BELL LABORATORIES RECORD

VOL. XXV NO. 9—SEPTEMBER 1947

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Electronic
Apparatus
Development

A NEW MINIATURE DOUBLE TRIODE

In developing new electronic equipment for post-war peacetime applications, a long-life miniature double triode was needed that had separate cathode leads. The tube should be capable of performing satisfactorily in very high speed trigger circuits, in oscillator circuits, and in various amplifier circuits. It was also necessary for the tube to be of small size so as to conserve space. To satisfy these needs, the Western Electric No. 396A tube—coded the 2C51 by the Radio Manufacturers Association—was designed. This tube, shown at the left of Figure 1, consists of two triode units that, except for parallel heaters, are built entirely separately into a single miniature envelope. To show the relative sizes, the 6AK5* miniature tube is shown at the right in the photograph, and a double triode tube in a conventional GT bulb, in the middle. In a general way, the illustration indicates the space-saving advantages to be gained by using miniature tubes in place of the present conventional types such as the one shown with a GT bulb.

Assunta Sciarillo performing a delicate welding operation on a 396A mount

Since many of the applications required separate cathode connections for each triode section, it was clear that the present standard seven-pin miniature base could not be used; at least one more pin was required to give three for the plate, grid, and cathode of each section, and two for the common heater leads. The design and standardization of a new stem having more than seven leads were discussed with one of the other major vacuum tube manufacturers and with the Receiving Tube Committee of the Joint Electron Tube Engineering Council. As a result, a new nine-pin miniature stem was introduced as an additional standard. The addition of the two pins has resulted in a slightly larger bulb diameter, since the spacing between adjacent stem leads was not changed. Whereas the maximum diameter of the

*RECORD, *November,* 1944, *page* 605.

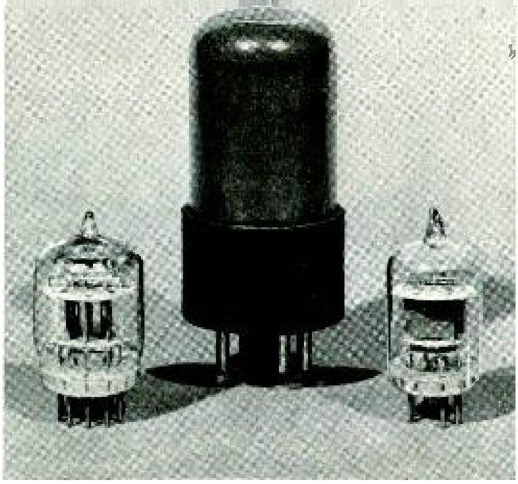


Fig. 1—A 396A tube at the left and a 6AK5 at the right, with a tube in the familiar GT bulb shown together for a comparison of size

6AK5 bulb is ¾ inch, that for the 396A is ⅞ inch—a difference just about enough to be evident in Figure 1.

A result of reducing the physical dimensions of the tube is, of course, to place a greater burden upon the mechanical design of the internal structure. The very small size of the tube parts and some of the difficulties of assembly can be judged from the accompanying photographs. A cross-section drawing of the tube, four times actual size, is shown in Figure 2, while Figure 3 shows a magnified section of an actual tube.

For proper control of the electrical characteristics of the tube, it is an essential requirement that the dimensions and spacings between the electrodes be accurately maintained from tube to tube. To accomplish this, each of the component parts must have accurately controlled dimensions before assembly. To maintain the grid-to-cathode spacing, for example, which is only 0.0035 inch, a very rigid control of the grid and cathode dimensions is essential. The cathode itself is an accurately drawn and stamped nickel sleeve, and highly skilled operators and technicians are required to control the thickness and density of the barium-strontium-calcium carbonate spray used on the cathode to enhance electron emission. This operation, as performed in the laboratory, is shown in Figures 4 and 5. For constructing the grid, a precision grid winding machine as shown in Figure 6 is used. In this operation, shown in greater detail in Figure 7, two support wires are fed into grooves of a mandrel which rotates while the machine is in operation. The lateral wires, a little less than the diameter of a human hair, are then wound into uniformly spaced notches cut into the support wires and swaged into place. By close inspection of Figure 8, which is a side view of a complete tube mount, the spacing between the grid and cathode can be seen through the windows of the plate.

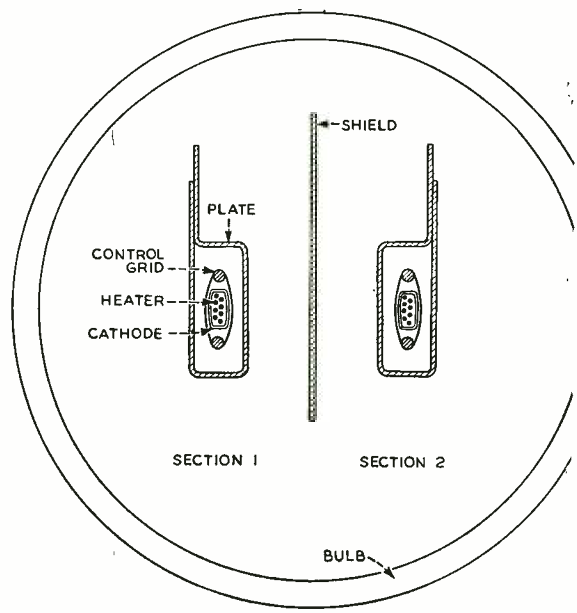


Fig. 2—Cross-section of the 396A shown four time actual size

Other carefully controlled operations and processes such as parts cleaning, glass working, and exhaust treatment, are used in making laboratory models of the 396A tube, but are too numerous to discuss here. It should be stressed, however, that in spite of the watchlike precision required in the assembly of the tube, the practicability of such tube design has been well borne out by the successful large-scale production of miniature tubes such as the 6AK5.

Since all of the tube dimensions are scaled down, the plate current, transconductance, and plate resistance of the tube remain substantially unchanged, but the

TABLE I—CHARACTERISTICS OF THE 396A VACUUM TUBE

HEATER RATING	
Heater voltage	6.3 volts a-c, or d-c
Nominal heater current	0.30 ampere
MAXIMUM RATINGS (Design Center Values)	
Plate voltage	300 volts
Plate dissipation, per section	1.5 watts
Plate current, per section	18 milliamperes
Heater-cathode voltage	90 volts
OPERATING CONDITIONS AND CHARACTERISTICS	
Heater voltage	6.3 volts
Heater current	0.30 ampere
Plate voltage	150 volts
Grid voltage	−2.0 volts
Plate current, per section	8.2 milliamperes
Transconductance, per section	5500 microohms
Amplification factor	35
Cut-off grid voltage	−10 volts
Interelectrode capacitances (No Shield):	
*Plate-grid, per section	1.3 μμf
*Plate-cathode, per section	1.0 μμf
*Grid-cathode, per section	2.2 μμf
Plate-plate, nominal	0.04 μμf
Plate-plate, maximum	0.11 μμf

*NOTE: Internal shield and heater connected to cathode of section under test; elements of other sections grounded.

TABLE II—CHARACTERISTICS OF THE TUBE OPERATING AS A PUSH-PULL AUDIO AMPLIFIER

CLASS AB1

Plate voltage	300 volts
Cathode resistor	800 ohms
RMS A-F grid to grid voltage	14 volts
Zero signal plate current (per section)	4.7 milliamperes
Maximum signal plate current (per section)	6.0 milliamperes
Load impedance (plate to plate)	40,000 ohms
Total harmonic distortion	10 per cent
Maximum signal power output	0.95 watt

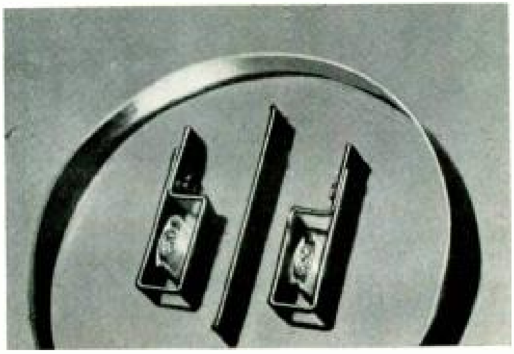


Fig. 3—A cross-section of an actual tube enlarged three times. The tube was filled with lucite, and after the lucite was hard, was cut transversely for photographing

heat dissipation ability becomes less. It is possible, however, to obtain excellent characteristics at relatively low plate potentials, as the characteristics listed in Table I and shown graphically in Figure 9 indicate. The scaling down results in more efficient operation and compensates, in part, for the lower plate dissipation rating. It is, of course, essential that in any application of the 396A tube, the maximum ratings given in Table I are not exceeded. Although no maximum grid dissipation or peak cathode current ratings have as yet been given, operation in the positive grid region is permissible provided the average grid current is kept reasonably small.

The applications of the 396A tube in

Fig. 4—Blanche Russielo spraying cathodes for the 396A

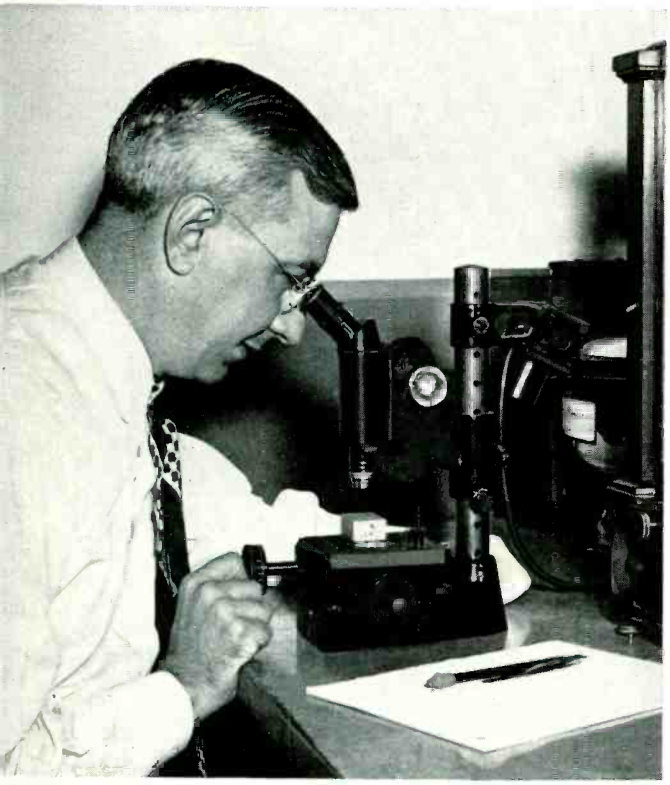


Fig. 5—Henry Conklin obtaining data for the cathode spray thickness and density control checks

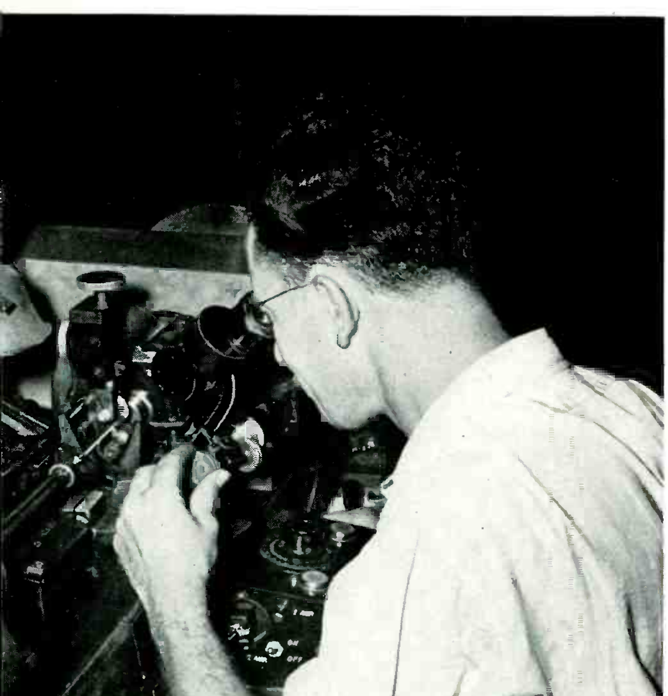
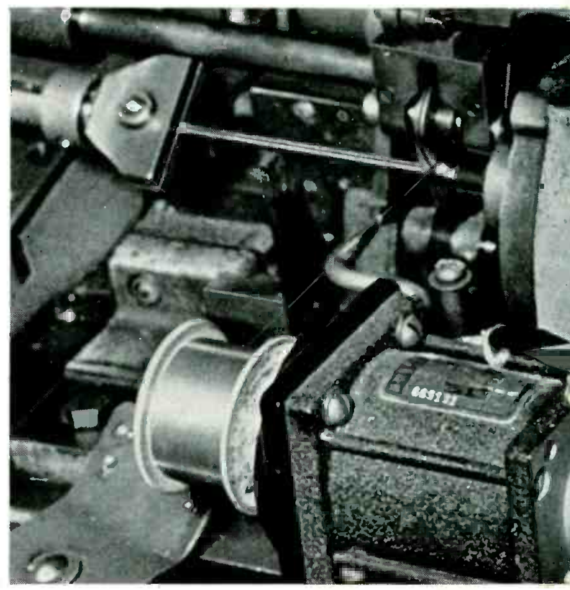


Fig. 6—Donald R. McLennan winding grids for the 396A

new equipment being developed for the Bell System are quite numerous. One is in the terminal equipment of the new microwave radio relay systems, now in development for the transmission of multiplex telephony. Here the 396A tube is used in high-frequency switching circuits, high-frequency multivibrator circuits, cathode followers, and other special circuits. It was largely the requirements of this application—small size, independent triode sections, low interelectrode capacities, and

Fig. 7—Close-up of grid winding process showing the notching knife and swaging roller

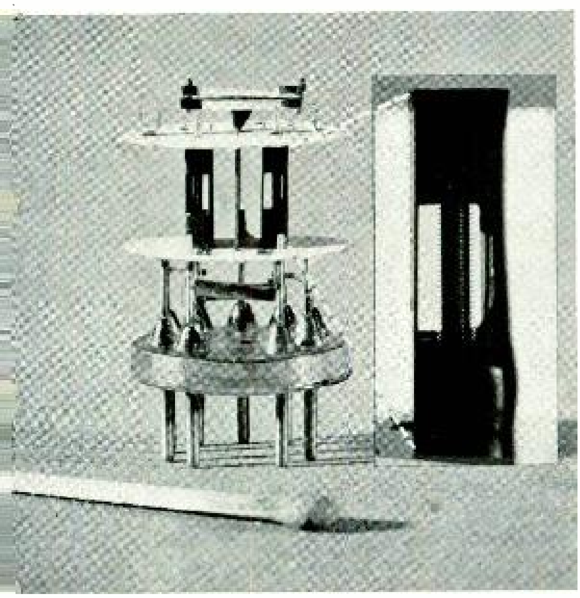


high transconductance—that led to the development of the 396A tube. Other applications have been in flip-flop circuits, R-C oscillators, audio amplifiers, and in several special trigger circuits. Frequently, in some of the mentioned applications, each of the two triode sections is made to operate in entirely different circuits. This has been made possible largely by the shield, shown in Figure 2, mounted between the two triode sections. The main functions of this shield are to reduce the capacity between the plates of the two tubes, and to prevent stray electrons from the cathode of one tube from reaching the plate of the other. This construction permits satisfactory operation of each section in different circuits, which might otherwise operate poorly due to interaction. When electron coupling between the two sections must be kept very low, the shield may be operated below ground potential.

In addition to performance information obtained on the tube operating in the above-mentioned equipment, some data were obtained in the laboratory on the high-frequency performance of the tube as an oscillator and also as an audio amplifier. Oscillation at frequencies as high as 800 mc was obtained in an open-circuited resonant line oscillator when the two triode sections were connected in parallel. Typical operation data obtained on the tube when used as a push-pull audio frequency amplifier are given in Table II.

The 396A vacuum tube is currently being manufactured by the Western Electric Company. It is expected that it will find many successful applications where good performance, long life and small size are the major requirements.

Fig. 8—A 396A mount, twice size, at the left. Enlarged view of a grid-plate unit at the right



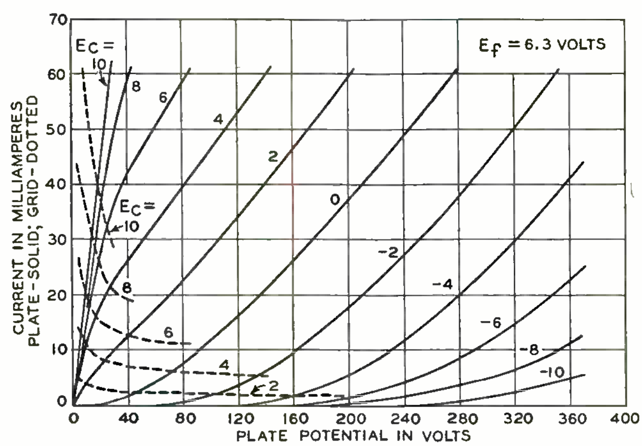


Fig. 9—Characteristics of the 396A vacuum tube

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RADIO RECEIVERS FOR MOBILE TELEPHONE SERVICE

U. S. BERGER
Specialty Products Development

Dependability, freedom from maintenance, small size and light weight were major objectives in designing receivers for the mobile radio telephone service recently inaugurated.* In these systems, receivers with similar characteristics are employed for mobile installations and for the fixed stations that receive calls from vehicles, but there are minor differences to take care of various operating conditions. All receivers are single-channel, crystal-controlled, double-superheterodyne sets, operating in the frequency bands from 30 to 44 and 152 to 162 megacycles, and require no adjustments after the initial installation.

The 38A receiver, shown in Figure 1, is intended primarily for urban mobile use and operates directly from the vehicle battery, which may be either six or twelve volts with either the positive or negative terminal grounded. The low d-c voltage is converted to a higher d-c potential for the vacuum tube plates by means of a vibrator power supply. All tubes except the rectifier associated with the vibrator are of the miniature type.

Crystal control insures high stability of the beating oscillators, and temperature control of the high-frequency crystal limits the over-all frequency deviation to less than 0.005 per cent. The high-frequency crystal operates between 43 and 47 megacycles, depending on the assigned radio frequency. Double conversion is used to provide high selectivity to unwanted signals both nearby and far removed from the assigned frequency. The selectivity obtained in the 38A receiver results in 50-db attenuation at 60 kilocycles off resonance, and 100 db at 120 kilocycles off resonance. All images and spurious responses are attenuated at least 80 db. The output volume is held at substantially a constant value by the action of the limiter stages.

Selective signaling equipment is included in the 38A radio receiver to permit calling a particular car, even though a number of cars are operating on the same radio channel. When a car is being called, the receiving selector steps in synchronism with impulses sent out by the land transmitter. If the transmitted code corresponds to that for which the receiving selector is adjusted, contacts will be closed to the control unit, the bell will ring, and the amber call lamp will light. The bell will continue to ring until the subscriber answers or, if the call is not answered, until the operator removes the ringing tone. The call lamp, however, remains lighted until the subscriber removes the handset from the control unit mounting. If the received call is intended for another selector, no call indication is conveyed to the control unit.

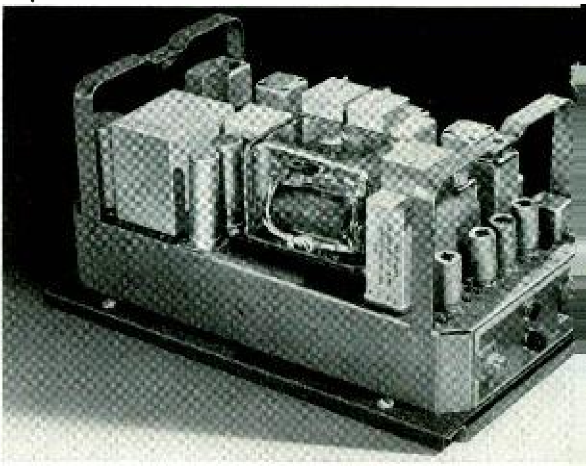

Fig. 1—The 38A mobile radio receiver with cover removed showing the selective signaling unit near the center of the chassis

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Removing the handset from the holder operates a relay to restore the selector to normal and to connect the audio circuits to the handset. A squelch circuit operating on the frequency-modulated noise silences the receiver when the fixed station trans-

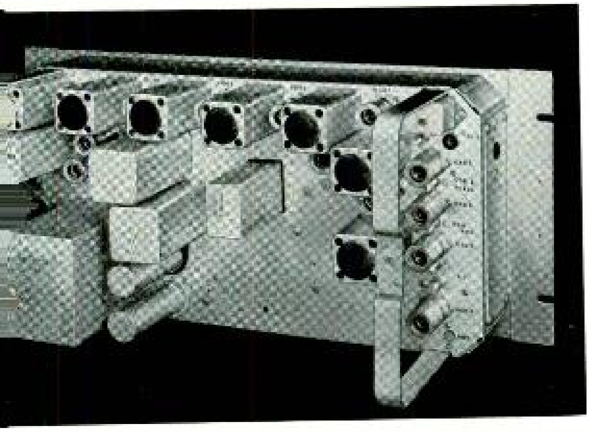


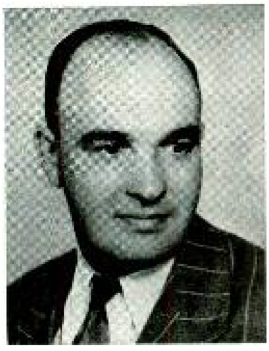
Fig. 2—The 40A fixed station receiver with cover removed. This operates on commercial a-c supply

mitter is not operating. Objectionable thermal and receiver noise in the handset is thus blocked when the subscriber undertakes to initiate a call from the car. This type of squelch circuit operates at a specific signal to noise ratio, depending on the setting of the squelch sensitivity control, and is not actuated by extraneous noise picked up on the antenna.

The 40A receiver for fixed station use, shown in Figure 2, is similar to the 38A radio receiver except that it operates on 117 volts, 50 to 60 cycles a-c. The 40B is like the 40A except that it operates on either 117 volts a-c or 6 volts d-c. This feature has been introduced to provide for emergency operation from a 6-volt standby battery should the commercial a-c power supply fail. The band width of the 40-type receivers is slightly greater than that of the 38A mobile receivers to accommodate the frequency variations that may be encountered with various mobile transmitters. Both of these receivers are rack mounted and may be operated in close proximity with other units of the same type which are tuned to other radio channels. A codan relay operated from the squelch circuit provides a lamp indication to the operator at a remote point.

The output impedance of the 40-type receivers is 600 ohms to match the telephone line to which it is normally connected. Depending upon the setting of the audio level control, an output of 2 to 100 milliwatts may be obtained. By a simple wiring change in the audio circuit, the output can be increased to approximately 400 milliwatts for applications where loudspeaker monitoring is required.

The 38 and the 40-type receivers are identical in size to the 38-type mobile transmitter. The mechanical design is simple and rugged, and all components used have been carefully selected to assure satisfactory operation under the wide range of conditions encountered in mobile radio telephone service.



THE AUTHOR: U. S. Berger received the B.Sc. in E.E. from Ohio State University in 1937. After coming to the Laboratories, he was concerned with circuit research of voice-operated equipment, including the voice-operated operator's telephone set. Early in World War II, Mr. Berger transferred to the Specialty Products Development Department, and was engaged in the development of radio receivers for the U. S. Coast Guard, and VHF aircraft communication equipment for the Armed Forces. After the war, he turned his attention to developing mobile vehicular telephone equipment, and at present is working on the development of future mobile equipments.

TELETYPEWRITER SYSTEM FOR SLOW-SPEED SUBMARINE CABLES

M. R. PURVIS
Telegraph Development

In 1943 the Laboratories was requested by the Navy to develop a teletype communication system to operate over existing slow speed, non-loaded submarine cables between New York and both the Canal Zone and Porto Rico. These cables were owned by All American Cables and Radio, Inc., who coöperated in the application of the system. Each of the circuits developed provided full duplex communication over a single conductor cable. The cables were normally used for Cable Company business, and the system developed included control features so that the Navy could seize the cable at any time for Navy traffic.

In normal Cable Company operation, signals are sent over the cable by means of an adaptation of the continental telegraph code. In sending the coded characters, three line conditions are employed: a positive battery potential is applied to the cable for a dot; a negative potential is applied for a dash; and the cable is grounded for a space. Following each character, a full spacing pulse is transmitted. At the receiving end of the cable, the signals are regenerated by a repeater of the tuning fork type, which is part of the regular Cable Company equipment. The fork of the regenerative repeater is held in synchronism with the received signals.

With the Cable Company's system, each positive, negative or ground pulse requires about 0.107 second, and the time required for the transmission of a single character will depend on the number of dots and dashes it includes. The length of the pulses and the timing for the entire transmission procedure are controlled by a commutator rotating at a speed of 560 rpm and thus making one revolution each 0.107 second. With the standard Bell System teletypewriter system, on the other hand, a five-unit, two-condition (current and no current) code is employed with a spacing (no current) start pulse and a marking (current) stop pulse. For the transmitting speed of sixty words per minute, each character is transmitted in about 0.163 second.

Since it was highly desirable to provide as little new apparatus as possible, the plan was to use the Cable Company's transmitting, receiving and regenerative repeater equipment and to operate the cable at its normal speed of 0.107 second per pulse by utilizing pulses generated by the Cable Company's fork-controlled commutator. The "start-stop" method of operation, in which the distributors at both ends of the circuit are caused to stop and start once per character, was adopted as a means for synchronizing the sending and receiving mechanisms. The problem, therefore, was to devise a three-condition code employing the same number of pulses for each character so that start-stop transmission could be employed, and then to design translating equipment for both the transmitting and receiving terminals to take care of the conversion between the two systems. Within the limits imposed by the 0.107-second period for each cable pulse, it was desired to secure as high a word speed as possible. Since there were three conditions available instead of the two used in the teletypewriter code, a four-unit instead of a five-unit code was possible. Under these conditions, a single character would require only four pulses or 0.428 second, and transmission over the cable would be at a speed of 140 characters per minute.

Some means was required for stopping and starting the receiving mechanism once per character in order to maintain synchronism. This was accomplished without further reduction of word speed by arranging the four-unit code so that the fourth pulse of each character is never a ground (spacing) pulse and is always different in potential from the third pulse. This arrangement permitted the receiving distributor to be stopped after the third pulse and automatically re-started by the changed condition of the fourth pulse, thereby avoiding the need for additional start-stop pulses such as are required with the conventional teletypewriter system. Table I compares the standard teletypewriter code with this special cable code. The symbol "0" represents a ground (spacing) pulse.

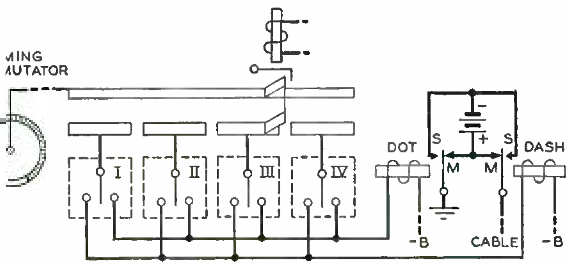
The apparatus developed for this project consisted of a distributor that made 140 rpm and relay circuits associated with it. The same distributor was used for both the transmitting and receiving terminals, but its segments were differently connected for the two functions, and the relay circuits differed. The timing commutator of the Cable Company's transmitter was retained to time the system at the transmitting end—its 0.107-second period for each revolution corresponding to one of the four segments of the distributor. Signals were supplied to the transmitting distributor in the form of a tape perforated in standard teletypewriter code. Contacts made by the sensing fingers through the perforations of the tape actuated relay circuits associated with the distributor to translate the teletypewriter code into the four-unit code, and as the distributor rotated, suitable pulses were transmitted over the cable.

A very much simplified diagram of the transmitter is shown in Figure 1. The four translating units marked I, II, III and IV represent groups of relays that perform the translation and other circuit operations. The brush of the distributor rotates—moves from left to right in the diagram—in step with the timing commutator, and as each of the segments of the distributor is passed over, a positive, negative or ground pulse is sent over the cable. Through the action of relays, the brush is stopped at the end of the third pulse, and thus rests near the end of the third segment as indicated until the beginning of the fourth pulse, which again starts the rotation.

Each of the four segments of the distributor of Figure 1 consists of three or four shorter segments which may be inter-connected as desired. For the distributor at the transmitting terminal, they are connected to form the equivalent of four single segments as shown, but at the receiving terminal they are connected differently, as shown in Figure 2 on the next page.

TABLE I—COMPARISON OF THE TWO CODES

Teletypewriter Code						*Cable Code*			
+	+	+	+	+	letters	+	−	0	+
+	+	+	+	−	K	+	−	+	−
+	+	+	−	−	U	+	−	0	−
+	+	−	−	−	A	+	+	0	−
+	−	−	−	−	E	−	0	0	−
−	−	−	−	−	blank	0	−	0	−
−	+	+	+	+	V	−	+	0	+
−	−	+	+	+	M	0	+	0	+
−	−	−	+	+	O	0	−	0	+
−	−	−	−	+	T	0	−	−	+
−	+	−	−	−	line feed	+	0	0	−
−	+	+	−	−	I	−	+	0	−
−	+	+	+	−	C	−	+	+	−
−	−	+	−	−	space	0	+	0	−
−	−	+	−	+	H	0	+	−	+
−	−	+	+	−	N	0	+	+	−
+	−	+	−	−	S	−	−	0	−
+	−	+	−	+	Y	−	−	−	+
+	−	+	+	−	F	−	−	+	−
+	−	+	+	+	X	−	−	0	+
+	+	−	+	−	J	+	+	+	−
+	+	−	+	+	figures	+	+	0	+
+	+	−	−	+	W	+	+	−	+
+	−	−	−	+	Z	−	0	−	+
−	+	−	+	+	G	+	0	0	+
+	−	−	+	+	B	−	0	0	+
+	−	−	+	−	D	−	0	+	−
+	+	+	−	+	Q	+	−	−	+
−	+	+	−	+	P	−	+	−	+
−	+	−	−	+	L	+	0	−	+
−	+	−	+	−	R	+	0	+	−
−	−	−	+	−	carr. ret.	0	−	+	−



1—*Simplified diagram of the cable transmitter*

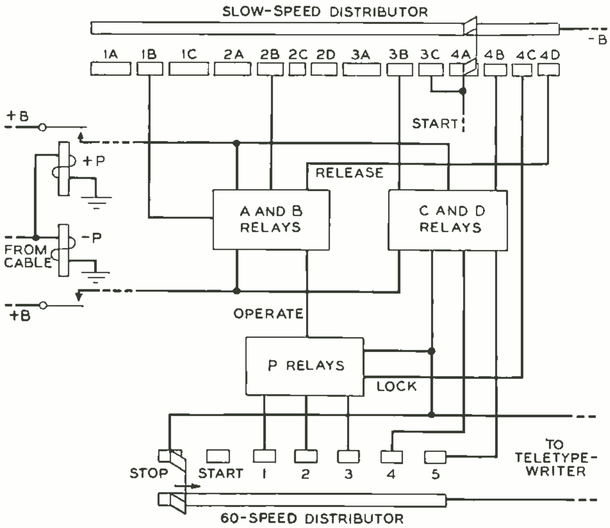


Fig. 2—Simplified diagram of the receiver

Besides the 140-rpm distributor, the receiving terminal also employs a standard sixty-speed distributor, and both are started at the same time, but the standard distributor starts from the stop segment, while the slow-speed distributor starts from the beginning of the first number 4 segment. Since the standard distributor rotates at 368 rpm, it will make one rotation and stop while the 140-rpm distributor is passing over the number 4 and part of the number 1 segments. When the receiving slow-speed distributor has stopped, the first three pulses of a character have been received and have operated relays at the receiving terminal that have, in turn, opened or closed connections to the corresponding segments of the high-speed distributor, so that as the high-speed brush passes over them, the circuit to the receiving teletypewriter apparatus will be opened or closed to represent the desired code.

When the sending distributor starts after having transmitted three of the four pulses of a character, the fourth pulse will start both distributors at the receiving terminal simultaneously. While the brush of the slow-speed receiving distributor is passing over its number 4 segments, the high-speed distributor brush will be sending the pulses translated from the three character pulses previously received by the slow-speed distributor. During this same interval, the fourth pulse from the slow-speed distributor, acting through relays already operated or not operated by the third pulse, will be setting up the proper open or closed circuits for the fourth and fifth segments of the high-speed distributor. It is because of the speed difference between the high and low-speed receiving distributors that the sending and receiving slow-speed distributors are designed to stop after transmission of the third instead of the fourth pulse of each character. Through the 4D segment of the receiving slow-speed distributor, the relays operated to represent the code of the first three pulses of the previous character will be released, and thus by the time the slow-speed brush reaches segment 1B, these relays will be

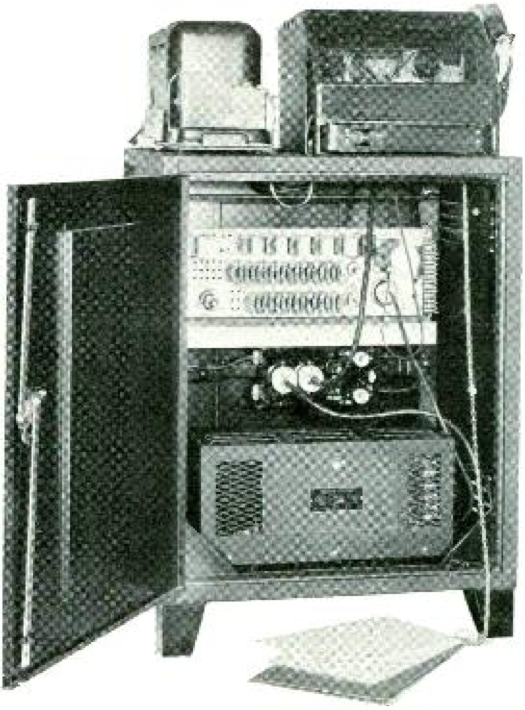


Fig. 3—Navy transmitting equipment for teletypewriter transmission over submarine cable

prepared to receive and translate the new character being transmitted. By this time the high-speed distributor will have sent the entire preceding character and stopped. This process is repeated in rapid succession until the entire message has been sent.

Figure 2 divides the translating relays into three groups. Although all three groups are inter-connected, in general the group marked A AND B RELAYS receives the first two pulses of a character, and the group marked P RELAYS sets up open or closed circuits to the first three segments of the high-speed distributor to correspond to the translated code. The group marked C AND D RELAYS performs similar functions for the last two received pulses and the last two segments of the high-speed distributor.

Besides these transmitting and receiving terminals, it was necessary also to provide arrangements for seizing the cable when it was needed by the Navy. This was done by transfer relays that would switch the required connections at both the transmitting and receiving terminals from the Cable Company's circuits to the Navy's circuits. When the switches were operated, a green light at the Cable Company's apparatus would be extinguished and a red light lighted to indicate that a transfer had been made. At the transmitting terminal, this transfer was accomplished merely by arranging to operate the transfer relay

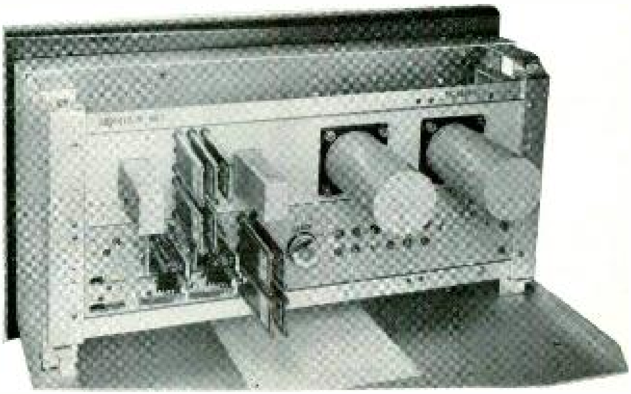


Fig. 5—The transfer circuit for the transmitting end is mounted on a separate panel

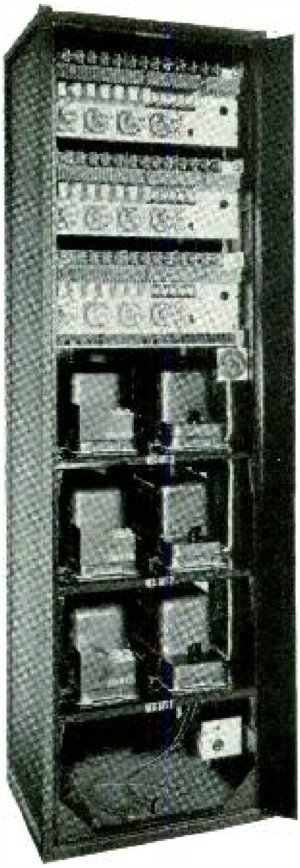


Fig. 4—The receiving terminal at New York

when tape was fed into the transmitter distributor, but more complicated arrangements had to be devised for operating the transfer relay at the remote end.

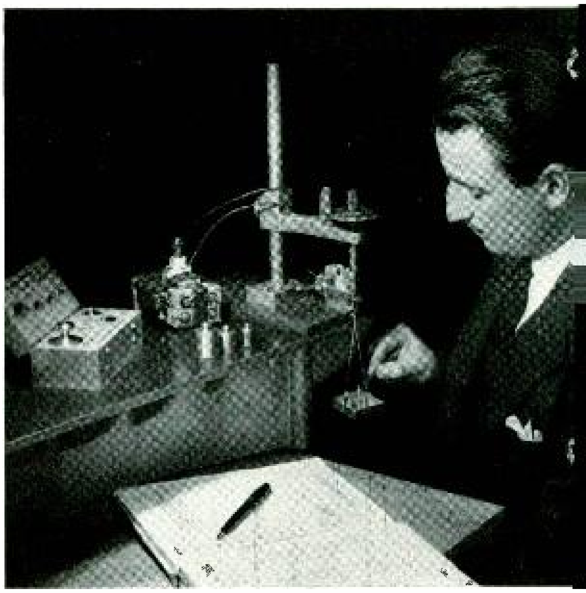
This was accomplished by introducing a short delay between the insertion of tape and the starting of the distributor. During this period, which is equivalent to about eighteen rotations of the timing commutator, the pulses from the timer are converted to dot pulses by the Navy transmitter, and this sequence of positive pulses is sent over the cable. At the receiving end they enter a six-pulse selector, and after six of them have been received, the transfer relay is operated. The remaining pulses of this preliminary series may cause the receiving distributors to make one rotation, but following this the brushes will remain stationary until the distributor at the transmitting end starts.

When the message tape runs out, the tape-out contacts of the transmitter distributor will release the transfer switch at the transmitting end, putting out the red lamp and lighting the green lamp at the Cable Company's transmitter. This latter transmitter will then send a series of ground pulses which will be received at the distant end by a six-space selector, causing the reconnection of the Cable Company's apparatus at the receiving end.

Transmitting equipment for the Navy is assembled in a cabinet as shown in Figure 3. A power supply unit is mounted in the bottom of the cabinet with the relay equipment on a panel above it. The 140-rpm sending distributor is on top of the cabinet at the left, while a standard typing reperforator is located on the right for the purpose of preparing the tape for the message to be transmitted. The transfer circuit, which was at the transmitting end of the cable, was mounted on a separate panel, shown in Figure 5. The receiving terminal for the New York end of the line is shown in Figure 4. Three receiving units, one for Panama, one for San Juan, and one serving as a spare, are mounted in a single cabinet. Each unit includes a shelf mounting a slow-speed and a high-speed distributor, and one panel of relay equipment in the upper part of the cabinet. This system was operated successfully during the war, but its use has since been discontinued because other Navy facilities are adequate.

THE AUTHOR: MATTHEW R. PURVIS received the B.E. degree from Johns Hopkins University in 1926 and at once joined the D. and R. Department of the American Telephone and Telegraph Company, where he first engaged in developing central office equipment and apparatus. Later he transferred his attention to developing demountable polar relays for telegraph service and to devising maintenance and testing practices applicable to them. He continued these activities until some time after the D. and R. Department was consolidated with the Laboratories in 1934. Since 1940 he has been concerned with the development of telegraph and teletypewriter circuits and equipment and in particular with telegraph test and service boards.

Simple Test Helps Design Telephone Crossbar Switch



With the weights in the scale pan, G. W. Galbavy applies a known deflecting force to the spring pile-up of a telephone crossbar switch. Then, by turning the micrometer above the sample, he lowers a pointer to make contact with the pile-up, closing a circuit which lights the neon lamp in the rear. Distance traveled by pointer in order to flash the lamp tells deflection of the pile-up. Load-deflection characteristic thus obtained provides basis for the design of magnets which operate switches in use.

G. H. HUBER
Transmission
Development

SPACE DIVERSITY RECEPTION AT SUPER-HIGH FREQUENCIES

In radio transmission, interference between waves traveling different paths often results in a continually shifting pattern of areas of good and poor reception. At any one receiving position, waves traveling two or more of these paths may add in phase to produce good reception, or they may add in various degrees out of phase to produce varying degrees of poor reception. Continually changing transmission over the various paths causes the space pattern of reception to shift. At any one point there may be good reception at one time and poor reception some time later.

To prevent these variations from seriously interfering with reception, several methods have been employed that can be classified as diversity reception. In one form, two or more receivers are installed sufficiently far apart so that when there is poor reception at one, there will probably be good reception at one or more of the others. This is known as space diversity reception. Whereas commonly used space diversity arrangements involve displacement between antennas in the horizontal plane, the arrangement described here makes use of vertically displaced antennas in connection with the AN/TRC-6,* which is a relay system working in the range 4350-4800 mc, employing pulse-position modulation. In tests† carried on in California during the summer of 1945, it was found that diversity reception was necessary when transmission was over the sea or smooth land. In the form used, the two receiving antennas are separated vertically, and so placed that the reception at one is complementary to that at the other. This system, which may be called complementary vertical space diversity reception, gave excellent results.

California was selected by the Signal Corps as a testing area to evaluate performance of the AN/TRC-6 system because conditions there resemble more closely those of the Pacific islands and the Asiatic mainland than do other parts of this country. The test circuit traversed a 510-mile path from San Francisco to San Diego in five spans as shown in Figure 1, with one branch span from Catalina to Fort MacArthur on the mainland. This was the first time that many detailed observations of performance at super-high frequencies had been made on long paths with high antenna elevation. The sites were selected so that all paths were optically clear, and included three overwater paths of 24, 76 and 102 miles in length and three overland paths of 56, 106 and 170 miles. During part

*Record, *December,* 1945, *page* 457.

†These experiments were made in collaboration with Dr. T. J. Carroll, Radio Propagation Section, Office of the Chief Signal Officer, Mr. Fred Morf and others of the Coles Signal Laboratory, and the officers and men of the New Equipment Introductory Division of the Signal Corps.

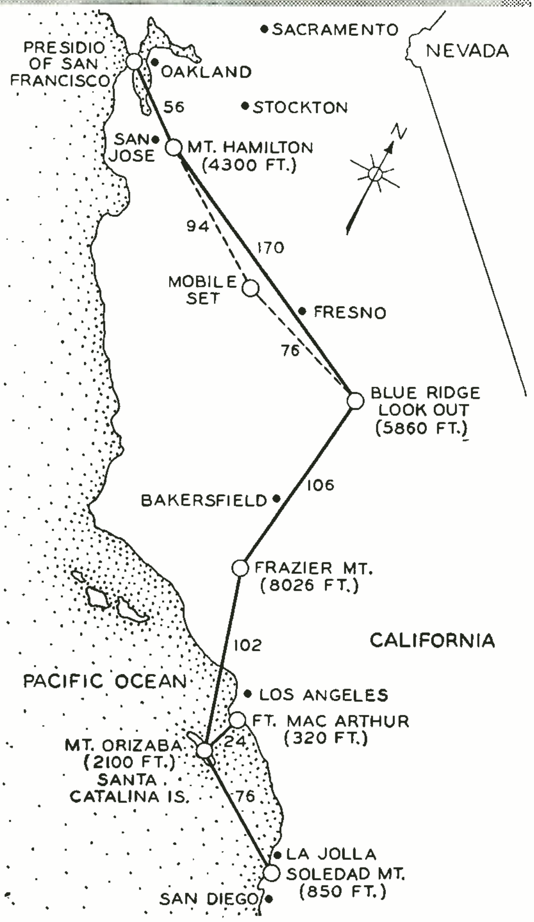


Fig. 1—Paths used for the California test of pulse transmission over a 510-mile path

of the time, the 170-mile path was divided into 76 and 94-mile sections. During the course of the tests with the standard single-antenna method of reception, frequent momentary circuit interruptions were noticed on all of the overwater paths and on the 170-mile overland path. These brief circuit outages were termed "hits" because of their similarity to the familiar circuit interruptions experienced on an open-wire line when two wires hit together.

These "hits" were apparently due to phasing of two received signals. A likely cause of failure seemed to be interference between the direct waves and waves reflected at or near the surface of the earth or sea. Radiation from a microwave transmitter using reflectors is in the form of a small-angle cone. Maximum radiation is in the direction of the axis, and the energy transmitted decreases rapidly with angular distance from the axis. With the microwave relay system, the antenna sites are selected as far apart as possible without bringing the line-of-sight path too close to the earth at some intervening point. As a result, there is an appreciable distance along the earth where the angle between the earth and the line-of-sight path is small, and thus the conditions for strong reflections are good, particularly with an oversea path. The length of the reflection path is slightly greater than that of the direct path, and thus transmission over it may not be in phase with the direct signal. Since the wavelength at the frequencies used is of the order of 6 centimeters, slight differences in length of path may have a considerable effect on phase.

Because the path between Catalina and Fort MacArthur was short and the transmitter sites comparatively high, the angle between direct and possible reflected path was large, about two degrees. It seemed, therefore, that any power traveling the reflected path could be greatly reduced relative to that following the direct path by tipping the antennas slightly upward. This was tried, and although there was a small loss in the direct signal, a good "hit-free" link was obtained.

From Catalina to Frazier Mountain, the 102-mile path is partly overland and partly overwater, but because Frazier Mountain is much higher than the Catalina antennas, the region of possible reflection is on the water section of the path, and thus this link was classified as an overwater path. Because of the much greater distance spanned, however, the angle between direct and reflected waves is much smaller—about half a degree. Tilting here, therefore, was not so effective. Although the total number of "hits" was reduced to about one-fourth of the former value, at times as many as twenty "hits" per hour were present.

Following these tests, one set of the Catalina antennas was moved so that an intervening mountain interrupted the reflected signals, and another set of antennas was directed toward Frazier Mountain. Reception at the shielded site was remarkably smooth, while simultaneous reception at the original site was often fluctuating.

On the path between Catalina and Soledad Mountain, the angle between direct and reflected signals was too small to make tilting offer a solution, and there is no convenient intervening mountain to intercept the reflected ray. A short trial was made of changing the polarization from the usual horizontal to vertical, but no improvement was noticeable.

Considering both direct and reflected waves, the signal strength along any vertical line may consist of a series of points of maximum reception with points of minimum reception in between—thus exhibiting the lobe structure encountered in other studies of super-high-frequency transmission and in radar. Because of varying atmospheric conditions, the effective length of the transmission paths varies. As a result, the pattern of peaks and nodes of reception often shifts up and down so that a fixed receiver may at one moment be at a peak and a short time later at a node. It is possible to calculate the approximate distance between the points of maximum reception. If two antennas are separated by half the distance between maximums, then when one antenna is getting maximum reception, the other will be getting minimum, and thus when the pattern shifts up or down so that the first receiver is getting minimum reception, the second will be getting a maximum. Two receivers so located should therefore give complementary reception.

Complementary vertical space diversity reception was first tried over the link between Catalina and Soledad Mountain. As shown in Figure 2, a second receiving parabolic antenna was fastened 25 feet below the regular receiving antenna on the tower at the site on Soledad Mountain. The position chosen was the calculated difference between a maximum and a minimum of the lobe pattern for this path. The outputs of both receivers were recorded continuously. Fades in the received signal were never observed to occur simultaneously on both receivers. In a one-hour period, seven fades deep enough to cause circuit interruption occurred in the signal received with the upper antenna, while at slightly different times ten equally intense fades occurred in the signal received with the lower antenna. This alternation of signal strength occurred not only for fades a fraction of a

Fig. 2—Antenna site on Soledad Mountain showing a receiving antenna twenty-five feet below the regular set which was used in the studies of complementary space diversity reception

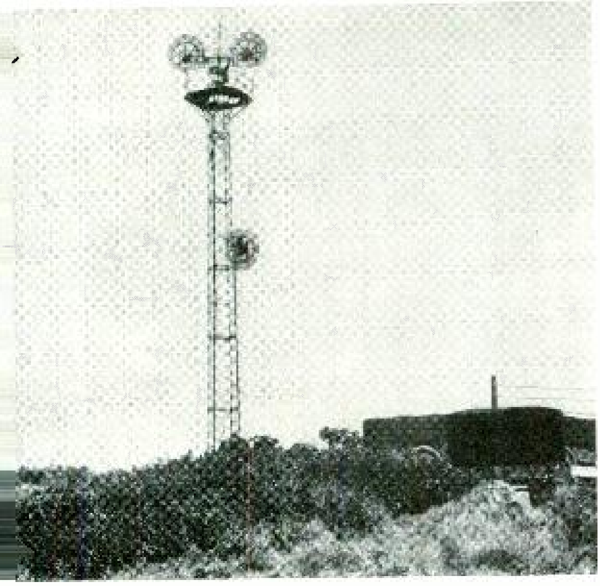


Fig. 3—Antennas as used on Mount Orizaba, Catalina Island, for test over the path to Soledad Mountain. Second receiving antenna attached to pole fifty feet lower than others

second long, but also for fluctuations over many minutes.

After this verification of the presence of complementary space diversity, the two receiving circuits were paralleled after the first video amplifier stages to feed in common the remainder of the video and audio circuits. The selection of this point for paralleling the receivers avoids many difficulties involved in other diversity receivers, since at this point the signals consist of pulses, and thus always add in phase regardless of the phase of the received radio signals. The automatic volume-control voltages, which vary the grid-bias voltage on the intermediate frequency amplifier stages, were connected together and fed back to both receivers. The shift of control from one signal to the other was smooth. The stronger signal always regulates the gain, and since all fades are out of phase, the result is a very quiet "hit-free" circuit. By this simple means, "hits" were absent on this circuit during the next month's tests. Excellent communication was likewise achieved in the opposite direction by installing a second receiving antenna 50 feet below the original antenna on Mount Orizaba, Catalina Island, as shown in Figure 3. This spacing was also about the computed half lobe spacing.

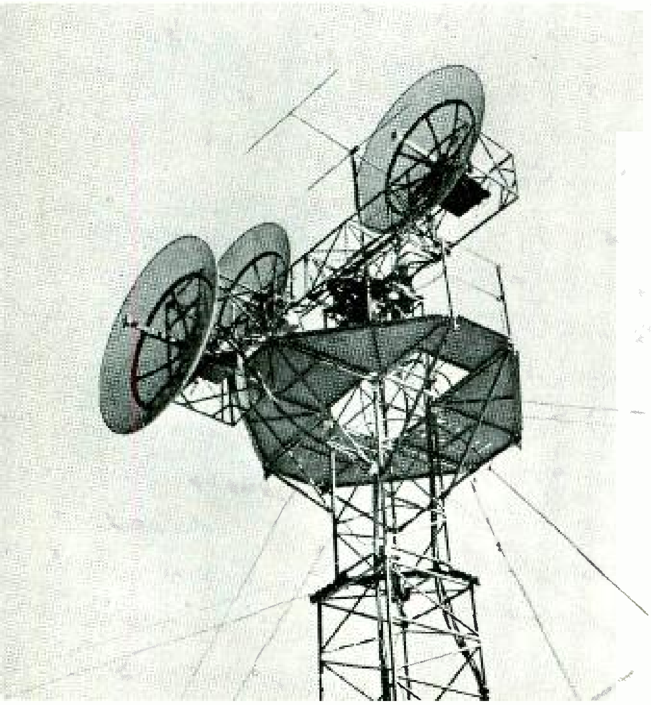


Fig. 4—Second antenna installed on tower at Catalina for space diversity transmission with Frazier Mountain

Following this success, the Mount Orizaba set associated with the 102-mile overwater path to Frazier Mountain was also arranged for complementary space diversity reception by placing a second antenna 6 feet below the original, as shown in Figure 4, and a second receiving antenna was added 20 feet below the regular antenna on Frazier Mountain. As before, these spacings were approximate half lobe separations for their respective transmitters over the path involved. Here, also, all propagation hits were removed by this procedure, whereas without diversity, the original circuit from the summit had proved too unreliable for radio relay service.

Records made of the 170-mile overland path, the longest optical radio-relay link ever tried at super-high frequencies, almost always showed varying signal strength, with frequent fades deep enough to cause communication failures. Because of this, a new relay station had been installed in the San Joaquin Valley, breaking the path into two sections of 76 and 94 miles each. Satisfactory circuits were then obtained.

Inspection of the recordings made of the single link 170-mile path, however, revealed that the fades appeared to be caused by typical interference between two components with broad peaks and deep narrow fades. A second antenna was therefore installed at Blue Ridge Lookout 43 feet below the regular antenna, and records were taken of the output of both receivers. Simultaneous fades sufficient to cause circuit failure or serious noise are not to be found on the record, although each antenna individually is subject to many such fades. Inspection of the records during deep fades showed that they were to a large extent complementary in that very deep fades on one antenna corresponded to peaks on the other. The possible reflection area lies in the San Joaquin Valley about five miles east of Firebough. For many miles in either direction the land is semi-arid and exceedingly flat with almost no vegetation. The unusual flatness of the land and the small grazing angle were probably favorable to the production of a strong reflected signal. Complementary vertical space diversity reception was added to this path, which then operated satisfactorily and did not require the extra relay station in the San Joaquin Valley, which had been found necessary with single-antenna reception.

Since these experiments, two Bell System installations of overwater AN/TRC-6 systems have been made, one from Los Angeles to Catalina, and the other from Hyannis, Mass., to Nantucket. The performance of both of these systems is satisfactory. Vertical space diversity arrangements were included on a trial basis, and have been found very helpful during periods of excessive fading. All of these experiments demonstrate that the complementary vertical space diversity method is of great value in improving performance of super-high-frequency relay paths operating over the sea or smooth land.

THE AUTHOR: George H. Huber joined the Engineering Department of the Western Electric Company in 1920. Upon completion of the Technical Assistants' Course, and other evening studies, he became a member of the Technical Staff. With the Transmission Development Department, he has been engaged in the development of carrier telephone systems, taking part in the development of the "C," "J" and "K" systems. In 1935 he transferred to the Research Department to pioneer the development of a carrier telephone terminal for coaxial cable, and then returned to the Transmission Development Department to continue development of the "L" system. During the war years his efforts were devoted exclusively to the development of devices for the Armed Forces, radar test equipment and the AN/TRC-6 radio relay system, but has since returned to his former work and at present is in charge of a group developing program channels for broad-band carrier systems. He is a senior member of the I.R.E., a member of the A.I.E.E. and the Acoustical Society of America.

NEW COIN CHUTE REDUCES WEAR AND TEAR

Nearly 5,000 nickels a year are dropped into each Bell System coin telephone on the average—and telephones in busy locations take in many more. Each nickel leaves its mark, not a very big one, of course, but over a period of time the 5¢ coin chutes suffer considerable wear and tear. To reduce this the Laboratories have developed a coating of neoprene for certain points of the nickel runway where it changes direction. Although this coating is only 0.005 to 0.012-in. thick, it effectively cushions the fast moving coin so that its energy is dissipated without deforming the chute. One such treated chute, tested in the Laboratories, has withstood the fall of a million nickels without injury to the coating. L. T. Holden of Station Apparatus and H. Peters of Insulation Engineering were the engineers on this project.

In the future, new coin telephones will be equipped with the improved nickel runway and as existing instruments undergo repairs, the new runways will be substituted.

GLASS-SEALED SWITCHES AND RELAYS

C. G. McCORMICK
Switching
Apparatus
Development

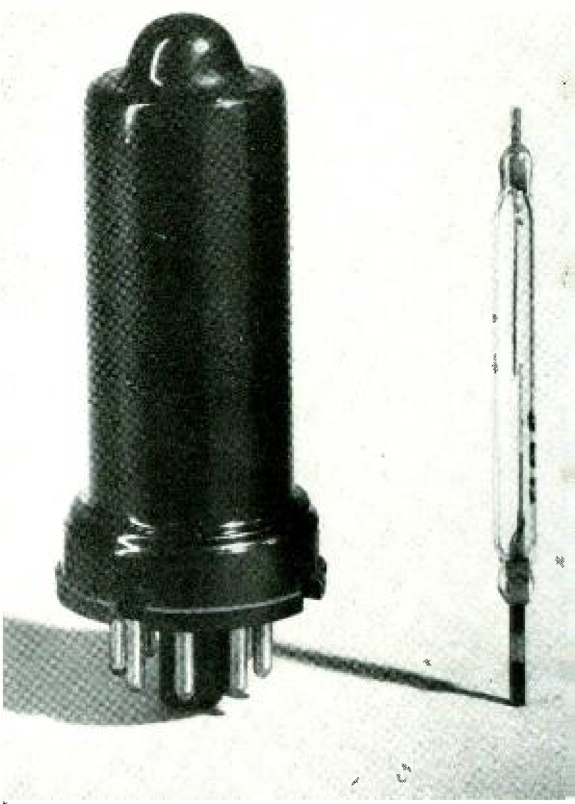
In connection with various projects undertaken by the Laboratories for the Armed Services during the late war, relay circuits were required for performing a number of essential high-speed switching operations. Because of the wide range of conditions to which this equipment might be subjected, ordinary telephone relays could not be utilized in all cases. In planes, for example, the equipment may be exposed to rapid and wide changes in pressure, temperature, and moisture conditions; in ground installations, tropical dampness, desert winds and arctic frosts have to be considered. Some type of hermetically sealed switch that would prevent moisture or dirt from collecting on the contacts and insure against excessive erosion of the contacts under low pressure exposures seemed essential to meet these exacting conditions.

For a number of years, a hermetically sealed reed type switch had been under development in the Laboratories, but it had been produced only in very limited numbers and for very limited applications. With the advent of the war, however, considerable impetus was given to both the development and application of these devices, with the result that a pilot plant for their manufacture was set up in the Laboratories early in 1944.

Two types of glass-sealed switches were produced; one known as the dry-reed type and the other as the mercury-contact type. Both consist of slender glass tubes, at the ends of which are sealed metallic members, one of which was tubular so that the assembled switch may be evacuated and supplied with a reducing atmosphere. In the dry-reed type switch, shown in Figure 1 and in cross-section in Figure 2, a gap is provided at the time of sealing between the overlapping magnetic reeds extending from the ends. When this switch is placed in a magnetic field in a direction lengthwise to the tube, the overlapping ends of the reeds are drawn together, causing a circuit to be completed between the terminals protruding at each end of the switch.

The mercury-contact type, shown in Figure 3 and in cross-section in Figure 4, is more complicated in that both a back contact and a front contact are provided. Both of these contacts are sealed in at one end of the glass tube with a fixed separation between them. An armature assembly on which the other contacting

Fig. 1—One type of dry-reed relay. Complete assem at the left, and the switch element alone at the ri



member is mounted extends from the opposite end of the glass tube. At the time this latter end is sealed, the armature is positioned so that its contact will press against the back contact, which is mounted on a non-magnetic member. The front contact is mounted on a magnetic member which overlaps the armature slightly. When this switch is placed in a magnetic field lengthwise to the tube, the armature is attracted toward the front contact, causing the back contact to break and the front contact to make. A small amount of mercury is inserted before the switch is completely sealed. Most of it remains at the lower end of the tube, which in operation must be held approximately vertically. It is fed continuously to the contacts by capillary action. The presence of mercury imposes a limitation of −40 degrees C as the minimum ambient temperature, since at this point the mercury freezes and the switch becomes inoperative. Due to the spacing employed and the surface tension of the mercury, the front contact usually makes upon operation of the armature before the back contact breaks, causing a momentary bridging of the front and back contacts. Bridging also occurs upon release of the armature. The operating field may be provided by a solenoid in which the glass-sealed switch is placed, or by mechanically bringing a magnet close to the tube. By providing a steady field of sufficient strength and at the same time an alternating field, polar operation can be obtained, and the switch will operate at a rate equal to the frequency of the alternating field, whereas without the steady field, the rate of operation would be twice the frequency, provided the frequency is not too great.

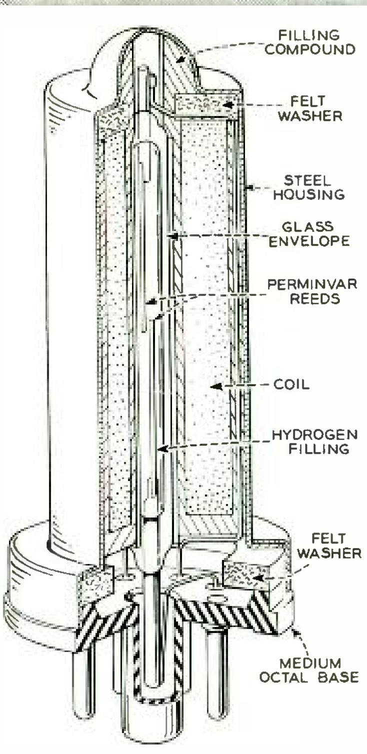


Fig. 2—Cross-section of one of the dry-reed relays

Most of the relays are made as plug-in devices using a metal vacuum tube type cover and a standard small wafer octal vacuum tube base. Other forms were provided as dictated by the apparatus with which they were to be associated, and need not be discussed further except to say that they all involve the same fundamental features of one or more reeds sealed in a glass container and operated in a reducing atmosphere. Low mass is always required to obtain high operating speeds and to minimize chatter of contacts. The performance capabilities of the different devices for two typical relays are given in the accompanying table.

When the pilot plant for producing the above switches and relays was originally planned, it was thought that the total demand for all of the different types of devices would not exceed about two thousand per month. This was early in 1944. Later in the year, the increase in tempo of war preparations made it clear that this figure was quite inadequate, and that additional facilities would be required. To meet the increase of demands, it was agreed with the Western Electric Company that the Laboratories facilities would be expanded to produce 10,000 mercury-contact switches per month together with a somewhat smaller number of dry-reed switches, the facilities to be operated on a two-shift basis. Since the manufacture of the associated parts and the assembly of switches into relays involved operations already familiar to the Western Electric Company, the responsibility for assembling mercury-contact switches into relays was assigned to the Bayonne Plant. To carry out our end of the bargain of producing the switches, arrangements were made whereby personnel of the Development Shop would be available as required, working under the supervision of the development engineers.

By the early part of 1945, the increased facilities and personnel had been provided, and the anticipated increase in production rate had been fully achieved. By this time, however, the war demands had again jumped, this time to such an extent it was felt that the Western Electric Company should take over full responsibility for mercury-contact switch production. It was thought that the experience gained in the pilot plant, together with the facilities used, should be made available to the Western Electric Company. They would make additions to the facilities as the demands required. In addition, the Laboratories personnel would be lent to the Western Electric Company for such period as they felt necessary for training their own personnel. Accordingly, the Laboratories facilities and personnel were moved to the Western Electric Tube Shop on Hudson Street, at which point operations were resumed two days later. The Laboratories personnel were replaced within about one month, production going forward with the Western Electric personnel until V-J Day, when production was discontinued because of the cancellation of war contracts. It is to the credit of the Western Electric organization that they were able to take over the responsibilities of such a new project in such a short time.

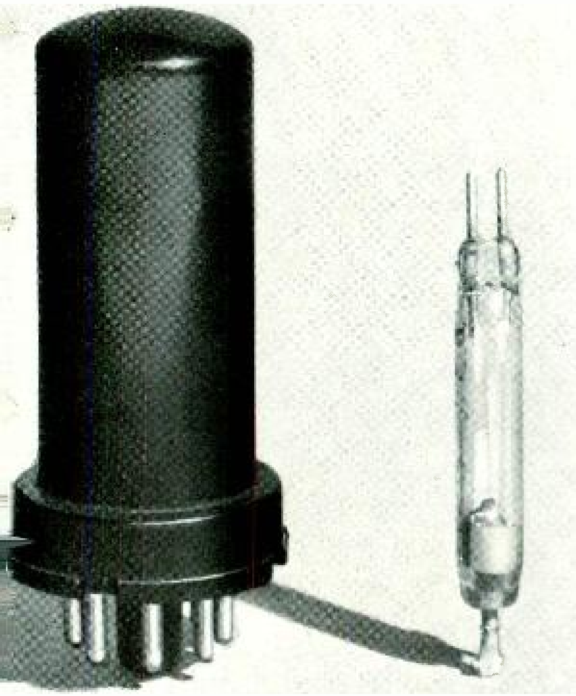
Although the mercury-contact relay represented the major part of the war requirements, the demand for dry-reed switches and relays increased considerably, especially during the early part of 1945. By the time the Laboratories personnel were released by the Western Electric Company, the demand for these devices had grown to the point where it was necessary to reestablish the plant at West Street for their production.

With the termination of war contracts, development at Bell Laboratories was continued to seek ways of improving designs and of applying the unique characteristics of these switches to Bell System needs. At present, a small but rapidly growing production for such purposes is under way.

Performance Characteristics of Dry-Reed and Mercury Sealed-Glass Relays

	Mercury-Contact Relay	*Dry-Contact Relay*
Magnetic Material	Permalloy	Perminvar
Contact Material	Platinum bathed in mercury	Gold infused in perminvar
Gaseous Environment	Hydrogen at 250 pounds pressure	Hydrogen at atmospheric pressure
Nominal Power—Operate	.18 watt	.03 watt
Nominal Power—Release	.10 watt	.01 watt
Time to Operate on 48 v. d-c	.0047 sec. (approx.) to make front contact; .0051 sec. (approx.) to break back contact	.002 sec. (maximum)
Time to Release on Open Circuit	.0039 sec. (approx.) to break front contact; .0035 sec. (approx.) to make back contact	.001 sec. (maximum)
Current Rating*	5 amps. (20 watts)	.25 amp.
Life Expectancy with Adequate Contact Protection	$>10^9$ operations	$>10^8$ operations

*Current rating dependent on voltage and load impedance and not to exceed value specified.



ɡ. 3—*One type of mercury glass-sealed relay; com-*
·tely assembled at the left, switch unit at the right

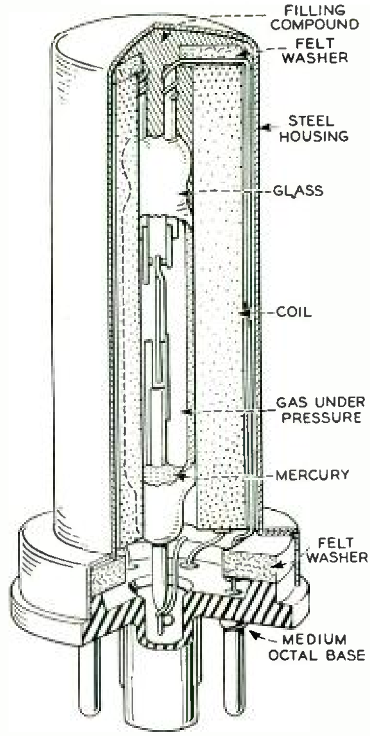


Fig. 4—Cross-section of one type of mercury relay in which both a front and back contact is provided

THE AUTHOR: C. G. McCormick received the B.S. degree in Mechanical Engineering from the University of Pennsylvania in 1921, and at once joined the Engineering Department of the Western Electric Company, which later became Bell Telephone Laboratories. He was assigned to the Physical Laboratory and engaged in testing and experimental work on panel, step-by-step and coordinate dial, and other Bell System apparatus until 1928, when he was transferred to the Step-by-Step Design Group of the Apparatus Development Department. For seven terms during the years 1929 to 1933 he was an instructor in the "Manufacturing Methods" out-of-hour course. Since 1933 he has been supervising at various times design and development work on step-by-step apparatus, contacts, resistances, retardation coils, message registers, and station ringers. During World War II he was associated with a group working on a U. S. Navy fire-control project until its completion. He then supervised the Pilot Plant which manufactured glass seal switches and relays for war applications. Since the close of the war he has returned to development work on central-office apparatus, and is now supervising the Relay Laboratory of the Switching Apparatus Development Department.

G. B. Thomas Retires After Thirty Years With the Laboratories

George B. Thomas, Personnel Director, retired from the Laboratories under the Retirement Age Rule on August 31 following thirty years of service. Mr. Thomas graduated from Ohio State University in 1907 with the degree of M.E. in E.E. He taught electrical engineering at the Massachusetts Institute of Technology from 1907 to 1910. For the next seven years, at Colorado College, he was professor and head of the Electrical Engineering and Physics Departments. From 1910 to 1916 he also conducted a summer program for engineering teachers at the Westinghouse Electric and Manufacturing Company. When World War I started in 1917, Mr. Thomas left teaching for work on submarine detection in the Engineering Department of the Western Electric Company, predecessor of Bell Telephone Laboratories.

At that time, personnel work in the Engineering Department had been handled for the most part individually by department heads and supervisors. Records and other routine matters were cared for by a small service group. With the growth of the Engineering Department, largely due to the rapid expansion of its research work, there was need for a coördinated development of personnel work along broader lines. In addition to the problem of selecting suitable men and women for employment, there was that of giving them an introductory training and, particularly, opportunities for subsequent study, for arranging interdepartmental transfers, and also for correlating medical and other assistance. To meet this situation the Personnel Department was formed in 1918, at which time Mr. Thomas was placed in charge of its work of technical training. With the formation of Bell Telephone Laboratories in 1925, he was appointed Personnel Director. Under his direction, unique training programs were initiated. These included part-time post-graduate study, out-of-hour courses given to members of the Technical Staff, and in-hour courses for training employees in a great many classifications —junior mechanics, bench hands, technical assistants, junior draftsmen, typists and stenographers.

For many years Mr. Thomas has been active in the affairs of the American Society for Engineering Education (formerly the Society for the Promotion of Engineering Education), the Committee on Student Selection and Guidance of the Engineers' Council for Professional Development, and the American Management Association, the A.I.E.E., and the Silver Bay Industrial Conference Committee. He is currently president of the Ohio Society of New York.

Telephone Service for Trains

On August 15, telephone service to and from moving trains became effective on two crack trains of the B. & O. and the Pennsylvania Railroads running between New York and Washington. At present, operating on an experimental basis, this new service utilizes the urban mobile radio stations at Washington, Baltimore, Philadelphia, and Newark, through which calls may be completed between the trains and any of the fifty-two million worldwide stations accessible to the Bell System. A telephone booth in a club car gives quiet and privacy to the talker, while an attendant at a small control cabinet outside establishes a connection by radio to the nearest mobile radio operator, who extends the call to the desired point. Rates for calls are the same as with the mobile service already in use. The apparatus and equipment aboard the trains were developed by Bell Telephone Laboratories, and will be described in a forthcoming issue of BELL LABORATORIES RECORD.

Apparatus Development Department I and II

Effective August 1, the Apparatus Development Department was organized into two general departments.

Apparatus Development Department I is under the supervision of D. A. Quarles, Vice-President and Director of Apparatus Development I. Reporting to Mr. Quarles are R. G. McCurdy, Director of Transmission Apparatus Development; H. A. Frederick, Director of

Switching Apparatus Development; J. R. Wilson, Director of Electronic Apparatus Development; M. H. Cook, Director of Specialty Products Development; and H. J. Delchamps, Specifications and Staff Engineer. Mr. Delchamps also serves in this capacity for Apparatus Development Department II.

Apparatus Development Department II is under the supervision of W. H. Martin, Director of Apparatus Development II, reporting to the Executive Vice-President. Reporting to Mr. Martin are: R. A. Haislip, Director of Outside Plant Development; and G. D. Edwards, Director of Quality Assurance. The Station Apparatus Development Department continues to be directed by Mr. Martin.

Part-Time Post-Graduate Study Plan

Individuals interested in undertaking post-graduate work under the Part-Time Post-Graduate Study Plan may obtain detailed copies of the announcement pamphlet, application form, and other information from the Personnel Department, Section 4-H, at West Street, Extension 628.

Any employee of the Laboratories who has been regularly employed for a minimum of approximately one year and who holds a Bachelor's degree in Arts, Science, or Engineering is eligible to make application. Candidates who wish to enroll under the plan should discuss the question of their proposed enrollment with their immediate supervisors in time to submit formal applications to them not later than three weeks prior to the beginning of registration for the term.

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

Social Security

As of the beginning of this year, the Social Security Act has been in effect for ten years, and during this period certain amendments have been made in the Federal Old-Age and Survivors' Insurance program. Those employees who are interested in reviewing the latest provisions may obtain a pamphlet, *Insurance for Workers and Their Families,* from any Social Security Administration field office. A limited supply of these pamphlets has been secured by the Laboratories and may be obtained by calling the Personnel Department at West Street, Extension 435, or at Murray Hill, Extension 224.

F. D. Leamer Appointed Personnel Director of the Laboratories

Frank D. Leamer, whose appointment as Personnel Director is effective September 1, enters his new responsibilities with excellent background and experience. To a lifelong interest in teaching he has added sound training in physical research and personnel administration, together with seventeen years' experience as a member of the Personnel Department.

A native of Vinton, Iowa, Mr. Leamer first became associated with the telephone business as a part-time telephone operator while he was studying at Morningside College, Sioux City, Iowa. Upon his graduation in 1926, he was awarded a teaching fellowship which led to a Master of Science degree from the University of Iowa. He was then head of the Physics Department at Willamette University, Salem, Oregon, for two years.

Mr. Leamer became associated with the Laboratories in 1930 when his teaching experience led to his assignment to training work in the Personnel Department. He continued his interest in physical research with a number of graduate courses at New York University and Columbia University and supplemented these with out-of-hour training in personnel and labor relations activities.

Under N.I.R.A. he took part in setting up the Laboratories' first bargaining machinery, and when the B.T.L.E.A. was formed he was a member of the Labor Relations Committee which negotiated the first union contract. In 1941 he was placed in charge of personnel matters for all of the Laboratories' New Jersey locations and moved his office to Murray Hill.

At Lincoln Park, New Jersey, where he had lived prior to this transfer, Mr. Leamer served as a member of the Borough Council for three years. In Summit, where he now resides, he has been a member of the Family Service Association since 1943 and is currently its president. He is a past-president of the Morris County Personnel Group and is also a member of the New York Personnel Management Association, the American Arbitration Association, the American Society for Engineering Education, and the Midtown Personnel Group.

M1 Carrier for Short-Haul Toll Lines

A new short-haul open-wire carrier system —the M1—has recently been added to the telephone plant. Field tests conducted by the Wisconsin Bell Telephone Company, the A T & T, and Bell Telephone Laboratories on a sixty-five-mile circuit between Appleton and Manitowoc, Wisconsin, have indicated that, under suitable conditions, the equipment can provide extra toll circuits more economically than can be accomplished by stringing additional wire or cable.

The M1 system, which will be described shortly in the RECORD, was originally developed for subscriber telephone service in rural areas over power or telephone lines, and installations of this type have been in use for some time.

The system's adaptability and ease of installation, however, suggested a wider field of use, and led to the trial referred to above. More recently it has been used to provide an extra trunk between an unattended community dial office at Enosburg Falls, Vermont, and the central office at St. Albans—some twenty miles away.

Plucky Rescue Attempt

Shortly after Mildred Hoogstraat went on evening duty as a lifeguard at Ruzicka's Pond, Chatham, on July 16, she heard a call for help offshore. She went into the water for a boy who had been swimming with a group when he sank. Because the water is not clear, Miss Hoogstraat surface-dived four times before she found the young man and brought him up to a waiting boat. On shore she administered artificial respiration until the Fire Department rescue squad arrived. Forty-five minutes later the young man was pronounced dead of heart exhaustion.

Miss Hoogstraat holds a Red Cross Life Saving Certificate and also a Water Safety Instructor's Certificate. The first was obtained after completing a life-saving course conducted by Red Cross Water Safety Instructors, who are members of the Laboratories at Murray Hill and who are conducting the swimming courses mentioned on the next page.

Electrical Definitions Being Revised

The present edition of the *American Standard Definitions of Electrical Terms*, issued in 1941, is now undergoing a complete revision. This work is being carried out under the sponsorship of the American Institute of Electrical Engineers by a Sectional Committee (C42) of the American Standards Association. C. L. Dawes of Harvard University is Chairman of the Sectional Committee, which has a total membership of 55, representing 33 interested organizations. E. I. Green is one of the A.I.E.E. representatives.

As in the previous edition, the definitions are divided into 17 general categories, comprising different fields of electrical engineer-

September Service Anniversaries of Members of the Laboratories

35 *Years*

J. H. Bower
H. A. Frederick
W. C. Jones
S. S. A. Watkins

30 *Years*

F. A. Anderson
Julian Blanchard
H. C. Brown
F. M. Costello
H. L. Coyne
H. C. Cramer
Helmuth Eckardt
L. N. Hampton
Patrick Healy
William Held, Jr.
H. W. Hodgkins
J. G. Knapp
A. H. Miller
G. L. Seigman
H. M. Trueblood
John Umscheid

25 *Years*

P. H. Betts
J. H. Bullwinkel
J. B. Connolly
J. E. Crowley
E. D. Deery
E. C. Erickson
F. A. Hubbard
V. E. Legg
H. C. Lloyd
Henry Peters
W. J. Rutter
E. J. Ryder
J. A. St. Clair

20 *Years*

E. M. Arndt
W. H. Aug
C. H. Bidwell
H. D. Doane
C. G. Erb
C. M. Gaston
Julia Goeltz
J. M. Hardesty
H. W. Holmlin
A. C. Kane
Elizabeth Lemmerz
V. J. McCarthy
H. A. Milmoe
G. E. Moore
W. R. Neisser
Ella Rohde
M. J. Spinler
J. E. Tarr
E. M. Tolman
Milton Whitehead
F. P. Wight
R. O. Wise

15 *Years*

Gerald O'Donnell
Anton Zeiss, Jr.

10 *Years*

Nicholas Brady
Grace Cooney
Laura Fenimore
J. P. Fraser
H. J. Glynn
L. A. Hopper
E. W. Houghton
J. B. Little
Herma Procopiadi
M. D. Rigterink
W. G. Turnbull, Jr.
Lillian Voss

ing. The work in each category is assigned to a subcommittee of the A.S.A. Sectional Committee. Members of the Laboratories are playing an active part on these subcommittees. J. D. Tebo is Chairman of Subcommittee No. 1, which is handling Group 05, General (Fundamental and Derived) Terms, and B. F. Lewis is Secretary of that subcommittee. H. J. Fisher is on Subcommittee No. 6 which covers Group 30, Instruments, Meters, and Meter Testing. H. E. Ives is a member of Subcommittee No. 11, handling Group 55, Illuminating Engineering. Subcommittee No. 13, which is responsible for Electrocommunication Definitions in Group 65, has E. I. Green as Chairman and J. C. Shelleng as Vice-Chairman and I.R.E. Representative. S. B. Ingram is Chairman of the subcommittee responsible for Group 70, Electronics.

A number of other Laboratories engineers are working with the above representatives in suggesting changes and additions. All who are interested are invited to review the present book of definitions and forward suggestions to any of the Laboratories representatives. Suggestions for groups on which Bell Laboratories is not officially represented will be forwarded to the subcommittee which is responsible for the work.

"Post" Articles Reprinted

At the request of various associated companies, Western Electric Company has prepared approximately 300,000 reprints of the series of three articles concerning the Laboratories which appeared in *The Saturday Evening Post* under the title of "Ma Bell's House of Magic."

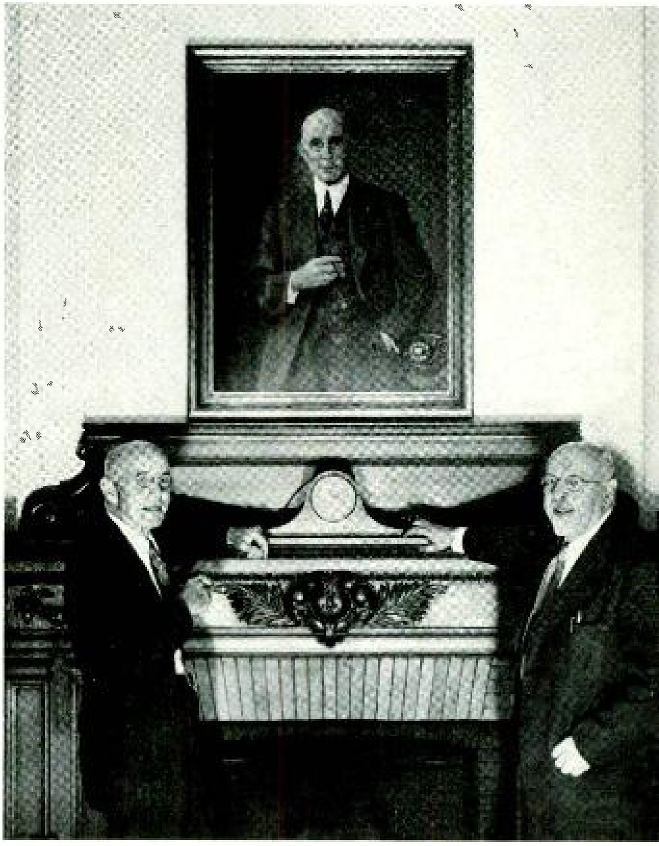
The Laboratories has received a small number of these reprints which are available in the library.

Get Into the Swim

Members of the Laboratories at Murray Hill and those who reside near Plainfield will have an opportunity to swim at the Plainfield YMCA on Wednesday evenings for the next four months. Regular Red Cross-sponsored swimming courses will be conducted during the fall of 1947 for beginners, intermediates and swimmers. Those who satisfactorily complete the swimmers' course may take the Red Cross Life Saving course which will be given in the spring of 1948. Members who want recreational swimming, without class instruction, may also attend. Transportation will be provided by members of the group who have cars. For particulars, please call W. C. Buckland, Murray Hill, extension 996.

News Notes

At ceremonies held on July 18, War Department Certificates of Appreciation were presented to H. M. Bascom of the Laboratories who retired on June 30, C. O. Bickelhaupt and J. B. Rees of the A T & T, and H. J. Schroll of the New York Company. The awards were made "for patriotic services during the initial development of operating methods and installation of signal equipment."



On Dr. Ives' last afternoon at West Street his friends gathered to bid him "au revoir." For the occasion, they had assembled an exhibition of his paintings, before one of which the camera pictures the subject (Dr. F. B. Jewett) and the painter

On August 5, the Jackie Jones Mountain repeater station was visited by Mr. Gifford, accompanied by Dr. Buckley. This is the first station to be completed on the New York-Boston radio relay system.

M. J. Kelly held a round-table discussion with the engineering group of the Northwestern Bell Telephone Company on July 18 at Des Moines. He also talked to the staff and supervisory force. Mr. Kelly has been appointed to the President's Visiting Committee of the University of Missouri for its School of Mines and Metallurgy to survey the Basic Science Departments.

HARVEY FLETCHER and M. B. GARDNER participated in a two-day Symposium on Sound held on July 21 and 22 at the Salt Lake City Tabernacle and the University of Utah in connection with the Utah Centennial. Mr. Fletcher presented papers on *The Relationship Between the Ability to Understand Conversation on the Telephone and Physical Characteristics of the Telephone System,* and on *An Institute of Musical Science—A Suggestion.* Mr. Gardner's paper was *The Subjective Analysis of Hearing Impairment.* Mr. Fletcher also spoke on the Laboratories and its work at the invitation of the Utah Chapter of Sigma Xi at the Utah State Agricultural College.

MR. GARDNER, at Provo, Utah, on July 23, repeated his Salt Lake City talk before the Utah Valley Medical Association. Included in addition to slides was a color motion picture of an operation for the restoration of hearing in cases of otosclerosis, shown through the courtesy of Dr. Julius Lempert, director of the Lempert Institute of Otology in New York City.

W. A. SHEWHART conferred at Hawthorne with analytical and metallurgical groups. He attended meetings of the American Society for Quality Control in Chicago as a guest of honor, and his election as the first honorary member was announced at the annual banquet. Mr. Shewhart also attended a meeting of the Board of Directors of the American Statistical Association in New York.

F. F. SIEBERT went to the Holtzer Cabot Company in Chicago on ringing machine problems, and the General Electric Company at Fort Wayne, Ind., regarding machine design.

J. B. MAGGIO assisted Chesapeake and Potomac engineers in setting up and adjusting a microwave television link in Washington for a special broadcast.

"The Telephone Hour"

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

September 8	*Bidu Sayão*
September 15	*Gladys Swarthout*
September 22	*Lily Pons*
September 29	*John Charles Thomas*
October 6	*Jascha Heifetz*

G. H. KLEM discussed microwave radio equipment at the Winston-Salem plant.

P. G. CLARK and A. W. DRING visited Point Breeze to discuss cable terminal questions.

J. H. SHUHART made leakage measurements on the Huntington-Portsmouth Line in Ohio in connection with tandem transpositions.

G. Q. LUMSDEN and F. F. FARNSWORTH visited Meridian, Miss., on the control of bleeding in southern pine poles.

R. H. COLLEY discussed non-pressure treatment of poles and crossarms with suppliers in Minneapolis and Chicago.

A. H. HEARN, in coöperation with Bell Telephone Company of Canada, visited Trenton, Pembroke and Arn Prior, Canada, to study woods and treating plant operations in connection with the seasoning control of northern pine poles.

M. W. BOWKER is coöperating with representatives of the Long Lines in a study of the gas pressure characteristics of "lepeth" (lead-polyethylene), sheath coaxial cable in the vicinity of Tucson, Ariz.

G. T. KOHMAN, A. C. WALKER and E. BUEHLER reviewed problems of crystals growing with members of the Naval Research Laboratory and the Geological Survey in Washington. Mr. Walker made three trips to Allentown in July on synthetic crystal problems.

C. J. FROSCH attended a meeting of the executive committee of the Society of Plastics Engineers in Detroit.

K. G. COMPTON and J. C. OSTEN visited the Research Laboratories of the Atlas Powder Company and the Hercules Powder Company of Wilmington, and the Resinous Products Company in Philadelphia where they discussed formulations of organic finishes. Mr. Compton and W. E. CAMPBELL attended the Chemical Research Conferences held at Colby Junior College in New London, N. H. Mr. Campbell spoke on *Indoor Atmosphere Corrosion of Non-Ferrous Metals* and Mr. Compton served as chairman of the Corrosion Division.

AMONG THOSE who visited Winston-Salem recently were P. H. THAYER, who assisted on production problems on waveguide components of naval radar; H. A. BAXTER and J. B. D'ALBORA, on the production of transmitters; and F. E. NIMMCKE, B. H. NORDSTROM and E. F. KROMMER, for participation in a quality survey conference with the Navy.

J. M. DUGUID, W. V. FLUSHING and L. J. STACY, at the Southern New England Company in New Haven, witnessed ringing machine tests.

BELL LABORATORIES CLUB OFFICERS FOR THE 1947-1948 SEASON

Gordon N. Thayer

Fred J. Singer

Florence McGuire

Gordon N. Thayer is the twenty-fourth president of Bell Laboratories Club. Mr. Thayer joined the Laboratories Radio Development group in 1930, just before he was graduated from Stevens Institute of Technology. At present he is Radio Projects Engineer on the New York-to-Boston microwave radio relay project. A family man, his two boys and little girl take most of his free time. Mr. Thayer is also interested in tennis and is fond of music.

First vice-president of the club is Fred J. Singer, Switching Development Engineer, whose forte is toll line dialing. In addition to supervising a large department, he holds a membership in the American Signal Association, the I.R.E., A.I.E.E., and the American Association for the Advancement of Science. Prior to the war he belonged to the 888 Club, composed of five Laboratories engineers, a minister, doctor, and a business man who met once a month for almost ten years to broaden their interests and outlook by presenting, in their turn, papers on any subject except their profession. For the same length of time he was adjutant of his regiment in the Coast Artillery Reserve. With such a background, Mr. Singer brings excellent qualifications to his new post.

Florence McGuire brings to the second vice-presidency of the club her training in settlement-house work and in recreational activities for convalescents while a nurse's aid at St. Vincent's. Her special assignment as a club officer will be the chairmanship of the doll and toy committee to provide Christmas gifts for sick and needy children.

A Villager, Miss McGuire was born a few doors from the Laboratories in the house on Bethune Street where she still lives. She works in the Development Shops Department, where she edits, records and follows orders placed with outside contractors.

W. A. Munson has been appointed by the Office of Naval Research as a member of the Naval Research Advisory Panel for Psychophysiology (research in vision and audition).

J. A. Potter made a trip to Detroit in regard to rectifiers for carrier systems.

The Laboratories were represented in interference proceedings at the Patent Office in Washington by H. S. Wertz and H. O. Wright before the Examiner of Interferences.

E. C. Wente has been made chairman of the Nominating Committee of the Acoustical Society of America.

C. H. Townes gave two talks to the Nuclear Physics group at Oak Ridge, Tennessee, on *Microwave Absorption and Its Use in Studying Nuclear Structure*. He also presented a paper on *Nuclear and Molecular Information from Microwave Spectra* at an American Physical Society meeting at Stanford University.

R. M. Bozorth's article *Magnetism* appeared in the Encyclopaedia Britannica and *Reviews of Modern Physics*.

W. R. Neisser and G. A. Persons discussed the manufacturing features of induction coil and balancing network for the new combined handset in Chicago.

RETIREMENTS

Recent retirements from the Laboratories include L. J. Bowne and E. D. Johnson, with 41 years of service; L. H. Johnson, 38 years; E. B. Hinrichsen and W. E. Stevens, 33 years; C. D. Hocker, 32 years; and Mrs. Ada Van Riper Ammon and R. V. Terry, 25 years.

Carl D. Hocker

Dr. Hocker received the A.B. degree from Wabash College in 1912 and three years later the Ph.D. degree from the University of Michigan. Entering the Chemical Research Laboratory of the Engineering Department of the Western Electric Company, he participated in investigations of vacuum-tube filaments, enameled wire, metal finishes, and corrosion and its testing; and supervised at various times groups engaged in metallurgy, chemical analysis, research on transmitter carbon, and current engineering activities.

When the Outside Plant Development Department was formed in 1927, Dr. Hocker joined the Department as Ceramics Apparatus Engineer, in charge of groups investigating conduits and their construction, cable joining and maintenance, insulators, and miscellaneous products. Five years later he became Plant Systems Engineer with increased responsibilities. From 1934 to 1939, as Plant Materials Engineer, he was responsible for special studies of outside plant problems, timber products, and miscellaneous products. In 1940 he became Plant Products Engineer in charge of five groups, covering wire development, outside plant tools and hardware, cable apparatus, including terminals and protectors, cable joining and maintenance, timber products and miscellaneous products. During World War II he was project engineer in connection with the development and pilot-plant manufacture of special batteries made for ordnance uses. In September, 1946, Dr. Hocker accepted an invitation to join the faculty of Union College as Associate Professor of Chemistry and during the past year has been a consultant to the Outside Plant Development Department on a part-time basis.

For more than twenty years, Dr. Hocker has been associated actively with the work of the American Society for Testing Materials, his interests relating principally to the corrosion of ferrous materials.

Lewis H. Johnson

After being graduated from the Massachusetts Institute of Technology in 1909 with an S.B. degree, Mr. Johnson joined the student course of the Western Electric Company at Hawthorne. He came to the Circuit Laboratory the next year where he was engaged in developing telephone system circuits. In 1911 he worked on the problem of analyzing new and special requirements for telephone circuits and designing appropriate circuits to meet them. Then for several years Mr. Johnson was in charge of the design of the circuits and systems for the non-associate telephone switchboard sales business of the Western. During World War I he worked on the development of various toll switchboard systems for use in Europe; later he was in charge of analyzing all the orders from the AEF for telephone and telegraph facilities.

With the close of the war, Mr. Johnson was assigned to the design of circuits required for the panel systems. In the next few years he developed the principles involved in increasing the revertive pulsing type of inter-office signaling from the early limit of 1,300 ohms of cable

C. D. Hocker

L. H. Johnson

E. D. Johnson

R. V. Terry

loop to more than 3,000 ohms. This resulted in the design of a new line of panel incoming and final selector circuits to incorporate the new principles. Mr. Johnson also set up the principles required to make possible the operation of panel-office selectors at an intermediate tandem office and designed the first "two-wire" office selector to use those principles.

About 1924, Mr. Johnson was placed in charge of several groups handling panel selector development, routine testing and basic design problems. When it was decided to establish fundamental development as a matter separate from current development, he headed one of two groups having the responsibility for that work. He remained in that capacity until he was loaned to the Patent Department of the A T & T to assist in the defense of an important patent suit. When he returned in 1933 he was placed in charge of a group concerned with the pulsing signaling on subscriber lines and trunks in the No. 1 crossbar system.

During World War II, in addition to work on some jobs still of a secret nature, Mr. Johnson headed a group in the Systems Department to study problems posed by the performance of electrical contacts of relays used both on war jobs and the telephone system. From early 1946 until June, 1947, he was again in charge of local signaling development. Since then he has been engaged in consultation work.

Edgar D. Johnson

Mr. Johnson joined the Bell System after graduate work at the Sheffield Scientific School of Yale University from which a year previous he had received a Ph.B. degree. For many years his activities were concerned for the most part with the development of repeater systems. He designed apparatus, developed circuits, worked on testing, and supervised the installation of mechanical repeaters put into service in numerous toll centers in the East previous to 1915. He assisted in the laboratory and field testing of the first vacuum tube repeater circuits.

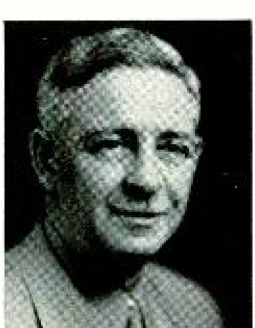
Mr. Johnson has been associated with many important telephone projects, both here and abroad. In 1915, he was in San Francisco to assist in the opening of the first transcontinental line, the repeatered circuits of which were built and tested under his supervision. He installed and tested vacuum-tube repeaters for a line that linked Vancouver, B. C., with Los Angeles; and supervised the repeater installation and assisted in the inauguration of the telephone circuit between Rio de Janeiro and Sao Paulo in 1918.

From 1921 to 1935 he was in charge of a group of engineers engaged in the development and standardization of telephone repeater and signaling systems. Included in this work were such projects as wire-line terminal circuits and equipment for transatlantic circuits, program supply circuits, and numerous other toll developments. He also was in charge of drawing up engineering recommendations for telephone and signaling circuits for numerous European long-distance systems. From 1935 to 1942, Mr. Johnson was concerned with apparatus requirements and fundamental studies for the Switching Development Department. Since then he has been active on Military Relations Personnel work.

Roy V. Terry

Mr. Terry joined the Technical Staff of the Laboratories in 1922, after extensive engineering experience with the Underwood Computing Machine Company, Thomas A. Edison, Inc.,

L. J. Bowne



W. E. Stevens

E. B. Hinrichsen

Ada Ammon

and other manufacturing concerns. His first work here was with the manual apparatus development group. In 1926 he joined the Specialty Products Development Department, where he took part in the development of public-address, sound-picture and picture-transmission systems, and television apparatus.

In 1935, Mr. Terry transferred to the Switching Apparatus Development Department, where he was concerned with timing systems and special service clocks until 1941. During the war years he designed target tracking devices for radar and electrical gun directors and, later, special servo mechanisms.

Langford J. Bowne

Mr. Bowne's association with the Bell System began with the New York Telephone Company as an inspector of subscriber station equipment apparatus. He continued this work and the inspection and repair of PBX's until 1911. After a brief absence he returned to the New York Company and was then assigned to trial installation work connected with the start-stop printing telegraph system and later as an inspector and installer.

In 1919, Mr. Bowne left the New York Company and came to the Engineering Department of the Western Electric Company at West Street. Since then he has been continuously engaged with the development of private-branch exchange systems and their associated circuits.

William E. Stevens

Mr. Stevens studied electrical engineering at the University of Maryland and, during summer vacations, worked for the Installation Department of the Western Electric Company. In 1915 he was sent to the semi-mechanical panel installation at Newark and later to a similar installation in Wilmington. At the beginning of World War I, he joined the Army. He was in France for seventeen months as a sergeant in the Coast Artillery.

In the fall of 1919, Mr. Stevens came to West Street, and his first work was in the laboratory of what is now the Switching Development Department on the testing of panel-line finders. From 1923 to 1925 he had charge of testing panel circuits. Since then he has been in the circuit design group engaged in the design and development of switching circuits for panel and crossbar systems. More recently he has been assigned to circuit design work required for the initial installation of the No. 5 crossbar system at Media, Pa. From May, 1942, to August, 1944, Mr. Stevens served as a Major in World War II.

Ernest B. Hinrichsen

After studying for two years at Illinois College, Mr. Hinrichsen joined the Illinois Division of the Central Union Telephone Company. Two and a half years later he went to the Plant Department of the Chicago Telephone Company, and then to the Equipment Engineering Department of the Western Electric at Hawthorne. In 1908 he left the company for several years, returning to Hawthorne as equipment engineer.

Mr. Hinrichsen transferred to the Inspection Engineering Department in 1919, first at Hawthorne and then at West Street, where he handled questions relating to field service. He joined Electrical Research Products, Inc., in 1926 and was installation and service supervisor in the Atlantic District. In 1937, he returned to the Laboratories and since then, with Electronic Apparatus Development, has had charge of investigations of tool-made samples and the engineering factors involved in complaints, particularly from the mechanical standpoint. He also had charge of the development of packing and shipping methods for vacuum tubes.

Mrs. Ada V. Ammon

Ada V. Ammon, better known to members of the Laboratories as Ada Van Riper and who has been on a year's leave of absence, retired on August 4 following twenty-five years of service. Mrs. Ammon joined the Patent Department in 1921, and since 1925 had been a supervisor of patent files.

News Notes

H. S. Black and J. O. Edson presented a paper on *Pulse Code Modulation,* R. B. Hearn on *An Electronic Regenerative Repeater for Teletypewriter Signals,* and H. W. Bode and E. G. Andrews, *Engineering Applications of Relay Type Computers,* at the A.I.E.E. summer meeting at Montreal. Others attending included R. K. Honaman, S. B. Ingram, and D. E. Trucksess.

M. Whitehead and D. A. Alsberg visited the Allen D. Cardwell Company, Plainville, Conn., to confer on air capacitor methods.

R. H. Nichols and L. Vieth, in Washington on July 18 and 19, attended meetings of the Subcommittee on Hearing Aids and Audiometry of the A.S.A.

D. P. Penick, B. A. Fairweather and I. M. Kerney at Los Angeles, and H. H. Felder at Denver have been making field tests of single sideband program channels on the type-K carrier telephone circuits.

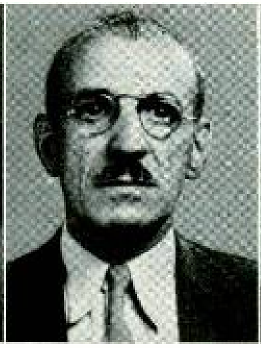
D. R. BROBST conferred at the Tonawanda Plant of the Western Electric Company, Buffalo, on switchboard cable.

C. D. OWENS discussed the manufacture of compressed molybdenum permalloy powder cores at Hawthorne. He also conferred at the Indiana Steel Products Company, Valparaiso, Indiana, on recent developments in magnetic recording tape and special magnets.

C. G. MCCORMICK went to Hawthorne for discussions of manufacturing problems on coils of filled type construction; T. H. GUETTICH, questions concerning the design of EA relays and the new multi-contact relay; B. F. RUNYON and E. R. MORTON, proposed relay designs; W. G. LASKEY, the new message register; and W. L. TUFFNELL, problems relating to the development of handsets.

OBITUARIES

W. C. F. FARNELL
1883-1947



J. P. FERRIGNI
1885-1947

C. H. BERRY
1879-1947

WILLIAM C. F. FARNELL, July 21

Mr. Farnell, Consulting Historian of these Laboratories, was born in South Hadley, Mass., and educated in the public and high schools of Cranford, N. J. He received his B.S. degree in Electrical Engineering at Cooper Union in 1906, four years after he had joined the Western Electric Manufacturing Department in New York. In 1909 he transferred to Hawthorne to engage in inspection and design work for the Engineering Department. Returning to New York in 1914, he continued to work on design until 1917, when he became supervisor in the Engineering Information Department. Nine years later Mr. Farnell's experience with telephone designs led to his being appointed to continue building the collection of historic telephone equipment then being assembled.

During Mr. Farnell's years as Curator, he took an active part in planning Laboratories exhibits at various exhibitions, including the Chicago and World's Fairs. On February 1 of this year he was appointed Consulting Historian and on July 11, the forty-fifth anniversary of his entry into the Bell System, some of his colleagues visited his home and presented him with a nine-star service emblem.

JOSEPH P. FERRIGNI, July 18

Mr. Ferrigni, a member of the Laboratories since 1920, died suddenly in the West Street Building. A Laboratory mechanic in the High Frequency Transmission group, he began his service in the Bell System as a bench hand, later becoming an instrument maker and a technical assistant in the Research Department before he was assigned to Transmission Development. During the war he was engaged in building early designs of radar equipment for experimental purposes. More recently, he had been working on equipment for video and for television terminals.

CLARENCE H. BERRY, August 3

Mr. Berry had completed forty years of service at the time of his retirement in July 1944. A member of the Technical Staff in Switching Development, he was graduated from Pratt Institute in 1899 and three years later started to work with the New York Telephone Company. He was a wireman and later a foreman in switchboard installation for seven years before he accepted a position under Lee De Forest as a draftsman and designer. Returning to the Bell System in 1910, he joined the Western Electric Company, inspecting and testing central office installations in New York and later in Hawthorne, finally becoming Division Inspector of New York territory. In 1919, Mr. Berry transferred to the Laboratories. From then until his retirement he was engaged principally in the design, development and analyzation of operating and testing circuits for dial and manual systems.

News Notes

J. M. ROGIE conferred on problems associated with hearing aid cords at the Wallace Barnes Company in Bristol, Conn.

H. W. HOLMLIN and E. C. McDERMOTT visited the Burlington shops on loud-speaker manufacturing problems.

J. R. POWER attended a meeting of consultants on audiometers and hearing aids held at the American Medical Association in Chicago.

AT THE ARCHER AVENUE plant in Chicago, A. S. MILLER discussed the newly developed wall-type combined set; H. C. PAULY, telephone sets for rural power line carrier service; W. H. EDWARDS, G. SAWYER and R. GUENTHER, the reduction of varieties of low-demand, old-design station apparatus items; L. T. HOLDEN, F. A. HOYT, D. W. MATHISON, B. O. TEMPLETON and G. A. WAHL, coin collectors; and F. L. CRUTCHFIELD and R. C. MINER, the operator's receiver.

Engagements

*Lillian Benjamin—Earl Fraser
*Marcae Bitowf—James G. Carolan
*Evelyn Doucet—Harold Burr, Jr.
*Berva Hardy—Samuel Kinsey
Elizabeth Marssdorf—*Lawrence B. Jones
*Joan Pisano—Henry Bruni
Alice Ramsland—*Battle H. Klyce, Jr.
*Adela Wojtaszek—Thaddeus Zoltowski
*Lorraine Zimmerman—Richard Carey

Weddings

*Angelina Avitabile—Alfred Tarantino
*Muriel Bey—Alexander Smart
*Mary Birofka—Vincent J. Kane, Jr.
*Kathleen Born—*Francis J. Seeber
*Ann Connor—George A. Roeder
Georgina Dieter—*Fred R. Dennis
*Rita Donnelly—Richard A. Johnson
*Florence Dvorsky—James P. Greene
*Viva Ferrand—*Robert Schuster
*Rosemary Fitzgerald—Malcolm L. MacEachen
*Frances Giambalva—Sal J. Calgemi, Jr.
*Patricia Giles—Steven Sockett
*Gloria Greaver—Andrew F. Morrison
*Vivian Harris—Theodore W. Vaughan
*Margaret Heussler—William J. Rigney
*Margaret Mackintosh—John Oliver
*Mary McAvoy—*Eugene T. Creaven
Margaret McCarthy—*Charles W. Muccio
*Anne Pipolo—Joseph Petrone
*Elrita Sargeant—Jervey C. Ector, Jr.
Madeline Schlegel—*Harry C. Meier
Lois Wadsworth—*William C. Bengraff
*Mary Ward—John B. Schnepf
*Virginia Williams—*Jack Keyser

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

G. D. EDWARDS, President of The American Society for Quality Control, presided over the Society's annual convention held in Chicago on June 5 and 6 in conjunction with the Mid-West Quality Control Conference. Papers were presented by R. H. WILSON, *Scientific Control of Stockroom Inventories*, and by H. F. DODGE, *Sampling Plans for Continuous Production*.

C. R. TAFT visited Washington to confer on radar equipment for submarines.

R. R. ANDRES, A. D. KNOWLTON and A. H. LINCE visited the Heywood-Wakefield Company at Gardner, Mass., in connection with the towers for microwave testing equipment.

F. E. NIMMCKE and J. T. MULLER attended discussions in Washington on high impact shock tests to be conducted on components of naval radar equipment at the Naval Research Laboratory and at Anacostia.

M. N. YARBOROUGH and F. L. LANGHAMMER went to Brooks and Perkins Company in Detroit regarding the manufacture of Army equipment. Mr. Langhammer also visited Winston-Salem to confer on the production of military airborne radar equipment.

R. O. WISE participated in a conference at Wright Field from July 21 to 25 on the possibilities of a school for the Army in connection with Army airborne radar equipment. Radar computer problems associated with the equipment were demonstrated to members of the Air Training Command.

N. C. OLMSTEAD visited the Superior Electric Company at Bristol, Conn., on radar.

W. C. HUNTER was in Trenton and Philadelphia on problems incident to placing a second urban mobile channel in service at Philadelphia and highway services in the Trenton area.

H. T. BUDENBOM attended a meeting of the RMA Waveguide Committee in New York.

R. R. HOUGH visited Washington to attend a meeting of the radar panel of the Joint Research and Development Board.

B. O. BROWNE, H. C. BRAUN, A. D. LIGUORI, A. C. PEYMAN, A. K. BOHREN and H. A. REISE inspected FM and AM broadcast projects in Burlington at various times during July.

H. E. MARTING, with S. J. BRYMER and R. J. PHAIR, visited Hawthorne to discuss current engineering problems.

G. A. ROBERTS was at the No. 4 toll office, Philadelphia, on problems concerning sheet-metal casings.