. The lower one contains the reed vibrator; one of which is shown separately at the lower right. These filters, together with the band filters and amplifiers, are mounted separately. Since this reed signaling apparatus is still under trial, final designs have not yet been completed.

THE AUTHOR: H. M. PRUDEN joined the Engineering Department of Western Electric during the summer of 1919 and engaged in laboratory work on voice-frequency signaling. In 1924 he became a member of what is now the Switching Development Department to engage in development of voice-frequency signaling and dialing systems, and of voice-operated switching devices and control circuits that are employed in radio systems. During the war he was in the Radio Research Department working on radar and short-wave radio transmission. At the end of the war, he returned to the Switching Development Department, where he has been concerned with mobile radio systems and remote control devices for unattended stations of coaxial and microwave systems.

Incoming register link for No. 5 crossbar

C. D. KOECHLING
Switching Systems Development

Calls incoming to the No. 5 crossbar system* from other offices terminate on incoming trunk circuits, which have appearances both on a trunk link frame for completion of the talking path to the called subscriber, and on an incoming register link frame for connection to an incoming register. A separate group of register link frames is required for each of the various types of registers, such as dial, multifrequency, and revertive pulsing, and for each ten registers of the same type. Incoming register link frames mount five twenty-vertical crossbar switches together with their control relays as shown in Figure 1. One hundred incoming trunks, one per switch vertical, have direct access to a group of ten incoming registers, each register being multipled to one horizontal on each of the five switches. To this basic frame a supplementary frame of five additional twenty-vertical switches may be added to increase to two hundred the number of trunks connecting to the same ten registers. A further increase in trunk capacity may be obtained by associating a second basic frame and its supplementary frame with the same registers. The number of trunks and registers varies with traffic, but the combination of capacities of one hundred or two hundred trunks and ten registers satisfies the average office.

Reduced to its simplest form, such a frame could be represented as shown in Figure 2. It differs from the sender link frame in the No. 1 crossbar system and from most crossbar frames in consisting of only a single switching stage instead of using a primary and secondary switch for the completion of a connection.

*Record, *March*, 1949, *page* 85.

A single-stage link frame seemed essential because of the rapidity with which a register must be connected to trunks carrying subscriber-dialled traffic from a step-by-step office. On calls from panel or crossbar offices, the pulses indicating the number wanted are transmitted by a sender, and they are

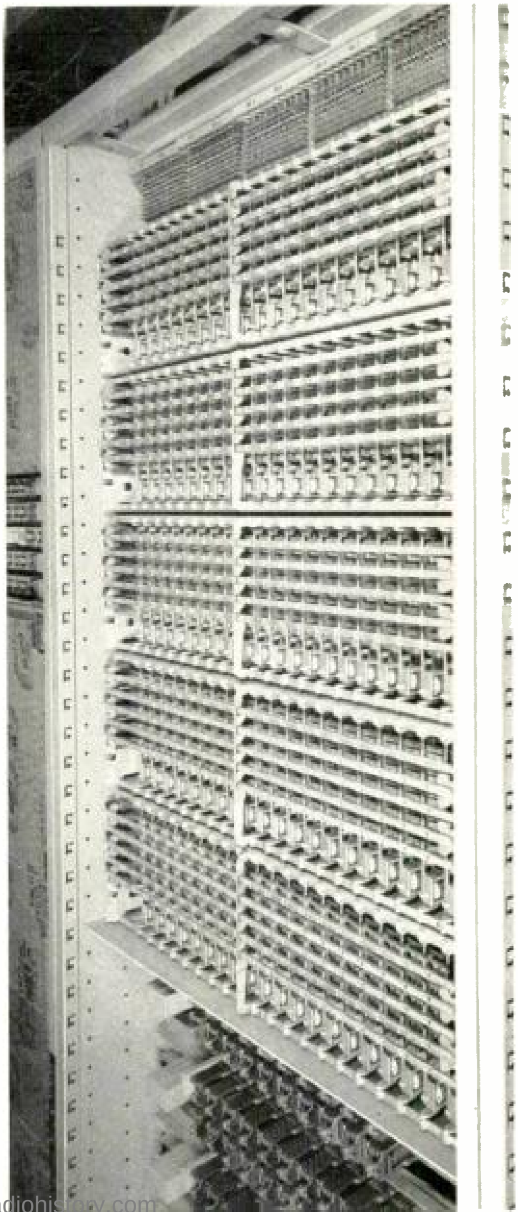

Fig. 1—Incoming register link frame for No. 5 crossbar system.

not transmitted until the sender gets a signal indicating that a register is ready to receive them. With subscribed-dialled step-by-step traffic, however, the pulses are sent directly from the subscriber's dial, and those for the first digit of the called number follow immediately after those for the last digit of the office code. The only time available for connecting an incoming register to the circuit, therefore, is part of the interdigital time between the last digit of the office code and the first digit of the subscriber's number.

The twenty trunk circuits connecting to one switch on the basic register link frame, or the forty trunk circuits connecting to one switch on the basic frame and the switch on the same level of the supplemental frame, are called a horizontal group. The complete link frame is thus divided into five horizontal groups. Although all trunks of all the horizontal groups have access to all of the ten registers associated with the frame, each horizontal group of trunks is given a different order of register preference. The control circuit that connects the trunks to the registers consists in effect of five separate control circuits—one for each horizontal group. Simultaneous calls appearing in different groups may therefore be connected to registers simultaneously, but simultaneous calls in the same group cannot be. One or the other of them is given preference, and the other must wait the fraction of a second required to connect the first to a register.

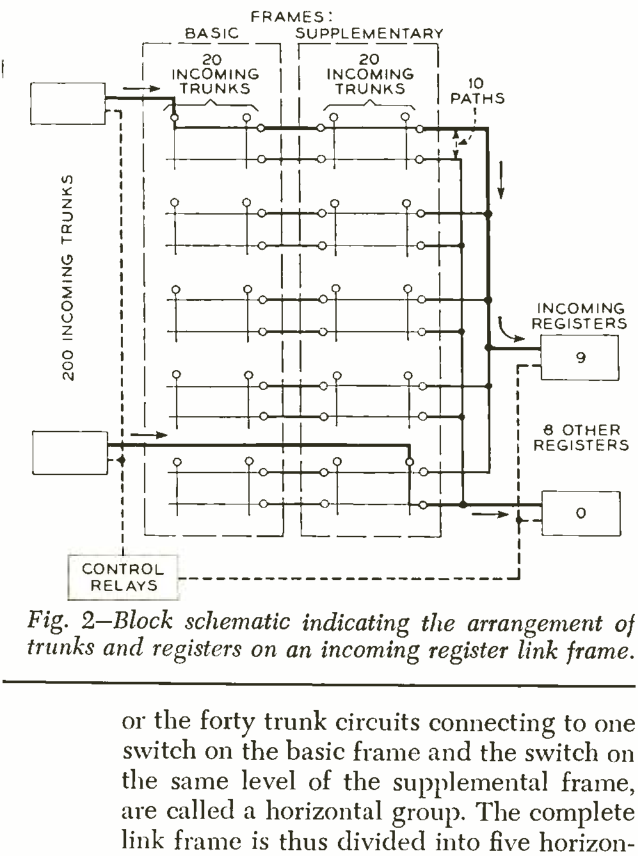

Fig. 2—Block schematic indicating the arrangement of trunks and registers on an incoming register link frame.

In the control circuit for each horizontal group there is a trunk preference, TP, relay for each trunk of that group, a register busy, RB, relay and a register preference, RP, relay for each of the ten registers, and the twenty hold and the ten select magnets for the crossbar switches of that group. There is also a TF, a CL, and sometimes a TN relay through which the register receives additional information. These various relays are interconnected as indicated in Figure 3. For the sake of simplicity it is assumed here that a supplementary frame is not employed, and thus there are only twenty trunks to be considered in a horizontal group, and relays are shown for only the fourth horizontal group and only for the fourth register, which is the first preference for that group. Since there are ten registers and five horizontal groups, there are in all fifty RP relays—one for each horizontal group for each register. In Figure 3, only the five RP relays for register No. 4 are shown; each of the other registers has a similar group of five RP relays. Register busy relays in horizontal group 4 are indicated for all ten registers. A lead from a back contact of each of these relays runs to the No. 4 RP relay for each register, but only the RP relay for the No. 4 register is shown in the diagram.

To illustrate the action of the circuit, assume a call comes in on trunk No. 10, and that register No. 4—the preferred register for horizontal group 4—is not busy. The No. 10 TP relay will operate, and through its No. 2 spring will connect ground—through a back contact of the No. 4 RB relay—to the winding of the No. 4 RP relay of register No. 4, and this RP relay will operate. Through a front contact on the No. 2 spring of the No. 4 RP relay, battery applied in the register will operate the No. 4 select magnet on the crossbar switch of horizontal group No. 4. When the magnet operates, a connection will be established from ground in the register to operate the hold magnet for No. 10 trunk. In the meantime, relays TF and CL, and TN if one is required—for trunk frame, class, and trunk number identification—have been operated through the No. 4 spring on the RP relay. These relays each close twelve sets of springs to make the necessary identifications, and through a set of cross-connecting terminals they are associated with leads from front contacts on springs 5 and 6 of the TP relays. From front contacts of the TF and CL relays leads run to the register to convey the required information.

It will be noticed that when the RP relay operated, it opened the operating path to the windings of all the other RP relays for that register. Should a call in one of the other horizontal groups attempt to seize that register, it will thus be unable to do so. Immediately upon selection, the register operates its RB relays associated with the other four horizontal groups so that calls coming in by way of these other groups will not attempt to seize the No. 4 register. After the hold magnet has been operated, the register—through circuits not shown—releases its RP relay that had been operated and operates its RB relay in the horizontal group from which it was selected. After this time, all calls from

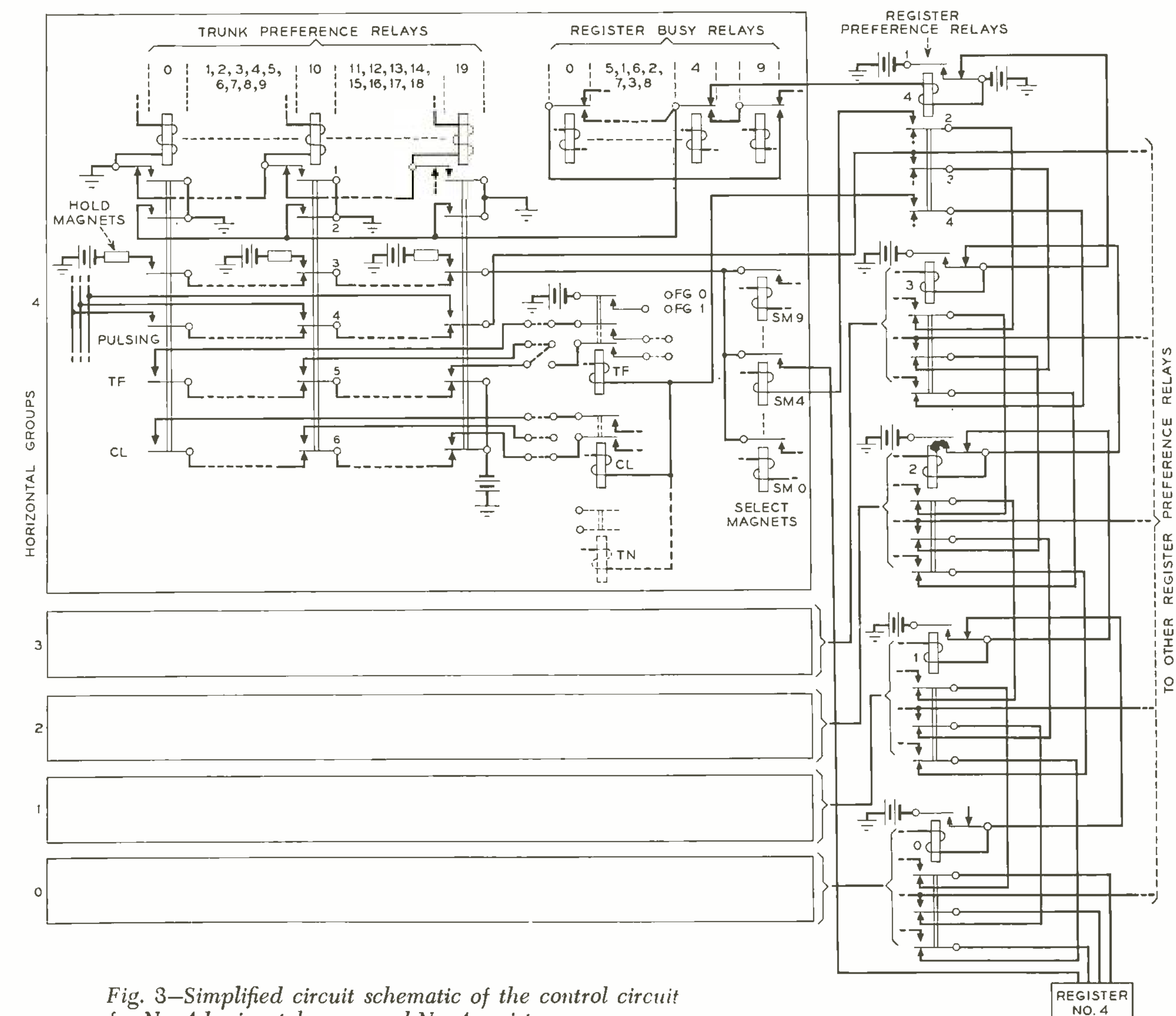

Fig. 3—Simplified circuit schematic of the control circuit for No. 4 horizontal group and No. 4 register.

that horizontal group will be passed to one of the other registers because of the operated RB relay.

In the fraction of a second between the operation of the No. 10 TP relay and the operation of the No. 4 RB relay, a call coming in on a higher numbered trunk of the same group—11 to 19, inclusive—could not operate its TP relay because the circuit to its winding would be open at the No. 1 spring of the No. 10 TP relay. A call on any of the lower numbered trunks—0 to 9, inclusive—could operate its TP relay, but the hold magnet for that trunk could not be operated since its circuit is opened by the No. 3 contact of the No. 10 TP relay. By these means complete lockout is secured.

When the hold magnet is operated, six leads are connected to the register from the trunk circuit. One of these is used to keep the hold magnet operated. Two are used for pulsing, two for passing information between trunk and register, and one over which the marker will operate a relay in the trunk circuit to identify the trunk when it completes the talking path through the trunk link frame. The select magnet and relays TP and RP are released after the crosspoints are closed so that other calls in the same horizontal group may be handled.

Reference was made earlier to the need for a quick connection when subscriber-dialled calls originate in step-by-step offices. Although with the frame idle, the connecting time of this link involves only the operating time of the control relays and one crossbar switch, even this interval of about 0.1 second may be too long on some connections. Because of this, a by-link circuit has been incorporated that permits dialing to proceed before the switch crosspoints are closed, thus reducing the time to about 0.04 second. The by-link path is closed through the No. 4 springs on the TP and the No. 3 springs on the RP relays as soon as the trunk preference and the register preference relays operate. The by-link path and the regular pulsing path through the crosspoints are in multiple so that there is no discontinuity in the reception of pulses when the crosspoints close. This by-link path, being part of the control circuit, is released as soon as the switch path is established, and is thereby made immediately available for use with the next call.

Some calls may arrive while the link is being used to set up one or more calls which have preference in the chain. When this occurs or when the dial pulses are received too soon for the register to have been attached, the trunk circuit will send back an overflow or paths-busy signal to the subscriber.

As mentioned in the article already referred to, the No. 5 crossbar system is arranged to serve as a tandem office or a toll center to switch calls through it to other distant offices. In such cases the incoming trunks have connections to both line link and trunk link frames, the former for calls passing through the office. The register link then has the additional function of indicating to the register, for use by the marker, the line

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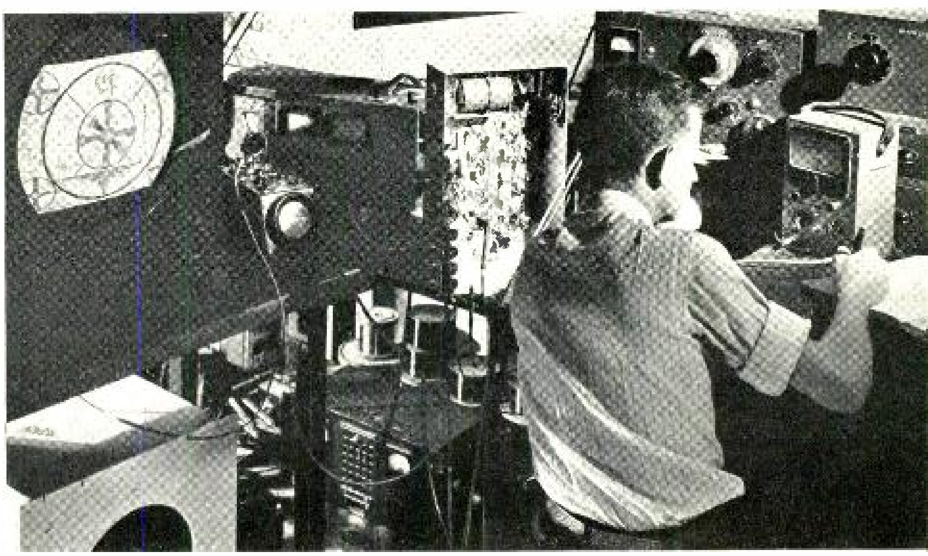
THE AUTHOR: C. D. KOECHLING was graduated from Brown University in 1922 with the Sc.B. degree, and immediately joined the Laboratories, then the Engineering Department of the Western Electric Company. He first engaged in the test, and then the design, of circuits for dial PBX's, and later for several years in the design of both large step-by-step central office and small community dial office circuits. With the local systems analysis group, he analyzed customers orders for step-by-step circuits for all parts of the Bell System. Just prior to the war he designed circuits for the War Department Pentagon PBX, and during the war he participated in the design of operational flight trainers. His postwar work has been concerned with the design of links, trunks, and associated test circuits for No. 5 crossbar offices.

link location in the form of a trunk number. The circuit for passing this information is not shown, but is similar to that for trunk frame and class, that is, by cross-connection from the trunk preference relay through another connector relay TN shown dotted in Figure 3. The equivalent of the three digit number, which is required to identify any one of the two hundred trunks, is derived on a link location basis. Because of the additional contacts needed for this purpose on the trunk preference relays, auxiliary relays are provided, one for each tandem trunk, and the contacts on these relays are cross-connected to a tandem connector relay. One set of contacts is connected to indicate whether the trunk is on the basic frame or the supplementary frame, thus indicating in which hundred the trunk is located. The frames are further subdivided into even and odd tens in each horizontal group. One of two leads from each horizontal group, therefore, identifies the second digit, and one out of ten leads identifies the unit or third digit.

The five horizontal groups of crossbar switches can be seen in Figure 1 at the top of the frames and below them some of the trunk preference relays in the control circuit.

The expanding coaxial cable and microwave radio relay facilities of the Bell System require a continuing program of research and development by the Laboratories. Special monitoring equipment such as that shown here is used to effect improvements in television transmission.



Historic firsts:

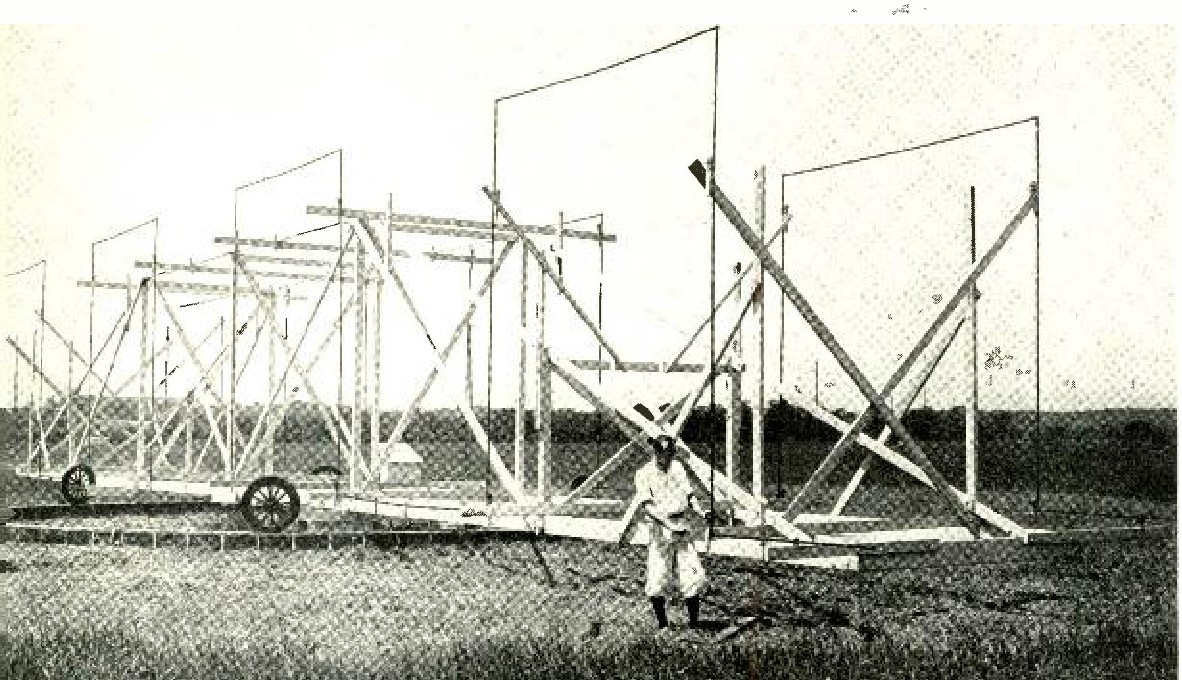
Radio astronomy

Ever since the earliest recorded history, man has observed the configurations of the fixed stars and speculated on the movements of the planets among them. Although conscious that distance seriously restricted his search for knowledge, he was entirely unaware that light was not the only means by which knowledge of celestial objects could be secured. He had not yet learned that the luminous radiation, including wavelengths only from 0.0004 to 0.0008 millimeter, comprises but an extremely narrow sector of the complete spectrum of electromagnetic radiation, and that radiation at other wavelengths might be conveying heretofore unsuspected knowledge. With the invention of the telescope in the opening years of the seventeenth century, the amount of light received was increased, thus permitting more information to be derived from the same band of frequencies, but information from other frequencies was still untapped.

These limits of astronomical knowledge endured until a little over fifteen years ago when the work of K. G. Jansky* of these Laboratories opened an entirely new and very wide field of astronomical research. It has since become known as radio astronomy. Prior to the work of Jansky, no radiation from celestial objects at radio frequencies had ever been detected. He was the first to establish that radiation in this wider frequency range is being regularly received from regions beyond the solar system. He went further than this, and indicated the source and suggested an interpretation.

In August, 1931, Mr. Jansky began a series

**Mr. Jansky died on February 22; the next issue of the* Record *will contain an account of his career.*



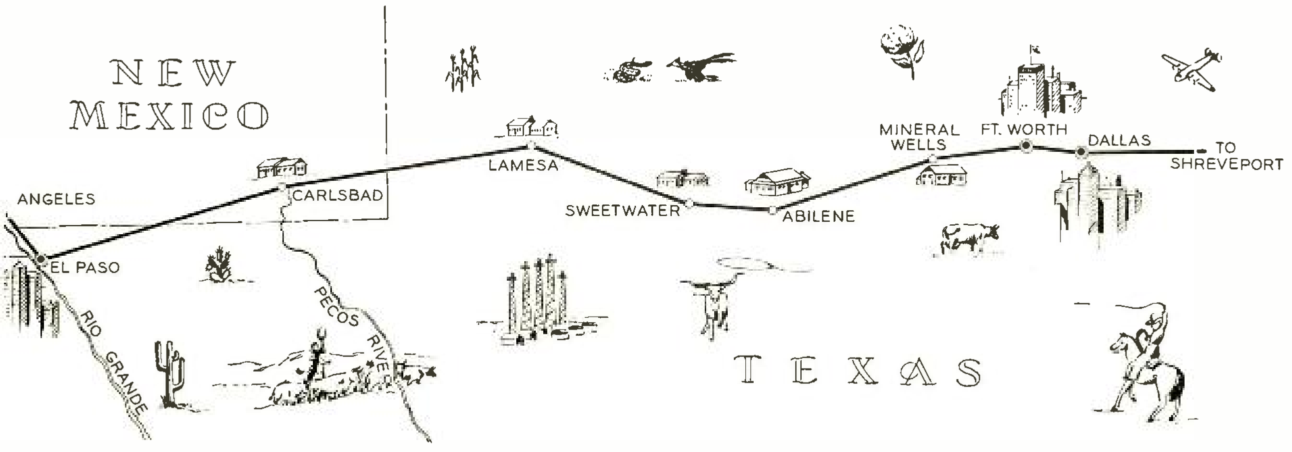
K. G. Jansky with the antenna array he used in 1931 to make a series of tests of radio noise.

of tests of radio noise at a wavelength of 14.6 meters—corresponding to a frequency of about 20 megacycles. He used an antenna array—shown in the accompanying photograph—that could be rotated to receive from any direction. During these tests, three major types of noise were encountered. One was identified as coming from local thunder storms. Another was apparently static from distant thunder storms that had been reflected from the ionosphere. The third was a steady hiss type of static, the source of which was not immediately determined. Its direction of arrival changed steadily during the day and differed somewhat from day to day, although its variation during successive days was similar.

Because of the unusual nature and behavior of the hiss type noise, a more extensive study of it was begun in January, 1932, and was extended throughout the year. During these early measurements, it appeared that the azimuth of the arriving waves changed nearly 360 degrees in twenty-four hours and was about the same as that of the sun. This led to the suspicion that the sun might be their origin. Later measurements, however, showed a greater and greater departure from the azimuth of the sun, and showed further that the cycle repeated not in twenty-four hours but in about twenty-three hours and fifty-six minutes. This at once indicated to Jansky that the source of the noise was outside the solar system and fixed in space, since twenty-three hours and fifty-six minutes is the period of the sidereal day—not the time between successive meridian transits of the sun but that between the similar transits of a fixed star.

With this as a clue, Jansky patiently analyzed the daily variations in the directions of arrival for a long series of tests, taking into consideration the position of the earth as it rotated around the sun, and the effects on direction of the position of the antenna on the earth. As a result of this analysis, he was able to show that the hiss static, instead of coming from a single point in space, came from all parts of the Milky Way—being greatest in intensity in the direction of its center and least in intensity away from the center. He thus concluded that the radiation was from stars comprising the Milky Way or from highly heated interstellar matter.

Reports of his investigations were published in the *Proceedings of the I.R.E.* for December, 1932, October, 1933, and October, 1935. Comparatively little work was carried on in this field during the immediately following years, but with the extensive use of ultra-high frequencies during the second World War, interest in galactic radio noise raidly grew. In 1946 a subcommittee of the International Scientific Radio Union (U.R.S.I.) was established to study and report on radio noise of extra terrestrial origin, and notices of other investigations in this new field have been appearing with increasing regularity in scientific publications. Besides reports in such publications as *Nature*, the *Proceedings of the Royal Society of London*, and the *Astrophysical Journal*, more popular articles have appeared in the *Scientific Monthly* and the *Scientific American*. A whole new field of science has arisen from Jansky's detection and analysis of the hiss noise he encountered nearly 20 years ago.



Coaxial's new alarm and control system

L. A. WEBER
Switching Systems Development

When situations arise which threaten the continuity of telephone service, especially over long distance telephone lines, adequate provision is necessary to give alarm signals to maintenance personnel. In coaxial and other broadband carrier systems equipped with unattended repeater stations, maintenance people may be as much as 200 miles from the trouble location, making it imperative that corrective measures be taken without waiting for the maintenance man to travel to the source of trouble. Although alarm systems have been in use for some time on carrier networks,* the new B1 alarm and control system has been designed to include remote control and centralized maintenance with the alarm feature, particularly for the "L" carrier telephone system.

In this carrier system, both main and auxiliary stations are located along the coaxial route—such as that shown in the head-piece for this article. Auxiliary stations are usually small hut-like structures spaced from five to eight miles apart and contain amplifiers for maintaining the transmission level of the carrier signals. Main stations, spaced at intervals up to 165 miles, contain the power equipment, switching facilities for spare channels, etc., and the circuits of the alarm and control system. As many as ten unattended main repeater stations may be controlled from a single attended station, and the condition of a maximum of 168 circuits (either talking or checking circuits) at each unattended main station can be checked.

The new system operates over three signaling channels as indicated in Figure 1. When a failure occurs at a station, an alarm circuit at once signals the maintenance center through channel 1. This signal is received and repeated at each unattended main station on the way. As it passes through each intermediate station, the signal operates relays which keep local alarms locked out while the troubled station is reporting. At the same time, channel 1 is cut off in the direction away from the reporting main station, so that more distant stations cannot originate alarms. If the alarm receiving circuit at the maintenance center is not then receiving an alarm from the opposite direction, it replies by sending an answering steady signal back over channel 1 to the unattended station that originated the alarm signal.

*Record, *July*, 1940, *page* 345.

The receipt of this signal tells the troubled station that the alarm receiving circuit is ready to receive alarm information. The troubled station then sends a series of dial pulses over channel 1, the number of which identifies the station reporting and indicates whether the alarm is of major or minor importance. The first station in line transmits a total of three pulses for a major alarm and four pulses for a minor one; the second station, five pulses for a major alarm and six pulses for a minor; the third station, seven and eight, etc. At the maintenance center, these pulses are counted on standard relay counting chains. A trouble of major importance will light a major alarm lamp, while a minor trouble will light a minor lamp. These lamps are located on the vertical section of the alarm receiving bay, shown in Figure 2. An audible signal supplements the lamps. After it has transmitted its pulsed information, the troubled station releases channel 1, thus making it available to any other station.

The troubled station is now ready to report more detailed information. This is done by means of the "indicator" circuit over channels 2 and 3. By dialing a three-digit code over a "director" circuit on channel 2, the attendant starts a local pulse generator at the troubled station. Pulses at a nominal rate of 10 per second are transmitted toward the maintenance center over channel 2, while at the same time the pulses are used to advance a group of counting chains in the troubled station. These counting chains form a "scanning circuit," which looks over a group of 168 indication leads, each of which may or may not be grounded, depending on the presence or absence of trouble. The pulses which are transmitted over channel 2 cause an identical scanning circuit at the maintenance center to scan a group of indicator neon lamps in a lamp bank. Thus, when the distant scanning circuit looks at a particular lead, the scanning circuit at the maintenance center is looking at the particular lamp associated with that lead. If a

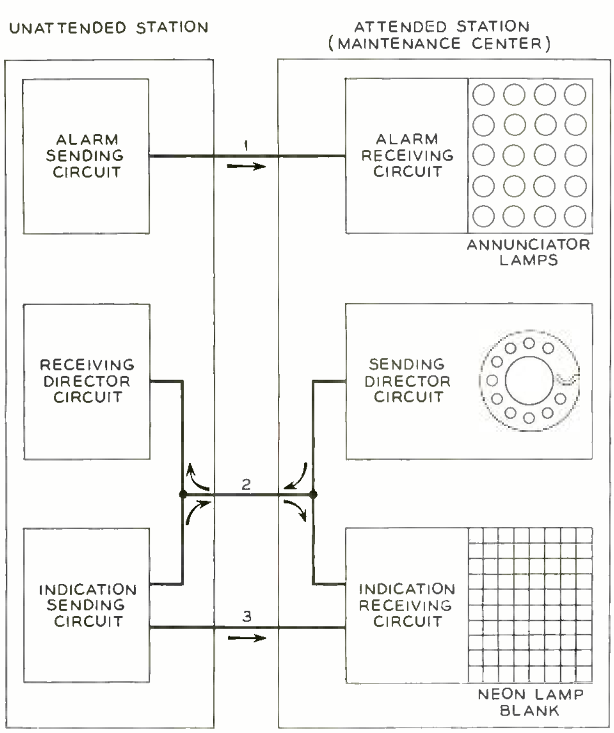


Fig. 1—Transmission paths of B1 system.

Fig. 2—Maintenance man dials unattended repeater station which responds by lighting lamps under log sheet.

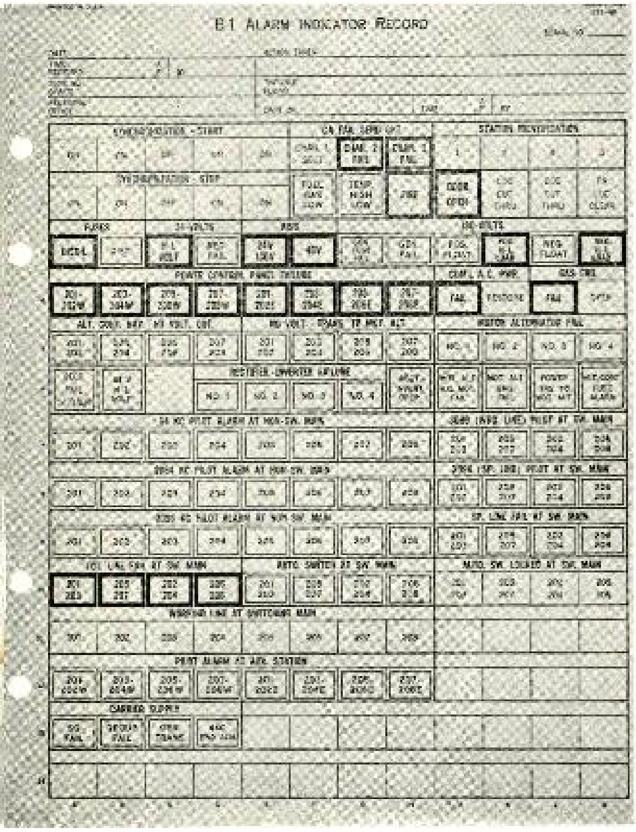

B1 ALARM INDICATOR RECORD

Fig. 3—Log sheet to record trouble conditions.

given lead is grounded, an additional signal is transmitted over channel 3, causing the associated neon lamp to be lighted and locked in.

The lamp bank containing these indicator lamps is located in the keyshelf as shown in Figure 2. Since each lamp may either be lighted or not lighted, two-value information about each circuit may be transmitted. For example, knowledge can readily be obtained as to which particular fuse has operated, which lines are working and which are spare, etc. The lamp bank is covered by a frosted plastic window the size of a standard letter page, over which the attendant places a printed log sheet, Figure 3, to mark the lighted lamps for a permanent record.

Since the accuracy of the displayed indication is dependent on the continuous synchronization of the two scanning circuits, provision is made for periodic checks to assure that the two circuits remain in step during the scanning cycle.

Once the maintenance force is apprised as to the detailed trouble at the unattended main station, remedial action can be taken. Over the director circuit operating on channel 2, the attendant dials a three-digit code. The first digit identifies the troubled station. At each unattended main station on the way, counting circuits receive and count the pulses in the first digit, transmitting them on to the other unattended stations until they reach the troubled station. Only that station will be conditioned to receive and count subsequent digits. Pulses of the second and third digits ground one of a hundred "orderleads," which can be used to operate external circuits and perform the corrective operations, such as starting a gas engine, switching working lines, etc.

Two No. 16 gauge pairs in the coaxial cable provide four channels for transmitting these trouble reporting and correcting signals. Pulses are transmitted over three of these channels by a modified differential duplex signaling scheme,* and steady signals, to compensate for differences in ground potential between stations, are transmitted over the fourth channel. The basic signaling circuit is shown in Figure 4. When the contacts on a sending relay at the left end of the line are operated, the currents in the line and in the balancing networks change in such a manner as to cause the distant polar relay to operate. The magnetic condition of the nearer polar relay, however, remains the same, and hence this relay does not operate. Similarly, if the contacts on a right-hand sending relay are operated, the corresponding left-hand polar relay alone will be affected. The operation of a sending contact at one end of the line thus affects only the distant polar relay, and signaling can be carried on simultaneously in both directions.

If, after giving the remedial orders, the attendant wishes to ascertain whether or not the trouble has been cleared, he operates a key to clear the keyshelf, and then dials the code for that particular station. This station will then retransmit an alarm signal if an alarm condition exists at the station. If everything is normal, no alarm signal will be transmitted, and the attendant will know that the trouble has been cleared. Similarly,

*RECORD, *October*, 1947, *page* 371.

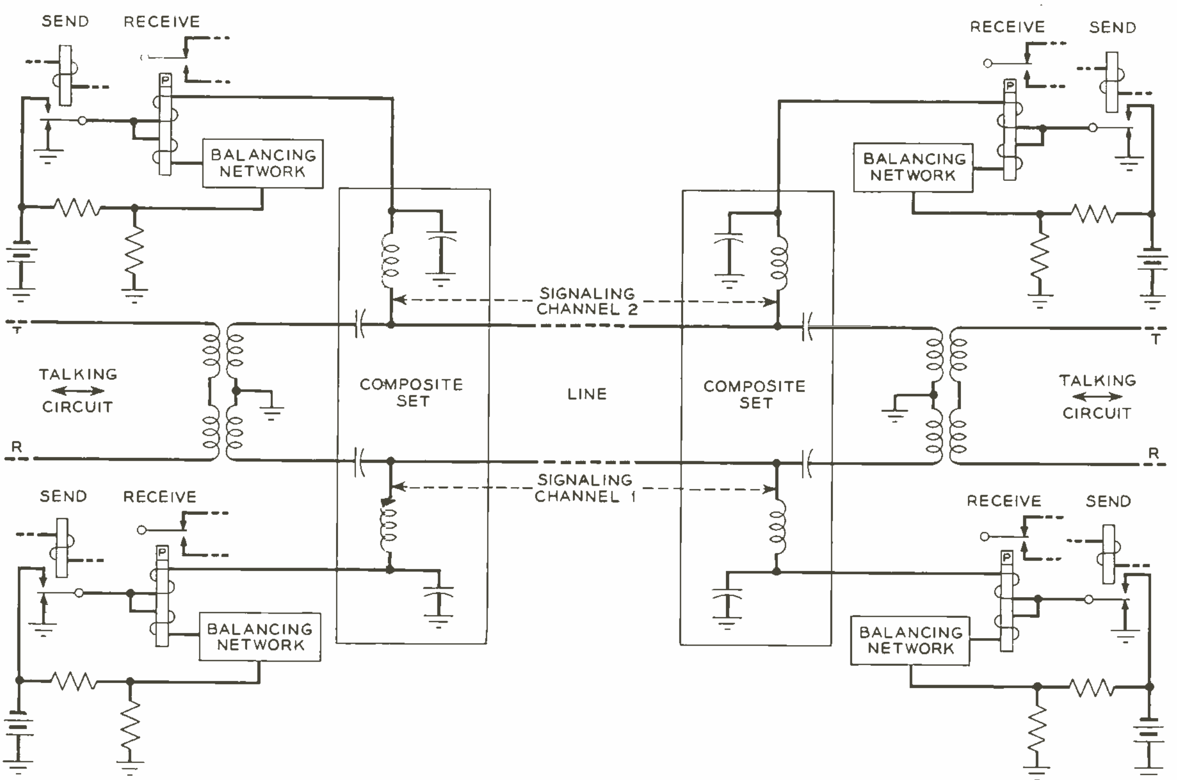


Fig. 4—Basic signaling circuit.

if the attendant wishes to check any other unattended main station, he may cause its alarm circuit to cycle by dialing the code for that particular station.

Additional features are incorporated in the system to make it as nearly self-checking as possible. Cable failure alarms and test signals are provided for. In this manner, the B1 alarm and control system provides an efficient, reliable maintenance tool for the control of unattended stations hundreds of miles away.

THE AUTHOR: L. A. WEBER received a Bachelor of Electrical Engineering degree from Cornell University in 1944. He was an electronics-radar officer of the United States Navy until 1946. He then joined the Laboratories immediately after being released to inactive duty in 1946. Since that time he has been engaged in developing alarm and control systems in the Switching Systems Development Department. Mr. Weber is presently working on built-in signaling arrangements for the N1 carrier system.

Excerpts *from the* Annual Report *of the* AT&T

Nineteen forty-nine was a year of outstanding progress and improvement in the Bell Telephone System. The men and women of the System turned in a splendid performance and the over-all quality of telephone service was raised to new high levels. At the same time, the scope and value of service were further increased and broad foundations laid to make it continuously better.

Progress in 1949 was carried forward on many fronts. The System handled a record volume of local, toll and long distance conversations. New equipment and methods contributed to faster and more accurate handling of calls. The proportion of dial telephones increased to 73 per cent. Service to farmers was further improved and some 295,000 more rural telephones were installed, bringing to about 1,300,000 the number added by the Bell System in rural areas since the war. Inter-city telephone facilities which are also suitable for transmitting television programs were greatly extended and more are under way. Stockholders increased to a record number and now total 940,000. For the third successive year, the System expended more than a billion dollars for construction of the best plant that telephone scientists and engineers can devise. Total expenditures for new construction since the war was $4,525,000,000.

Well over 40 million telephones—better than one for every four people—are now interconnected throughout all parts of the United States. Some 33,400,000 are Bell System telephones and about 7,200,000 are served by several thousand independently owned telephone companies and by additional thousands of rural or farmer lines and systems. For many years the Bell and Independent organizations have worked effectively together in providing nationwide telephone service.

Further Telephone Rate Increases Are Necessary

To obtain earnings that are adequate for the long pull, the Bell Companies have applied for additional rate increases in many states and will make other applications in the near future.

Telephone rate increases are necessary for a very simple reason: the increased cost of doing business has made it impossible to earn a reasonable return without them. The Telephone Companies have not asked nor do they intend to ask for more than is needed to enable them to meet their responsibilities properly and well.

While increases in telephone rates have varied for different classes of service in different places, the increases already authorized, plus the full amount now being sought, average only about 20 per cent of Bell System revenues. The rate increases that have been granted are only about half the current annual cost—$728,000,000—of telephone wage increases made effective during the war and postwar periods. In addition to wages, of course, the costs of materials and almost everything else used in furnishing telephone service have risen substantially.

These higher costs not only increase current operating expenses. They also increase the cost of construction, and hence the amount of capital per telephone on which a return must be earned. New facilities required to serve new telephones and to replace used plant cost more than the plant previously in service. Technological developments and improved operating methods help to meet the problem, but in a period of rapidly lifted costs such as we are experiencing they cannot meet it entirely. It is essential that these higher construction costs be adequately recognized in the repricing of telephone service.

Good Service Grows Steadily Better

Not only was over-all service by the end of 1949 as good or better than the best before the war—the trend of performance was steadily upward and we are looking forward to further improvement. Both local and out-of-town calls are going through faster and more accurately. The average time for putting through toll and long distance calls is now down to 1.5 minutes and 95 out of every 100, more than ever before, are being completed while the calling party holds the line. Equipment troubles were again reduced in 1949 and the quality of plant maintenance has never been better. Service was marked, as usual, by the courtesy, friendliness and consideration which are at once a pleasure and a tradition with telephone people.

Advances in Telephone Science Benefit Users

A new telephone set has been developed that uses new materials and new ideas. It is attractive in appearance, convenient and light in weight. Through application of new scientific principles, talking and hearing qualities are improved and the loudness of the set is automatically adjusted to compensate for its distance from the central office. A trial lot of several thousand has been installed to check performance under all conditions before regular production of the sets begins.

From its earliest days the Bell System has carried on organized research to give telephone users prompt and full benefits from advances in science. This work at Bell Telephone Laboratories covers all phases of communication, from improving the simpler things used in telephony to developing complex new systems and studying fundamental principles.

Operator toll dialing, mentioned above, is an illustration of a complex system. It works through an intricate web of equipment spread over many cities. Various parts of this equipment remember what telephone is wanted, locate a route, pass the number from place to place, and connect together the various sections of lines over which telephone users will talk. Other devices then keep constant watch over the connection and promptly light signals in front of the calling operator when the call is answered, and when it ends. If the called line is busy, that also is indicated. Equipment to do all these things is now in use, and additional facilities are being developed which will provide still greater speed, reliability and economy.

One of the most recent inventions of the Laboratories is the Phototransistor. It is based on the same principle as the amplifying Transistor mentioned in last year's report, but is controlled by light rather than by electric current. One of its applications will be in a machine to be used in toll dialing.

Bell Laboratories also draws upon developments made elsewhere. For example, radioactive isotopes, developed by others as by-products of atomic energy research, are now being used to study the penetration of preservatives into telephone poles, the wear that occurs in important moving parts, the causes for deterioration of vacuum tube filaments and many other problems.

Western Electric Serves Atomic Energy Commission

At the request of the United States Atomic Energy Commission, Western Electric Company, the manufacturing and supply unit of the System, took over on November 1 the operation of the Commission's Sandia Laboratory near Albuquerque, New Mexico. This Laboratory has an important function in bridging the gap between research and the manufacturing operations on atomic weapons. The contract with the Commission is effective through 1953 and at the Company's suggestion provides for no profit. To conduct the work, Western Electric has organized a subsidiary named the Sandia Corporation which will be able to call upon both Bell Telephone Laboratories and Western Electric itself for scientific services and technical and managerial assistance.

Keeping Pace with Television

The System in 1949 substantially increased its facilities for carrying television programs. Networks in the East and Mid-West, linked together early in the year, were extended to about 8,500 channel miles and now interconnect 25 cities having 50 television stations. Facilities will be further increased in 1950. We are also keeping in close touch with color television developments and will be in a position to transmit color programs when that is desired.

Breaking New Ground

Telephone service today is generally as fast, clear, accurate and dependable as at any time in history and the Bell System is breaking new ground in service betterment.

It is fundamental in the policy of the business that the only good service in the long run is one that is always improving. We expect to go forward in the years ahead as we have in the years gone by. Bell System research was never more effective than it is today. Bell System manufacturing, supply and service operations were never better performed. The men and women of all departments are doing a magnificent job and the facilities they design, build and operate are far and away the best in history and getting better every day.

We are confident too that telephone users desire good and improving service and prefer to pay what it reasonably costs. We believe the public understands the need for good telephone wages and working conditions—for a sound financial structure—and for earnings that will continue to provide a steady and reasonable return on the billions of dollars invested in the Bell System by hundreds of thousands of men and women. We have confidence that under wise regulation, in future as in the past, the System will continue to have the means and the freedom it needs to do the best job that it can.

Those are cornerstones in the building of a communication system that is a great national asset. The character of the organization is in its full acceptance of the responsibilities entrusted to it. It is in the knowledge and skill that the Bell System has gained and is constantly increasing. It is in the desire of telephone people to serve with friendliness and courtesy and cheerful will to get the message through. All of these things are as real as the ring of the telephone bell. They are found alike in "the voice with the smile"—in the mind and hands of the craftsman—and in the consideration of every problem of policy. They mean that the Bell System can be relied on to move steadily forward in providing better and better telephone service to the American people.

Frank B. Jewett Fellowships

Five young scientists, including a young woman mathematician, were named on February 5 by Bell Telephone Laboratories to receive the 1950-51 Frank B. Jewett post-doctoral fellowships. The awards, for research in the physical sciences, grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research.

Winners of this year's awards are: Dr. James Bruce French of the Massachusetts Institute of Technology, Cambridge, Mass.; Dr. Ilse Lisl Novak of Wellesley College and New York City; Mr. Robert Frank Steiner of Harvard University and Coral Gables, Florida; Dr. David Emerson Mann of the University of Minnesota, Minneapolis, Minn.; and Dr. Roy J. Glauber of the Institute for Advanced Study, Princeton, N. J. and New York City. Two of the winners are chemists, two are physicists and one a mathematician. Dr. Mann was also among the award winners last year.

Grants for the fellowships were established in 1944 by the American Telephone and Telegraph Company, upon the retirement of the late Dr. Jewett as Vice-President in charge of Development and Research. Since that time thirty-three fellowships have been granted.

The fellowships are awarded on recommendation of a committee consisting of seven members of the Technical Staff of the Laboratories. Primary criteria are the demonstrated research ability of the applicant, the fundamental importance of the problem he proposes to attack and the likelihood of his growth as a scientist. The awards are post-doctoral and only scientists who have recently received doctor's degrees or who are about to receive them are normally considered.

Brief biographies of the winners follow:

Dr. James Bruce French, 28, of 73 Upland Road, Cambridge, Mass., is a research associate at Massachusetts Institute of Technology. He attended Memorial University, St. John's Newfoundland, and was graduated from Dalhousie University, Halifax Nova Scotia, in 1942 with a bachelor of science degree in physics and mathematics. He received a master of science degree from that institution in 1945 and in 1948 received his doctor's degree from Massachusetts Institute of Technology. He plans to conduct his research at the Institute for Advanced Study, on higher order radiative processes in the quantum theory of fields.

Dr. Ilse Lisl Novak, 26, of 1212 Fifth Avenue, New York City, is an instructor in mathematics at Wellesley College. She plans to continue research at the University of California at Berkeley, on the subject of relation algebras. She was graduated from Hunter College in 1944, received a master of arts degree from Radcliffe College in 1944 and her doctor's degree in mathematics from Radcliffe in 1948.

Robert Frank Steiner, 23, of 2623 North Greenway Drive, Coral Gables, Florida, is a graduate student at Gibbs Memorial Laboratory, Harvard University. He is engaged in light scattering investigation of the actin-myosin system. This system is related to the phenomena of muscular contraction. He received his bachelor's degree in chemistry from Princeton University in 1947 and this year expects to receive his doctor's degree in physical chemistry from Harvard. He plans to do his research at the University of California, at Berkeley.

Dr. David Emerson Mann, 25, of Como and 29th Avenues, SE, Minneapolis, Minn., is engaged in research in quantum mechanics at the University of Minnesota and plans to continue his work at Harvard. He was graduated from The College of the City of New York in 1944 with a bachelor of science degree in chemistry and physics. He received a master of science degree in 1948 from the University of Chicago and a doctor's degree from the same institution in 1948. Dr. Mann received a Jewett Fellowship for 1949-50.

Dr. Roy J. Glauber, 24, of 110 Seaman Avenue, New York City, is an Atomic Energy Commission Post-Doctoral Fellow at the Institute for Advanced Study, Princeton, N. J. His research, which he plans to do at the Institute, is related to the theory of elementary particles. He was graduated from Harvard College in 1946 with a bachelor of science degree in physics and received his doctor's degree from Harvard University in 1949. From 1944 to 1946 he was employed as a theoretical physicist with the Atomic Energy Commission at Los Alamos, N. M.

Best Heads New A T & T Department

Recently named a vice-president of the American Telephone and Telegraph Company, George L. Best will have charge of a new department, business research and new business development. Mr. Best joined the Bell System in 1922, and in 1946 was elected vice-president of Western Electric, in charge of patent licensing.

Succeeding Mr. Best as vice-president of Western Electric is J. R. Bransford, who has been Personnel Director.

T. E. Shea, some years ago a member of the Laboratories and lately President of Teletype Corporation, has resigned that office to become Personnel Director of Western Electric.

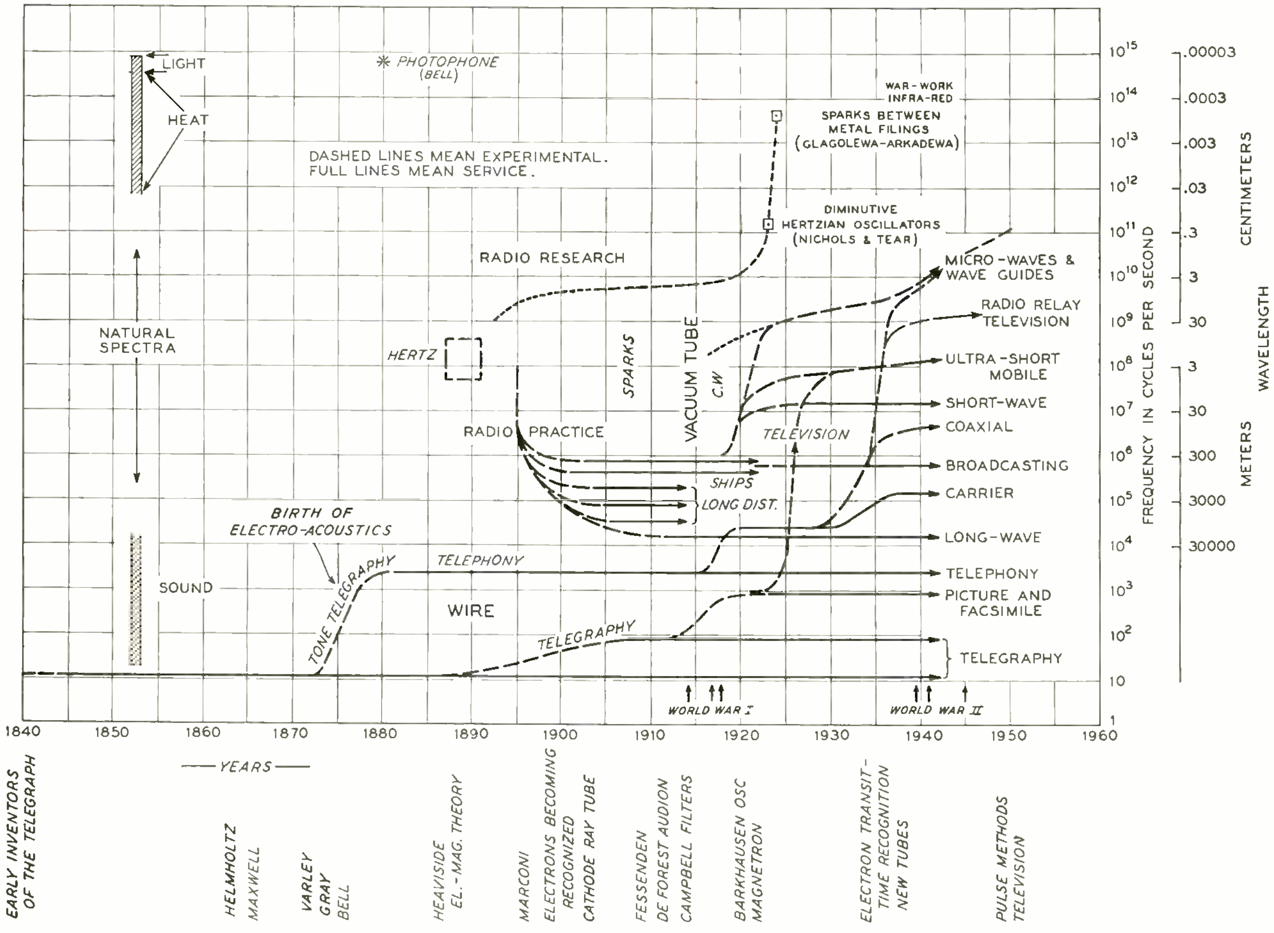
The March to Higher Frequencies

Speaking at the Mid-Century Meeting of the I.R.E. on February 1, Lloyd Espenschied discussed the broad changes in radio transmitters and transmitting systems. He outlined the fundamental trend that has run through the entire history of telecommunications as that of the speeding up of the response and sensitivity of the terminal apparatus and attaining shorter and shorter electromagnetic waves, higher and higher frequencies.

This underlying trend, said Mr. Espenschied, is illustrated in the accompanying chart. Manual telegraphy began with a signaling frequency of the order of 10 cycles per second. Then came the attempts at tone telegraphy and the birth of telephony based upon laboratory devices reaching frequencies of the order of 1,000 cycles. Followed then, the great step of attaining the all-electric oscillator devoid of mechanical inertia, attaining frequencies of hundreds of megacycles in the classical experiments of Hertz. In the realm of pure science, radio research has carried to still higher frequencies and there has been explored pretty much the entire spectrum up to the range of radiant heat and infrared wave lengths.

But the *practice* of radio first went to longer waves, lower frequencies, to attain greater distances. Then came continuous wave operation and the entry of the greatest leaven of all, the vacuum tube. Thereafter frequencies continued to mount, in radio and on wires, giving birth to many new services and industries, as indicated on the chart.

The frequency spectrum in electric communications.



M. J. Kelly as he spoke before a large group of The Pacific Telephone and Telegraph Company in San Francisco on January 10.

About 940,000 People Own A T & T Stock

The owners of A. T. & T. shares are small stockholders, about one-third of whom own five shares or less. As for the number of shares owned by the Company's 30 largest stockholders, magazine writer Robert S. Byfield made a study which produced some interesting results.

"Of the 30 names, the largest owned 70,000 shares and the smallest 15,174," he observed in the *Commercial and Financial Chronicle*. Twenty-one were identifiable as bank nominees for trust and custody accounts, one was a trust company in Louisville, one was an estate, two were brokerage firms, two were insurance companies, one a private banking house and two were foreign banks.

"King and Company is the nominee of the City Bank Farmers Trust Company which promptly confirmed to me that the 62,988 shares in its name belonged to 600 trust accounts and 350 custodian accounts, an average of 66.28 shares each. Chemical Bank and Trust Company advised that the 16,443 shares in the name of Whitten and Company represented 304 trust and agency accounts, an average of 54.8 shares per holder. Merrill Lynch, Pierce, Fenner and Beane, alleged owner of 35,931 shares, advised that neither the firm nor any of the partners owned any Telephone stock, but that the shares belonged to 1,487 holders or an average of about 24 shares each.

"In view of my researches," Mr. Byfield points out, "the 1,023,891 shares supposed to be owned by the 30 'big shots' are probably owned by 30,000 separate people." Under the circumstances, he concludes, the propaganda put out by labor papers concerning the 30 largest stockholders has been "just about 99.9 per cent wrong."

Ruling on Stock Plan

Employees buying shares under the Employees' Stock Plan have been notified that the difference between the price paid per share and the average price for the stock on the New York Stock Exchange on the date the certificates were issued is considered to be taxable income under a ruling of the Bureau of Internal Revenue.

Since late in 1946, when the Employees' Stock Plan was first under consideration, the A T & T repeatedly urged the Government that no taxable compensation was involved in the Plan. Despite the Company's efforts, however, the Bureau maintained its basic position and issued the ruling November 18, 1949.

This means that the difference in price per share, multiplied by the number of shares of stock purchased, is considered to be taxable income in the year in which the shares were issued. For example, the average market price on February 1, 1950, was $149.00, or $22.07 more than the purchase price of shares issued under the Plan on this date. An employee buying one share issued on that date would therefore be considered to have received $22.07 of taxable income for 1950. Such amount should be added to the purchase price to determine the "cost basis" of this stock in subsequent transactions involving the share.

Organization Changes

C. E. Brooks and W. W. Carpenter have been appointed consulting engineers, reporting to F. J. Singer.

H. C. Harrison has been appointed consulting engineer, reporting to A. C. Keller. W. W. Werring has been appointed switching apparatus engineer, also reporting to Mr. Keller.

A.I.E.E. Winter General Meeting

The Winter General Meeting of the American Institute of Electrical Engineers was held in New York, January 30-February 3. A highlight of the February 1 evening session was the awarding posthumously of the Hoover Medal to Dr. F. B. Jewett.

The technical program included the following papers and a motion picture by Laboratories' members:

R. K. Honaman, right, spoke to a group of business and industrial leaders in Philadelphia on January 3. Guests at this meeting were invited by W. D. Gillen, left, president of The Bell Telephone Company of Pennsylvania for the opening of the Looking Forward Exhibit in that city.

A New Electronic Telegraph Regenerative Repeater by B. Ostendorf; *Magnetic Cores of Thin Tape Insulated by Cataphoresis* by H. L. B. Gould; *Compandors for Telephone Circuits* by P. G. Edwards; *The No. 5 Crossbar Dial Telephone Switching System* by F. A. Korn and James G. Ferguson; *Fundamentals of the Automatic Telephone Message Accounting System* by John Meszar; *Magnetostriction of Permanent Magnets and Other Materials* by E. A. Nesbitt; a motion picture, *Domain Boundary Motion*, by H. J. Williams; *Recording Fluxmeter* by P. P. Cioffi; *Clampers in Video Transmission* by S. Doba, Jr. and J. W. Rieke; and *A Cold Cathode Counting or Stepping Tube* by M. A. Townsend. Other papers presented were *Automatic Calibration of Oscillator Scales* by W. J. Means and T. Slonczewski; *Progress and Development of Crystal Unit Test Oscillators* by L. F. Koerner; *Protective Grounding of Electrical Installations on Customer's Premises* by A. H. Schirmer; and *Conductor Phenomena in Gases* by J. P. Molnar.

The following presided at various sessions: R. C. Davis at the Telephone Switching session; H. A. Affel at the Telephone and Telegraph Transmission Systems session; W. H. Tidd at the Electronic Instruments session; and J. A. Becker at the Symposium on Dielectrics.

Press relations for the meeting were handled by A. R. Thompson. Mrs. D. A. Quarles was chairman of the Ladies A.I.E.E. Entertainment Committee.

A. O. Jehle, 1894-1950

A. O. Jehle, who was Comptroller of the Laboratories, died as the result of a fractured skull in a fall which he suffered on January 26.

First attending school in Westfield, N. J., Mr. Jehle was a student of accounting at Columbia University, after which, in 1910, he joined the Western Electric Company as a record clerk. In 1919 he entered the company's Accounting Department, and was later put in charge of accounting and cost methods. He continued to hold this position when the Engineering Department of Western Electric Company became Bell Telephone Laboratories in 1925. The following year he became chief auditor, and in 1929 chief accountant. He was appointed General Auditor in 1942 which title changed to Comptroller in 1945. Among his associates in and outside of the Bell System, he was highly respected for his grasp of accounting principles.

Arthur O. Jehle

Mr. Jehle was the first treasurer of the Frank B. Jewett Chapter No. 54, Telephone Pioneers of America, which office he held at the time of his death.

He was a director of the First National Bank and Trust Company of Tuckahoe, where he made his home. He is survived by his widow, Mrs. Mae E. Jehle formerly a member of the Laboratories; a son and three daughters.

A ball of molten glass is drawn between rods down a 100 ft. corridor until it is no bigger around than your finger.

Punch presses soften the rod so it won't shatter, then punch out the lamp caps.

Little Things of Great Importance

"Little Things" . . . What a big difference they make in the telephone system! For example, in its job of making equipment for the Bell Telephone Companies, Western Electric is prepared to make over 150,000 different parts, many of them "little things" seemingly unimportant in themselves. Yet each of these little things must be made with painstaking care so that there will be no weak link in our complex telephone system; so that all parts big and small will function together as a single well-integrated mechanism.

Take lamp caps for instance. If you have ever been in the operating room of a central office you have seen them, even though you may not have known it. They're the little jewel-like gadgets—some no bigger than a shirt button or the eraser on a pencil—that fit over the tops of lamps in the switchboard. When the lamp lights, the light glows softly through the cap instead of with a distracting glare.

Lamp caps have many other functions too. Their shapes, their color—white, red, green, amber, etc.—and the symbols, letters, numbers, geometrical characters which appear on them, are a code. All these things signal something to the operator when the lamp flashes on. Yes, lamp caps are just little things but they have an important job to do.

To make sure that they do their jobs well, lamp caps get plenty of attention in the shop in Western's Hawthorne Works where they are made. For one thing, just any glass won't do for Bell System lamp caps. It must be opalescent so there won't be a glare from the lamp in the operator's eyes, yet clear enough so that the signal is easy to see. The colors must be true and uniform so that the operator knows at a glance what signal is being shown. To make sure that these and other requirements will be met Western has developed its own formula for glass and makes its own glass right from scratch. These photographs show you some of the steps through which lamp caps become a part of telephone service.

Standard characters are embossed on caps mechanically, filled with glaze and baked. Special symbols must be hand painted.

Newly painted lamp caps go into an oven for preheating. In an even hotter oven characters are baked until they attain a hard, glossy finish.

A New Book on Piezoelectric Crystals

In "Piezoelectric Crystals and Ultrasonics" W. P. Mason contributes his second book to the Laboratories Series and the twenty-third of the Series published by Van Nostrand. A comprehensive introduction to the science of piezoelectricity, the book features the newest developments such as the synthetic DKT and EDT which are able to replace quartz crystals in certain electric wave filters. Detailed accounts are also given of the other crystals ADP (ammonium dihydrogen phosphate), which was used during the last war as an electro-mechanical transducing element in underwater sound work; KDP (potassium dihydrogen phosphate), a new ferroelectric type of crystal; and the ceramic barium titanate which produces an electrostrictive effect comparable with the largest piezoelectric effects in crystals.

As a book for reference, the volume should prove valuable, especially through the chapters on crystallographic systems, stresses and strains, thermal and electric relations; four chapters on the production and measurement of ultrasonic waves in gases, liquids and solids as a means of studying their properties and molecular processes; and an appendix showing how tensors can be applied to the calculation of the properties of rotated systems. Analytical expressions are developed for writing the elastic, piezoelectric, pyroelectric and dielectric relations of a crystal.

Details are given of a program under way for the past ten years at Bell Telephone Laboratories for determining the properties of crystals. The methods used in the search are described and facts are given on a number of crystals, to furnish a basis for predicting the chemical and atomic properties necessary for obtaining the best crystals for meeting definite requirements.

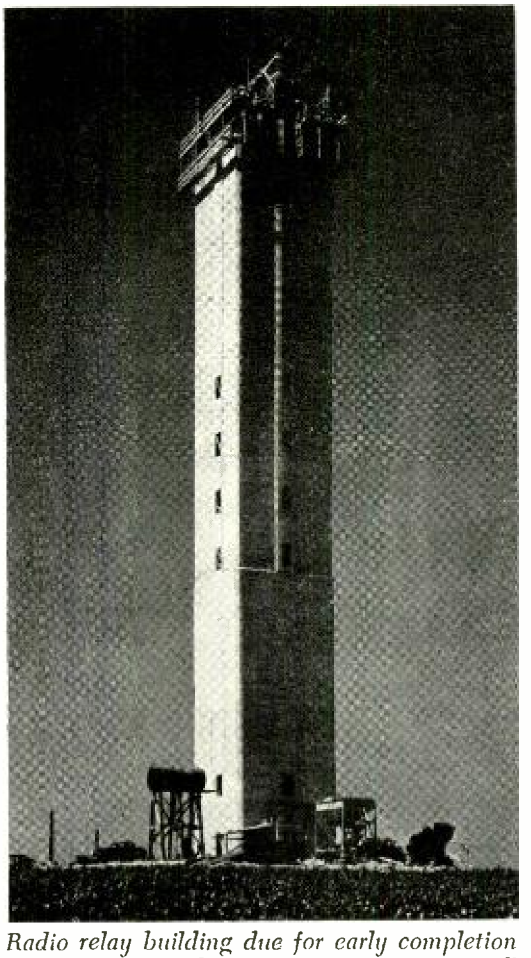
Covered in detail are the methods of measuring the properties of crystals, their particular cuts and methods of mounting for various purposes; also such practical analytical approaches as the use of equivalent circuits to represent the mechanical and electrical properties of crystals.

New York-Washington Radio Relay

Proposed in a Long Lines Department application for a construction permit is a relay system between New York and Washington. In addition to the equipment required at the New York and Washington terminals, this system will require installation of additional equipments at eight of the radio repeater locations already under construction for the New York-Chicago system and two additional radio repeater locations, one in Maryland and one in Virginia just outside of Washington.

American Physical Society Meeting

The 1950 annual meeting of the American Physical Society was held at Columbia University February 2-4. W. Shockley presided over the Symposium of the Division of Solid-State Physics at which J. Bardeen presented a paper on *Energy Bands and Electron Mobilities in Non-Polar Crystals.* During the session on Ferroelectricity, Ferromagnetism, Cryogenics, presided over by R. M. Bozorth, papers were presented by P. W. Anderson, *A Simple Model*



Radio relay building due for early completion at Valparaiso, Ind. The 190-foot structure will be one of the links in the chain of radio relay stations now under construction between New York and Chicago.

for Ferroelectricity; G. H. Wannier, *On the Triangular Ising Net;* H. J. Williams and W. Shockley, *Memory in Simple Ferromagnetic Domain Crystal;* and W. Shockley, H. J. Williams and C. Kittel, *Dynamic Experiments with a Simple Domain Boundary in a Ferromagnetic Crystal.* Mr. Shockley introduced W. T. Read who presented a paper on *Quantitative Prediction of Grain Boundary Energies by Anisotropic Dislocation Theory* during the session on Semiconductors. J. P. Molnar's paper *Conduction Phenomena in Gases* was presented at the Symposium on Dielectrics of the American Institute of Electrical Engineers. W. L. Bond presided over the session on Crystals and G. E. Moore, secretary of the Division of Electron Physics, over the session on Discharge in Gases and Mass Spectrometry. K. K. Darrow was reelected secretary of the American Physical Society.

PAYMENTS PROVIDED BY THE LABORATORIES

Term of Employment	Sickness Disability Benefits (Payable after 7 consecutive calendar days' absence—see NOTE 1)	Accident Disability Benefits — Total Disability—NOTE 2 (Payable on first day of absence)	Accident Disability Benefits — Partial Disability (Payable on first day of absence)
Less than 2 years	Note 1	13 weeks' full pay Half pay thereafter	Full loss in earning capacity 13 weeks—Note 3
2 to 5 years	4 weeks' full pay 9 weeks' half pay	13 weeks' full pay Half pay thereafter	Full loss in earning capacity 13 weeks—Note 3
5 to 10 years	13 weeks' full pay 13 weeks' half pay	13 weeks' full pay Half pay thereafter	Full loss in earning capacity 13 weeks—Note 3
10 to 15 years	13 weeks' full pay 39 weeks' half pay	13 weeks' full pay Half pay thereafter	Full loss in earning capacity 13 weeks—Note 3
15 to 20 years	26 weeks' full pay 26 weeks' half pay	26 weeks' full pay Half pay thereafter	Full loss in earning capacity 26 weeks—Note 3
20 to 25 years	39 weeks' full pay 13 weeks' half pay	39 weeks' full pay Half pay thereafter	Full loss in earning capacity 39 weeks—Note 3
25 to 30 years	52 weeks' full pay	52 weeks' full pay Half pay thereafter	Full loss in earning capacity 52 weeks—Note 3
30 years or more	52 weeks' full pay	52 weeks' full pay Half pay thereafter	Full loss in earning capacity 52 weeks—Note 3

It is impossible to crowd into this limited space all the details and qualifications of the Employees' Benefit Plan and nothing in this article supersedes in any manner the provisions set forth in the Plan. If you have any questions, do not hesitate to discuss them with your supervisor.

Note 1: Any payments for the first seven days, and payments to employees with less than two years' service are made in accordance with Laboratories practice and do not come under the Benefit Plan.

Note 2: Off-the-job accidents are classified as sickness.

Note 3: Half of loss of earning capacity remainder of disability. Partial disability payments limited to 6 years.

Note 4: Pensions are computed by multiplying one per cent of the employee's average annual pay for

Local Industrial Group Visits Murray Hill

The Industrial Group of the Chamber of Commerce of Summit, and Borough and Township of New Providence, visited the Murray Hill Laboratory on February 6. This continues a series of visits that had previously included Ciba, Koppers Company and Berkeley Engineering Company. The party was greeted by R. K. Honaman and given demonstration lectures by R. M. Ryder and W. E. Kock in the Arnold Auditorium. A tour of the main buildings for further demonstrations and exhibits followed after which dinner was served in the conference dining room. O. E. Buckley was guest speaker at the dinner. J. G. Segelken, a member of the Board of Directors of the Sum-

UNDER THE EMPLOYEES' BENEFIT PLAN

Pensions —(NOTE 4)	DEATH BENEFITS (NOTE 5) — **Sickness**	**Accident**	**Pensioners**
Disability Pension. For employees who, when sickness disability benefits expire, are totally disabled for Laboratories work and have at least 15 years of service and who are ineligible to a service pension. Continues as long as disability prevents employee from resuming active service.	Under 2 years None 2 to 3 years 4 months' salary 3 to 4 years 5 months' salary	No service requirement for Accident Death Benefit, which is 3 years' salary. Maximum — $10,000.00 or the equivalent of Sickness Death Benefits if the latter would be in excess of $10,000.00. In addition, funeral expenses not exceeding $250.00.	An amount equal to 12 months' wages based on final salary if death occurs within one year of retirement date. If death occurs after more than one year of retirement, 12 months' wages reduced by 10 per cent for each full year of retirement. Minimum — 12 months' pension.
Class A. Age Requirements — Women, 55 years or over; Men, 60 years or over. Service requirements—20 years or more. Granted at employee's request or on Company's initiative.	4 years 6 months' salary 5 years 7 months' salary		Additional payments, up to 12 months wages, discretionary in cases of hardship as determined by Benefit Committee.
Class B. Age Requirements — Women, 50 through 54 years; Men, 55 through 59 years. Service requirements—25 years or more. Granted only on approval of retirement by Benefit Committee.	6 years 8 months' salary 7 years 9 months' salary 8 years 10 months' salary		
Class C. No age requirements. Service requirements—30 years or more. Granted only on approval of retirement by Benefit Committee.	9 years 11 months' salary 10 years or over 12 months' salary		

his last 10 years or highest 10 consecutive years of service by the number of years of his employment. The minimum pension is $75.00 per month up to age 65 for full-time employees with 20 or more years of service. Beyond age 65, the minimum is the sum which added to the Primary Insurance Benefit under the Social Security Act will equal $100.00 a month. Pension payments will be adjusted by one-half of the Social Security benefit, but not below the minimums as described above.

Note 5: Obligatory only where survivor is wife of deceased employee if living with him at time of his death; child under 18, or dependent husband or child over 18 and incapable of self-support and actually supported in whole or in part by employee at time of his death. Where there are no survivors as described above, see Section 7, Paragraph 4 of the Plan for other possible beneficiaries. Payment to other dependent relatives is at the discretion of the Benefit Committee.

Sequel to the Arts Class picture in the February Record *is this picture showing portraits in oils by the group a few weeks later. Shown here are, left to right, Hayes Jacobs, model Raymond Pippin, Helen Cruger, Elizabeth Bates with the instructor, E. Stanley Turnbull, and Ruth Scodellaro.*

mit Chamber and chairman of the Industrial Group, presided at a business meeting which followed. The moving picture *Rehearsal,* depicting The Telephone Hour, was shown previous to adjournment.

Dr. Brode at Murray Hill

Professor Robert B. Brode, of the University of California at Berkeley, visited Murray Hill on February 7. During his visit he spoke on *Cosmic Ray Researches.* He explained how the energy and mass of the elementary particles, electrons, protons, and mesons constituting the rays, can be ascertained by measuring the range of the particles in lead and the curvature of their tracks in a magnetic field. In his prefatory remarks Professor Brode spoke of the present great emphasis on nuclear studies, to the detriment of the non-nuclear research which is of chief importance to industry, and mentioned the plans of the University of California for increased non-nuclear work.

Murray Hill Bridge Club

The Murray Hill Bridge Club completed the Pair-Individual tournament on January 23. This was the main event of the first half of its 1949-1950 season. The three highest scratch scores were made respectively by G. Nielsen, Jr., A. H. White and J. A. Hornbeck. First prize on a scratch basis went to G. Nielsen, Jr., and first handicap prize to A. H. White. Second scratch and handicap prizes were won respectively by J. A. Hornbeck and H. F. Hopkins. At the present time a team-of-four tournament consisting of six sessions is in progress.

The club meets regularly on Monday evenings from October through April. All are welcome to play. Any players interested in duplicate bridge who cannot play on Mondays should communicate with the club secretary, Mary Wiggins, Room 2D-527, M. H. 2617.

Former Staff Member Honored by Eta Kappa Nu

At the annual Eta Kappa Nu Recognition dinner for Outstanding Young Electrical Engineers, a former member of the Electrodynamics group, Lester M. Field, now on the electrical engineering staff of Stanford University, was awarded honorable mention for his work in the microwave electron tube art. Entertainment at the Recognition dinner, which was held the evening of January 30 in New York, was furnished by L. A. Meacham, violinist, accompanied on the electronic organ by its inventor W. E. Kock. F. J. Hallenbeck, of Transmission Apparatus Development and president of the New York Eta Kappa Nu Alumni Association, was in charge of dinner arrangements.

Microwave Antennas

In talks given to engineers at the West Street and Murray Hill auditoriums, W. M. Sharpless discussed microwave antennas for radio relay systems. Starting with simple isotropic radiators, and using optical analogies, he explained the fundamentals of antennas able to send narrow beams of radio waves. The comparative performance of parabolic reflectors and the shielded lenses of the New York-Boston and New York-

Chicago antennas was discussed in relation to requirements for beam width, gain, band width, and crosstalk ratios. Concluding remarks were concerned with future trends in microwave antenna design.

Ship-Shore Radiophone Popular

The *Queen Mary*, on a recent trip to New York, was delayed at Ambrose Light for more than 48 hours due to heavy fog. Considerable use was made of the high seas telephone service by passengers, a total of 219 calls being handled on the trip, of which 199 were handled during the last three days. One caller was James Campbell, Jr., of Publication, whose nephew was making his first trip to the United States.

News Notes

M. J. KELLY spoke on *The Present Research Outlook in the United States* at the Second Annual Northern California Research Conference on January 11 at San Francisco. While in California, Dr. Kelly visited the headquarters of the Pacific Telephone and Telegraph Company at San Francisco and Los Angeles. He talked to a supervisory and engineering group at the San Francisco headquarters. Dr. Kelly also visited Stanford University and California Institute of Technology.

M. J. KELLY, D. A. QUARLES, J. B. FISK and W. A. MACNAIR attended conferences that were recently held at Albuquerque, White Sands and Los Alamos.

First Aid Training

Learning to load a stretcher properly are Genevieve Weldon, Harry Fischer and A. G. Olson. Adeline Duske is holding the stretcher. Tene Sullivan is the model victim in all three pictures.

Instructor, L. E. Coon, demonstrates to A. G. Olson the proper method of applying a splint to a fractured ankle, lower right.

L. E. Coon shows a First Aid class how to apply a triangular bandage as a sling for a fractured collarbone, below.

RETIREMENTS

Among those retiring from the Laboratories are K. S. Johnson with 40 years of service; P. C. Smith, 30 years; R. C. Eggleston, 29 years; and Beatrice Koukol, 21 years.

Kenneth S. Johnson

This century's first decade had its telephone problems, but engineers could cope with them by methods which now seem relatively simple. Transmission was expressed in "miles of standard cable" and tested by a talking comparison. By 1909, when Mr. Johnson entered the Engineering Department of the A T & T, the picture was changing. His first assignment was to the application of transmission theory to practical problems, and as the art progressed to see that theory always preceded it. Important problems of the day were new cord circuits, side tone reduction circuits. Later came equalizers, filters, balancing networks; and with the advent of


K. S. Johnson


Beatrice Koukol

high frequencies there were more filters, more equalizers, more and more complicated networks. Mr. Johnson was right in the middle of this development; he designed many types of multi-section filters and investigated theoretically their properties of impedance, phase shift and losses. Forty-two patents record his inventions. Gradually he brought together the first collection of network drawings and of formulas for their calculation.

In 1913, Mr. Johnson transferred to what is now the Laboratories; in 1915 he gave one of the earliest of our out-of-hours courses. In 1922 he gave a one-semester course at Harvard, from which he was graduated in 1907. The text he wrote for the earlier course became *Transmission Circuits for Telephone Communication,* the first of the Bell Laboratories Technical Series of books, now regarded as the transmission engineer's bible.

As the years passed, Mr. Johnson kept adding to his collection of formulas and circuits. He was frequently consulted by his colleagues who needed a network to meet particular conditions; often his notebooks would yield just what was wanted; otherwise he would supply his inquirer with the formulas and a word of guidance. Because the ratio of reactance to resistance is a measure of the efficiency of most circuits it is an important network parameter. Mr. Johnson had often to mention the concept, so he styled it "Q"; the name stuck and grew with the art until it is now part of the universal language of communications.

In retirement, Mr. Johnson expects in the next few months to put his extensive notebooks material into shape for publication, and then hopes to do some teaching.

Beatrice Koukol

Beatrice Koukol, a member of the Technical Staff and wife of an A T & T engineer, has retired at her own request. Her career has been a full and varied one. An engineer, mother and now grandmother, she has also maintained top rank in tennis and bridge circles in her home community and at the Laboratories. Mrs. Koukol was graduated from Vassar College during the first World War, immediately joined the D & R Department, and became one of its first women engineers. Early in her career she engaged in protection development engineering in Transmission Development and, except for two short periods, has devoted herself to that work.

In the late twenties, she left for a time to


R. C. Eggleston


P. C. Smith

raise her family, but returned again shortly before the D & R consolidation in 1934. She did protection work until 1941 when she was assigned to war projects. Mrs. Koukol contributed important work on circuit analysis for the Armed Forces and also wrote instruction books for the Army and Navy. During that period she lost her only son in the service of his country. The war over, she returned to Protection Develop-

Relaxing at noon hour in the 2G cafeteria at West Street, members of the Development Shop enjoy a game of cards. Left to right around the table are: Richard Shine, John Whitaker, John Olesko, James Shindle, Eric Strubing, and Walter Burkart. Standing in the background is Eric Johnson.

ment projects at Graybar and in 1948 was transferred back to West Street. For the past year and a half she had been engaged in economic study work in the Transmission Engineering Department.

Mrs. Koukol has ranked top player in the Laboratories' Bridge Club for many years and has helped to keep the Club bridge team at the top in outside tournaments. In retirement she will continue to play bridge and tennis, and to enjoy her homes, in Jersey in the winter, and on Staten Island in summer. She is now on a leisurely trip to San Diego to see her parents and is stopping en route to visit her daughter and grandchildren in Chicago.

Richard C. Eggleston

Forty years ago a bright young Master of Forestry graduated from Yale and went to work for the U. S. Forest Service. After a few years in the Northwest woods, and a year in the Army, he entered A T & T in 1920. At that time, development of Outside Plant material and methods was handled in the Department of Development and Research. In 1927, soon after outside plant development was made a function of the Laboratories, Mr. Eggleston was transferred to West Street. Through many years he has added much to our knowledge of timber. His studies on strength, permissible defects, proper dimensions and sizes for timber used in outside plant have been translated into basic requirements in Bell System and A. S. A. Standard specifications. Some of his test results have been published in three professional articles, together with description of apparatus and methods to which Mr. Eggleston made major contributions. Recently he has been a consultant for Committee D-7 of the ASTM on proposed standard methods for static bending tests of treated and untreated pole timbers.

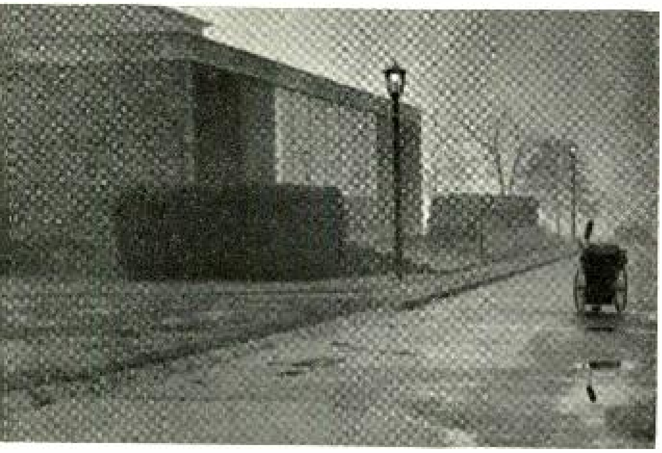
In retirement, Mr. Eggleston will remain in Morristown. Because mathematics is his hobby, his immediate plans include teaching the subject in a veterans' vocational school.

Percy C. Smith

Following his graduation from Worcester Polytechnic Institute (B.S. in E.E., 1907), Mr. Smith was for eleven years with the Patent Office, where he rose to be an assistant examiner and specialized in dial telephone systems. In 1919 he entered our Patent Department, continuing his activity in telephone switching systems. During his thirty years in the Laboratories he has had an active part in all our dial systems; his most recent work has been with the No. 5 crossbar and crossbar toll.

News Notes

Ralph Bown visited the Ohio Bell Telephone Company in Cleveland on January 30 and at noon talked to a supervisory group of twenty-five people about research at the Laboratories. In the evening he spoke at the annual banquet of the Cleveland Technical Societies Council on the subject *New Techniques in Intelligence Transmission*. On January 31 and February 1 Dr. Brown attended meetings of the Advisory Board of the Naval Ordnance Laboratory.



"Darkness at noon."

J. W. McRae visited the Northern Electric Company, Ltd., in Montreal and addressed groups from that company and the Bell Telephone Company of Canada on the subject of *Apparatus Development.*

Recent visitors to Murray Hill on January 24 were Fred Lowry, the famous whistler, together with his wife, and Richard Montgomery, who is collaborating in writing a book on *Whistling.* Mr. Lowry visited R. K. Potter with whom he discussed visible speech patterns. He also whistled into the spectograph to make some spectograms which will be used in his forthcoming book.

John Bardeen talked on *Flow of Electrons and Holes in Semiconductors* and H. D. Hagstrum on *Dissociation Energies of Molecules* before the American Association for the Advancement of Science meeting in New York City.

K. K. Darrow lectured on *Nuclear Energy* at Kent State College, Kent, Ohio, and on *Electricity in Metals* at the U. S. Air Force Institute of Technology, Dayton, Ohio, in January. He also visited the University of Cincinnati.

S. Darlington gave the third lecture of a series of six in the *Symposium on Modern Methods of Network Theory and Their Application* before the Basic Science Division, New York section, A.I.E.E. Dr. Darlington's lecture was entitled *Potential Theory Applied to Networks.*

R. L. Dietzold lectured on *Complex Function Theory Applied to Networks* at the Basic Science Symposium of the New York section of the American Institute of Electrical Engineers.

C. E. Shannon spoke on *Information Theory* before the Physics Colloquium at Cornell University and before the meeting of the American Statistical Association in New York.

The January 1950 issue of *The Journal of the Acoustical Society of America* contains papers on *A Method of Calculating Hearing Loss for Speech from an Audiogram* by Harvey Fletcher; and on *Reciprocity Pressure Response Formula which Includes the Effect of the Chamber Load on the Motion of the Transducer Diaphragms* by M. S. Hawley. It also contains a Letter to the Editor by W. Koenig on *Subjective Effects in Binaural Hearing.*

Guests of the Red Cross Chapters of New York City at their annual luncheon were D. D. Haggerty, Secretary of the Bell Laboratories Club, and Mrs. C. A. Smith, who will spark this year's campaign in the Laboratories; and P. B. Findley, Editor, who is a director and former chairman of the North Shore Chapter.

March Service Anniversaries of Members of the Laboratories

40 *years*
A. G. Hall

35 *years*
R. A. Clarke
G. G. Muller

30 *years*
F. J. Aimutis
W. W. Andrews
Valerie Beers
Hattie Bodenstein
C. T. Boyles
A. A. Carrier
G. C. DeCoutouly
K. M. Fetzer
Fred Gebhardt
R. E. Hartwig
R. S. Hawkins
W. J. Heitsmith
J. B. Hennessy
J. M. Holahan
H. G. Jordan
Mary Joyce
R. L. Lunsford
R. J. Miller
W. A. Moore
J. A. Oetzman
W. A. Schroeder
F. F. Siebert
M. N. Smalley
E. A. Wieland

25 *years*
Gustav Bittrich
C. A. Charity
W. S. Gunnarson
John Leitl
G. C. Otterbein
C. E. Pollard, Jr.
Ermenegildo Rampone
B. F. Runyon
J. A. Sherwin

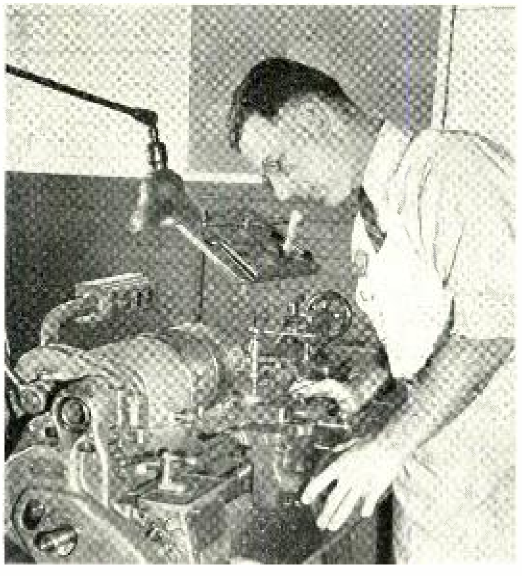
20 *years*
J. C. Bayles
M. D. Brill
Lawrence Cassano
A. B. Conner
R. V. Crawford
C. S. Fuller
W. M. Kellogg
R. H. Klie
J. L. Lindner
Maude Marks
Martha Maus
J. J. McCallion
Annesley Megraw
F. W. Metzger
W. C. Michal
James Morrell
Nelius Murphy
R. C. Newhouse
E. W. Nielson
A. E. Pattinson
R. L. Robbins
V. E. Rosene
A. H. Schafer
K. D. Smith
Walter Sokolosky
D. H. Wenny, Jr.

15 *years*
Blanche Adams
Stephen Balashek
T. J. Doherty
C. A. Haas
Paul Reiche
Catherine Swenson

10 *years*
G. A. Barbier
J. W. Bell
W. P. Brander
Gloria Carstensen
J. F. Gulbin
J. M. Hoagland, Jr.
C. J. Keyser
R. J. Martin
C. W. Peterson
E. T. Sheldon
J. F. Sweeney

THE FOLLOWING ARTICLES by members of the Laboratories appeared in the *Proceedings of the Institute of Radio Engineers,* January, 1950: *The Application of Thermistors to Control Networks* by J. H. BOLLMAN and J. G. KREER; *Radio Propagation Variations at VHF and UHF* by KENNETH BULLINGTON; and *Nonlinear Coil Generators of Short Pulses* by L. W. HUSSEY.

THE PHYSICAL REVIEW, January 15, 1950, contains articles by G. E. MOORE and H. W. ALLISON on *Thermionic Emission of Thin Films of Alkaline Earth Oxide Deposited by Evaporation;* and by R. D. HEIDENREICH on *Theory of the "Forbidden" (222) Electron Reflection in the Diamond Structure.* It carries Letters to the Editor by H. B. BRIGGS on *Optical Effects in Bulk Silicon and Germanium;* and by G. L. PEARSON and J. BARDEEN on *Erratum: Electrical Properties of Pure Silicon and Silicon Alloys.*



E. N. Profahl, left, operates a nine-inch lathe in the Whippany Shop. Wiremen R. Cook and F. B. Walters, right, were wiring amplifiers when photographed by the cameraman on his tour of Whippany.

J. P. GUERARD attended meetings in Philadelphia of A.S.T.M. Committee B5 on Copper and Its Alloys; and I. V. WILLIAMS, meetings of Committee A1 on Steel.

W. BABINGTON visited Hawthorne to discuss die castings.

H. W. HERMANCE and T. F. EGAN visited Hawthorne in connection with contact studies on wire spring relays.

A. C. WALKER gave talks on *Growing Piezo Crystals* before local sections of the American Chemical Society in Ashland, Kentucky, Charleston, West Virginia, Cincinnati, Indianapolis, and Terre Haute. He also spoke on this subject before National Metal Trades Association at the Advertising Club in New York.

J. B. DE COSTE and V. T. WALLDER discussed aging of polyvinyl chloride with representatives of the Rohm and Haas Company in Philadelphia. Mr. Wallder presented a paper entitled *Weathering Studies on Polyethylene for Wire and Cable Applications* at the meeting of the North Jersey Section of the American Chemical Society in Newark.

H. W. HERMANCE, T. F. EGAN, C. W. MATTSON and G. T. KOHMAN were in Pittsburgh and Chicago in connection with contact studies being carried out in cooperation with the Bell Telephone Company of Pennsylvania and the Illinois Bell Telephone Company. Mr. Kohman also visited the Mellon Institute and the Underwriters Laboratories to discuss problems relating to the use of gases in cables.

H. F. DIENEL, J. R. FLEGAL and G. K. TEAL visited the Norton Company in Worcester to discuss silicon carbide in connection with its use in varistors.

E. K. JAYCOX presented a paper entitled *The Role of Spectrochemical Analysis in Research* at a Symposium on Industrial Spectroscopy held under the auspices of the A.I.E.E. at the Statler Hotel in New York. Mr. Jaycox has been appointed Technical Editor of the Bulletin of the Society for Applied Spectroscopy.

C. B. Robertson
1894-1950

A. F. Gilson
1880-1950

RECENT DEATHS

Charles B. Robertson, *January 15*

Mr. Robertson, upon being graduated from the University of Tennessee in 1910, joined the Bell System student course at Hawthorne. At the completion of the course, he spent two years in Apparatus Development Engineering and then transferred to General Cable Engineering. That department later became a part of the Outside Plant Development Department of the Laboratories. Mr. Robertson was located at Hawthorne from 1910 to 1928, 1931 to 1938, and at Kearny from 1928 to 1931, and 1938 to 1949. His life work was the design and development of lead-covered cable for Bell System use. In his early career he was particularly concerned with quadded land and submarine cable for long haul toll routes. More recently he had been associated with the design of fine gauge cables for use in the exchange plant, and stub cables for loading coils.

Mr. Robertson, who retired last November, died during a visit with relatives in California. He is survived by his wife.

Albert F. Gilson, *February 13*

Mr. Gilson's early Bell System service was interrupted by a year and a half with General Electric, but in 1909 he reentered Western Electric "for keeps" as an apparatus design engineer at West Street. Ten years later he was put in charge of apparatus specifications and drawings. In 1922 he returned to designing, having charge of a group responsible for subscribers station and manual switching apparatus, and in 1928 he was put in charge of apparatus inspection engineering.

When the Laboratories' program of subcontracting began to grow, Mr. Gilson in 1941 was made purchasing engineer in charge of relations with subcontractors. In this post he supervised many millions of the Laboratories' purchases for government account during World War II. He personally visited scores of small plants to pass on their capabilities, and through his group was responsible for their meeting schedules.

Retiring in 1945, Mr. Gilson busied himself with civic affairs in his home town of Oradell. He served on the Borough Council and the Board of Health, and was overseer of the poor and executive assistant to the Mayor; he was also a director of the local building and loan association.

Mr. Gilson is survived by his wife, two sons, and a daughter.

News Notes

W. O. Baker spoke on *Polymer Research and Development* at the meeting on February 10 of the Deal-Holmdel Colloquium.

H. A. Birdsall, K. L. Schmitz and W. F. Vieth conferred at the Ribbon and Ticker Paper Company, Paterson, regarding a quality survey on perforator tape. Mr. Birdsall attended a meeting of the Metropolitan Section of the Technical Association of the Pulp and Paper Industry in New York.

The Hudson River once flowed along the spot where the West Street building now stands. Built on piles set in filled-in ground, the building is still over water. There are three places in the basement where soundings can be taken. Here we see Philip Curran making his weekly sounding of the water level below Section G.

W. ORVIS, T. S. HUXHAM and R. E. HECHT were in Point Breeze to discuss molding of plug shells.

K. G. COMPTON and R. C. PLATOW visited the Minnesota Mining and Manufacturing Company in St. Paul, Minnesota, to discuss electrical and magnetic recording tape. They also visited the Chrysler Company in Detroit in connection with adhesive problems associated with the manufacture of military equipment.

K. G. COUTLEE has prepared an article on *Electric Instruments* at the request of Interscience Encyclopedia Incorporated. The article has been accepted and will appear in *Encyclopedia of Chemical Technology*.

J. R. TOWNSEND, E. E. SCHUMACHER, H. G. ARLT and I. V. WILLIAMS visited Hawthorne to discuss materials engineering problems.

J. G. WALKER, H. J. WILLIAMS and R. M. BOZORTH have written on *Growing and Processing of Single Crystals of Magnetic Metals* in the *Review of Scientific Instruments* for December.

R. J. PHAIR gave a talk before the Lacquer Division of National Paint Varnish and Lacquer Association on *Testing Techniques and Uses of Equipment for Evaluating Organic Coatings* in Washington on January 19.

R. K. POTTER spoke on *Application of Sound Portrayal Techniques* on January 5 before the Philadelphia section of the Institute of Radio Engineers.

J. C. STEINBERG attended the annual meeting of the Volta Speech Association and rededication of the Volta Bureau at Washington.

AT THE MEETING of the Acoustical Society of America in St. Louis, papers were presented by H. K. DUNN, *The Calculations of Vowel Resonances*; W. A. MUNSON and F. M. WIENER, *Sound Measurements for Psychophysical Tests;* and B. P. BOGERT and L. C. PETERSON, *A Dynamical Theory of the Cochlea.*

J. L. GARRISON and R. M. C. GREENIDGE discussed preliminary designs of the packaged Transistor amplifier for crossbar toll switching with V. L. RONCI at Allentown and V. C. PETERSON at Haverhill.

R. A. SYKES attended the subcommittee meeting on piezoelectric crystals at I.R.E. headquarters in New York.

F. J. BIONDI conferred at the Cleveland Wire Works of the General Electric Company and the Cleveland Tungsten Company on tungsten and molybdenum raw material and specification problems. He also spent several days at Hawthorne where he reviewed chemical problems connected with the manufacture of switchboard lamps.

I. E. FAIR attended a meeting of the R.M.A. subcommittee on quartz crystal units TR-9.1 in New York.

L. W. GILES conferred with Western Electric personnel at Point Breeze, Hawthorne, Kearny, and Haverhill on details of plans proposed for the retirement of "D" specifications.

Noon hour finds this group of Personnel girls, Eleanor Fischer, Eleanora Freeman and Eunice Cottrell, selecting a silk scarf which Vicki LaBarbera is displaying.

M. WHITEHEAD's visit to the Sprague Electric Company, North Adams, Massachusetts, concerned electrolytic capacitors.

E. C. HAGEMANN and A. H. SCHAFER were at Allentown in connection with the quality survey on deposited carbon resistors.

C. C. HOUTZ observed inspection of initial production of tantalum capacitors for use in N carrier at the Fansteel Metallurgical Corporation in Chicago. He also visited the General Electric Company in Pittsfield for the same purpose.

L. W. STAMMERJOHN visited Haverhill to discuss voltage regulator and frequency generator production; A. R. D'HEEDENE and W. E. KAHL to confer on the manufacture of filters for the type N carrier system.

E. S. Willis was awarded the A.I.E.E. second prize in the Communication Class for his paper on *Crystal Filters Using Ethylene Diamine Tartrate in Place of Quartz.* He received a Certificate of Award at a session in the Grand Ballroom of the Hotel Statler during the A.I.E.E. Winter General Meeting.

J. C. Davenport, Jr. and J. H. Harding participated in a noise and waveshape investigation involving an inductive coordination problem at Summerville, West Virginia.

H. B. Noyes was in Syracuse in connection with crosstalk tests at video frequencies.

A. J. Aikens and R. M. Hawekotte are conducting field tests related to carrier telephone on R.E.A. power systems at Celina, Texas.

M. T. Dow is making tests of transmission on exchange cables in various parts of New Jersey.

E. L. Le Bright accompanied W. H. Goodell of A T & T on a field inspection trip to examine lens antenna installations on the New York to Chicago TD-2 microwave route.

"The Telephone Hour"

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

March 6	*Fritz Kreisler*
March 13	*Marian Anderson*
March 20	*Robert Casadesus*
March 27	*Bidu Sayao*
April 3	*Ferruccio Tagliavini*
April 10	*Ezio Pinza*
April 17	*To be announced*
April 24	*Clifford Curzon*

J. A. Coy and L. Pedersen, with W. R. Scherb of Western Electric, visited the Dohler-Jarvis Corporation at Pottstown, Pennsylvania, in connection with aluminum die castings for the N1 carrier telephone equipment.

V. I. Cruser, N. Monk and H. S. Winbigler, and G. Smith of A T & T, discussed with representatives of the Pennsylvania Railroad and the Bell Telephone Company of Pennsylvania problems associated with converting railroad mobile telephone systems for operation on a coin collector basis. Such systems are now in service with an operator in full-time attendance.

G. A. Boeck and G. S. Phipps investigated waveguide component troubles during the microwave installation at Tallyville, Delaware.

Engagements

*Evelyn Brady—*Edward T. Wojciechowski
*Molly Denman—*Earl T. Harkless
*Jean Ferry—George P. McCreedy
*Joyce French—Jean DeJorna
*Beatrice Hoke—*David E. Bilton
*Virginia Kingsley—Thomas Hill
*Rose Kovac—Stanley J. Rupnick
*Iris McLean—Ronald Samuels
*Margarethe Meyer—Robert Donahue
*Rita Thoubboron—Lawrence J. Ryan
*Eunice Whitley—Richard Costello

Weddings

*Doris Boyajian—John Laylagian
*Dorothy Brick—H. Allen Orshan
Joan Gilmartin—*Gregory Fiederowicz
Sybil Greenan—*Frederic N. Rolf

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

S. B. Ingram, showed kodachromes in the Arnold Auditorium taken on the trip which he and V. L. Ronci of Allentown made to Europe last year. The meeting was attended by many including the International Relations Group.

A. A. Hansen and C. Breen visited No. 5 crossbar offices in the Cleveland area in connection with field trials of simplified maintenance facilities. Mr. Hansen recently made a trip to Albany regarding single frequency signaling performance studies.

C. W. Halligan, W. H. Edwards and W. O. Arnold visited Washington with T. L. Smith of A T & T to confer with members of the Civil Aeronautics Administration on new requirements for the 111A key equipment.

A. J. Busch, F. S. Entz, F. A. Korn, R. L. Lunsford, R. W. Harper, and F. W. Treptow visited Hawthorne to discuss various matters relating to the No. 5 crossbar and step-by-step switching systems.

In Pursuit of the Minute→

The picture which graced the front cover of the September issue now appears in the Laboratories national advertisement. The chemist who sees his studies as a matter for reflection is J. D. Struthers. He works at Murray Hill and is assisted by Katherine Wolfstirn.