



BELL LABORATORIES RECORD

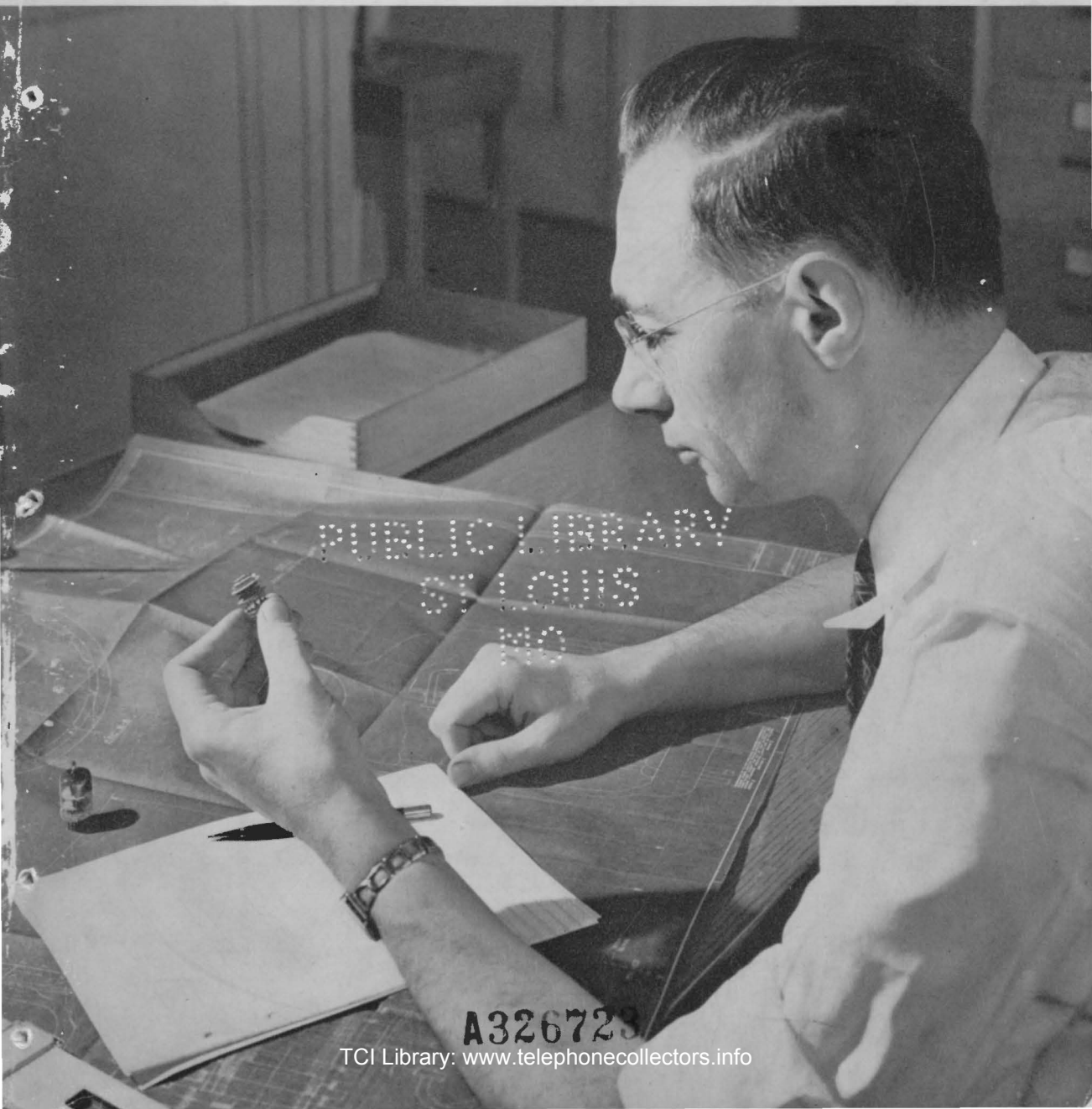


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THE COVER; G. T. Ford makes calculations for a new type of high-frequency amplifier tube based on the 6AK5.

BELL LABORATORIES RECORD: a monthly magazine for members of Bell Telephone Laboratories, for their associates in the Bell System and for others interested in the progress of the communication art.

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To all the Members of the *Laboratories*:

♦ ♦ ♦ Just twenty-five years ago, the name of Bell Telephone Laboratories was given to a long established research and development activity of the Bell System. During the eventful first quarter-century of our corporate existence, luster has been added to that name by our achievements in electrical communication and by our contributions to national defense and to the advance of scientific knowledge. Before us lies the opportunity for still greater accomplishments.

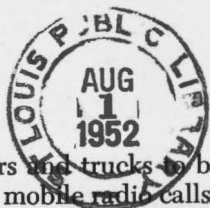
May the spirit of adventure and the high ideal of public service that have characterized our success of the past, continue to inspire us in our common endeavor.

For the year 1950, my wish for all of you is health, happiness, and satisfaction in your association with a team of which we can all be proud.

Oliver E. Buckley

Vibrating reed selectors for mobile telephone systems

A. C. KELLER
*Switching
Apparatus
Development*



To permit cars and trucks to be signaled individually for mobile radio calls, a 60 type selector has been used with the mobile radio receiver. This selector, originally developed for railroad dispatching circuits, was first adapted for coastal-harbor service to permit dialing ships at sea.* As used for mobile telephone systems,† it was arranged to receive five series of pulses, which permitted approximately 2000 numbers to be separately identified. With the prospect of growth in the mobile traffic, however, it was decided that provisions should be made for identifying as many as 10,000 different numbers, and since the 60 type selector was relatively expensive and required a comparatively large amount of operating power, it seemed desirable to develop a new selector not only to secure a larger choice of numbers but to secure a less expensive selector and one that would require less power to operate.

While models of this new stepping selector were being prepared, H. C. Harrison proposed an entirely different type of signaling system. It was to employ sharply tuned magnetic reeds that would respond to a group of signaling frequencies sent simultaneously from a land station.

The use of tuned magnetic reeds to respond to different frequencies goes back at least as far as Alexander Graham Bell, who, prior to his invention of the telephone, was experimenting with such a system for his harmonic telegraph. Tuned reeds have been tried many times since for one purpose or another, but there have always been practical

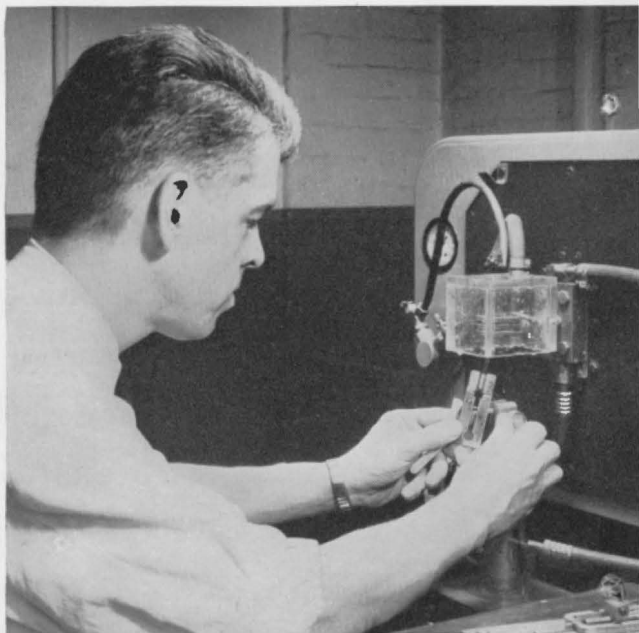


Fig. 1—G. E. Perreault making a tuning fork for a vibrating reed selector.

difficulties that prevented full success. Chief among these has been the difficulty in avoiding changes in tuning with variations in temperature. It was to a large extent the overcoming of this difficulty that has made possible the simple and effective signaling system that is now being tried out in mobile telephone service.

How these reeds are used in a complete signaling system will be described in a forthcoming article. Briefly it consists in generating at the land stations thirty-two frequencies, 15 cycles apart in the band from 350 to 850 cycles, and transmitting four of them simultaneously to signal a mobile receiver.

*RECORD, April, 1936, page 255.

†RECORD, April, 1947, page 137.

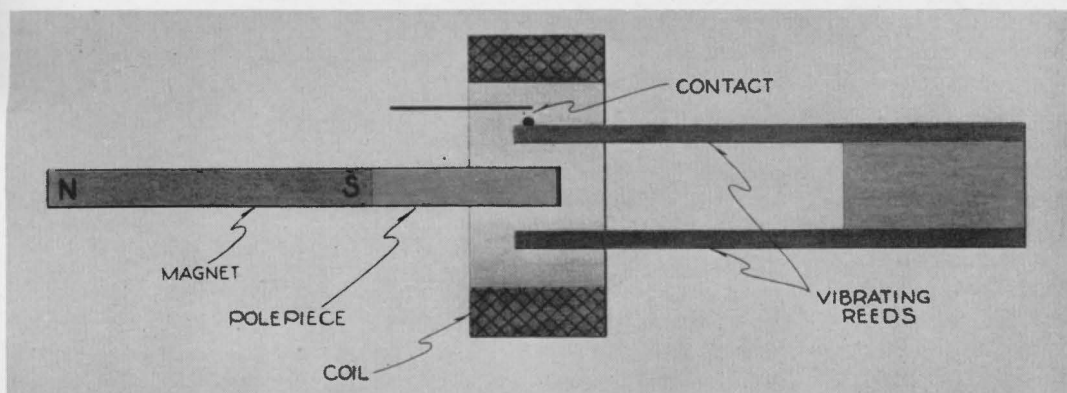


Fig. 2—Schematic of the vibrating reed selector.

Four selectors at the receiver will respond to only one combination of four frequencies, and in closing a series circuit through their contacts will ring a bell.

A simplified cross-section of the vibrating reed selector developed for this apparatus is shown in Figure 2. Two slender strips of magnetic material, only about an inch long, an eighth of an inch wide, and 15 mils thick, are securely attached to a block to form what is essentially a small tuning fork. Projecting between the two tines of the fork is the pole-piece of a permanent magnet. A coil of wire surrounding the ends of the tines is connected to the output of the radio receiver. If the current in the coil carries no component of the frequency to which the fork is tuned, the reeds will remain station-

ary, but when a component of the frequency to which it is tuned is present, they will start to vibrate, and in less than half a second will have attained an amplitude great enough to close the contact during a portion of each cycle.

The selector unit employed at the receiver includes four such selectors surrounded by a single coil. This unit is shown at the left in Figure 3. Each of the four selectors is tuned to a different one of the thirty-two frequencies available, and when the signal sent out by the land station includes the four frequencies to which the reeds are tuned, all four will vibrate and close their contacts. The series circuit through the contacts includes shunting capacitors to store charge each time a contact closes, and the output of

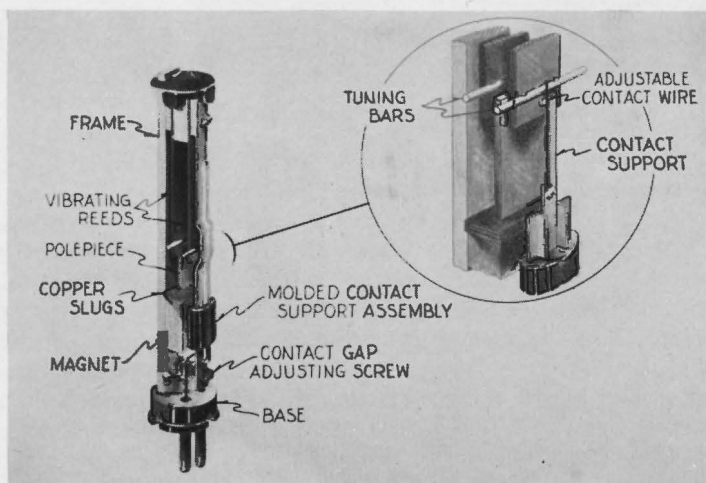
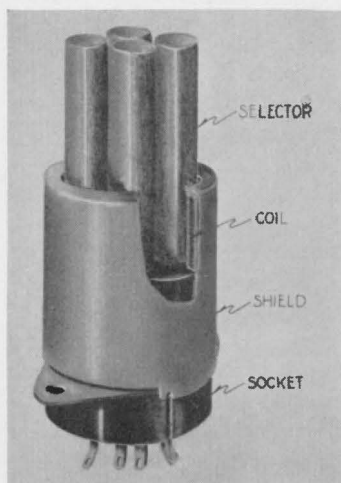


Fig. 3—Left, a complete selector as used at a mobile station; right, perspective drawing of the vibrating reed selector unit.

the circuit is applied to the grid of a vacuum tube to actuate the bell circuit.

Such a method of signaling has many advantages, which are discussed in the article already referred to. If the system is to be satisfactory, however, the reed selecting unit must meet a number of strict requirements. In the first place, the tuning must be sharp enough so that it will respond only to its intended frequency, but must not be so sharp that a slight shifting of the frequency at the land station will cause the reed to fail to respond. A study of the conditions to be met led to the requirements that the reeds must be adjustable to within 0.05 cycle of the desired frequency, and that with temperature changes from -40 degrees to $+185$ degrees

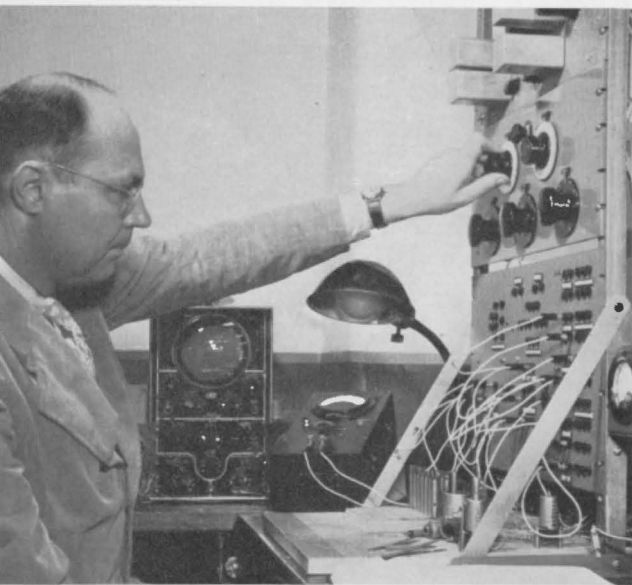


Fig. 4—S. D. White measuring frequency and sensitivity of vibrating reed selectors.

If they shall not vary by more than ± 0.5 cycle. The frequency at which the reeds vibrate is a matter of the mass and stiffness of the tines, while the sharpness of the tuning is a matter of the mechanical resistance effective in the vibrating system. Stability with temperature changes requires the consideration of the thermo-elastic, expansion, and magnetic properties of the materials that are used.

Still other requirements pertained to the arrangement of the contact which the reed makes when it vibrates. The fixed contact

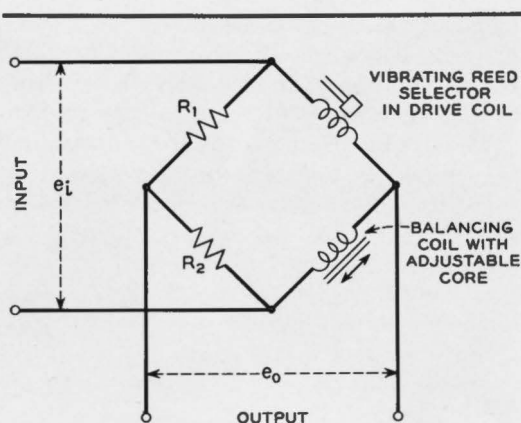


Fig. 5—Vibrating reed controlled selective circuit used at the land stations.

is a spring as in usual relay practice, and the spring must be stiff enough to insure a good contact and freedom from chattering. On the other hand, the spring must not be too stiff, or the mass of the contact too large, or the vibration of the reed would be upset because after striking the fixed contact, the amplitude of vibration of the reed would at once decrease to such an extent that contact would not be made. As a result, the resulting contact would be periodic, occurring in spurts instead of continuously once every cycle as desired.

How these various requirements are met may be seen by a study of Figure 3, right, which is a perspective drawing of one of the vibrating reed units. Tuning is accomplished by means of short rods fastened across the reeds near their free ends. By bending the ends of these rods toward or away from the fixed end of the reed, the center of mass of the vibrating reed is moved toward or away from its fixed end, and thus the frequency of vibration is increased or decreased. The reeds themselves are alike for all the thirty-two frequencies, and the particular frequency desired for each selector is secured by varying the length of the separating block to which the reeds are brazed. The final adjustment of the frequency is always made by bending one or more of the tuning rods.

To secure the required amount of damping, and thus to control the sharpness of tuning, a copper sleeve is slid over and at-

tached to the pole-piece of the permanent magnet. This gives the effect of a short circuited winding that introduces a loss and thus lowers the Q of the vibrating circuit.

The fixed contact is a small wire attached to a frame that may be moved toward or away from the reed by an adjusting screw near the base. The wire makes contact with one of the tuning rods on the reed. Its position relative to the reed is adjusted so that contact is made after the vibration has reached a specified amplitude, and will be maintained for a certain fraction of the vibrating period depending on the electrical input level.

The tuning fork assembly is mounted on a plug type base and enclosed in a protecting casing to form a selector unit. In the selector shown in Figure 3 are four receptacles, and four selector units of the proper frequencies all different are plugged in to make a complete selector. Once these selectors are installed in a mobile station, the calling code may be changed merely by replacing one or more of the selector units by others of different frequency.

Because of the unusually low mechanical impedance of these vibrating reed forks at resonance, L. G. Bostwick suggested that they could be used advantageously to provide exceptionally sharp band pass selective circuits. Such circuits are used at the land stations of the system to derive the thirty-two frequencies required. When a single selector without the contacts and without damping sleeves is mounted in a driving coil,

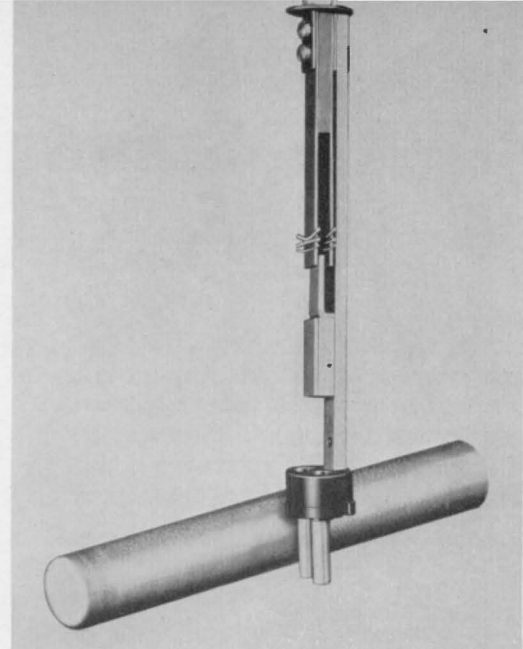


Fig. 6—The vibrating reed unit as used in a filter.

the electrical impedance of the coil increases several fold sharply at the resonance frequency. This characteristic is used to obtain a sharply selective circuit by making the coil with a selector serve as an arm of a bridge which is balanced with the fork not vibrating by adjusting the core in a similar coil in an adjacent arm. When a voltage is applied to the input of this bridge, the output voltage will be small except at frequencies near the resonance frequency of the fork, where the fork vibration unbalances the bridge. In the multifrequency source of the fixed station, a number of these bridge circuits are connected in parallel across a complex frequency source and each bridge cir-

THE AUTHOR: A. C. KELLER joined the Laboratories in 1917 as a laboratory assistant. Later he received the B.S. and E.E. degrees from Cooper Union and the M.S. with honors from Yale; he has also taken graduate courses at Columbia. His career, until World War II, was concerned principally with telephone transmitters, receivers, loudspeakers, sound recording and reproduction, including sound motion pictures, electrical transcription for broadcasting, and switching apparatus. This background was valuable in World War II when he had an active part in the development of underwater sound devices for submarine detection and signaling. Two awards from the Navy recognize his personal contributions and leadership of a group.

Following the war, Mr. Keller returned to the field of switching apparatus, where, as Switching Apparatus Engineer, he was responsible for new

relay and crossbar switch developments, vibrating reed selectors, and other electromechanical devices. At the present time he is Director of Switching Apparatus Development.



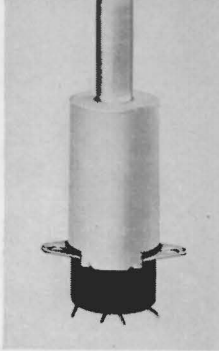


Fig. 7 — Filter selector mounted in single unit coil.

cuit supplies an output of one frequency. The circuit in which these filters are used will be described in a forthcoming issue.

One of these filter reed units is shown in Figure 6. The contacts and damping evident

in Figure 3 are absent, but the tuning rods or their equivalent are retained. These filter reeds are mounted in a single unit coil as shown in Figure 7.

A field trial of this new method of signaling, including the apparatus described in this article, has been under way at Richmond, Virginia, for some time to get experience with this new type of equipment. In this trial the new apparatus has given very satisfactory service, and future systems will very likely make use of this new vibrating reed selector.

Television network expansion

Seven more cities were added to the Bell System's present 18-city network during the latter part of 1949 and an additional 18 cities will join the network in 1950, the A T & T recently informed the Federal Communications Commission. Plans also call for the addition of more channels to existing routes.

The System's television network mileage were about 8,400 channel miles at the end of 1949—some two and a half times greater than at the beginning of the year. By the end of 1950, the System's intercity network will have grown to some 15,000 channel miles. Engineering work is under way west of Omaha, Neb., looking toward the extension of radio relay channels westward to San Francisco.

In accordance with the plans, Providence joined the Bell System television network on September 1. In October, service was extended to Rochester and the Ohio cities of Dayton, Cincinnati and Columbus. Schenectady, Utica and Syracuse, N. Y., received network service in December.

The three radio relay channels from Dayton to Columbus and the three others

from Dayton to Cincinnati were placed in service in time for the World Series broadcasts which were picked up at Dayton from the coaxial cable video network. One channel to each place is now being arranged for reversible operation. TE2 radio equipment is used with buffer amplifiers at all stations. This is the first use of the buffer amplifiers which were designed to permit the radio equipment to be located on the ground with the radiator on a tower or other inaccessible spot.

Memphis will be added to the network in March, 1950, and Norfolk will be included the following month. Johnstown will come into the net in the summer of 1950 with the opening of the new radio relay system now under construction between New York and Chicago.

Five Southern cities scheduled for network service in September, 1950, are Charlotte, Greensboro, Atlanta, Birmingham and Jacksonville. In October, 1950, it is planned to extend service to Indianapolis, Louisville, Davenport, Des Moines, Rock Island, Minneapolis, Omaha and Kansas City.

The original dial pulse register circuit for the crossbar system No. 5

The originating dial pulse register circuit receives information in the form of dial pulses from a calling subscriber's station and holds it for the marker to use in establishing a connection between the calling station and the line or trunk wanted. As described in an earlier article of this series,* the connection between the register and line over which the register receives the dial pulses consists of three wires extended from the register circuit, through the contacts of crossbar switches of the trunk-link and line-link frames, to the line termination on the line-link frame. Two of the wires, the tip and ring, are extended over the outside line to the subscriber's station, and the third, the sleeve, is used for holding the switches in the operated position under control of the register circuit, and for other functions not related to this description.

When the tip and ring connection has been established, there will be a series circuit consisting of the subscriber's instrument, the line wires, the two line windings of the dial tone transformer in the register, and a winding of the supervisory and pulsing relay L of the register, as shown in Figure 1. Relay L will operate in this circuit, and will cause the connection to be held, unless the subscriber abandons the call by "hanging up." The third winding of the transformer is connected to a source of tone, known as dial tone, which is thus transmitted to the calling station as a signal that the equipment is ready for dialing.

In most areas, the subscriber will dial a three-digit designation for the wanted central office, for example ME6 for Media 6, and then the four numerical digits of the wanted station. Three-digit or one-digit operator

codes, such as 211 for the long-distance operator, and 0 for the assistance operator, may also be dialed. Variations in this pattern of digits will be described in a later article. During the return rotation of the dial, a contact opens the tip and ring circuit momentarily a number of times corresponding to the number dialed, once for one, twice for two, etc., up to ten times for zero. A governor controls the speed of the return stroke, so that these pulses occur at the rate of about ten per second. These pulses are counted by the relays at the bottom and right of Figure 1, and at the termination of a train of from one to ten pulses, this count is transferred to two of a group of five relays. The counting relays are then released and prepared for counting the pulses of the succeeding digit. A group of five relays is provided for each digit to be recorded, and thus for seven-digit numbers, seven groups of five relays would be required.

The register circuit is able to recognize the end of a digit by the fact that the dial contact remains closed for more than 0.2 second between digits (trains of pulses), whereas the closed period between the momentary openings of the dial contact within a train will always be less than 0.07 second. A slow-release relay, which will respond to the longer but not to the shorter of these intervals, is used for this purpose. Actuation of this relay causes the pulse count to be transferred to the group of five relays, the pulse counting relays to be released, and the circuit to be advanced so that the next pulse count will be recorded upon the succeeding group of five relays.

When all of the required digits have been recorded, the register engages a marker and transmits to it the called subscriber number or operator code. After the marker has se-

*RECORD, March, 1949, page 85.

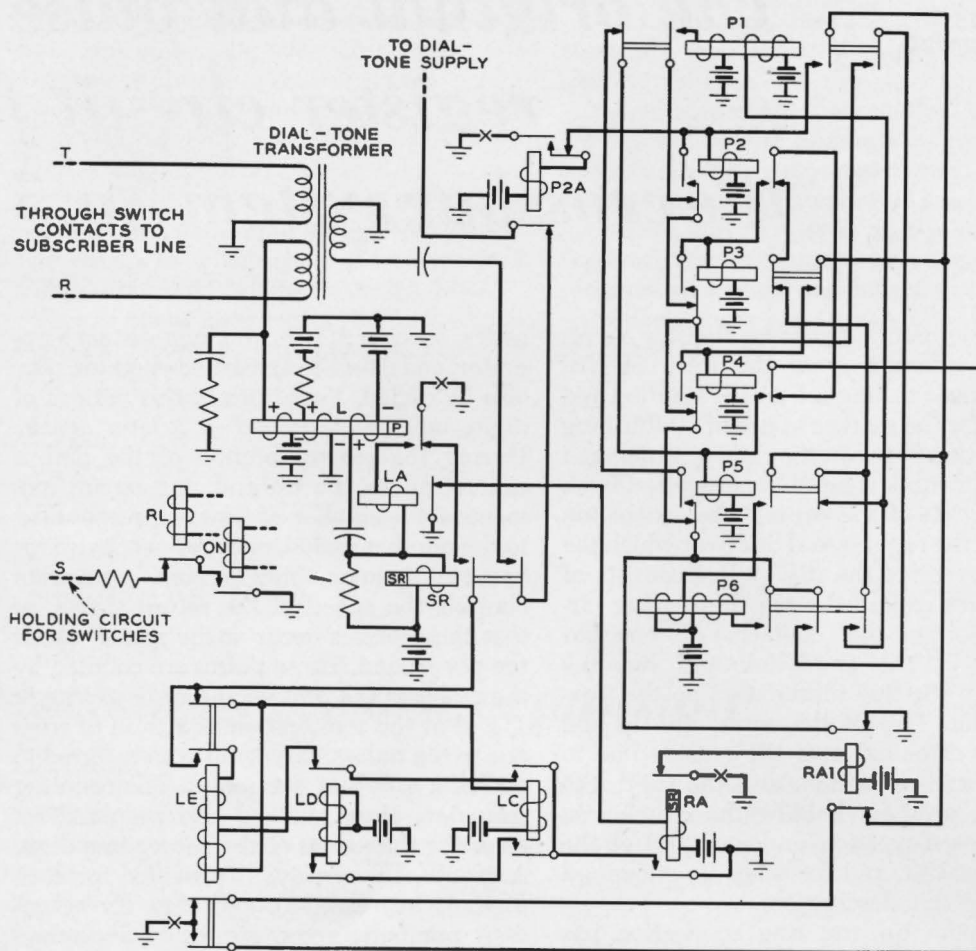


Fig. 1—Dial pulse counting circuit of the originating register.

lected a trunk in the wanted group and has decided what channel through the switches of the line-link and trunk-link frames to use for connecting the line to the trunk, it signals the register circuit to release its connection to the calling line, but it holds the connection between the register and marker so that the information recorded in the register circuit will be available until completion of the marker functions. It is necessary to release the line-to-register connection before setting up the line-to-trunk connection, because part of the apparatus is used for both connections.

When the desired line-to-trunk connection has been established, the connection between the register and marker is released, and both circuits restore to normal and are

available for other calls. The register is used about fifteen seconds in the performance of its functions. This time is determined principally by the speed with which the customer dials the call. The marker takes a fraction of a second, determined principally by the time required for testing and selecting an idle trunk and channel and actuating the magnets of the crossbar switches.

Pulse counting is carried out by the LC, LD, LE, RA, RA1, and the six P relays of Figure 1. With the tip and ring wires connected together at the station, the L relay operates, operating the LA and SR relays. The latter is slow in releasing, so that it will remain operated when relay L releases momentarily during dialing, but will release and cause the connection to the line to release if the cus-

tomer abandons the call by replacing the handset. Each momentary opening of the dial contact during dialing causes relays L and LA to release and then reoperate.* The first release of relay LA operates relay RA, which is slow release and remains operated until LA remains operated for a long time—0.2 second or more—at the end of the series of pulses for a digit. In its operated position, relay RA provides a locking circuit for relays LC, LD, and LE and causes the release of RA1. With relay RA1 released, the locking circuits of relays P1 to P6 are established, and the circuit is ready for counting dial pulses. Reference to Figure 2 will help in understanding the following description.

Each momentary release of the L relay closes a circuit for actuating relays LC, LD, and LE. The first release of the L relay operates relay LC, and the reoperation of L causes relay LE to operate in series with LC. The second release of L operates LD and holds LE. Relay LD in operating causes LC to release. When L again reoperates, relays LD and LE release. The third pulse has the same action as the first and the fourth the same as the second. The significant fact is that relay LE is operated by each odd pulse, and released by each even pulse.

The first operation of LE operates relay P1, and the first release of LE operates P2, which releases P1. This operation continues in such a manner that at the end of any number of pulses, the relays will be operated in the pattern shown in Table 1 on the next page.

When a digit has been completed, relay RA releases, and through contacts not shown in Figure 1 but indicated at the left of Figure 3, connects ground to two of the five register wires as shown in Table 1. These five wires are connected through the contacts of the "steering" relays—shown in the upper part of Figure 3—to the five relays of the digit being recorded. The corresponding two relays are operated, thereby recording the number dialed in the standard two out of five code.

The release of relay RA also releases relays LC and LE, if they are operated, and then operates relay RA1, which in turn releases the

P-relays, thereby preparing the circuit to count the pulses of the next digit.

Contacts of the RA1 relay, indicated in Figure 3, also control the steering relays, so that the five register wires will be advanced to the register relays of the following digit. This is accomplished in the following manner. Relay AS is operated when the register is selected. When relay P2A operates during

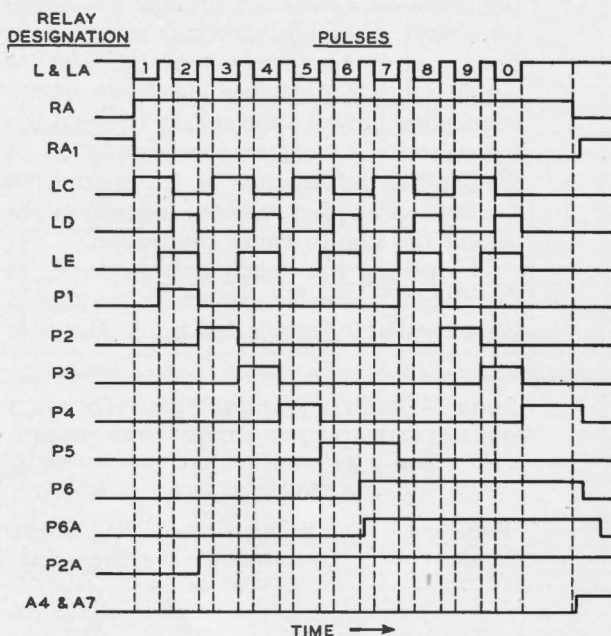


Fig. 2—Time diagram for the operation and release of the relays of Figure 1.

the dialing of the first digit, relay EV operates and completes the circuits of the five register wires to the five relays of the A digit. When relay RA1 operates at the end of the first digit, one of its contacts operates relay BS via contacts of EV and AS. Another contact of RA1 provides a holding circuit for AS. When RA1 releases at the beginning of the next digit, the holding circuit of AS is opened, and AS releases, releasing EV. Relay BS remains operated in a circuit through a break contact of CS (not shown), and causes OD to operate through a break contact of EV. The five register wires are now switched into the register relays for the B digit. A similar action takes place for the following digits. The contacts of the operated register relays are used to inform the marker of the called

*A pulse correction feature associated with the L relay was described on page 32 of the RECORD for September, 1940.

office designation and subscriber number.

In addition to recording the designation of the wanted line or trunk, the register circuit must perform certain other functions. One of these is recording and remembering certain information with respect to the calling line. These are: its location on the switches, the class of service to which the customer subscribes, and the numerical designation of the linkage used in making the connection between the line and register circuit. This information is recorded on groups of memory relays in the register circuit when the marker is setting up the connection between the calling line and the register circuit, and at the completion of dialing this information is transmitted to the same or another marker for use in establishing the line to trunk connection.

The calling line location is required, so that the marker will know which line should be connected to the selected trunk. The class

charge for service, and for other purposes of a similar nature.

The number designation of the linkage in use on the connection to the register is needed, so that the marker can consider this linkage to be idle when deciding what channel to use in connecting the line to the trunk. Although this linkage is actually in use when the marker selects a channel, it will become available when the register to line connection is released, just prior to establishing the trunk to line connection.

The register is also required to identify which of the parties on a two-party line is calling. In offices equipped with message registers, this information is used to cause the operation of the proper register of the two associated with the line, and in AMA offices it informs the AMA equipment which party is calling, so that the call can be charged to the proper station.

The two parties on a line are distinguishable from each other by dissimilarities in the station instruments. When the tip station is calling and its handset is raised, contacts in the instrument close a circuit from ground through a 1000 ohm ringer winding to the line wires. There is no similar connection at the ring station. The register, having been informed by the marker that the calling line is in the two-party service class, makes two tests to identify the calling station. One test is made before dial tone is transmitted to the calling line, and a similar test is made at the completion of dialing. The two tests are made to avoid errors which might be caused by accidental depression of the buttons that actuate the switchhook contacts, thereby removing the ground at the tip station. If the results of the two tests do not match, the marker will cause a trouble card to be perforated, and will cause the register circuit to transmit busy tone to the subscriber.

To prevent registers from being held out of service unduly long, due to the failure of subscribers or circuits to perform their required functions, each register circuit is provided with an electronic timing circuit, which causes the register circuit to take appropriate action if a function is not completed in a normal time. The principal functions thus timed are the interval required to

TABLE I—OPERATION OF THE P RELAYS OF FIG. 1 AND THE GROUNDING OF THE REGISTER WIRES 1, 2, 4, 7 AND 0 OF FIG. 3 THAT RESULT FROM SUCCESSIVE PULSES.

Pulse Number	Relays Operated	Reg. Wires Grounded
1	P1	0, 1
2	P2	0, 2
3	P3	1, 2
4	P4	0, 4
5	P5	1, 4
6	P5, P6, P6A	2, 4
7	P1, P6, P6A	0, 7
8	P2, P6, P6A	1, 7
9	P3, P6, P6A	2, 7
10	P4, P6, P6A	4, 7

of service is required for several reasons. The type of station equipment may determine which of several trunk groups to the same destination should be used. Coin and noncoin stations, for example, usually require either different trunk equipments or a universal type of trunk equipment that can arrange itself for either kind of station upon signal from the marker. Another need for class of service is to restrict groups of lines with respect to the offices they are permitted to dial, depending upon their geographical location and the monthly

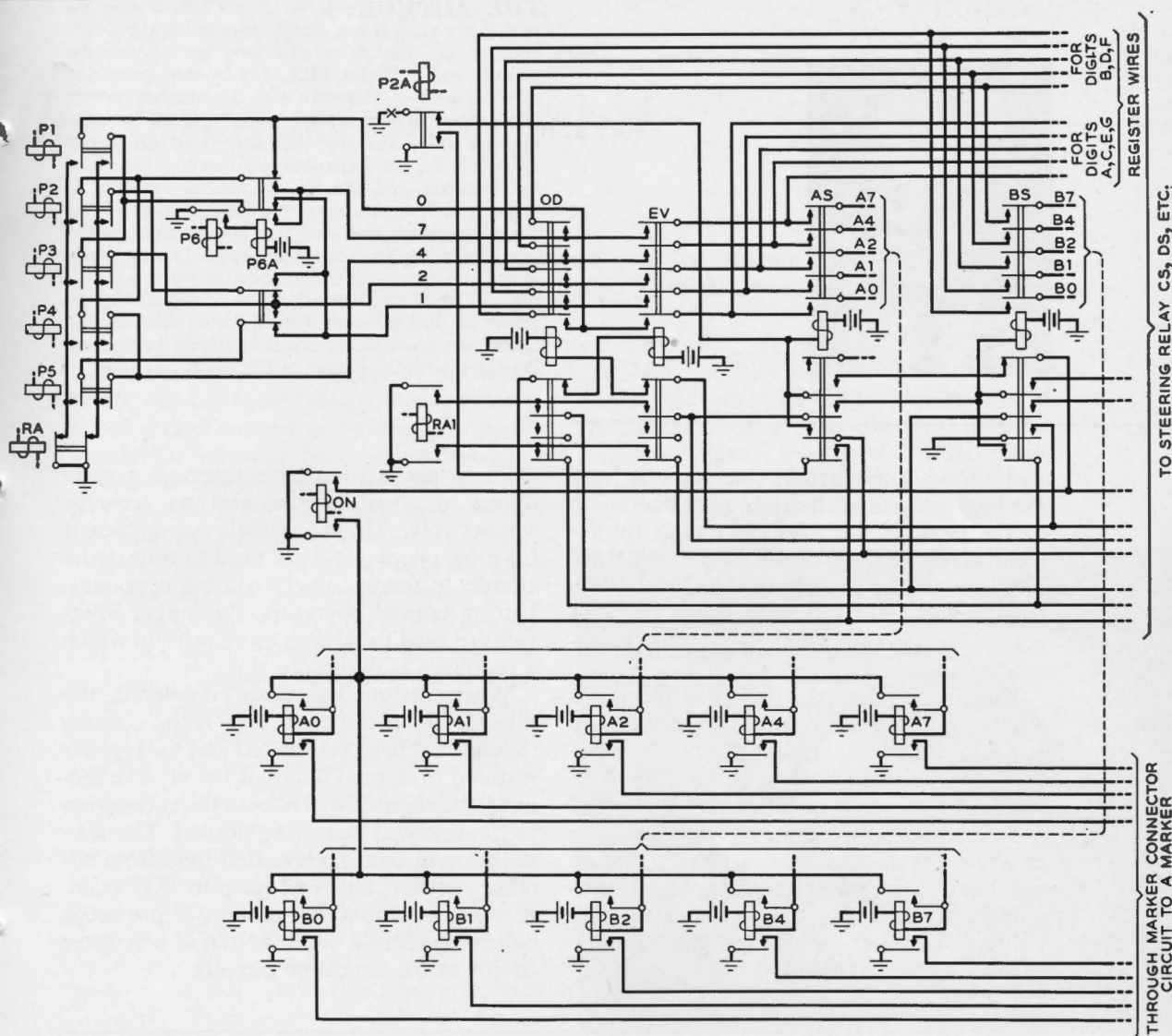


Fig. 3—Digit registering circuits of the originating register.

start dialing the first digit, the interval required for dialing each succeeding digit, and the interval required, after the completion of dialing, for completing the connection and restoring the register circuit to its normal condition.

About twenty-five seconds are allowed, after the register has been selected, for the subscriber to start dialing. If dialing is not started in this time, the register circuit requests a marker to connect the line to a permanent-signal holding trunk, and the register and marker are then released as on

a normal call. In this manner the register is restored to useful service in a reasonable time even though a line gives a "permanent signal" due to the handset being accidentally off the cradle, or due to a line fault in the outside plant wires. An operator is signaled by the permanent-signal holding trunk, and means are provided for locating the line that is in trouble.

If the customer starts dialing within the time allowed, the timer is returned to its starting point and restarted. It is returned and restarted at the beginning of each digit,



THE AUTHOR: J. W. DEHN has, during the past thirty years, been chiefly engaged in the development and design of switching circuits for the manual, call indicator, PBX, step-by-step, panel and crossbar systems. His work with the crossbar systems was principally on the common control circuits—markers and senders and their associated test circuits as used in the No. 1 crossbar, tandem crossbar, No. 4 toll crossbar, and the No. 5 crossbar systems. At present, he is supervisor of the group responsible for the development and design of the common control circuits for the No. 5 crossbar system. During World War II he developed communication systems for the Signal Corps, and trained military personnel in the operation and maintenance of the equipment. Mr. Dehn is a graduate of the Polytechnic Institute of Brooklyn with the degree of Electrical Engineer.

and allows about twenty-five seconds from the beginning of each digit to the beginning of the next. If the subscriber dials insufficient digits, or dials too slowly, the register will request the marker to connect the line to a partial dial trunk, which will transmit a tone to the subscriber as a signal to re-originate his call.

During traffic overloads, when there is a shortage of registers, some subscribers do not wait for dial tone, but start dialing before a register is attached to the line. As a result of this, some or all of the digits may not be received by the register. Also, due to accidents to the outside plant, a large number of lines may present permanent signals simultaneously, thus causing another kind of overload on the registers. In any case of register overload, the permanent sig-

nal and partial dial time intervals are reduced to about twelve, and six seconds, respectively. These intervals are sufficient for most people, and are used to restore the circuits to service quickly during overloads. During normal operation, the longer intervals are used to salvage those calls on which a customer is unusually slow.

When dialing has been completed, the timer is again restarted, and, if the connection has not been completed and the register restored to normal in about twenty-five seconds, the register will release the connection to the line and restore to normal. The subscriber will then receive dial tone from another register, and will have to dial again. It is expected that this action will not occur unless there is a fault within the register circuit or its associated circuits.

Japan Holds Memorial Services for Dr. Jewett

A memorial service for Dr. Jewett was held at the G.H.Q. Chapel Center, Tokyo, on Sunday, December 11. Following Scripture readings and prayer by Chaplain A. L. Simonson, there were addresses by Dr. Harry C. Kelly, acting chief of the economic and scientific section, S.C.A.P., and by Mr. Kamayama, president of the Japan Science Council. A message was read from General MacArthur, and from Dr. Jewett's old friend Kokichi Mikimoto.

Dr. Jewett's constructive friendship for Japan was recognized in 1923 by the Order of the Rising Sun and in 1930 by the Order of the Sacred Treasure.

The case of the barnacled crystal

G. T. KOHMAN
*Physical
Chemistry*

One day, Western Electric engineers inspecting the growth of EDT crystals at their Allentown plant made a startling observation. The crystals had started to grow what looked like barnacles (Figure 1) but which turned out on closer examination to be crystals of a kind never seen before. Worse—the mysterious intruder had caused the EDT crystals, urgently needed for the Bell System's coaxial program, to stop growing and appeared to be feeding on them.

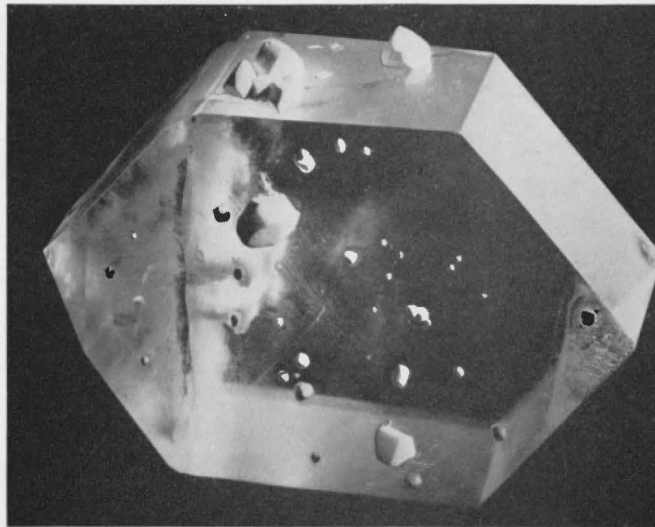
Alarming the infection spread from tank to tank, then over to the experimental tanks at the distant Murray Hill laboratory and even to the Western's production unit at Kearny where it appeared as a white fungus on crystal plates. Crystal production was threatened with complete shutdown and the situation was referred to the Laboratories where EDT crystals originated.

There the problem was attacked by a team of physicists, chemists and crystallographers in close cooperation with the Western Electric engineers. Within three days they had discovered the remedy and soon thereafter EDT production was headed back to normal. How this was done is a dramatic illustration not only of fundamental chemistry and physics in the role of Sherlock Holmes in the communication art, but also of the effectiveness of the team method of attack characteristic of the Bell Telephone System.

EDT (short for "ethylene diamine tartrate") is a piezoelectric synthetic crystal developed by the Laboratories for use as a substitute for scarce quartz in the filters of telephone carrier systems. Each crystal is grown* from a "seed," a section of EDT crystal, in a super-saturated solution of ethylene diamine tartrate. As the seeds rotate in the solution, molecules of EDT

pass out of solution to precipitate on the seed in rigid crystallographic order and in a few weeks the seeds grow large enough for the cutting of plates for filters.

It had been known from the start that "veils" and other flaws mar the crystals if the strictest control is not exercised over the concentration and temperature of the growing solution. But this was a new phenomenon in which the solution was apparently



sprouting new crystals of unknown origin. This the solid state group quickly established by measurements of crystallographic angles and by X-ray diffraction studies. Meanwhile, the physical mechanics group showed that the new crystal was worthless as a filter element because of its very slight piezoelectric activity.

That the new crystal was not due to any radical changes in the growing solution was obvious when the solid state group showed (1) that the new crystal grew well from freshly prepared solutions, (2) that the EDT crystal could grow well from the old solution, and (3) also that it grew well from

*RECORD, October, 1947, page 357.

a solution of the new crystal alone, in the absence of any seeds of the new crystal. Furthermore, the organic chemists were able to recover from the new crystals the exact ingredients from which the growing solutions were initially prepared!

The analytical chemists found that the composition of the strange crystal was the same as that of EDT except that it contained exactly one molecule of water for each EDT molecule thus establishing it to be a monohydrate of EDT. The solid state group also showed that when this water molecule was removed the intruding crystal broke down into a mass of very small EDT crystals.

These findings established that the solution itself was not to blame; so at any rate growing solutions need not be discarded. But what was the explanation?

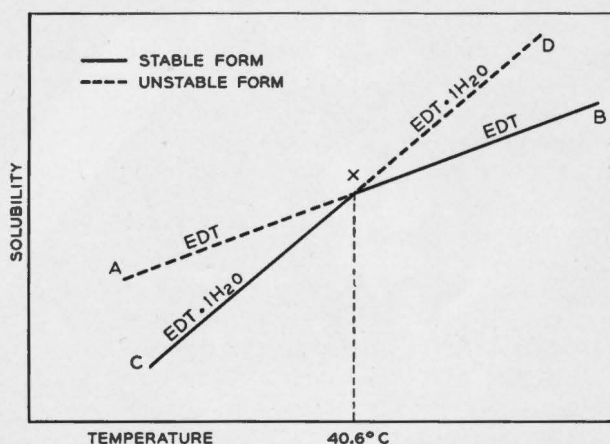


Fig. 1—EDT solubility relationships.

Physical chemists possess in the phase diagram or solubility relationship a powerful tool for determining under what conditions one or the other of several crystalline forms of a compound can be grown from solution. A few solubility determinations by physical chemists were sufficient to establish approximately this relationship as shown schematically in Figure 1. From this it is obvious that at temperatures below approximately 40 degrees C. the hydrate is the less soluble form. It also follows from physical-chemical principles that the less soluble form is the stable form in the presence of a saturated

solution and theoretically the two forms of EDT crystal can exist in equilibrium with the solution only at the point of intersection X of the two curves of Figure 1. The relationship shown in Figure 1 requires that at any point within the area AXC, the EDT crystal must go into solution and recrystallize as the hydrate if a hydrate seed crystal is present. At any point in the area DXB the situation is reversed and only the EDT crystal can grow.

Now the crystal plant had been operating at a growing temperature of 38 degrees C, in the region favorable to the formation of the hydrate if by chance a dust or other foreign particle of the right structure for a seed is carried into the tanks. Fortunately the point of intersection of the two solubility curves shown in Figure 1 occurs at only three degrees above the temperature at which the plant had been operated and it was a simple matter to raise the growing temperature by 4 degrees C to above the danger point.

To harassed engineers, under pressure to produce EDT crystals because of the critical quartz supply situation, this slight increase in temperature hardly seemed adequate to salvage a process which the mysterious intruder had sabotaged. Yet surely enough, in conformance with the solubility relationship shown in Figure 1, when the temperature in the Allentown tanks was raised by 4 degrees C, the hydrate began slowly but definitely to shrink while the EDT crystals recovered their normal rate of growth.

There remained the serious difficulty of preventing the formation of the hydrate in the processing of crystal plates for filters. In the Kearny plant, where it had been the practice to cut EDT crystals by techniques involving the use of water, the hydrate was found to sprout like a fungus growth on the carefully cut plates and the powdery hydrate seriously interfered with the extremely fine adjustment of the crystal plates to the desired frequency. These difficulties were gradually resolved by protecting the crystal from moisture as far as possible and by processing the crystal when possible above 40 degrees C.

In the Laboratories, where previously

THE AUTHOR: G. T. KOHMAN received the B.S. degree in 1920 from the University of Kansas, and then attended Yale University for graduate study. In 1923 he received the Ph.D. degree and joined the Laboratories. For some years he was in charge of investigations of the absorption of water and oxygen by organic substances and of the physical and chemical behavior of the paper and impregnants used in condensers. More recently he has been responsible for groups working in the chemistry of ceramics, crystal growth, and contact phenomena, and of dielectric measurement.



EDT crystals had been grown in large numbers by a "dropping temperature" process, the appearance of the hydrate rendered this process inoperative because as soon as the temperature of the growing solutions reached 40 degrees C the hydrate appeared in the solutions, causing the EDT crystal to stop growing and in some cases actually to redissolve.

The hydrate contains all the ingredients required for the growth of EDT crystals and it was found that it can be recovered from solution in a much purer form than the EDT salt which, until then, had been used to prepare the growing solutions and to keep them up to strength. At temperatures above 40 degrees C hydrate added to the growing solution dissolves completely in the solution in which EDT crystals are growing and cannot reform as the hydrate. Besides it is safer to feed to the growing solution, as crystal fragments which may

accidentally be carried into the growing tanks do not act as EDT seeds causing spurious growth. Growing solutions prepared and fed with the hydrate may be used much longer before the need for reprocessing to remove impurities and, because the hydrate crystallizes from contaminated solution in pure form, it is now used to advantage in the recovery of salt from spent growing solutions.

Had it not been for the alertness of the Western Electric engineers in detecting the presence of a new crystal in their growing tanks the production of EDT crystals could have been seriously delayed. The effectiveness of an organization where the services of a number of specialists in a variety of fields can be promptly brought to bear on an emergency problem, has been impressed on the writer who, after one look at the new crystal, had visions of a prolonged shutdown of the crystal plant.

Thermistor Aids in Measuring Humidity

Application of the Thermistor to measurement of atmospheric humidity is described in a recent article by Kenneth H. Jehn. The method is to mount a D-177232 Bead Thermistor on a mechanism which alternately dips it in a reservoir of water lifted up into the air stream to be measured. The usual difficulty of clogging of the wick is thus avoided. The wet bulb temperature of the air is measured by an electrical circuit including the Thermistor. Quick responses in changes to temperature of the Thermistor give the apparatus a lag of about 3 seconds which is approximately one-tenth of the lag of the usual mercurial psychrometer.*

* "Wet Bulb Temperatures without a Wick"—*Review of Scientific Instruments*, September, 1949.

Murray Hill auditorium as a listening room

L. B. COOKE
*Audio
Facilities*

At the Murray Hill Laboratory, the Arnold auditorium in the acoustics building is not exclusively an auditorium in the accepted sense of that word. Primarily it is a development tool known as a Listening Room—an uncommon laboratory in which

P. V. Brunck uses the intercommunication telephone of the backstage equipment.



sound equipment can be assayed by the human ear in such tests as loudspeaker response, amplifier overload, frequency bandwidth or the usable range of volume limiters and automatic volume control circuits. Although the room itself, with its special acoustical design, was completed in 1941, it was only recently that the comprehensive sound system necessary for optimum laboratory use could be installed. Now the combined Auditorium and Listening Room, through its associated sound equipment, affords extensive facilities for tests by ear.

Exceptionally good listening conditions have been built into this 93,000 cubic foot auditorium. Portions of the walls and ceiling are shaped to direct the sound originating on the stage into the seating area, and other surfaces are broken for sound dispersion. The 363 seats are heavily padded for sound absorption to yield in the empty room acoustic conditions approximating those when there is an audience. The rear wall of the stage is built of rectangular steel panels which are individually removable for loudspeakers to be mounted in their place.

Requirements for the new sound system called for an arrangement sufficiently complete and flexible for any need, yet simple enough so that ordinary listening tests could be set up easily and quickly. The result was the over-all system shown schematically in Figure 1. The level diagram of Figure 2* shows the drops in signal level, caused by mixers and gain controls, as well as the increases due to the amplifiers that overcome those losses and also raise the weak input signals to the power required for the loudspeakers. Flexibility was obtained by terminating all transmission

*On the charts VU is the transmission engineer's unit for the measurement of volume in electrical circuits. *RECORD*, January, 1949, page 16; and June, 1940, page 310—Ed.

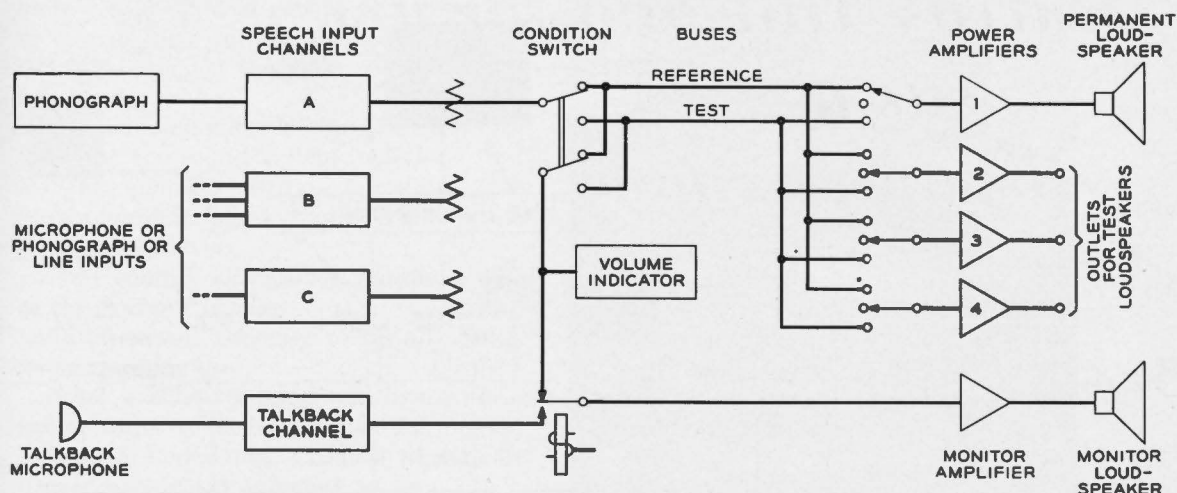


Fig. 1—Simplified schematic of the auditorium sound system.

equipment on normalled-through jacks. Circuits were arranged so that combinations most frequently used can be obtained without patching-cords. As illustrated by the example in Figure 3, operators of the system are guided by that and similar instruction charts that are mounted at the various equipment locations.

Amplifiers, gain controls and switching equipment are mounted in five cabinets backstage, as shown on the facing page. Those controls likely to be used most often are duplicated in a convenient console centrally located in the Listening Room and shown, Figure 4, in operating position. The console can be folded down without dis-

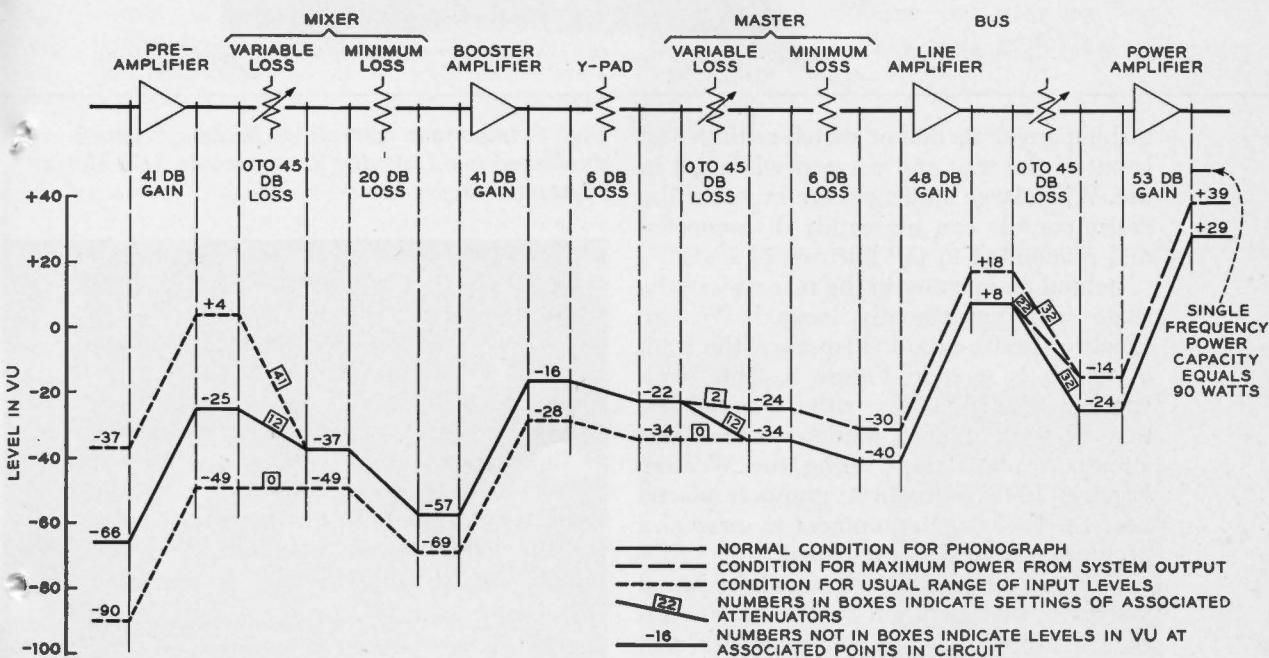


Fig. 2—Level variations of one channel of the system.

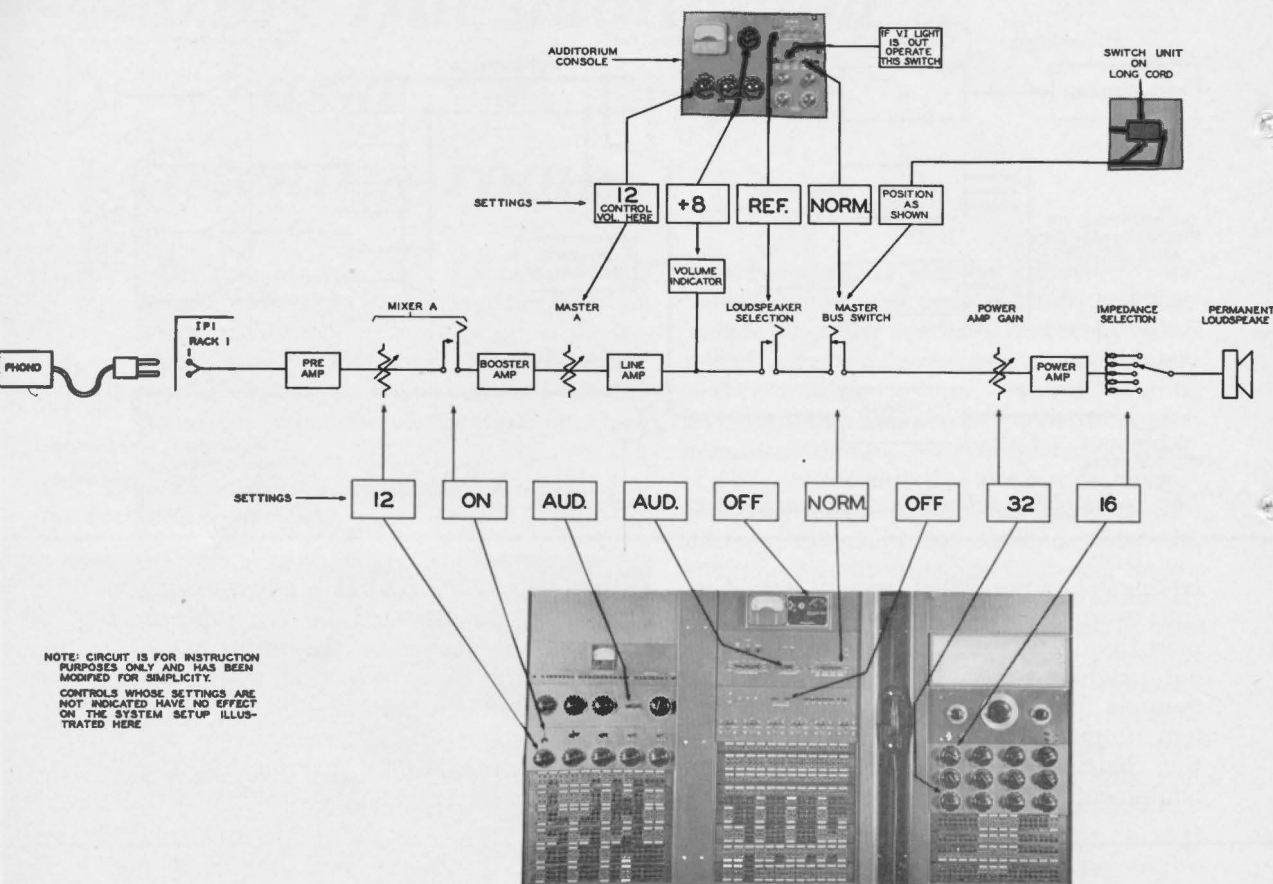


Fig. 3—One of the instruction charts which are posted near the equipment to assist in making simple setups.

turbing any of its dial or switch settings and is out of the way and covered when not in use. When large audiences are expected the entire console can be readily disconnected and remounted in the last row of seats.

Behind an opening in the rear wall of the stage is a permanently located Western Electric theatre-type loudspeaker, the front of which is seen in Figure 5. This loudspeaker is for use either with the sound system or with 35-mm motion picture machines. A phonograph using the Western Electric 109B reproducer group is placed near the backstage equipment to serve as a program source when required.

Heart of the testing facilities of the sound system is the condition switch. It is a 24-pole double-throw mechanism whose contacts, on relays, are accessible through plug and jack connections. The contacts are sep-

Fig. 4—Important controls of backstage panels are duplicated in a Listening Room console. J. Z. Menard is the operator.



arately controlled in groups of four and all or part of them can be operated by master switches either at the main control or console positions.

Transmission and switching facilities provided by the sound system include:

Gain sufficient to raise program from microphone or phonograph to the proper loudspeaker levels.

Gain control sufficient to handle a wide range of input levels.

Audio power capacity to fill any anticipated need.

Broad frequency band and low noise to insure high quality reproduction.

Output impedance variable to suit the usual loudspeaker impedances.

Amplifier and control equipment convertible to a 3-channel stereophonic setup by simple patching operations.

Talkback from auditorium control console to backstage monitor.

Phonograph reproducer for permanent program source.

Loudspeaker permanently installed and outlets for other loudspeakers on stage and backstage.

Patching and switching facilities for comparing standard equipment with a wide variety of experimental equipment such as microphones, phonographs, amplifiers and loudspeakers.

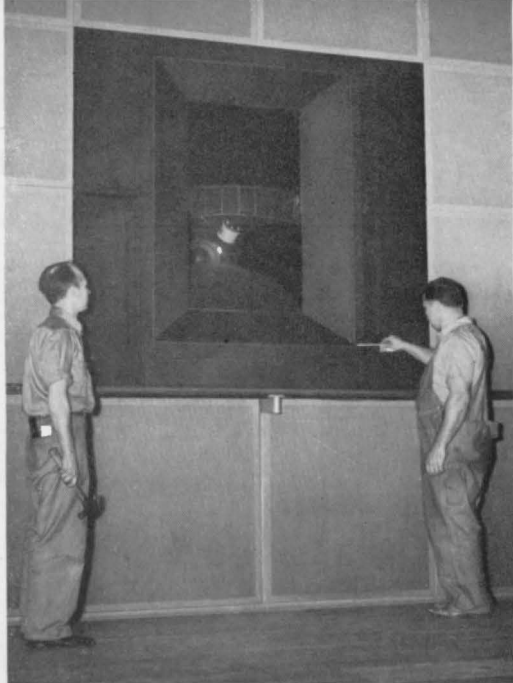


Fig. 5—Building Shop artisans E. Speck, left, and C. Scherer preparing to install the muslin shield at the rear of the stage, covering the loudspeaker installation. This loudspeaker is used with either the sound system or with 35-mm motion picture machines.

Complete control of the equipment at amplifier setup backstage.

Control console in auditorium to permit level control, volume indicator reading, loudspeaker selection, and switching between any two preset conditions.

THE AUTHOR: L. B. COOKE joined the Laboratories in 1921 and, with the Commercial Products Department, engaged first in the development of radio receivers and then in the design of circuits for power line carrier telephone equipment. In 1928 he turned to the development of circuits for reproducing equipment such as sound pictures, public address systems, speech input systems and, during the war, battle announcing systems for naval vessels. Since the war he has engaged in the design of special sound systems such as the one described in the accompanying article and in consultation with the telephone operating companies on sound system and acoustical problems.



Bell Laboratories served by Western's new teletypewriter switching network

The Western Electric Company has recently set up a new teletypewriter network which links nearly all its locations in the United States—as shown in Figure 1. The new network connects 56 locations in 40 cities and 24 states, through switching centers in New York and Chicago. Directly connected with the 195 Broadway switching center are 30 stations; 26 locations are linked with Hawthorne.

Included in this network is the Bell Laboratories' station at West Street. This station provides service for the three principal Laboratories areas—West Street, Murray Hill, and Whippany—and includes facilities for transmitting and receiving messages for Murray Hill and Whippany by an auxiliary

teletypewriter circuit to those locations.

The development of the 81C1 system has been previously described.* It is designed for large private line networks and can handle automatically a greater volume of messages with more speed and efficiency than is possible with earlier systems. Duplex circuits† make it possible to send and receive messages simultaneously over separate channels, which, with the use of automatic sending, receiving, switching and intercepting and storing of messages when necessary, make it possible to keep the switching system fully loaded and yet is capable of han-

*RECORD, September, 1948, page 370.

†RECORD, October, 1947, page 370.

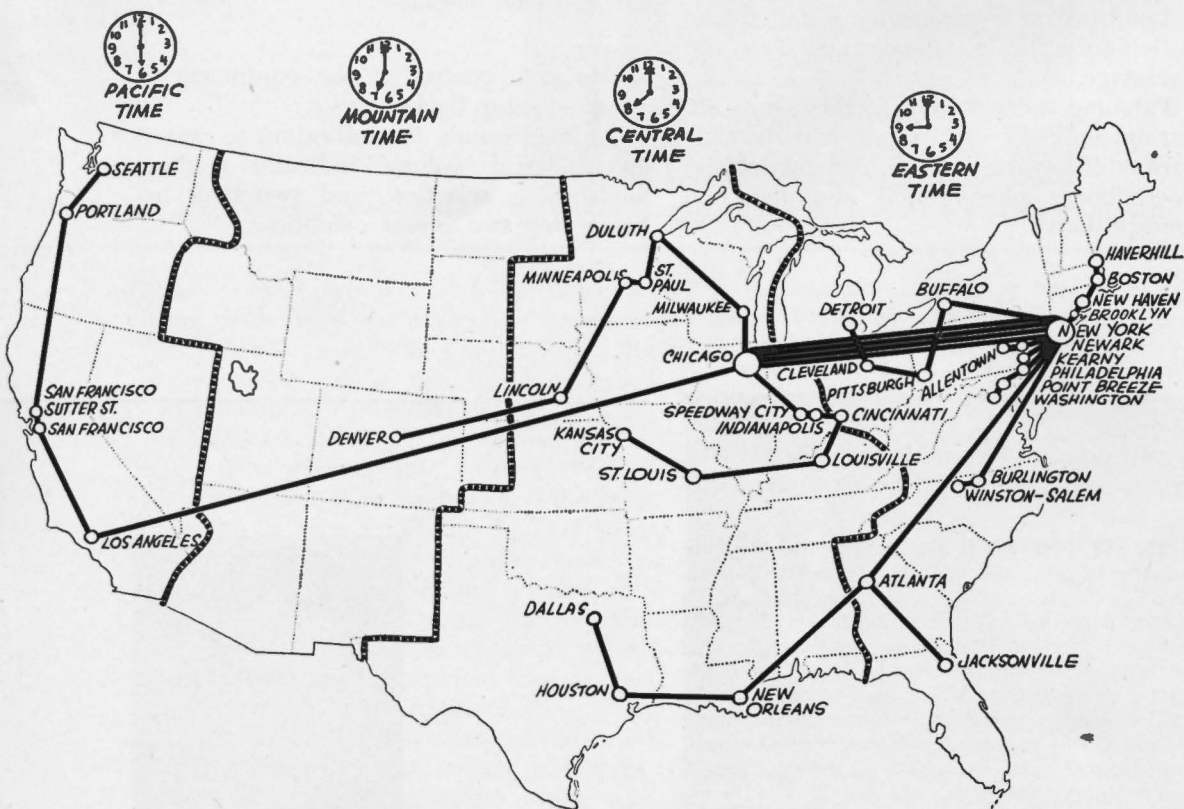


Fig. 1—The Western Electric 81C1 teletypewriter network.

dling rush communications with dispatch.

Each station in the network is given an address code which conditions that station to receive messages intended for it. The Bell Laboratories equipment accepts messages preceded by the code letters NL (West Street), LW (Whippany) and LJ (Murray Hill). It is also possible to send multi-ad-

At the switching office, the message is transcribed on a new tape by a reperforator-transmitter, which, "reading" the address code, sends the message to a similar machine connected with the outgoing circuit leading to the destination. This machine makes still another tape and sends out the message when the circuit is available.



Fig. 2—The Bell Telephone Laboratories teletypewriter station. Marie Taliaferro is at the receiver (left), Kathleen Curran operates the transmitter and, behind her, is the central cabinet. Vera Monohan, at the desk, is in charge of the Telegraph Department. Justina Howansky is at the machine in the corner.

dress messages to all offices, or to pre-arranged groups, by a single group code; or to any number of offices by using address-codes for the individual offices. It also permits routine messages to be classed as "deferred," in which case they will yield preference to other traffic. At peak load periods, however, a delay of only a minute or two is usually long enough to secure an idle path.

To transmit a dispatch, an operator types the message, preceded by the address code of the office of destination, in perforations in a paper tape on the originating teletypewriter. This tape is placed in a transmitter which sends the message over wire lines to the switching office.

At the receiving end, the message encounters a selector unit which confirms that office as addressee and permits the message to be recorded in page form for delivery.

Each station has a station control unit which provides automatic pick-up of outgoing messages and responds to its particular code to receive incoming messages. This unit connects and disconnects the receiving teletypewriter at the start and end of each message carrying the code. The stations transmit from individual tapes containing one to five messages. The number of messages perforated in a single tape and sent in one transmission is limited to five in order to provide each station on the line an equal opportunity to send its traffic.

Equipment features of the cable carrier system

A. J. WIER
Transmission
Development

In designing equipment for the Type-K carrier system, a large number of problems arose that were new to the telephone plant, either in conception or in emphasis. The use of crosstalk balancing coils,* for example, was distinctly new in conception; they never had been used in the plant before, and their disposition required careful study. The avoidance of crosstalk through office wiring and the picking up of noise, on the other hand, requires attention in any telephone office, but because of the wide range of frequencies employed by the Type-K system, and the wide difference in level between the input and output of the amplifiers, far greater attention had to be paid to these problems than was formerly necessary in cable circuits. As a result, practically every feature of a terminal or repeater station for the Type-K differs in its equipment features from practices previously followed. New types of frames, new types of wire, and new equipment layouts were required in addition to such things as the assemblies of crosstalk balancing coils. Also, since the higher

frequencies necessitated more repeaters in tandem than were required for voice circuits, and since the additional repeater stations would usually be in rural areas, new methods had to be developed for installing, maintaining, and operating unattended stations.

CROSSTALK BALANCING

The function of the crosstalk balancing coils has already been described.* They are required in large numbers—one to couple each carrier pair to every other carrier pair—and their best arrangement from the point of view of minimizing the connecting wiring proved a difficult problem. An intra-group balancing panel of Figure 1 contains the coils required for balancing the crosstalk of twenty carrier pairs. Pair 1, for example, will pass successively through a series of coils, first to couple it to pair 2, second to couple it to 3, etc., in the same intra-group. For proper phase relations, the coils should be arranged so that if the coil coupling pair

*RECORD, February, 1939, page 185.

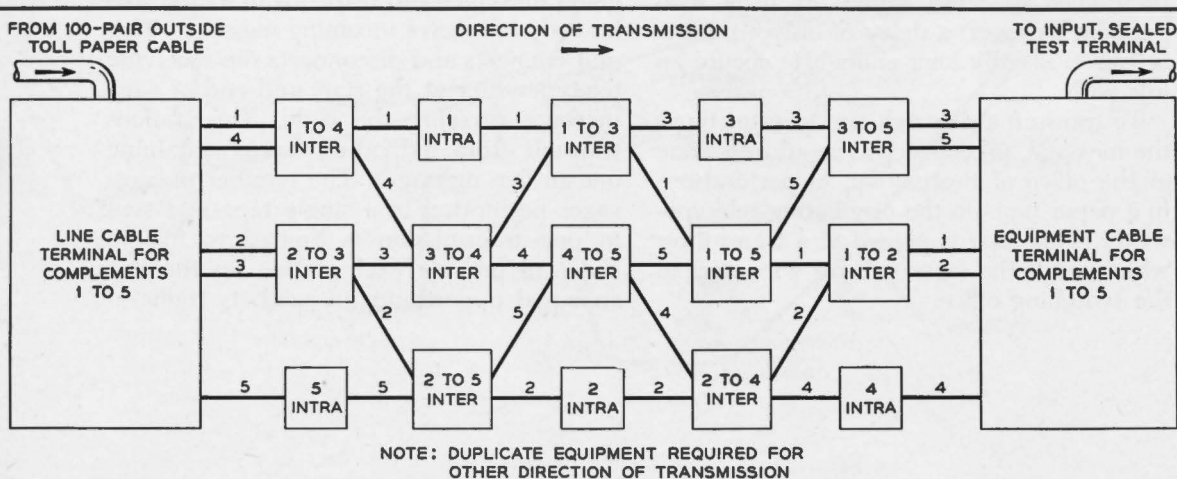


Fig. 1—Arrangement of panels for intra and inter-group balancing coils for 100 pairs.

3 to pair 16, for example, is the third coil through which pair 3 passes, it should also be the third coil through which pair 16 passed. To secure such an arrangement with the shortest possible connecting leads, an arrangement was devised that meets this requirement with a maximum deviation of one coil; no coil, in other words, is more

pedance of the nonloaded cable pairs, and the severe crosstalk and noise requirements per unit length, new arrangements had to be worked out for terminating the carrier pairs of the outside toll cable. Voice-frequency cable is generally sealed by gas plugs in the cable vault, and is then terminated at the main distributing frame by a

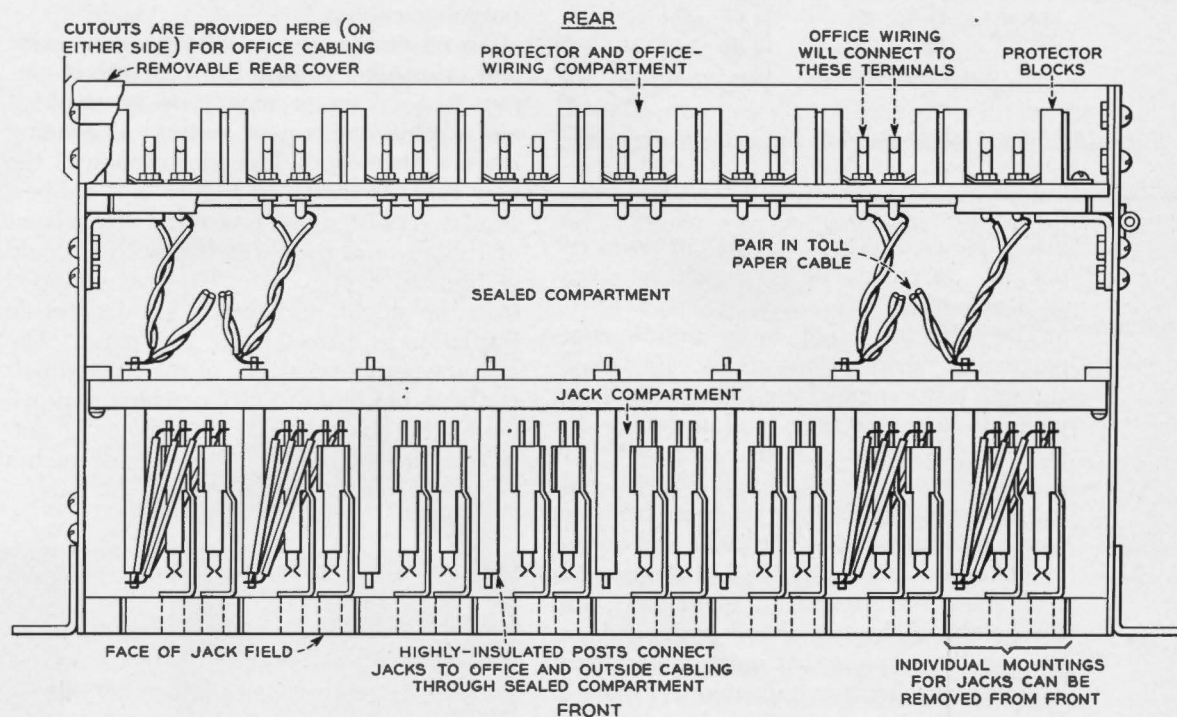


Fig. 2—Simplified cross-section of sealed test terminal.

than one coil from its ideal order in any pair.

Besides these intra-group panels, inter-group panels are employed to provide the required crosstalk balancing between the pairs of different groups. The coils of these inter-group panels must be arranged with a similar object in view, and the arrangements of the various intra- and inter-group panels must likewise follow a similar pattern. The interconnection between intra- and inter-groups serving 100 carrier pairs is indicated in Figure 1.

CENTRAL OFFICE EQUIPMENT

Because of the higher frequencies and longer circuits, the considerably lower im-

pedance of the nonloaded cable pairs, and the severe crosstalk and noise requirements per unit length, new arrangements had to be worked out for terminating the carrier pairs of the outside toll cable. Voice-frequency cable is generally sealed by gas plugs in the cable vault, and is then terminated at the main distributing frame by a short piece of textile-insulated lead covered cable. From there textile-insulated switchboard cable is run to the office equipment. Such an arrangement at carrier frequencies would leave an exposure at the main frame where noise could be picked up or trouble introduced on the carrier pairs, and also would introduce a length of textile-insulated cable having characteristics different from the paper-insulated toll cable. To avoid this situation, a paper-insulated tip cable is spliced into the main cable to take the carrier pairs directly to the carrier equipment without the use of textile cable. Here a sealed test terminal is provided as a connecting point between the outside and

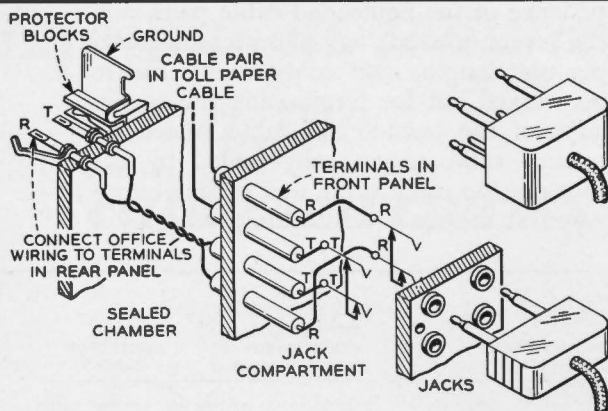


Fig. 3—Simplified wiring diagram for sealed test terminal.

inside plants and as a convenient point for test. Its arrangement is shown in cross-section in Figure 2.

The cable is brought to the middle compartment where connections are made through test and patching jacks on the front panel to the protectors and terminals for the office equipment on the rear panel. This middle compartment is then filled with sealing compound to exclude moisture from the paper-insulated pairs. The jacks and equipment terminals are arranged in strips, each with space for terminating eight pairs, and the height of the test chamber depends on the number of pairs that must be provided. The wiring scheme is indicated in Figure 3. Each conductor of a pair is brought to a jack and—through back contacts on the jack springs—to one terminal of the office equipment. A pair of jacks for a line is mounted immediately above a pair for the associated office equipment. Similar jack arrangements are provided for the high frequency patching, where both ends of the circuit connect to central office equipment. By inserting a double plug into the upper jacks, a connection is made to the line side, and the office side is disconnected. Plugging into the office side, disconnects the line side and makes a connection to the office side. This arrangement also permits the use of a four-prong plug for making level measurements on an in-service basis without the necessity of providing separate jacks for that purpose. The upper prong on each side of these plugs is directly connected to the lower one, so that

when the plug is inserted the connection between line and office equipment will not be broken. The level-measuring circuit is then bridged across the two sides of the line. A small aligning prong is provided on the plug so that the plug always has to be inserted in the same way, and thus avoids incorrect placing. Figure 4 shows the front or jack side of two such sealed test terminals, one for an incoming and one for an outgoing cable.

To offset the greater likelihood of noise and crosstalk resulting from the use of carrier frequencies, a new type of shielded office cable and a new method of running it were developed. The construction of the new cable is shown in Figure 5. A rubber-insulated twisted pair is covered with a layer of rubber, and over this is placed a shield of braided copper wire. Paper is wrapped over the shield, and then a braided textile insulation is placed over the paper. The characteristic impedance of the twisted pair is about 125 ohms at 60 kc, which approximates the characteristic impedance of outside cable pairs. The impedance of such a

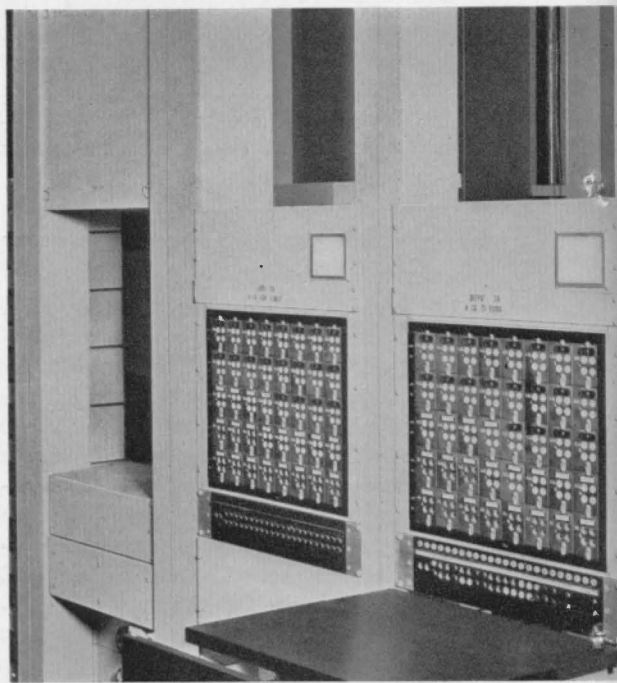


Fig. 4—Sealed test terminals at Albany, N. Y. (K2W) auxiliary station.

pair, moreover, is very stable with temperature and humidity.

The new method of cabling increases the separation of low and high level cables by using separate cable racks up to the point where the cables enter the equipment bay. Beyond this point, adequate separation is provided by a new design of bay framework. Its chief features are shown in Figure 6, which is a typical cross-section. The equipment is mounted on standard nineteen-inch panels, and all apparatus such as coils, condensers, and resistances, which do not require maintenance, are mounted on the rear. The wiring, vacuum tubes, and

level and low-level leads throughout and at the same time having the feedback circuit as short as possible.

The appearance of these bays is illustrated by Figure 7, which shows the rear of A1 channel banks at the left and the front of K2 and K1 group terminals at the right. Although the various carrier panels and units are designed to be as compact as possible, even this arrangement results in excessive length of wiring between units in the large offices. The arrangement of the panels with all apparatus requiring maintenance on one side, however, will permit mounting the bays back to back, with aisle

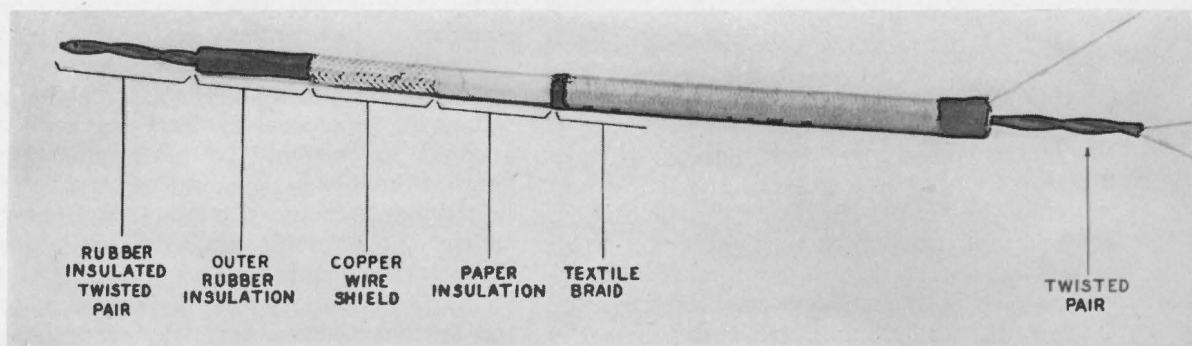


Fig. 5—Rubber insulated shielded wire developed for cable carrier systems.

any apparatus that may require attention from time to time is mounted on the front. With this arrangement, the heat from the vacuum tubes tends to keep the wiring dry, and results in greater stability. At each side of the bay, vertical troughs are provided for the bay wiring. The trough on one side is used for quiet power-supply leads and low-level carrier-frequency leads, while the trough on the other side is used for the a-c power and high-level carrier leads. Between the two troughs of adjacent bays a shield is placed to separate the low-level from the high-level wiring; a single member provides both support for the equipment and electrical shielding. The panel cover, which encloses and shields the apparatus on the front of the panel, overlaps the opening to these troughs through which wiring for the panel passes. The panels are arranged with their input circuit at the left and the output circuit at the right so that the greatest possible separation is maintained between the high-

space only along the front side of the bays. This arrangement, which is now being used quite extensively on A3 channel banks, will considerably shorten the wiring and save some thirty per cent of the floor space.

The system is designed so that high-frequency tests and measurements can be made from the main repeater stations while the system is in service. This is accomplished by the use of three pilot-channel frequencies obtained from the carrier supply equipment, which appear on the line as 12, 28, and 56 kc, and the four-pronged plugs already described in connection with the sealed test terminals.

ALARM SYSTEM

Each main station and its associated unattended auxiliary stations are equipped with the necessary alarm and communication equipment so that if anything at the auxiliary station is not functioning properly, the attendant at the associated main station

is automatically notified by both visual and audible signals. Some of the trouble conditions resulting in an alarm are fire, either too high or too low room temperatures, an open door, failure of the rectifier charging equipment, main or distribution fuse failure, and any other unusual conditions. These alarm signals are passed over either a carrier pair or a separate pair in the cable, which is operated on a closed-circuit basis so that a break in the alarm circuit will also give an alarm.

This alarm circuit, which has already been described in the Record,* uses step-by-step type selectors, both at the auxiliary and the main stations, which are stepped around in unison by an interrupter circuit at the main station when the alarm comes in. Each alarm circuit in the auxiliary station is connected to one of the points of the selector, and when the alarm is operated, ground is placed on the corresponding contact of the selector. At the same time a pulse is sent over the alarm circuit to the main station, where it causes both an audible and visual signal, and starts an interrupter. The selectors at both stations then start stepping around their contacts, and when the grounded one is reached at the auxiliary

station, current is passed over the corresponding contact of the selector at the main station, where it lights a lamp to indicate the nature of the trouble. Appropriate steps may then be taken at once for its correction. The alarm trunk unit for an auxiliary station is shown in the adjacent bay just above the left-hand sealed test terminal in Figure 4.

The object of lighting a number of lamps at the main station is primarily to indicate the type of trouble so that the degree of the emergency may be known. At the auxiliary station, however, the trouble is more specifically located. Relays in this unit lock up on each case of trouble and start the alarm trunk unit operating to register the alarm at the main station. When the maintenance man arrives, he operates a key which causes a lamp in the bank immediately above the sealed test terminal to light and indicate the source of the trouble. This method is adopted to prevent the pilot indicating lamps from placing an unnecessary drain on the battery before the maintenance man arrives. If the trouble condition is minor or the weather conditions are extreme, the maintenance man may not be dispatched to the auxiliary station for days or perhaps for a number of weeks.

The alarm trunk relay circuit at an unattended auxiliary station can be routine

*RECORD, July, 1940, page 345.

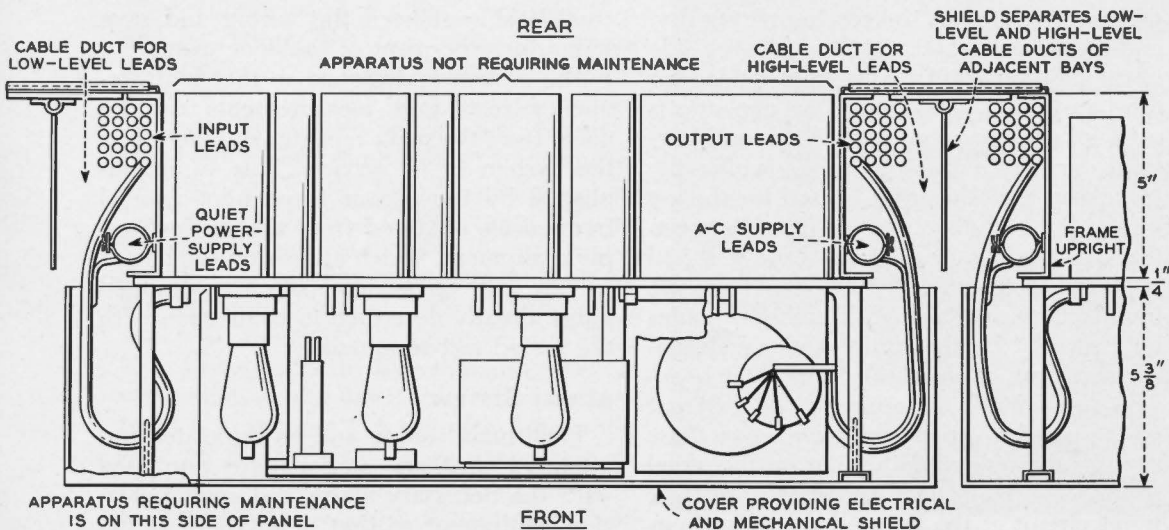


Fig. 6—Typical cross-section of bay construction for cable carrier systems.

tested on a remote control basis from the controlling main station so that a maintenance man need not be dispatched to an auxiliary station for that specific purpose.

GENERAL

Much of the terminal equipment, such as the channel banks, the four-wire channel jack bays, the four-wire terminating, and the carrier supply equipment is designed to be suitable for other multichannel carrier systems. This permits the standard units to be built in larger quantities and thus under more efficient conditions. The cable duct type bay framework together with the new double side mounted equipment arrangements are now standard for all toll transmission equipment.

The cable carrier systems, known as K1 and K2, now provide about 7,000,000 circuit miles of two-way message facilities and 55,000 circuit miles of program facilities. The heaviest development covers the area between Maine, Georgia, Nebraska, and Wisconsin. A lighter development is on routes from San Antonio and Beaumont to Kansas City and Wichita; from Omaha and Denver to San Francisco; and from San Francisco to San Diego and Whitewater.

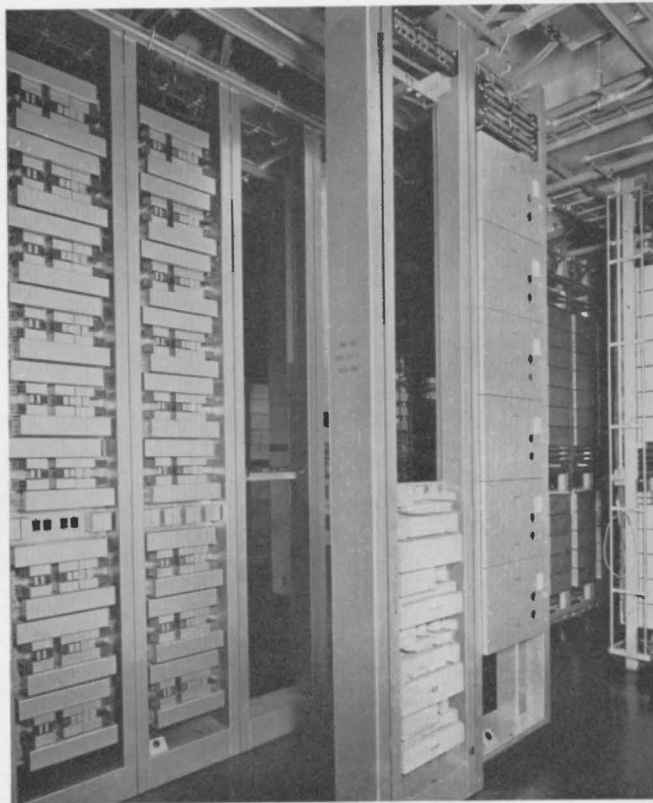


Fig. 7—A1 channel bank bays at left and K2 and K1 group terminal bays at the right.

THE AUTHOR: A. J. WIER started with the Western Electric Company Installation Department in 1911. Two years later he transferred to the New



York Telephone Company at Buffalo, where he engaged in central office maintenance work. Then after a year with the Pierce-Arrow Motor Car Company, he returned to the New York Telephone Company to engage in toll maintenance work until 1917, when he joined the United States Army. Upon his return from France in 1919, Mr. Wier resumed his previous work with the Telephone Company, but in July of that year, he was loaned for one year and later transferred to the Equipment Engineering Department of the Western Electric Company at Hawthorne and later at Kearny. In 1923 he was given charge of the Western-Zone Analyzing Department and later he took charge of the Toll Practice Department. In 1928, he was transferred to the Laboratories, where he has continued his work on transmission development problems. In 1935 he received an LL.B. degree from New Jersey Law School.

Montgomery Visits Murray Hill

Field Marshal Viscount Montgomery, hero of El Alamein and chairman of Europe's Western Union Defense, made a brief but intensive tour of the Murray Hill Laboratories November 30 as a side trip on his recent visit to New York.

Beribboned and with his familiar beret at a jaunty angle, the distinguished visitor was escorted to the Building II lounge where he was received on behalf of the Laboratories by W. H. Martin, Ralph Bown and R. K. Honaman. After they had outlined the purpose and general work of the Laboratories, J. W. McRae guided the party through the electron dynamics laboratory where J. A. Morton described the Transistor. The Viscount expressed keen interest in the device, asking a number of pertinent questions, and as he left good-naturedly commented, "I think I got that. At least I got most of it."

In another laboratory the new telephone set was explained by A. F. Bennett, and J. R. Townsend described the Laboratories' program in the growing of synthetic crystals and their use in the telephone plant. Waving his beret at a group of admiring spectators, Field Marshal Montgomery was escorted to the metallurgical laboratory, where he donned safety glasses to watch the pouring of a melt. In the anechoic chamber, W. A. Munson described its features, after which he commented, "If I ever want to do a bit of quiet thinking, I'll drop in here again."

Following a brief description of the auditorium at the end of the tour, he expressed hope that he would have the opportunity to visit the Laboratories again.

On the tour, the Marshal's only New Jersey



Viscount Montgomery learns of the growing of synthetic crystals and their uses in telephony from J. R. Townsend of the Chemical Laboratories.

visit, he was accompanied by William A. Hughes, president of the New Jersey Bell Telephone Company; Lloyd M. Felmly, editor of *The Newark News*; Horace Corbin, Port of New York Authority commissioner; Ralph Layte, president of Purolator, Inc.; Major General Edward C. Rose, chief of staff of the New Jersey State Department of Defense; and William Griffin, president of the English Speaking Union, whose New York house guest Viscount Montgomery was.

"Radar Systems and Components"

Most recent of the additions to the Bell Laboratories series of books published by D. Van Nostrand is *Radar Systems and Components**, written by members of the Technical Staff. Originally published individually in the *Bell System Technical Journal*, these papers have been collected within a single volume that should make the book a useful tool for persons engaged in this field of activity.

Following an introduction by M. J. Kelly, the papers follow in their proper relationship to the whole program of radar research and development. The first paper, *Early Fire Control Radars for Naval Vessels*, by W. C. Tinus and W. H. C. Higgins, discusses principally the Mark 3 and Mark 4 fire control radars for

naval vessels, with some of the history preceding their development. The second paper, entitled *The Magnetron as a Generator of Centimeter Waves*, by J. B. Fisk, H. D. Hagstrum, and P. L. Hartman is divided into two parts which respectively review the fundamentals of the theory of the magnetron oscillator and trace the research and development on this device during the war years 1940-1945.

The next three sections of the book cover the methods of applying the high voltage pulses to the magnetron oscillator. These sections are *High-Vacuum Oxide Cathode Pulse Modulator Tubes*, by C. E. Fay, *Coil Pulsers for Radar*, by E. Peterson, and *Spark Gap Switches for Radar*, by F. S. Goucher, J. R. Haynes, W. A. Depp, and E. J. Ryder.

Next is the paper, *The Gas Discharge Trans-*

*Price, \$7.50

mit-Receive Switch, by A. L. Samuel, J. W. Clark and W. W. Mumford. It concerns the development of the single antenna micro-wave radar, in which the same antenna is used for both transmission and reception. Many of the early radar sets employed separate antennas for the transmitter and receiver but the development of the gas-discharge switch resulted in tremendous improvements in gain, directivity, and simplification of tracking.

Receiver design and apparatus systems of the receiver are discussed in the next four sections. First is *The Radar Receiver*, by L. W. Morrison, Jr.; it considers the performance and design aspects of radar receivers. The second paper, *Reflex Oscillators* by J. R. Pierce and W. G. Shepherd, presents a broad exposition of the theory of reflex oscillators, and describes a number of typical tubes designed by the Laboratories to show the relation between theory and practice. The third paper, *Development of Silicon Crystal Rectifiers for Micro-Wave Radar Receivers*, by J. H. Scaff and R. S. Ohl, reviews the work done on silicon point contact rectifiers, discussing briefly typical properties of the rectifiers and describing several of the more important applications of their production history. The fourth paper, *Characteristics of Vacuum Tubes for Radar Intermediate Frequency Amplifiers*, by G. T. Ford, concerns the development of the Western Electric 6AK5 vacuum tube to meet the desired characteristics for tubes in broad-band IF amplifiers.

Radar Antennas, by H. T. Friis and W. D. Lewis, is the next section. This paper provides a general discussion of radar antennas and summarizes the results of research and development at the Laboratories.

The complexity of radar systems necessarily requires testing apparatus approaching the complexity of the radar systems themselves. In the next paper, *Techniques and Facilities for Micro-Wave Radar Testing*, by E. I. Green, H. J. Fisher and J. G. Ferguson, the techniques of radar testing are discussed and the types of test gear developed by the Laboratories and manufacturing by Western are described.

The last three sections of the book treat cylindrical cavity resonators. *High-Q Resonant Cavities for Micro-Wave Testing*, by I. G. Wilson, C. W. Schramm and J. P. Kinzer, considers the application of right circular cylinder cavity

resonators to the design of an echo box radar test set. *End Plate and Side Wall Currents in Circular Cylinder Cavity Resonator*, by Messrs. Kinzer and Wilson, discusses the electromagnetic field distribution in these cavity resonators and includes plates and figures to show the current distribution for a number of modes of oscillation. The final paper, *Some Results on Cylindrical Cavity Resonators*, also by Messrs. Kinzer and Wilson, contains the results of studies on wave guides and allied cavity resonators. An extensive bibliography is included.

Long Haul Radio Relay

In auditorium talks to engineers at West Street and Murray Hill, G. N. Thayer discussed the technical problems involved in the design of a microwave radio relay system suitable for transcontinental distances for which the first link (TD-2) is scheduled to open between New York and Chicago in the latter part of 1950. The new system using frequency modulation has been engineered to carry five television programs in each direction, or 2400 telephone conversations when fully equipped. That hundreds of telephone conversations can be carried in each radio channel was amply demonstrated during several weeks of trial over the New York - Boston link (TD-X).

Experience with the successful operation of the Boston link operated experimentally for



TD-2 repeater station at New Holland, Pa. The top floor houses the transmitting and receiving equipment which connects through waveguides to the antennas on the roof. Lower floors house rectifier, battery and power equipment.

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telephony and commercially as a television carrier since early 1948 disclosed the kind of improvements required for a system able to cover thousands of miles. The new system will utilize much improved microwave amplifiers featuring the 416A (Morton) tube in which the cathode-grid separation is one-fifth of a human hair. These close-spaced triodes amplify efficiently over more than three times the band width afforded by the velocity-modulated tubes used in the TD-X link and require one-sixth the plate voltage. An entire repeater amplifier will run on less than 500 watts, about one-third the power required by the present repeaters.

Closely following the cable route, the Chicago link will utilize wire circuits for order wire and alarm services. Unlike the Boston route, where advantage was taken of hills for repeater points, the country west of Cleveland is largely flat, necessitating special concrete towers up to 200 feet in height. Westward of Omaha the terrain is under survey, with specially developed portable antennas, for topographic and atmospheric obstacles to microwave transmission. Construction is under way to extend the system to Omaha.

New Long Distance Center Opened in Boston

A major addition to the nation's operator toll dialing network was placed in service during November with the opening of the New England Telephone and Telegraph Company's new long distance toll center at 185 Franklin Street in Boston.

As the sixth major control point in the country for long distance calls dialed by operators, the center provides swift machine switching on in-



The new building which houses the New England Company's Long Distance center in Boston.

tercity calls to and from the Boston area, and between other cities on calls routed by way of Boston.

The addition of Boston as a toll dialing center, together with the other New England communities tied into the network through Boston, brings to about 600 the number of cities and towns in the United States to which long distance calls can be dialed by the operator. All told, approximately 30 per cent of the Bell System's long distance calls are now handled in this manner.

The new Boston center is jointly operated by the New England Company and the Long Lines Department of A T & T, which provides the facilities for connections with points outside the New England Company's area.

Placing the toll center in operation represented the largest post-war project of its kind in the Bell System. Construction of the building, which is 20 stories high, started in July, 1946. Although primarily an operating center, including toll switchboards and a local crossbar tandem switching system in addition to the toll crossbar system, the structure also



← *New York Telephone Company's new television pick-up truck for use in New York City and nearby territory. The truck has a reinforced top for the transmitting antenna and a gas-driven generator for power in case normal supply is not available. It is expected that it will be used extensively for football, polo and golf matches and racing events outdoors, and contests inside sports arenas.*

serves as the headquarters for the Company's executive and general administrative offices.

The Franklin Street center replaces the Company's building at 125 Milk Street, Boston, as the link which interconnects 101 other long distance centers in New England and 48 major centers in the United States and Canada. The Milk Street building, after nearly 60 years of use, had become outgrown and was not adaptable for modern operating equipment.

H. T. Killingsworth Heads Long Lines

The Board of Directors of the A T & T has elected Henry T. Killingsworth vice president in charge of the Long Lines Department, effective November 16. Mr. Killingsworth, formerly general manager of Long Lines, succeeded Fred R. Kappel as head of that organization. Mr. Kappel became vice president in charge of A T & T operations and engineering, succeeding Cleo F. Craig, who became vice president in charge of finance and also continues to be responsible for rate and revenue matters.

New Microwave Radio Demonstration Set

Several demonstration models of microwave radio relay systems have been developed in the past under the direction of the display group of the Publication Department for use at conventions such as the I.R.E. and, more recently, for the A T & T "Looking Ahead" exhibit. These earlier systems were somewhat elaborate and complicated and required expert operation.

A compact new system was recently devised to provide reliable microwave demonstration equipment for science museums, fairs, and open houses, and for general use by telephone companies in telling the story of Bell System radio relay. The equipment is designed to operate at a frequency of 10,000 megacycles. The transmitter is arranged for modulating sound and the system has a frequency response of from 60 to 8,000 cycles. This will give excellent speech quality and acceptable music transmission quality.

The equipment is housed in two metal cabinets 17" x 10" x 9½" high, weighing approximately 30 pounds each. In a demonstration set-up, shown in the accompanying illustration, the transmitter is at the right and the receiver at the left. A metal-strip delay lens is shown interposed between the horns. This lens concentrates the radio waves in a manner analogous to a glass lens concentrating a light beam.

The transmitter input consists of a three-stage electronic mixer and a pre-amplifier. This permits music and speech to be mixed and sent simultaneously at any level desired. The fourth stage of the transmitter consists of a power amplifier and modulator for the velocity-modulated tube. The final stage has this tube, associated resonant chamber and antenna coupling unit. This coupling unit and its coaxial transmission line are gold plated at the contact surfaces, where they may be turned for directing the antenna horn. The transmitter also includes a regulated power supply for the velocity-modulated tube and another power supply for all other tubes. Three control knobs are provided, one for the electronic mixer, the second for the pre-amplifier and the third for tuning the velocity-modulated tube.

The first three stages of the receiving unit consist of an electronic mixing circuit and a



Elena Tighe demonstrates the new microwave radio relay equipment.

pre-amplifier. The fourth stage is a phase-inverter amplifier, the fifth, a push-pull power output feeding loud speakers. The output has several different steps so that any desired impedance may be selected for matching. A microphone may be connected directly into the amplifying system where speech can be mixed with the received radio signal. The amplifier section of the receiver may be used separately as a high-quality ten-watt output address system.

A number of these microwave systems have been furnished to telephone companies who have installed them in scale models of Bell System radio relay towers and other appropriate



New York Journal-American

This New York Telephone Company radiotelephone truck relayed messages from reporters to the sidewalk city desk set up outside the New York Journal-American's offices after a cable break had disrupted the newspaper's communications.

display backgrounds. In demonstrating micro-waves, the attendant shows the effect of direct transmission, reflection of radio beams by metal plates, polarization, the concentrating effect of various types of metal lenses and other micro-wave phenomena.

Mobile Service Helps Newspaper After Cable Break

Mobile service came to the rescue of the *New York Journal-American* on November 3 after a bulldozer had ripped up all the communication lines serving the newspaper. The bulldozer, working on the site of a housing project in downtown Manhattan, tore through ten cables—four of them of the New York Telephone Company—and disrupted telephone service in an area about one mile square. All sixteen lines of the *Journal-American*, including three teletype and nine trunk lines, were restored to service the same day.

During the period the newspaper was without service, the New York Company made every effort to assist the paper establish emergency communication facilities. One of the Company's mobile radiotelephone trucks was run alongside an auxiliary city desk which was set up on the sidewalk outside the *Journal-American* building. Messages from reporters were telephoned to the truck over the mobile system and passed

along to the sidewalk desk, then relayed further through telephones at the desk which were connected with the PBX board on the fifth floor. The switchboard was kept in service by means of an emergency power generator set up on a roof extension by Company engineers.

The newspaper also relied heavily on its fleet of cars equipped with radiotelephones. Reporters in these telephoned messages to the mobile truck for relaying to the city desk.

One of the New York Company's cables was a 1,200-pair, two were 900-pair and one was 300-pair. Some 1,800 lines in the area as well as 400 inter-office trunk lines between New York and Long Island, involving nearly 800 subscribers, were knocked out.

Cold Cures

Dr. C. E. Martin, Medical Director

Recently there has been much in popular periodicals and the press concerning the use of anti-histaminic drugs in the curing, and to some extent the prevention of colds. Many industries are using them on a company-wide scale.

We in the Medical Department have decided to proceed more cautiously, and have used them only in a few selected instances. We have found support in such a position in a recent announcement of the American Medical Association, through its Council on Pharmacy and Chemistry. The Council stated that it "is not convinced that the present evidence is sufficient to warrant the positive statements that are being made about the drugs."

In addition the Council stated that many of those who take these drugs "become drowsy or even fall asleep while at work or driving cars or operating machinery. Experience with these drugs is not yet long enough to know whether or not they are harmless when used over long periods of time. Furthermore, the amounts taken in persistent colds may be definitely beyond what has been established as safe."

Accordingly, until more satisfying evidence has been adduced, the Medical Department will make use of these drugs in only a very limited fashion for the treatment of colds.

West Street Choral Group Sings in Auditorium

On December 22 the West Street Choral Group sang in the Auditorium for the first time since its inception six years ago. The Chorus began with a small group in Systems Development and in other years sang on Christmas Eve to visitors in the Drafting Room 9C. Their voices were transmitted into the courtyard by

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means of loud speakers for all to hear. This year the Chorus sang ten traditional Christmas airs, with the audience participating in three. Under the direction of R. P. Yeaton, the Chorus was accompanied by Helen Forrester of the Club Store.

Dr. Gainza Paz from Buenos Aires Visits Laboratories

Dr. Alberto Gainza Paz, editor and publisher of the distinguished Buenos Aires newspaper, La Prensa, visited the Laboratories both at West Street and Murray Hill on November 23. He was accompanied by Joseph L. Jones, vice president and general foreign manager of the United Press Associations, and Harry Frantz, chief of the United Press foreign bureau in Washington. The group was received by R. K. Honaman and escorted on a tour of the West Street laboratories, during which there were discussions of automatic message accounting by J. Meszar, the transmission standards laboratory by P. W. Blye, and relays by H. O. Siegmund.

During the afternoon at Murray Hill, the general work of these laboratories was explained by J. W. McRae, after which a tour included discussions of the new telephone set by W. L. Tuffnell, the electron dynamics laboratory by J. B. Little, sound measurements reference laboratory by F. F. Romanow, synthetic crystals by A. C. Walker, the Transistor by J. N. Shive, and the anechoic chamber by H. B. Ely. J. G. Bell of the A T & T Information Department and Wesley Fuller accompanied the group on the tour.

H. C. Franke at the microwave transmitter controls at North Bend, Nebraska, during current tests of propagation over the North Bend-Arlington path in the Platte River valley.



Conservation of New York City Water Supply

Press and radio announcements have been stressing the seriousness of the water shortage facing the city of New York. The situation is such that, unless substantial economies in use are effected, emergency measures may have to be adopted by city authorities.

Murray Hill Chorus

The Murray Hill Chorus completed the first half of its 1949-1950 season with the traditional noon hour program of Christmas music on December 22. The Chorus will soon start work on the Spring programs. Membership is open to all Laboratories personnel and newcomers will be most welcome at the first rehearsal, Tuesday evening, January 10 at 8 o'clock in the Summit Y.M.C.A. auditorium. Light refreshments will be served.

The first 1950 appearance of the Chorus is scheduled for the Murray Hill auditorium in March.

Club Members in New York Study Ceramics

Under the sponsorship of the Bell Laboratories Arts and Crafts Club, two groups at West Street are being instructed in ceramics at the Wolfe Studios. Tuesday nights find beginners learning the uses of the potters' wheel and kilns, and Wednesdays advanced students study under the well-known ceramist in his spacious workroom located on Horatio Street near the Laboratories.

Murray Hill Stamp Club

The Murray Hill Stamp Club inaugurated with its December meeting a series of instructional talks for novice stamp collectors. It is hoped by this program to attract the interest of those who have had a mild interest in the past or are now contemplating philately as a hobby.

Subjects for successive meetings will be: *How to Collect Postage Stamps, Types of Specialized Collections, Album Mounting Arrangements, The Stamp Album and Its Use, The Tools of Philately, Sources of Supply for the Collector, and The Printing of Postage Stamps.* Lecturers will be qualified experts from Laboratories' members as well as outside organizations.



Christmas Dolls and Toys

At Christmas time members of the Laboratories dressed seven hundred dolls and sent toys to thirty-five hundred children in orphanages, nursery schools, hospitals, boarding homes, and homes for crippled children. In New York alone, where requests from forty-three institutions were received and filled, there were 3000 stocking fillers for the poor ranging from baseball gloves, fire engines with whirring sirens and accordions for little boys, to cuddly animals and stuffed dolls and a variety of sewing sets for girls.

There were also 350 dressed dolls for girls in the New York area. Girls at Murray Hill and wives of the engineers dressed 230 dolls and bought 200 toys for the Family Welfare League

of Summit, while those at Whippany dressed 125 dolls and, with 250 toys, gave them for the New Jersey State Board of Child Welfare for youngsters in boarding homes.

Fay Hoffman was the New York Doll and Toy Committee chairman with Helen Racz, secretary, and Marguerite Hutchinson, treasurer. At Murray Hill the officers were Muriel Rafter, chairman, Virginia Olan, secretary, and Marie Cusick, treasurer, and at Whippany Pat Rooney, chairman, Fanny Nobile, secretary, and Marion Merck, treasurer. As in former years, Mrs. Stevens, wife of P. A. Stevens of the Graybar-Varick building dressed twenty-four dolls for the display at that location, which was headed by Mollie Radtke.

The huge cornucopia of toys and dolls, shown above, was filled to overflowing for Santa at Whippany. In New York 43 children's hospitals and institutions received the Christmas presents shown in part below.





Left—The RECORD's favorite Santa looks over some of the dolls that were dressed by people at West Street. With him, left to right, are Eleanor Burden, Elena Benvenga, and Marguerite Hutchinson.

Left, center—The Graybar Doll and Toy Committee Mollie Radtke, chairman, left, Rose Rovegno, center, and Bernadette Fullhardt. Twenty-four of the dolls donated at Graybar were dressed by the wife of P. A. Stevens.



Members of the Murray Hill Doll and Toy Committee pose with their treeful of presents for youngsters of Union County whose Christmas is brightened by the Family Welfare Service of Summit.



Fay Hoffman, left, 1949 chairman of the Doll and Toy Committee at West Street and Edna Aamodt, right, a founder of the committee helped Santa to pack his bag.

News Notes

J. F. BELL, Chairman of the Board of General Mills, Inc., and a Director of the A T & T, was escorted through the West Street and Murray Hill laboratories by DR. BUCKLEY.

O. E. BUCKLEY, a member of the Engineering College Council of Cornell University, attended meetings of the Council at Ithaca on November 29 and 30.

A RESOLUTION on the passing of Frank B. Jewett was adopted by the Executive Committee of the Life Member Club and copies sent to the members of his immediate family. It read in part: "the Executive Committee of the Life Member Club sorrowfully record the passing of Dr. Jewett and their appreciation of his life and work, and sympathetically express sincere regrets to the members of his family in their bereavement."

D. A. QUARLES has been appointed to the Executive Committee of The Engineering Foundation.

MR. QUARLES gave a talk entitled *Military Communications* on November 28 before the USAF Special Staff School, Gunter Air Force Base, Alabama, and before the Air War College, Maxwell Air Force Base, Alabama.

A. B. CLARK attended the General Commercial Managers Conference, held at Seaview, N. J., from November 30 to December 2.

R. BOWN visited the Southwestern Bell Telephone Company territory and while there spoke on *Modern Transmission Methods in Electrical Communication* before joint meetings of the A.I.E.E. and I.R.E. in Kansas City, St. Louis, Oklahoma City, Dallas and Houston. In St. Louis he spoke to a group of Southwestern Bell Telephone employees on the work of the Research Department.

R. H. WILSON was the guest speaker at the meeting of the Hampton Roads Chapter of the National Association of Cost Accountants at its third technical session on November 18 at Norfolk, Virginia. Mr. Wilson's subject was *Scientific Control of Stock Room Inventories*. He also spoke on that subject before the Richmond Chapter of the National Association of Cost Accountants.

J. W. SCHMIED appeared before the Board of Appeals at the Patent Office in Washington relative to an application for patent.

THE LABORATORIES were represented in interference proceedings at the Patent Office by G. T. MORRIS before the Board of Interference Examiners.



Edna Buckner, chairman of the Activities Committee of the Women Pioneers, practiced making Christmas decorations under the guidance of Mrs. Marion Feddersen of the New York State Garden Clubs who gave a demonstration-lecture on floral arrangements in the West Street game room.

R. O. WISE and H. H. BAILEY flew to Fort Worth, Texas, for consultations with Western Electric Field Engineers on equipment for the Armed Forces. Mr. Wise and J. R. LOGIE visited the Griffin Air Force Base at Rome, New York, in connection with flight tests.

L. C. BROWN, O. P. CLARK, A. M. GARBLIK, and J. R. HARRIS visited Winston-Salem on production airborne communication equipment.

E. A. BESCHERER and R. F. LANE attended a conference on communication equipment at the Bureau of Aeronautics in Washington.

W. P. SMITH of the Whippany Staff Organization has been re-elected Mayor of Atlantic Highlands, a position he has held for the past four years. Previously he had served as Councilman for ten years and prior to that had served on the Board of Education. A native of Atlantic Highlands, he is a vestryman of the All Saints Church and a committeeman of Troop 22 of the Boy Scouts of America. He joined the Laboratories

in 1942 and worked in the Laboratory at Atlantic Highlands during the war. Another of Mr. Smith's accomplishments has been his convincing portrayal of Santa Claus for the blind, the sick, and the aged of his town whom he visits. This year he assisted the Doll and Toy Committee of Whippany and donned the red suit and whiskers for their display.

K. G. MCKAY has written on *A Germanium Counter* and CHARLES KITTEL on *Theory of the Formation of Powder Patterns on Ferromagnetic Crystals* in *Letters to the Editor* section, November 15, 1949 issue of *The Physical Review*.

O. E. DELANGE has written on *A Variable Phase-Shift Frequency Modulated Oscillator* in the *Waves and Electrons* section of the November, 1949, *Proceedings of the I.R.E.*

K. K. DARROW went to Philadelphia to attend meetings of the American Philosophical Society and to Chicago for meetings of the American Physical Society.

J. BARDEEN has written on *Diffusion in Binary Alloys* in *The Physical Review*, November 1.

C. E. SHANNON reviewed the book *Cybernetics or Control and Communication in the Animal and the Machine* in the November, 1949, issue of the *Proceedings of the I.R.E.*

R. A. HEISING's biography appeared in the November *Proceedings of the I.R.E.* He is a member of the I.R.E. Board of Directors.

B. T. MATTHIAS is on a leave of absence from Physical Research for advance studies at the University of Chicago. He is working on crystal structure analysis under Professor W. H. Zach-

ariasen. While at the University Dr. Matthias is also teaching classes in elasticity and hydrodynamics as an assistant professor of physics.

AT A CONFERENCE to discuss the work of the Physical Electronics Research Group at Murray Hill, J. A. HORNBECK lectured on *The Townsend Discharge on a Microsecond Time Scale* and H. D. HAGSTRUM on *Electron Ejection from Metals by Ions*.

J. R. HAYNES presented an invited paper "*Drift Mobility and Lifetimes of Injected Electrons and Holes in Germanium*" before the American Physical Society meeting in Chicago.

H. J. MC SKIMIN presented a paper at the Acoustical Society meeting entitled *Ultrasonic Measurement Technique for Small Specimens*.

L. E. ABBOTT discussed brazing problems at the Western Electric Company, Allentown, and the Bundyweld Company at Detroit.

R. M. BURNS addressed the Deal-Holmdel Colloquium on *The Role of Chemistry, Metallurgy and Material in the Bell System*.

H. W. BODE selected the topic *Speaking at Random* for his talk before the American Society for Quality Control at Princeton.

R. W. HAMMING attended a seminar on *Computer Methods* sponsored by the International Business Machines Corporation.

R. L. DIETZOLD presented the second lecture in a series of six in a Symposium on Modern Methods of Network Theory and Their Application. The lecture, entitled *Complex Function Theory Applied to Networks*, was given before the New York section A.I.E.E. Basic Science Division.

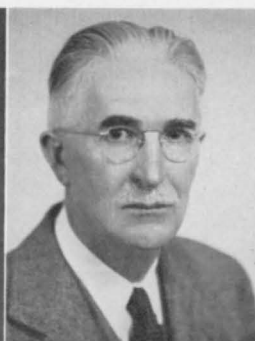
Another pre-Christmas activity sponsored by the Women Pioneers was the demonstration and talk Gift Wrapping Magic given by Rose Kinsey of the Tie-Tie Corporation. Miss Kinsey is shown demonstrating a figure-eight pom-pom.



RETIREMENTS



C. N. HICKMAN



R. V. L. HARTLEY



ANNA MARSHALL

Among those retiring from the Laboratories are R. L. Quass and Charles White with 40 years of service; W. M. Beaumont, 39 years; E. G. Hilyard, 36 years; T. L. Dowey, 35 years; F. M. Costello and S. F. Hayès, 32 years; Anna K. Marshall and Vina M. Allan, 31 years; R. V. L. Hartley, 30 years; and C. N. Hickman, 20 years.

RALPH V. L. HARTLEY

Early in 1914 the transcontinental telephone line was near enough to success that Chief Engineer Carty of A T & T began to seek new fields to conquer. Radio seemed promising and so orders came down to Ralph Hartley to look up the literature. Mr. Hartley had come to the Laboratories the previous September, after an under-graduate course at University of Utah and a Rhodes Scholarship for three years at Oxford. Soon experiments were going on, and within the year he contributed the famous Hartley oscillator circuit. He became the expert on receiving sets, and when tests were made from a transmitter connected to the Navy's antenna at Arlington, he was listening at San Francisco.

During World War I, while working on the problem of binaural location of a sound source, Mr. Hartley formulated the now accepted

theory: that direction was perceived by the phase-difference of sound waves due to the longer path to one ear than to the other.

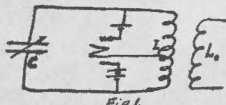
At war's end, Mr. Hartley took over research into repeaters, voice- and carrier-transmission. During the next decade, his keen imagination and skillful guidance carried the art a long way. Many early models of voice-operated devices were made in those days; one was the vodas, which prevents singing around long four-wire circuits. Mr. Hartley fostered the treatment of telegraph pulses by Fourier analysis so that a.c. measurements could be used in telegraph transmission studies. In an attempt to secure some measure of privacy for radio, he developed the simple frequency-inversion system known to the initiated as "greyqui hoy."

Broadly, however, Mr. Hartley's contribution was the intangible one of clarifying ideas and arranging them in a useful pattern. Nowhere is that better seen than in a paper "Transmissions of Information" which brought together a lot of ideas which had been implicit in the thinking of transmission men. Here he enunciated the law, later to be known by his name, "the total amount of information which may be transmitted over a system is proportional to the product of the frequency-range which it transmits by the time during which it is available for the transmission." The paper was presented at an international conference at Lake Como, Italy, in 1927.

Two years later, failing health halted Mr. Hartley's active work for several years. In 1939 he returned to become a research consultant on transmission problems—a post where he could bring together and fuse the knowledge of many men on a common problem. In retirement, Mr. and Mrs. Hartley will continue to live in Summit. He expects to continue his interest in information theory and learn more of the newer physics.

Oscillator

This consists of an oscillatory circuit L_1C , in which oscillations of its own natural period are maintained by means of a vacuum tube connected as shown in figure 1.



The plate is attached to one end of the inductance, the grid to the other end, and the filament to some intermediate point. An open circuit inductance L_2 is loosely coupled to L_1 .

Mr. Hartley's earliest known drawing of his oscillator circuit.

Mr. Hartley holds the A.B. from Utah and the B.Sc. from Oxford. He is a fellow of the I.R.E., the A.A.A.S., the Physical and Acoustical Societies and a member of A.I.E.E. The I.R.E. Medal of Honor was awarded to him in 1946. Seventy-two patents and five papers record his contributions and developments.

CLARENCE N. HICKMAN

It was fortunate for our country's war effort that C. N. Hickman did his graduate work at Clark University. There he met Dr. R. H. Goddard and during the last months of World War I, while the two were working together on rocket research, Dr. Hickman invented a recoilless gun. Came 1940 and he was loaned to N.D.R.C. to develop rockets; an early achievement was the famous "bazooka" used successfully by infantry against tanks. Eventually Dr. Hickman had charge of the Allegheny Ballistics Laboratory where he developed measuring techniques, including the Ribbon Frame Camera,* for studying the behavior of rockets, and participated in the design of many types of rockets. In 1944, with the temporary rank of colonel, he was sent to Europe to investigate captured launching sites for V-1 "buzz" bombs.

After his earlier rocket work was concluded, Dr. Hickman was at the Bureau of Standards on ballistics and electrical standards; and from 1922 to 1924 worked on mines at the Naval Ordnance Laboratory. He then did research work for the American Piano Company until 1930, when he entered the Laboratories in Acoustical Research. An early assignment was to look into magnetic recording, a technique which had been proposed but had not been particularly successful. In the first organized attack on this problem, Dr. Hickman developed means for magnetic recording on tape, which were ultimately embodied in the Western Electric "Mirrophone,"† widely used for recording and reproducing the voice. Other applications were to the weather announcing system used in many large cities, which in New York has answered as many as 268,000 calls in a day; and the audition demonstration at the 1939 World's Fairs. In 1937 Dr. Hickman transferred to Electromechanical Apparatus Development, where he has since been concerned with various switching devices.

Long interested in archery, Dr. Hickman has pioneered in scientific studies of bows and arrows, and has contributed extensively to the

literature. He founded the Laboratories Archery Club which he has been coaching.

In retirement, Dr. Hickman will have archery as one hobby and "magic" as another. His first sleight-of-hand tricks were performed at the age of six; at twelve he made his professional debut and two barnstorming tours helped put him through college. Dr. Hickman holds the A.B. in mathematics and physics from Winona College, and the Ph.D. and honorary D.Sc. from Clark University. The Medal of Merit was conferred on him for his war work. He is a member of A.I.E.E., S.M.P.E., the Acoustical and Physical Societies. The American Rocket Society has established the Hickman Award in his honor. Fifty-five patents have been issued to him, and many others are still classified as "secret." He is the author of the article "War Rockets" in the Encyclopaedia Britannica for 1947, and of about thirty professional papers.

ANNA K. MARSHALL

Anna K. Marshall came to the Laboratories thirty-one years ago following a stint on a West Coast newspaper for which she had created a woman's page. She had majored in botany at Syracuse University, and after a short time at West Street became associated with F. F. Lucas in new micrographic work that was getting under way. Miss Marshall grew with the laboratory and their microscopic analysis in metallography and biology made the laboratory one of the best known in the world. From the studies she made on sample materials used in telephone plants and the changes on samples due to various treatments, the Laboratories' engineers were able to suggest more serviceable and economical materials to the Bell System. She also did cancer research and during the war made special studies at the request of the government. She is the author of several RECORD articles and of a monograph.

Miss Marshall's retirement will be an active one. She joined the Women's Press Club and has begun to write seriously for publication. She is also considering an offer of a cancer institute to do part-time research in that field.

WILLIAM M. BEAUMONT

Bill Beaumont was born in Philadelphia and worked for "Bell of Pa." there for eight years before he entered the Laboratories in 1919. For a while he designed toll circuits, then in the local manual circuits group developed the No. 11 switchboard. In 1935 he shifted to PBX and wiring-plan circuits; his big jobs were the 755 PBX, the 101 key equipment, and the 1A key telephone system. During the recent war he designed circuits for air raid warning and re-

* Record, February 1945, page 40.

† Record, September 1941, page 2.



W. M. BEAUMONT



CHARLES WHITE

lated communication facilities. Currently he has been working on improvements in the 1A key telephone system.

The Beaumonts think well of Bell Telephone—two of their sons are in “Bell of Pa.” A third is at Rensselaer Poly.; all were in the war, all came home safely. Bill expects to go to Florida “to see what it’s like” and to indulge his hobbies—color photography, golf and piano.

CHARLES WHITE

When the transcontinental telephone demonstrations of 1914 proved that long repeatered lines were practicable, it was necessary to design circuits and equipment for commercial production. “Charlie” White, having just come to West Street after several years at Hawthorne, was moved from the 1-D switchboard job to repeaters. A couple of years later he worked on the first carrier telephone circuits between Pittsburgh and Baltimore; then followed terminal and signalling equipment for the first Key West-Havana cables in 1921. Until 1934 he had charge of toll switchboard developments; during those years he and his group took part in two notable developments. One was the first Bell System use of multi-frequency pulsing over toll lines; the other was the recording-completing trunk which is used to give the present “non-hangup” toll service. The No. 3 toll switchboard also came under his guidance.

After four years on telegraph, Mr. White in 1938 took up his present work—current engineering of toll circuits. This job required vast familiarity with what has been done, because he had to adapt new developments to what is in the telephone plant today.

Mr. White entered the Bell System in 1909 with an engineering degree from his State University—Kentucky—and soon transferred to the Western Electric Company as an equipment engineer. He is now returning to his native state where he will devote himself to raising flowers—and grandchildren.



E. G. HILYARD



R. L. QUASS

EDGAR G. HILYARD

From 1898 to 1913 Mr. Hilyard worked on or directed maintenance of step-by-step dial switching equipment with an independent telephone company in Delaware. During this period he acquired a basic knowledge of switching equipment which was to serve him well in his future career with the Bell System. In 1913 he entered the engineering department of the Bell Telephone Company of Pennsylvania in Philadelphia where he remained until 1925; he was responsible for formulating and supervising acceptance tests and for the training program for maintenance personnel.

In 1925 began the second phase of Mr. Hilyard’s career, when he transferred to A T & T in the Department of Development and Research, now a part of the Laboratories. There he pioneered in coordinating the design and field points of view in the preparation of “Requirements and Adjusting Procedures.” For many years Mr. Hilyard was responsible for seeing that designs of switching apparatus were adaptable to practical maintenance in the field. This work became increasingly more important as new relays and switches were produced for the crossbar system. In 1943 Mr. Hilyard was placed in charge of a group responsible for the formulation of requirements for maintenance facilities for switching systems, both toll and local. In this capacity he was identified with such developments as No. 5 crossbar, AMA, toll crossbar and single frequency signaling.

With his wife, two married children, four grandchildren, and a new record-player, Mr. Hilyard expects to find plenty to occupy his time without going away from Cranford.

RALPH L. QUASS

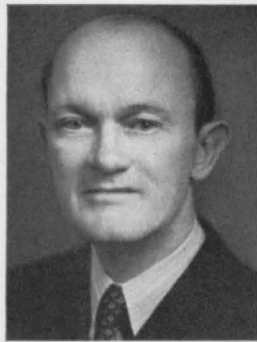
On graduation in 1909 from Western Reserve University and Case School of Science at Cleveland, Ohio, Mr. Quass enrolled in the student course of the Western Electric Company, and



VINA ALLAN



T. L. DOWEY



S. F. HAYES



F. M. COSTELLO

early in 1910 was transferred to circuit work in the laboratory at New York. Here he worked on many features of the early panel system, was responsible for the first manual machine ringing cord circuits and had a part in developing the automatic call distributing system at Wilmington and the semi-mechanical system at Bound Brook.

After World War I, during which he was engaged in government projects, he was assigned to adaptation of Automatic Electric Company step-by-step dial systems to meet the requirements of Bell System standards, becoming a group supervisor. Special operator circuits for use in step-by-step switching, a coin box trunk arrangement for automatic control of coins and a number checking system were some of his contributions. Subsequently he was transferred to the Patent Department, later returning to step-by-step system development and for the past fifteen years has contributed solutions to the many circuit problems that have helped to place the step-by-step system on the high plane of reliability it enjoys today. Seventeen patents in all have been credited to him during his service in the Bell System.

Mr. Quass and his wife are long time residents of Hawthorne, New Jersey, and Southampton, New York, where five children were born and raised. Currently they have seven grandchildren. As financial secretary of his church and a boating enthusiast, Mr. Quass plans to continue his present interests and will now devote his time to directing a stock investment business.

VINA M. ALLAN

Vina M. Allan, a graduate of Smith College, joined a computing group in the D & R during World War I to work on scrambled-speech projects for the Armed Forces. Later, she did similar work on carrier systems in Transmission Development. Miss Allan transferred as a

supervisor of the departmental service group in 1923. Two years later she became the engineering assistant responsible for records on licensed radio stations and frequency allocations made by the F. C. C., and for the compilation of short wave radio frequency assignments for companies and government administrations throughout the world. She was a member of the A T & T group which participated in the International Radio Conference in 1927.

Upon the consolidation of the D & R with the Laboratories in 1934, Miss Allan became a Member of the Technical Staff and continued to maintain frequency allocation records until 1938 when the work was turned over to the O & E. Miss Allan transferred to work on trans-oceanic telephone systems and later on land mobile systems. During World War II, she analyzed confidential data on silicon crystals. Since 1947 she has been designing balancing networks for the V3 telephone repeaters, and filters and equalizers for the L3 coaxial transmission system.

THOMAS L. DOWEY

When World War I had ended and the Laboratories forces were being "re-deployed," Tom Dowey was put into the group working on high-quality sound recording on wax. In 1924 he went over to public address work and followed this line to Graybar in 1926. When sound picture systems came into commercial production in 1927, he transferred to E.R.P.I. In that organization he eventually had charge of engineering information, including operating and installation instructions, specifications and drafting. After the completion of installations in studios and theatres, Mr. Dowey returned to the Laboratories. Among the projects on which he has since worked in Physical Research have been a telephone traffic recorder to obtain data in central offices; a key-operated type



A familiar sight at West Street is the mail car on which the mail is collected, sorted, and delivered to mail clerks on all floors from the first to the ninth. Riding with the operator, Clare Mansfield, left, is Catherine Aiello, foreground, and Harriet Salt, rear.

of subscriber's telephone dial; tape recorders; a tone synthesizer; and a method of making diaphragms from ultra-thin stock. During World War II he worked on the 10-kw air-raid siren, and on other projects still under government security restrictions.

Mr. Dowey is a graduate (B.S., 1911) in electrical engineering from the University of Durham, England. Coming to this country in 1913, he immediately entered the Laboratories as a draftsman.

STEPHEN F. HAYES

Mr. Hayes joined us during World War I as a storekeeper in the vacuum tube shop. Except for two years in Receiving, he has been with the Stores Department all his thirty-two years.

Steve says, "Treat your machines right and they will treat you right." This philosophy made him the ideal man to operate the big cutter in the Development Shop storeroom, where, for many years, he has faithfully served his legion of customers—all his friends.

He now looks forward to tending his dahlias and zinnias which he raises in his roof-garden back of his home on West 20th Street during the summer, a bit of ice-skating in the winter; an evening stroll and his church all year round; with maybe a part-time job.

FRANCIS M. COSTELLO

Until World War II, all of Mr. Costello's Bell System experience was in apparatus drafting and specification writing. Then he became an

expediter, responsible for following the production of Laboratories designs by outside machine shops—a job which he retained until retirement.

As preparation for his drafting job, which he entered in 1918, Mr. Costello had had several years in the City Topographic Bureau, in Queens and the Bronx. His first job here was on submarine detectors during World War I. Then he went into Specifications, becoming a supervisor and finally returned to the drafting room, having charge of electrical drawings.

In retirement, Mr. Costello expects to pursue one hobby—singing—among the Friendly Sons of St. Patrick, and the other—carpentry—in making a summer cottage into an all-year residence. He expects also to teach drafting and to enjoy for many years his three children, now aged seventeen, sixteen and four.



This Christmas poster, used on bulletin boards throughout the Laboratories, was done by J. F. Neill of Systems Development.

News Notes

C. KITTEL spoke on *Physical Theory of Ferromagnetic Domains* at the National Bureau of Standards in Washington and on *Recent Advances in Paramagnetism* at the Solid State Colloquium at the Naval Research Laboratory, Washington.

G. E. MOORE's talk to the Physics Department Seminar at the University of Missouri was entitled *Thermionic Emission*.

Laboratories Men Win Eight Stamp Club Awards

During the 1949 Exhibit of the Associated Business Stamp Clubs at the Consolidated Edison Company auditorium, Laboratories men took eight winners from seventeen entries submitted. W. S. R. Smith, president of the Clubs, announced that M. E. Esternaux had won grand award and first prize; P. W. Blye, three first prizes; M. A. Specht and Walter Kuhn each a second prize; and Mr. Smith two second prizes. Photographs of prize winners were taken by courtesy of the Consolidated Edison Company.

News Notes

W. P. MASON presented a talk before the Physics Colloquium at Iowa State College at Ames, Iowa, entitled *Use of Ultrasonic Waves in Determining the Properties at Liquids and Solids*, and attended meetings of the Acoustical Society of America at St. Louis.

C. HERRING spoke on *The Oxide Cathode as a Semiconductor* at a Physics Colloquium at Syracuse University.

P. W. ANDERSON, G. E. MOORE, W. SHOCKLEY, F. E. HAWORTH and J. R. HAYNES attended the American Physical Society meetings in Chicago.

K. B. McAFEE, K. G. COUTLEE, L. EGERTON, W. McMAHON, and G. T. KOHMAN attended the National Research Council Conference on Electrical Insulation held at Pocono Manor,

H. A. BIRDSALL visited the Exeter Manufacturing Company, Exeter, New Hampshire, in connection with frame cleaning curtains.

A. MENDIZZA and J. B. DIXON visited Cape Charles, Virginia, and vicinity in connection with unusual corrosion problems of new outside plant installations.

C. L. LUKE attended an American Wood Preservers Association subcommittee meeting, deal-

ing with the analysis of pentachlorophenol in oil and wood, which was held at the Forest Products Laboratories in Madison, Wisconsin.

J. B. DeCOSTE and V. T. WALLDER conferred on the aging of vinylite plastics at the Bakelite Corporation, Bound Brook.



W. S. R. Smith, left, president of the Associated Business Stamp Clubs, looks over prize winner frames with P. W. Blye, center, winner of a first prize, and M. E. Esternaux, right, winner of the grand prize.

A. C. WALKER addressed the Queens Mineral Society in Richmond Hill, Long Island, and the New Jersey Foundation for the Blind in Newark, New Jersey, on *Growing Synthetic Crystals*.

F. G. FOSTER was awarded an Associateship in the Royal Photographic Society of Great Britain for his work in photomicrography.

U. B. THOMAS was appointed as representative of the Electrochemical Society on Section Com-

January Service Anniversaries of Members of the Laboratories

35 years	H. F. Hopkins	20 years	O. S. Mesch	T. J. Fennelly
F. D. Waldron	R. E. Kuebler	V. J. Albano	L. C. Munch	J. J. Flanagan
	C. A. O'Malley, M.D.	E. E. Aldrich	Henry Oldenbusch	Nellie Luckner
30 years	Theodore Osmer	Jean Brown	Edwin Prohaska	
Smart Brand	Joseph Shea	John Doherty	F. J. Saxton, Jr.	10 years
R. W. DeMonte	L. G. Young	Thomas Dolan	Denis Sullivan	R. M. Hostetter
Loretta Farrell		H. M. Elhome	Robert Wighton	Mary McKay
John Filmore	25 years	E. M. Fliedner	W. L. Willdigg	Agnes Munro
H. T. Friis	C. L. Becker	C. N. Hickman		Myrtle O'Neill
F. F. Harlin	E. F. Ennis	Elizabeth Kerr	15 years	M. C. Ruggiero
	G. W. Pfarrer	G. H. Martin	L. H. Edmed	W. J. Wheat

mittee Z15 of American Society of Mechanical Engineers on Standardization of Graphics. He also visited the Electric Storage Battery Company in Philadelphia to discuss new design of batteries for telephone use.

P. P. DEBYE visited Johns Hopkins University Cryogenic Laboratory to discuss hydrogen liquefaction problems.

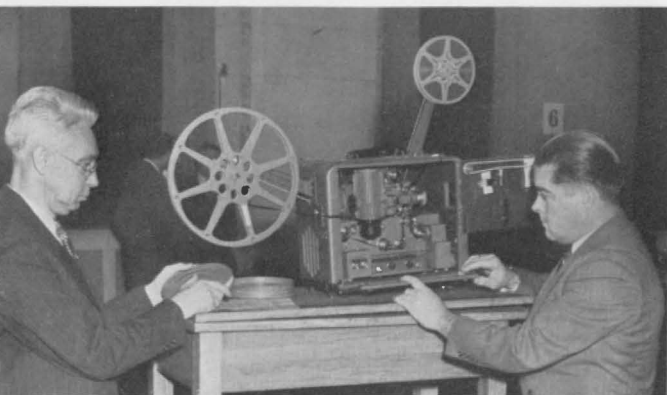
J. R. TOWNSEND presided at a meeting of Committee E1, Methods of Test, of the American Society for Testing Materials at the Society's headquarters in Philadelphia.

D. A. MCLEAN was one of a special committee of the American Institute of Chemists which inspected the instruction facilities at the Montclair, New Jersey, State Teachers' College.

W. E. KOCK spoke on *How Sound Waves Are Controlled and Focused* before the Western Electric Science Club at Hawthorne.

R. K. POTTER gave a talk *Applications of Sound Portrayal Techniques* before the Princeton section of the Institute of Radio Engineers.

R. L. HANSON gave demonstration lectures on *Transistors* before the Philadelphia section of



The sound projector (above) used for all 16-mm movie programs is being examined by R. Wighton at the right as Fred Frampton prepares a film for a run.

At a meeting of the Motion Picture Camera Club Mr. Frampton demonstrates dual turntables with three pick-up arms that are used to provide background music when silent films are projected. Watching, left to right, are: F. J. Bertola, R. Wighton, and H. Hall.



J. A. BURTON attended the American Physical Society meeting in Chicago.

L. A. WOOTEN and H. E. KERN discussed vacuum tube problems at the RCA Laboratories in Harrison, New Jersey.

I. L. HOPKINS and J. B. HOWARD attended sessions of Committee D-20 of the American Society for Testing Materials in New York. Mr. Hopkins was appointed secretary of Subcommittee VIII.

H. W. HERMANCE and C. W. MATTSOON conducted studies of new techniques of sequence switch maintenance in Chicago central offices during the month of November. T. F. EGAN initiated similar studies in Philadelphia.

the Electrochemical Society and the Providence section of the A.I.E.E. in November.

W. E. KOCK delivered a lecture on *Lenses, Reflectors and Superdirectivity* in a course on Recent Developments in Antenna Design sponsored by the Communication Division, New York Section, A.I.E.E., jointly with the New York Section, I.R.E.

F. W. WEBB visited Winston-Salem to discuss special network problems.

E. I. GREEN, F. J. GIVEN, P. S. DARNELL, A. G. GANZ, N. BOTSFORD, H. A. STONE, and W. A. KRUEGER visited Haverhill, Massachusetts, on quality control procedures for L3 carrier and G. F. J. TYNE and B. STALLARD, on coil problems.

D. E. CAVERNAUGH conferred at the Development and Research Laboratories at Fort Belvoir, Virginia, on portable high-voltage power supplies and miniature vibrator transformers.

D. R. BROBST visited the Tonawanda Plant in connection with the quality survey on magnet wire and with switchboard wires and cables.

D. A. McLEAN, D. R. MASON, and M. V. SULLIVAN participated in the Conference on Insulation of the National Research Council held at Pocono Manor, Pennsylvania, on November 7-9. On November 8, Mr. McLean led a round-table discussion on *Ionic Losses in Dielectrics*.

L. A. DORFF with R. D. Campbell and O. T. Laube of A T & T and representatives of the Illinois, Michigan and Ohio Bell Telephone Companies attended the Fall Assembly Meeting of the Radio Technical Commission for Marine Services, held in Cleveland, Ohio, on October 25 and 26. In addition to the business meeting and panel session, a field trip to Lorain, Ohio, was made on the Coast Guard Cutter "Mackinac" to inspect Great Lakes shipping and communications. Mr. Dorff represents the Bell System on RTCM Special Committee 12—Selective Signaling and Ringing Devices for Marine Services.

L. G. ABRAHAM, R. H. BADGLEY, J. M. BARSTOW, C. H. BIDWELL, M. E. CAMPBELL, S. DOBA, J. R. HEFELE, P. MERTZ, and L. W. MORRISON were in Washington, D. C. in connection with comparative tests of CBS and RCA color television systems and the Dumont black and white system.



"I understand they're having a water shortage in New York."

P. H. BETTS, T. J. GRIESER, and G. H. WILLIAMS, JR. reviewed requirements of polystyrene foam for use in the delay lens antennae of the TD-2 microwave radio relay system with the Dow Chemical Company at Midland, Michigan.

M. B. McDAVITT, A. C. KELLER, C. A. LOVELL, W. W. WERRING, and O. M. HOVGAAARD visited Allentown to discuss mercury and dry reed switches and relays.

R. B. HEARN and N. A. NEWELL went to Omaha during November to discuss 1000-cycle ringing.

R. C. PFARRER, on recent visits to Oakland, California, and Boston, Massachusetts, observed the cutover of the No. 4 toll crossbar system at these toll switching centers and obtained data on operator and central office performance. A visit was also made to Vineland, New Jersey, a No. 5 crossbar office, to take data on marker performance.

C. H. McCANDLESS and A. M. ELLIOTT were in Chicago to discuss with representatives of the Illinois Bell Telephone Company and the Automatic Electric Company arrangements for interconnecting offices.

R. F. MASSONNEAU and S. P. SHACKLETON assisted Bell Telephone Company of Pennsylvania engineers in making accuracy tests of AMA equipment at Camden.

R. F. MASSONNEAU, R. A. MILLER, H. W. AUGUSTADT with S. J. McDermott of A T & T and J. Hunt of Western Electric conferred with officials of the Audichron Company at Atlanta.



Snow poles are now a part of the Murray Hill scene.

A. A. HANSEN visited the new Boston No. 4 toll office during the cutover period, and the Philadelphia toll office on field studies.

S. P. SHACKLETON assisted the Engineering and Accounting people of the Michigan Bell Telephone Company in organizing pre-cutover accuracy tests on the AMA system at Royal Oak and Detroit. He also joined with Accounting people of the Ohio Bell Telephone Company in visiting Connecting Company offices at Warren, Lorain, Elyria, Bellevue and Mansfield.

O. A. FRIEND attended the cutover on November 19 of the No. 1 crossbar equipment of some 28,000 lines serving Royal Oak, Michigan. This



Helen Miller is one of three newly trained stenographers assigned to telephone dictation at Whippany. On questioning dictation taken by fountain pen, the editors learned that Miss Miller, like all Gregg stenographers, was taught to use a pen for smoother and speedier dictation.

installation is the first application of automatic message accounting outside the Philadelphia area, and works with a new AMA center located in Detroit.

L. H. HOFMANN and W. BUHLER visited Philadelphia in connection with field studies of inter-office pulsing conditions in the new No. 5 crossbar office.

R. B. HEARN and N. A. NEWELL visited Omaha in connection with 1000-cycle signaling circuits. W. W. BROWN went to Cleveland, Ohio, Elkhart, Indiana, Sturgis, Michigan, and Hawthorne in connection with relay rack equipment arrangements and operator's chairs.

A. O. ADAM, W. B. GRAUPNER, R. E. HERSEY, E. A. KUENZLER, O. J. MORZENTI, and J. G. WALSH visited Chicago in connection with No. 5 crossbar.

W. WHITNEY visited Somerville, New Jersey, and W. WAGENSEIL visited Libertyville, Illinois, in connection with No. 5 crossbar.

M. B. McDAVITT, A. C. KELLER, and A. J. BUSCH visited Hawthorne and the Teletype Corporation to discuss various switching apparatus and systems matters.

W. KEISTER gave a talk at the A.I.E.E., Philadelphia Section, meeting on the subject *Automatic Control in Telephone Switching*.

G. V. KING, E. W. FLINT, and A. A. BURGESS visited Detroit on AMA installation problems.

R. MUELLER and C. SCHNEIDER went to Hawthorne regarding new relay developments.

F. M. TYLEE is author of an article on *High Speed Motion Pictures in Full Color*, J. T. MULLER on *Measuring Shock with High Speed Motion Pictures*, and J. H. WADDELL on *Design of Rotating Prisms for High Speed Cameras* in the November, 1949, *Journal of the Society of Motion Picture Engineers*. Mr. Waddell's report as chairman of the High Speed Photography Committee is given in the same issue.

H. H. SPENCER has written on *Power Supplies for Coaxial Systems* in the December, 1949, *Electrical Engineering*.

J. W. GEILS has completed a spare time project, rebuilding and reactivating the internal public address system in the Alfred Vail School of Morris Township. Mr. Geils gave 400 evening hours to the project which he began over a year ago with the expectation of overcoming a few minor difficulties and ended after building a new system from the bottom up.

F. A. ZUPA at Hawthorne discussed line and cut-off relays for crossbar and step-by-step systems.

F. M. THOMAS and F. C. KUCH visited Philadelphia to discuss AMA problems.

F. J. REDMOND visited Hawthorne in connection with the crossbar switch.

M. SALZER was at the Sycamore No. 5 crossbar office in Verona, Pennsylvania, in connection with the KS-13834 perforator.

C. A. DAHLBOM and F. S. FARKAS witnessed tests of signaling circuits in Philadelphia.

R. E. COLEMAN and W. R. GOEHNER visited the General Electric Company at West Lynn, Massachusetts, to discuss photoelectric cells.

L. J. COBB visited Chicago and Indianapolis in connection with problems involving handsets and operators' telephone sets.

J. B. DIXON and A. MENDIZZA with representatives of the Chesapeake and Potomac Telephone Company of Virginia and D. S. BENDER, Field Engineer at Washington visited Wallops Island, Virginia, in connection with strand corrosion problems.

G. E. HADLEY and O. B. COOK conferred at the Western Electric Company at St. Paul on station protectors.

J. M. HARDESTY and D. C. SMITH went to Baltimore in connection with underground cable maintenance methods.

C. F. WIEBUSCH attended a meeting of the American Standards Association Committee on Acoustics in St. Louis.

C. T. WYMAN and C. F. WIEBUSCH discussed cable problems at Hawthorne.

J. R. STONE, W. L. BETTS with M. P. Woodard of Western Electric Purchasing Department discussed machine designs for proposed motor generator sets, which are to be used for the L3 carrier system, with various electrical machinery manufacturers at Milwaukee, Dayton, Cleveland, and Buffalo. Messrs. Stone and Betts also discussed the same problem with the General Electric Company at Fort Wayne.

D. H. SMITH studied voltage regulator designs, for use with mechanical rectifiers, at the offices of the I.T.E. Circuit Breaker Company in Philadelphia.

V. T. CALLAHAN conferred on Diesel engine designs with the General Motors Corporation engineers at Cleveland. At Pittsburgh, he conferred with the Westinghouse Electric engineers upon voltage regulator designs; at Philadelphia, he investigated an emergency shut down device on a portable Diesel engine of the Bell Telephone Company of Pennsylvania; at Detroit, with L. D. FRY, he conferred upon Diesel engine improvements at the Detroit Diesel Engine Division, General Motors Corporation plant.

H. M. SPICER participated in conferences upon variable autotransformer designs with engineers of the Sorensen Manufacturing Company.

L. S. NEEB and H. T. LANGABER discussed power distribution equipment with the Bull Dog Electric Products Company, Detroit, and with the Frank Adam Electric Company, St. Louis.

J. A. POTTER conferred with the Power Equipment Company in Detroit on rectifier designs.

R. H. MILLER and R. E. D. ANDERSON inspected the new No. 4 toll offices in Boston and discussed various problems with engineers of the Telephone Company.

W. J. BROWN attended the joint Fall meeting of the Radio Manufacturers Association and Institute of Radio Engineers.

C. A. NICKERSON visited the Audichron Company at Atlanta to discuss magnetic recording and reproducing equipment for transcribed message services.

R. O. L. CURRY attended a conference on the Western Electric hearing aid fitting device at the Central Institute for the Deaf at St. Louis.



The 1950 Telephone Almanac features early means of sending signals. A limited number of copies are available for distribution—call Extension 565 at West Street.

F. E. DORLON addressed a group of Industrial Cafeteria Managers at the Eastman Kodak Company plant at Rochester on the subject *Restaurant Purchasing*. This Association, organized by A. B. Wolz of Eastman and Mr. Dorlon, includes in its membership such companies as the following: Armstrong Cork Company, Bell Telephone Laboratories, Caterpillar Tractor Company, Eastman Kodak Company, Eli Lilly and Company, Firestone Tire and Rubber Company, Goodyear Tire and Rubber Company, General



Little Miss Handset is Mitzi, daughter of R. F. Mallina, who won first prize at school for this original costume. She designed the set and made it to scale by hand from cardboard and heavy twine.

Electric Company, National Cash Register Company, Owens-Illinois Glass Company, Tennessee Eastman Corporation, Thompson Products, Incorporated, and Western Electric Company. Its purpose is to exchange ideas among the managers of the company owned and operated restaurants. This procedure has been so well received that several of the companies represented are forming similar groups for discussion of other subjects in the service field.

M. W. BALDWIN, JR., and W. T. WINTRINGHAM recently conducted a three-day test on adjacent channel interference in television broadcasting. The tests took place at the NBC laboratories in Rockefeller Center. Mr. Wintringham acted as chairman of a group under the auspices of the Joint Technical Advisory Committee.

D. E. TRUCKSESS, H. T. LANCABEER, and C. S. KNOWLTON were at Philadelphia in connection with the manufacture of mechanical rectifiers by the I.T.E. Circuit Breaker Company.

L. B. COOKE and R. A. MILLER were in Washington in connection with time-of-day service applications. Mr. Cooke also attended the Radio Manufacturers Association, Audio Facilities Committee meeting, held in New York City.

F. W. REYNOLDS attended the annual meeting of the Optical Society in Buffalo.

A. H. SCHIRMER directed a discussion on *The Importance of Common Grounding at Customers' Premises* at a meeting of the International Association of Electrical Inspectors in Boston.

H. W. AUGUSTADT and R. A. MILLER, with J. T. Hunt of Western Electric, went to Cambridge to visit the General Radio Company with regard to time measuring equipment, and Hermon Hosmer Scott, Inc., in connection with noise measuring equipment.

A. H. WHITE, L. H. GERMER, L. W. HUSSEY, J. A. HORNBECK, H. D. HAGSTRUM, J. P. MOLNAR, and G. H. WANNIER attended the Conference on Gaseous Electronics held at the Mellon Institute, Pittsburgh. Mr. Wannier spoke on *The Kinetic Theory of Ion Mobilities*, and three papers were presented under the general title of *The Gamma Process of Electron Emission from Cold Cathodes* by Mr. Hornbeck on *Studies Employing Pulsed Townsend Discharges on a Microsecond Time Scale*; by Mr. Molnar on *Studies Employing Pulsed Townsend Discharges on a Millisecond Time Scale*; and by Mr. Hagstrum on *Studies Employing Monoenergetic Beams of Slow Ions*.

W. A. YAGER, S. O. MORGAN, and E. J. MURPHY attended the Conference on Electrical Insulation of the National Research Council at Pocono Manor, Pennsylvania. Mr. Murphy gave a talk entitled *D-C Conductivity of Barium Titanate*.

R. C. NEWHOUSE, along with representatives of other principal electronic organizations, was a guest of the Chief of Naval Operations on board the aircraft carrier U.S.S. *Saipan*, during a two-day electronics demonstration cruise off the Virginia Capes.

K. G. COMPTON was reelected vice chairman of the Management Committee of the Gordon Research Conferences for the Association for the Advancement of Sciences.

"The Telephone Hour"

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

January 9	Clifford Curzon
January 16	Ferruccio Tagliavini
January 23	Ezio Pinza
January 30	Lucile Cummings and Edwin Steffe
February 6	Jascha Heifetz
February 13	Oscar Levant
February 20	John Charles Thomas
February 27	Barbara Gibson



***Y*our telephone
uses ceramics, too!**

Five thousand years ago, potters were making household vessels of clay. As skill grew, grace of shape and ornament were added. The beauty of fine china has been recognized by every civilization, while the availability, ease of manufacture and durability of other ceramics have given them wide use.

Your telephone, too, uses ceramics. Behind its dial is a metal plate, glazed as carefully and in much the same manner as this fine piece of pottery. It carries the letters and numbers you dial, so it must resist both fading and abrasion. You will find other ceramics as insulators, supporting wires on pole lines; in eighty thousand miles of underground conduit, where fired clays defy decay and corrosion.

Today at Bell Telephone Laboratories scientists utilize ceramics in ways undreamed of in ancient times. Ceramic thermistors provide automatic controls for electric current, to offset temperature and voltage fluctuations. One kind of ceramic makes low-loss insulation at high frequencies. Another supplies controlled attenuation for microwaves in waveguides.

Each use demands a special composition, scientifically controlled and processed. Basic studies in the chemistry and physics of ceramics have shown how to utilize their versatile properties in electrical communication. And research continues on ceramic materials as well as on every other material which promises better and cheaper telephone service.



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EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.



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