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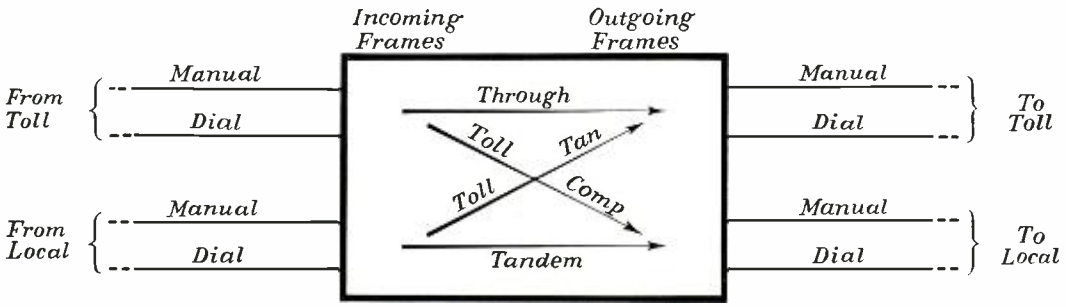



# Senders of the Crossbar Toll System

By R. E. HERSEY
*Switching Development*

SINCE their first development for the panel system, senders have been designed in a number of varieties, but their basic functions have remained unchanged. Acting as automatic operators, they record the number transmitted to them and send out pulses or other signals to guide the setting up of the connection through one or more switching frames. Their variations have been due largely to the type of pulses* used for transmitting information to them and to the kind of pulses they send out to control the connection.

With the crossbar toll system, the situation with regard to senders is much more complicated because of the wide variety of incoming and outgoing trunks with which they are to be associated. The interconnections that can be made by the new system are indicated in the diagram at the head of this article. Besides being able to handle all the types of pulsing normally employed with such trunks, senders for the crossbar toll system must also be able to send and receive multi-frequency pulsing, which has recently been developed for use over various types of toll lines. Signals coming in to a crossbar toll office may be d-c key pulses, dial pulses, multi-frequency pulses, or speech from a manual operator, while over the outgoing trunks it may be necessary for the sender to transmit dial pulses, multifrequency pulses, call-indicator pulses, revertive pulses, or to use a call announcer, which will transmit the call by voice. It would have been possible to provide one multi-class sender for controlling all types of calls. By using various signals from the different types of trunk circuits, this sender could recognize what class of pulsing it was about to receive. Similarly the same sender might have been arranged to pulse out through the outgoing circuits as required. In spite of the advantage of being placed in one common group, such a sender would have been very complicated because of the necessity of handling so many different types of both incoming and outgoing pulses. It seemed more desirable to provide several types of senders, each to handle traffic over certain types of trunks. The association of the senders with these various types of trunks and with other units of the system is indicated in Figure 1.

In all, five types of senders are provided, three to be associated with incoming trunks and two with outgoing trunks. For each incoming call, one of the incoming senders is employed and, unless the call is to be completed over a manual trunk on either a

*RECORD, *November*, 1943, *p.* 110.

straight-forward or ring-down basis or over a trunk to an office equipped to receive multi-frequency pulsing, an outgoing sender will also be employed. When an outgoing sender is used, the incoming sender transfers to it all of the digits received except the first three, which are used by the marker to control the connection within the office. Transfer of digits is at the rate of eight per second by d-c key pulsing, and all incoming senders are designed to transmit d-c key pulses, and all outgoing senders to receive them.

All incoming senders are also arranged for sending out multi-frequency pulses. This method will be used for pulsing over the outgoing circuits without the aid of outgoing senders whenever the terminating points are provided with senders capable of receiving multi-frequency pulses. At present, only two such services are provided: completing to local crossbar offices and to other crossbar toll offices. Ultimately, it is possible that the use of outgoing senders will be completely eliminated by the extension of the use of multi-frequency pulsing. This, however, may be a rather long look into the future.

While all three types of incoming senders are thus arranged to send either d-c or multi-frequency pulses, they are each arranged for receiving different types of signals. Dial senders are arranged to receive dial pulses, at the rate of either ten or twenty per second. The receiving circuit for these senders is similar to that of the subscriber's senders* of the local crossbar system, and the digits received are recorded on crossbar switches.

Key-pulsing senders are arranged to receive either d-c or multi-frequency pulses, and are prepared for the type of signal to be received by a signal from the incoming circuit. These senders record the digits on relays—four for each digit.

Position senders, which are the third type of incoming senders, are really part of the cordless positions. The operators at these positions receive oral information regarding the connection wanted, and then "write-up" the proper number on locking-type strip keys, which serve as the recording unit for the senders.

All of these incoming senders are arranged for connecting to the markers, into which they usually pass the first three digits received for use in determining and setting up the connection to the desired outgoing trunk. As soon as an outgoing trunk has been chosen, an outgoing sender is attached except when the call is to be handled in the straight-forward, ring-down, or multi-frequency pulsing manner.

Both of the types of outgoing senders are arranged to receive d-c key pulses as already noted, but each is arranged for sending out two different kinds of signals, and which it sends will depend on a signal received from the outgoing circuit. One type receives four or five digits, and controls the sending of either revertive or call-indicator pulses. Revertive pulses are used for completing calls to either panel or crossbar

*Record, *April*, 1939, *p.* 234.

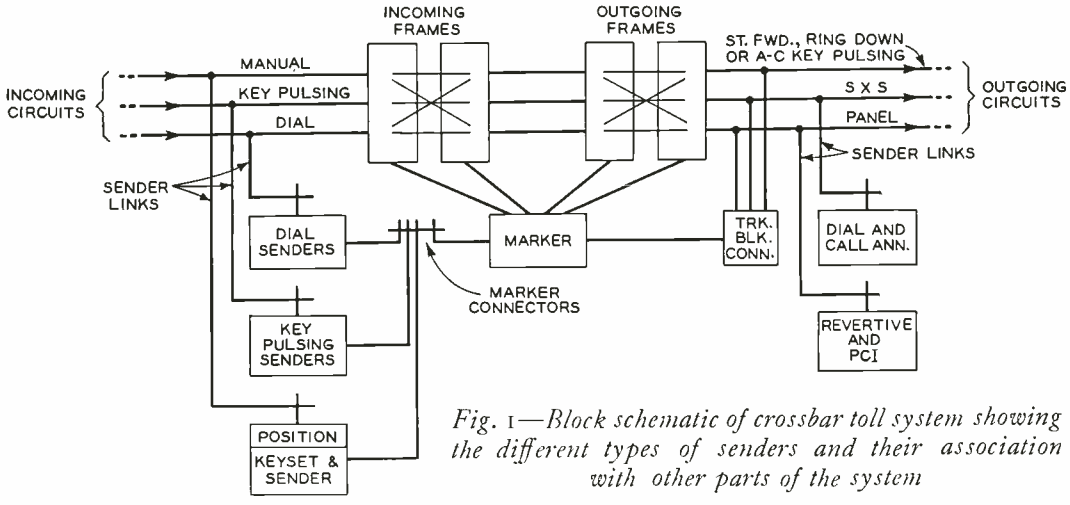
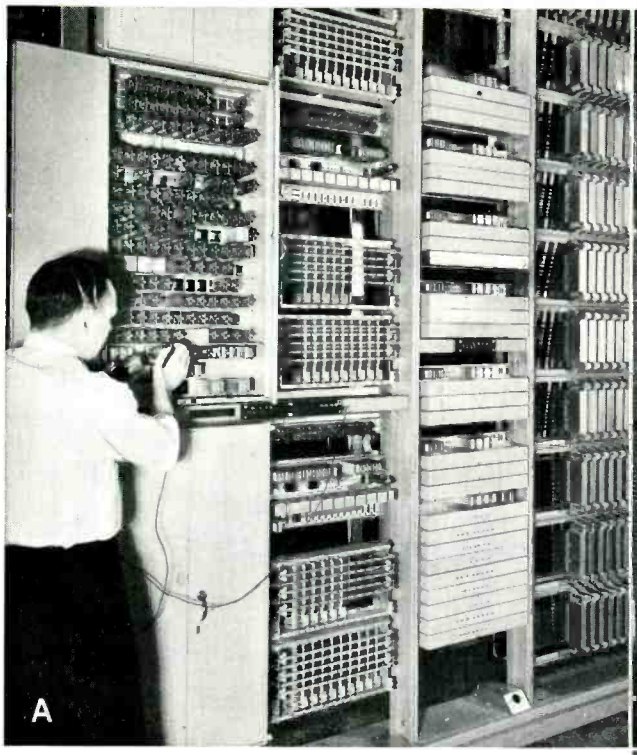



*Fig. 1—Block schematic of crossbar toll system showing the different types of senders and their association with other parts of the system*



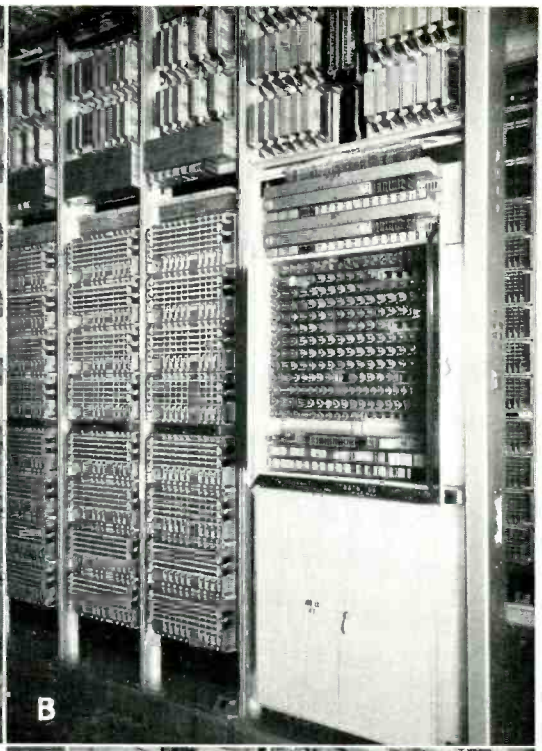




*Fig. 2A—Dial senders and marker connectors in the Philadelphia crossbar toll office*

*Fig. 2B—Two sender-link controllers and their connectors comprise the bay at the right. The primary and secondary switches of a sender-link frame occupy two bays, as shown at the left of the controllers*

*Fig. 2C—A position sender at the right with the associated position relay equipment at the left*

*Fig. 2D—Receiving units for incoming key-pulsing senders are mounted six on a bay*

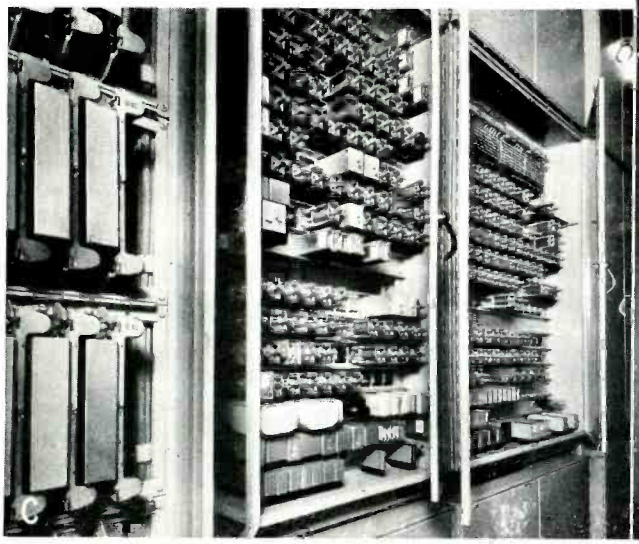



TABLE I—NUMBERS AND TYPES OF SENDERS AND THEIR ENGINEERED CAPACITY IN THE PHILADELPHIA OFFICE

| *Incoming Senders* | *Toll Calls Per Busy Hour* |
|---|---|
| 42 Dial Pulsing | 8000 |
| 27 Key Pulsing | 9000 |
| 34 Cordless Position | 6000 |
| *Outgoing Senders* | |
| 27 Revertive and Panel Call Indicator | 7000 |
| 27 Step-by-Step and Call Announcer | 7000 |

offices; call-indicator pulses for completing calls to manual offices in panel areas.

The other type of outgoing sender receives up to eleven digits, and either sends them out as dial pulses for completing calls to step-by-step systems, or connects itself to a call announcer and controls its sending of voice announcements — the latter being limited to five digits.

Both the incoming and outgoing senders and the toll-cordless positions are associated with the circuits they serve through sender links, which consist of crossbar switches. These switches are actuated by sender-link controllers, which control the connection to the proper type of sender.

Incoming dial senders are mounted on two bays with the marker connectors on two adjacent bays. Four such bays of the Philadelphia installation are shown in Figure 2A. The cabinets on the left-hand bay—one of which is shown open—house the relay equipment for three senders, while the second bay carries certain miscellaneous equipment and the two crossbar switches on which the fourteen digits are recorded. Incoming key-pulsing senders have their multi-frequency receiving circuits on separate bays as shown in Figure 2D. Their relay equipment is in cabinets on an adjacent bay. Position senders are mounted in cabinets adjacent to their associated position relay equipment as shown in Figure 2C. Each type of outgoing sender occupies only a single cabinet. The cabinets are mounted three on a bay and each bay may include either or both types. Figure 4 shows an outgoing step-by-step sender at the bottom of the bay and a revertive sender above it. The third sender on the bay is not shown.

The types of connections that incoming and outgoing senders are required to control are indicated in Figure 3. When the call is completed to an office within the local area where the crossbar toll office is located, only the called-office code and four or five digits are required, since the trunks picked connect directly to the office called. For a call to another switching area, a switching code must be dialed or keyed ahead of the called office code and number. Similarly for a call to another switching area through an

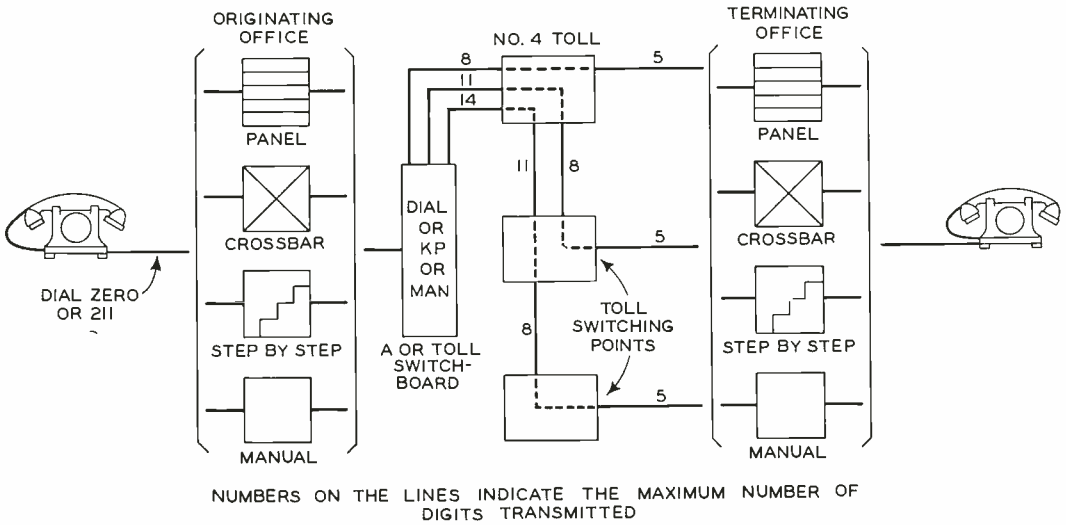



*Fig. 3—Schematic representative of the types of calls handled by the crossbar toll office*

intermediate switching point, one, two, or three additional digits for use at the intermediate switching point must be dialed or keyed following the switching code. Thus all fourteen digits may be used where calls are completed through one crossbar toll office to another switching area by way of an intermediate switching point.

For the Philadelphia crossbar toll office, senders are provided in sufficient numbers to handle over 200,000 calls in a ten-hour day. The distribution of busy-hour calls for the various types of senders is shown in Table I. To permit these senders to dispose of this large number of calls, they are arranged with a number of safeguards. All senders have timing circuits to insure that they will not be held too long when they have encountered some kind of traffic delay or trouble condition. When time-out occurs because of traffic conditions, the senders cause a re-order flash to be returned to the originating operator so that she may promptly start the call again, and are then released. When time-out occurs as a result of trouble conditions, however, the sender is held for maintenance attention. All senders are equipped with a trouble lamp and a make-busy jack. These are located on a lamp and jack bay in the maintenance center along with an automatic sender test frame for testing every function of each sender. Some types of sender troubles are automatically displayed on the trouble indicator. With these maintenance facilities, the all-important senders of this system are rigidly tested to insure the high standard of services obtained with the crossbar toll system.

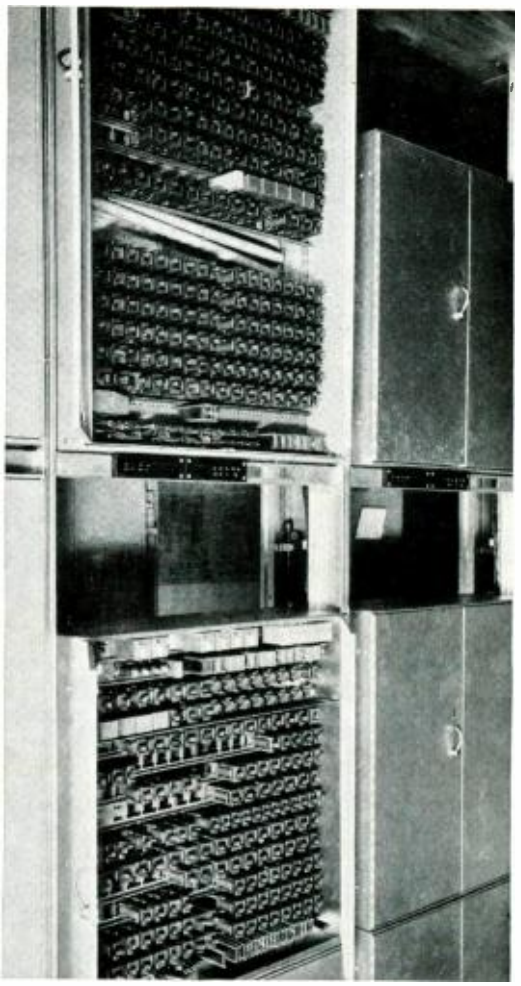


*Fig. 4—Three outgoing senders are mounted on a single bay. The photograph above shows a step-by-step sender at the bottom of the bay with a revertive sender above*

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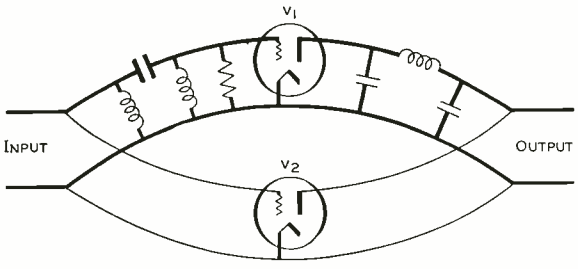
THE AUTHOR: R. E. HERSEY'S studies at Beloit College were interrupted by fourteen months of service with the Signal Corps in France during World War I. After the armistice he studied at the Sorbonne University in Paris until July, 1919, when he returned to this country and received a B.S. degree from Beloit College. Following a year with the Delco-Light Company and two years at Harvard Engineering School he joined our Systems laboratories in 1922. Two years later he transferred to the local systems circuit group where he engaged in the development of the call distributing "B" board and key-pulsing type toll and DS"A" boards. Mr. Hersey was associated with the fundamental studies for the crossbar system and designed the first issue of the originating marker. In October, 1941, he took over supervision of circuit design of senders, decoders and markers for all systems. In this capacity he has been instrumental in the design of the No. 4 crossbar toll system. Mr. Hersey has also been concerned with the design of the automatic ticketing equipment recently installed in the Los Angeles area.

# Historic Firsts

## High-Efficiency Amplifier for Radio Transmitters

VACUUM-TUBE amplifiers are generally operated over the straight section of their characteristic curve so as to secure a linear relationship between their output and input. When operating over such a limited range, however, their efficiency is low, and for the output amplifiers of broadcast transmitters, where the much greater power made higher efficiency imperative, the full range of the tube was used. The negative halves of the output-current waves were cut off almost completely, while the tops were flattened by saturation of the tubes. The efficiency obtained by this means might be as high as 60 or 70 per cent, while the heavy production of harmonics that such practice entails was prevented from reaching the antenna by the design of the output circuit.

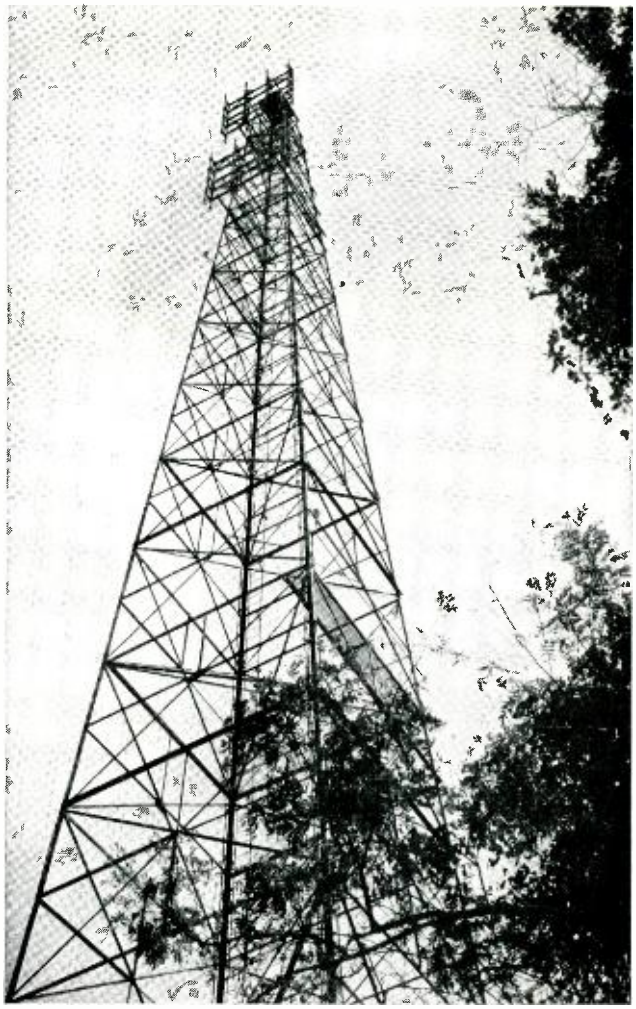



This high efficiency, however, was obtained only at the peaks of modulation, which occurred during the very loudest passages of the program; and these peaks were few and far between. The average load was much less, and the average efficiency was about 33 per cent. This meant, for a 50-kw transmitter, that 100 kw was lost in the final amplifier—twice as much as was transmitted. This situation began to assume more serious proportions ten or twelve years ago, as it became evident that very large broadcast transmitters would shortly come into more extensive use. W. H. Doherty, like many other radio engineers, had been troubled by the large losses inherent in such transmitters, and he conceived a method of cutting them to one-third of their former value. After a period of development and testing, his ideas resulted in the Doherty high-efficiency amplifier, for which patent No. 2,210,028 was granted to Mr. Doherty on August 6, 1940. The first commercial application was in a 50-kw transmitter for Station CBF in Montreal, which went on the air in November, 1937. This amplifier is now incorporated in all Western Electric broadcast transmitters from 1,000 watts upward.

In principle, the scheme is simple. The output amplifier tubes are divided into two groups, referred to as V1 and V2. One group, V2, is biased so that it contributes no output until the load is greater than the unmodulated carrier power. Below that, the V1 tubes carry all the load, and at carrier output, which prevails during a large part of the program, the efficiency obtained is 60 per cent or better. For greater loads, the V2 tubes come into action, and besides contributing to the output themselves, cause the V1 tubes, by a special coupling arrangement, to contribute further output. The action of such an amplifier was described on page 333 of the RECORD for June, 1936. By effectively holding half of the tubes in reserve until the load reaches the point where they can be operated efficiently, the average efficiency is raised from the usual 33 per cent to over 60 per cent. Two-thirds of the losses formerly encountered are thus saved.

# Multi-Channel Radio Telephone Spans the Chesapeake Entrance

By A. C. PETERSON, JR.
*Radio Transmission Engineering*



SOUTHEASTERN Virginia is a narrow peninsula terminating in Cape Charles and lying between Chesapeake Bay to the west and the Atlantic Ocean to the east. Across the entrance to Chesapeake Bay, some twenty-five miles to the south of Cape Charles, lies Cape Henry, and to the west of it Norfolk, Portsmouth and Newport News. Telephone communication from Norfolk and other points south and west of the Chesapeake has had to pass through Washington and Baltimore over some 400 miles of circuit to reach Cape Charles. This situation has now been changed by the installation of a radio link between Norfolk and Cape Charles. Not only is the circuit reduced to less than a tenth of its former length, but the telephone traffic over the busy Baltimore and Washington routes is lightened.

Radio links as extensions of land lines are not new. There is one between Boston and Cape Cod* that has been in service for a number of years, and there is the more recent installation† between Crisfield and two of the islands in Chesapeake Bay. These previous installations, however, use single-channel links; their radio circuits carry only single conversations. Over the new radio link between Norfolk and Cape Charles, on the other hand, as many as twelve conversations may be transmitted simultaneously. Whereas the earlier radio links transmitted the frequencies from 200 to 3,000 cycles comprising a single voice channel, the new link transmits twelve voice channels which have been modulated to form a group lying in the frequency band that ranges from 12,000 to 60,000 cycles.

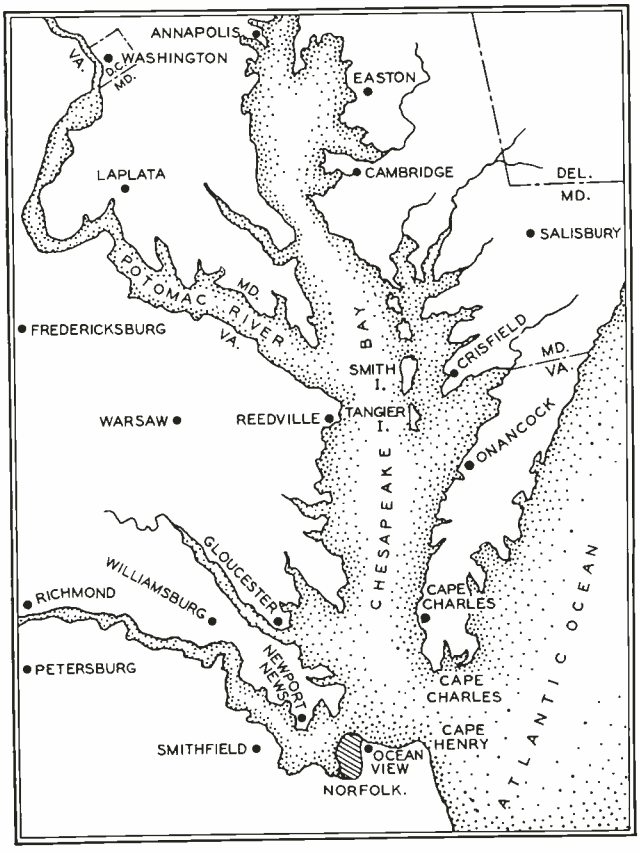
This group of twelve channels is that used by the type-K carrier system* now widely installed on cables all over the country. Twelve voice-frequency circuits arriving at Cape Charles, for example, are passed through a type-K carrier terminal, and the resulting frequency band—extending to 60 kc—is then modulated in the radio transmitter, which operates in the very high frequency range, and is sent through the ether to Cape Henry. After demodulation in

*RECORD, *Oct.*, 1934, *p.* 34. †*Aug.*, 1941, *p.* 358.

*RECORD, *April*, 1938, *p.* 260, and *May*, 1938, *p.* 315.

the radio receiver, the 12- to 60-kc band is transmitted over a cable to the Norfolk office. Here it is passed through a type-K receiving terminal, and the twelve channels resulting are brought to the Norfolk toll switchboard as twelve separate voice channels. The arrangement is indicated schematically in an accompanying illustration. The radio system operates continuously and unattended, and serves merely as a section of "line" between two complete type-K terminals.

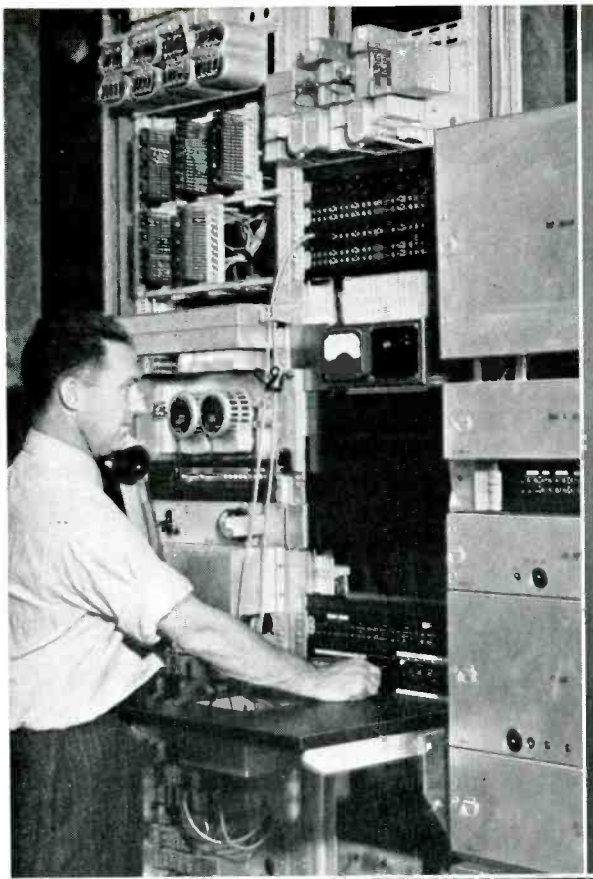
Steel towers nearly two hundred feet high support the antennas at each terminal. Transmitting and receiving antennas are essentially alike. Each consists of two parallel arrays of half-wave elements, one behind the other. The front array contains twenty-four horizontal radiating or receiving elements, while the rear array contains twenty-four similar elements that act as parasitic reflectors. A view of the Chape Charles tower and antennas is shown in the photograph at the head of this article. The transmitting antenna is at the top of the tower, and the receiving antenna directly beneath it. Coaxial transmission lines connect the antennas to the radio equipment in buildings near the base of the towers. At Cape Charles, the building is of brick and hollow tile, and houses the type-K carrier terminal as well as the radio equipment. It is connected to the Cape Charles central office by a fifty-pair telephone cable. At East Ocean View, a reinforced concrete house has been built to provide for the radio equipment alone. The type-K carrier terminal is in the Norfolk central office—some eleven miles away. The radio equipment is operated from commercial power lines, but at each terminal a stand-by generator, driven by a gasoline engine, has been provided to insure adequate power in emergencies. These auxiliary generators start automatically on failure of the commercial power supply.

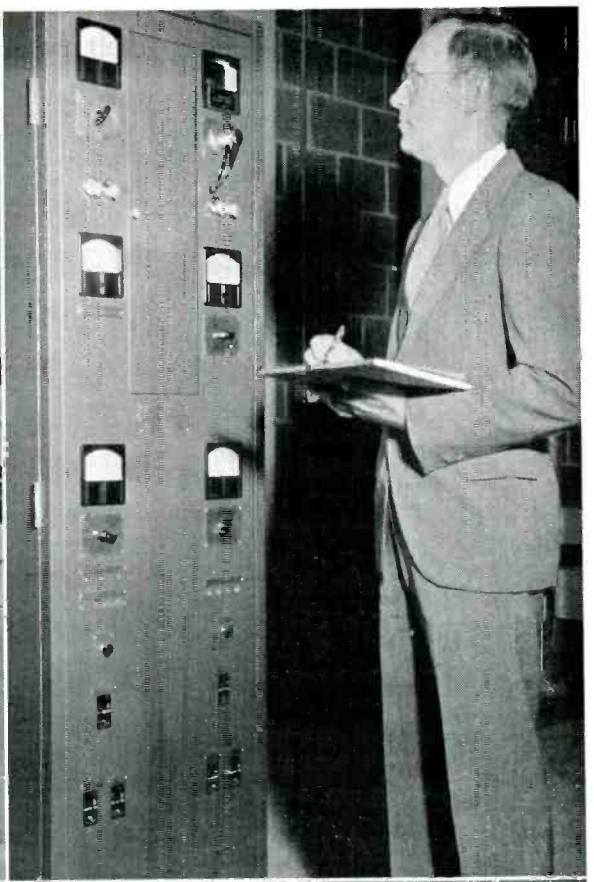


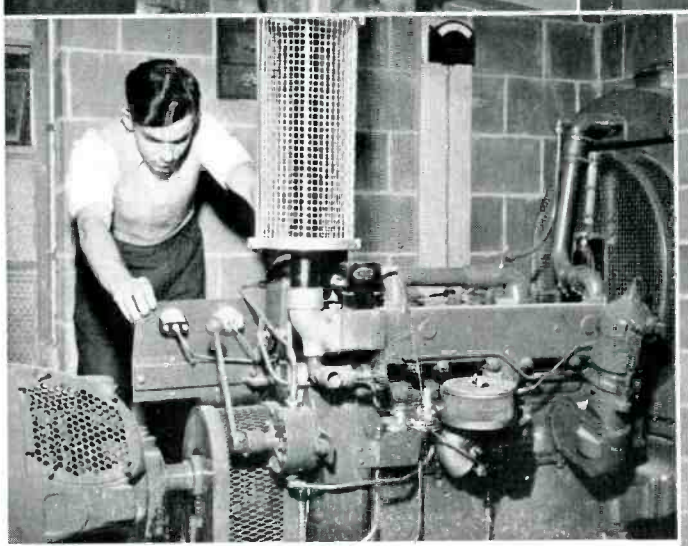

*By spanning some twenty-five miles of water between Cape Henry and Cape Charles with a multi-channel radio telephone system, a 400-mile route by way of Baltimore and Washington is avoided*

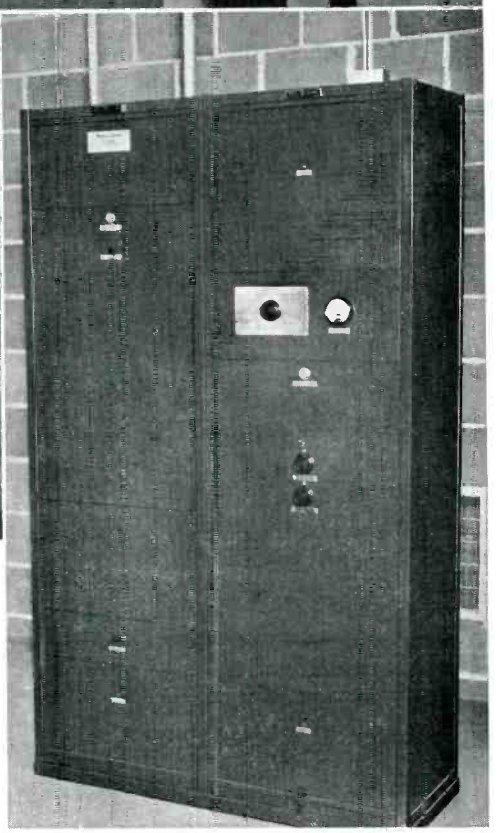
Although the radio link forms what is essentially a short type-K carrier line circuit, it differs from it in several respects. With the type-K carrier system, the group of twelve single sidebands resulting from the modulation of twelve speech bands is transmitted over the cable as a single sideband of the group carrier frequency. The radio transmitter, on the other hand, transmits a double sideband of the type-K carrier group, and thus requires a total band width of 120 kc, instead of the 60 kc transmitted over the cable. A double sideband transmitter was decided upon since it is simpler and less expensive to build.

Another difference is in the regulating scheme. The radio receiver employs automatic gain control to compensate for variations in loss over the radio path, as is common practice in most radio systems. Additional overall regulation is provided for the

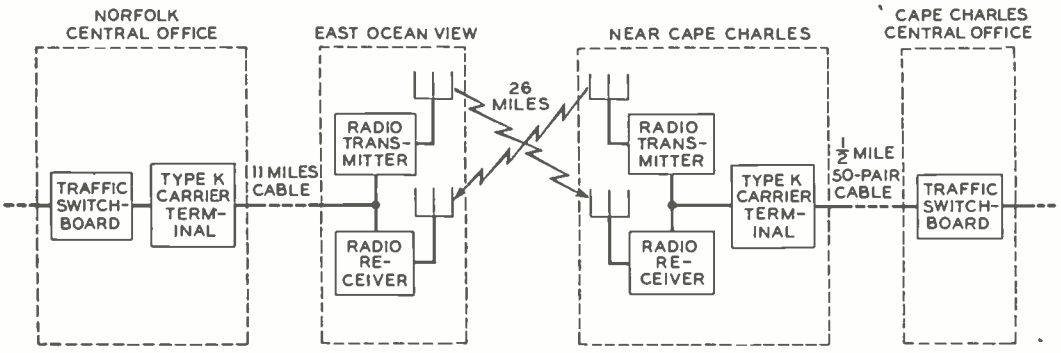








*Upper left, J. O. Smethurst at the voice-frequency bay of the Cape Charles terminal. Upper right, D. M. Black at the radio transmitter at Cape Charles. Lower left, a gasoline engine-driven generator at each station provides power for operation in emergencies. Lower right, the radio receiver in the Cape Charles radio station*




*Arrangement of the circuit between Cape Charles and Norfolk*

complete system between Norfolk and Cape Charles to maintain a substantially constant net loss between terminals. This follows type-K carrier practice, in that the gains of the receiving amplifiers are controlled by means of pilot frequencies transmitted in the frequency space between speech bands. As a result, the net loss of each of the twelve channels is held constant to within $\pm 0.5$ db.

The change in loss of a cable circuit due to changes in temperature varies with frequency; and consequently long type-K carrier systems employ both flat gain and twist regulators. In the link between Cape Charles and Norfolk, however, there is less than twelve miles of cable, and since changes in loss over the radio path are essentially flat with frequency, no twist regulation is needed. Only one pilot in each direction is required, therefore, to control the gain, but another is used to operate alarms to give an indication of transmission failure. On the channel from Cape Charles to Norfolk, the 12-kc pilot controls gain and the 28-kc pilot is used for the alarm circuit, while for the channel from Norfolk to Cape Charles, the functions of the pilots are reversed. A third pilot channel at 56 kc, used on type-K systems, is not employed.

Several alarm and test circuits are provided in addition to the transmission alarms just mentioned. To check the frequency of the carrier of the distant transmitter, each radio receiver has an alarm circuit fed through a crystal filter. A deviation in carrier frequency of as little as 0.002 per cent will operate this alarm. Alarms are provided to warn of excessive temperatures, power failure, and other conditions that might ultimately affect the satisfactory operation of the system. Each receiver is also equipped with an oscillator of such a frequency as to permit the output of the local transmitter to be detected. This permits a "loop" test to be made through the local transmitter and receiver. Whenever the transmission alarm indicates a circuit failure, these loop tests are made at each end of the radio circuit to determine the location of the trouble.

This new link has been in satisfactory commercial service since October, 1941. Initially all the channels were not fully equipped. Two circuits were provided between Norfolk and Cape Charles, and three between Norfolk and Onancock, which is a toll center. Since then, however, all of the channels have been placed in service.

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THE AUTHOR: A. C. PETERSON, JR., received the B.S. degree in Electrical Engineering from the University of Washington in 1928, and in December of that year joined the Development and Research Department of the American Telephone and Telegraph Company. With the later consolidation of this department with the Bell Laboratories, he became a member of the Transmission Development Department and in 1940 a member of the Research Department. With these organizations, Mr. Peterson has been concerned with problems dealing with radio transmission and development. In 1937 he received the E.E. degree from the University of Washington.

*U. S. Navy Photo*

# The Gang We Work For

## and What Their Leaders Say About Us

"The men and women of Bell Laboratories who participated in the development and production of the AN/ARC-1 Communication Equipment are to be congratulated upon the initial month's delivery of this important new radio. Principles embodied in the AN/ARC-1 will be of value to the planes and carriers of the United States Fleet in maintaining adequate communications in the vital Pacific offensive. The Bureau of Aeronautics looks to you who are engaged in this production to double and redouble your efforts to reach your * * * per month peak by this summer.

DeWitt C. Ramsey, *Rear Admiral, U.S.N.,*
*Chief of the Bureau of Aeronautics*"

In transmitting Admiral Ramsey's telegram, the Inspector of Naval Material, Admiral Brinser, said: "The inspector also wishes to express his appreciation of the splendid work your plant is doing to further the war effort by furnishing the Navy with this vitally needed equipment. Keep up the good work!"

Commendation from the Bureau of Ships on the same achievement was posted on Laboratories bulletin boards early in April. The equipment referred to is a new two-way radio telephone for Navy airplanes, which the Laboratories developed on a rush basis. Preproduction models were built in the Preproduction Shop of the Laboratories at Chambers Street and by the Western Electric Company to fill the urgent need within the time specified by the Navy.

The photograph shows members of a fighter squadron, operating from one of the aircraft carriers in the U. S. Navy Task Force which raided Truk on February 16 and 17. They played a major rôle in neutralizing the ability of the Jap air arm to defend the bastion.

**". . . vitally needed equipment. Keep up the good work!"**

# A T & T Announces Coaxial Program

## Facilities Planned to Meet Requirements for Intercity Telephone Circuits May Also Be Used for Television

PLANS for the construction of a large amount of coaxial cable to be operated by radio relays have been announced by the American Telephone and Telegraph Company. Tentatively, the coaxial extension plans call for the installation of 6,000 to 7,000 route miles of coaxial facilities in the next five or six years to help meet expected increasing demands for long distance telephone service. These facilities would be suitable for interconnecting television stations for network operations.

The extent of the coaxial construction, and when and where it will be undertaken, will depend upon the requirements of the Armed Forces, general business conditions, the volume and distribution of long distance telephone messages, the availability of the necessary cable and equipment, and other factors.

Work on one coaxial project, the 295-mile Atlanta to Jacksonville route, already is in progress and is expected to be in service for telephone purposes by the spring of 1945. The cable is in place between Atlanta and Macon.

Popular attention was centered on the Bell System's place in the television picture recently by the National Broadcasting Company's published plans for regional national television broadcasting networks, and by NBC's request for a statement from the A T & T on what it could expect in the way of intercity facilities by which television stations could be connected for network operations. "The National Broadcasting Company looks to the Bell System to provide and make available to NBC the necessary interconnecting facilities for such a television network system," NBC President Niles Trammell said in a letter to Vice-President Keith S. McHugh of the A T & T.

At that time Mr. McHugh replied that when coaxial facilities are being constructed for telephone purposes the Bell System companies would be glad to provide additional conductors for television if then it appears likely that there will be a demand for such facilities sufficient to justify the large additional investment. He said the Bell System wishes to do anything it can practically to coöperate in the development and extension of television, just as it has coöperated in the distribution of sound programs for radio broadcasting.

Mr. McHugh added, "We shall be glad to consider on their merits any requests for television facilities over routes where coaxial cable is not being planned during this five- or six-year period for telephone purposes. The question of when such facilities could be provided would, of course, depend upon conditions in the individual case and its relation to the total program. . . ."

Present coaxial equipment will provide television channels of 2,700,000 cycles in width. Careful tests have shown this equipment capable of transmitting the visual images with satisfactory clearness. Further technical improvements will make it possible to use a much wider band of frequencies, which will permit simultaneous use of the same coaxial for an improved (4,000,000 cycles) television channel and a large number of telephone messages.

Experiments with coaxial as a means of transmitting many telephone messages simultaneously over two pairs of conductors began more than a decade ago. The New York-Philadelphia cable, containing two coaxials, was installed in 1936 for further experiment. Its use for transmitting visual images for television broadcasts was first demonstrated in 1937. The cable recently has been providing telephone circuits.

The first commercial installation was the Stevens Point-Minneapolis cable, containing four coaxials (two in regular use and two in "stand-by" use). This is capable of providing 480 telephone circuits with its present amplifiers. It now is equipped to handle

nearly 100 circuits and soon will be stepped up to about 150.

One of the cables now in use between Philadelphia and Baltimore and another between Baltimore and Washington contain coaxials, but the coaxials have not yet been equipped for service. The former contains six coaxials and the latter four. Construction of the remainder of the Atlanta-Jacksonville route is expected to be started next fall.

As many as six or eight coaxials are likely to be built into some of the new cables. In a six-coaxial cable, for example, with the present amplifying equipment, two coaxials could be used to provide 480 telephone circuits, another two could provide either two one-way television channels or 480 more telephone circuits, and the other two would serve as equipped stand-by circuits to protect both services.

For the future, there are two methods of utilizing coaxials for the combined job of providing long distance telephone and television service: (1) Use some of the coaxials in the cable for telephone messages exclusively, and some for television. (2) Expand the frequency band width, in order that both telephone and television transmission can be handled through the same coaxial.

The tentative program of coaxial cable routes, which has been furnished to people interested in network television transmission, follows:

Approximate dates at which television transmission facilities might be made available, if demand justifies their provision and manufactured cable and equipment can be secured, in accordance with present tentative programs for extension of principal coaxial cable or equivalent routes for telephone purposes—

1945

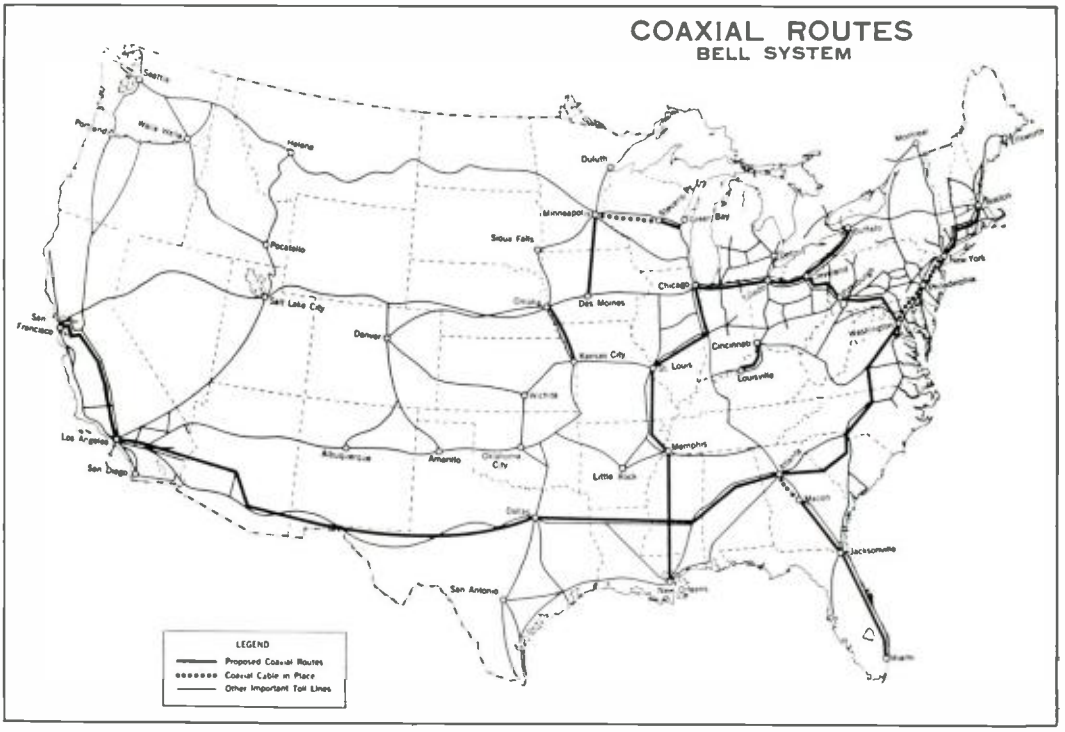
New York-Washington

1946

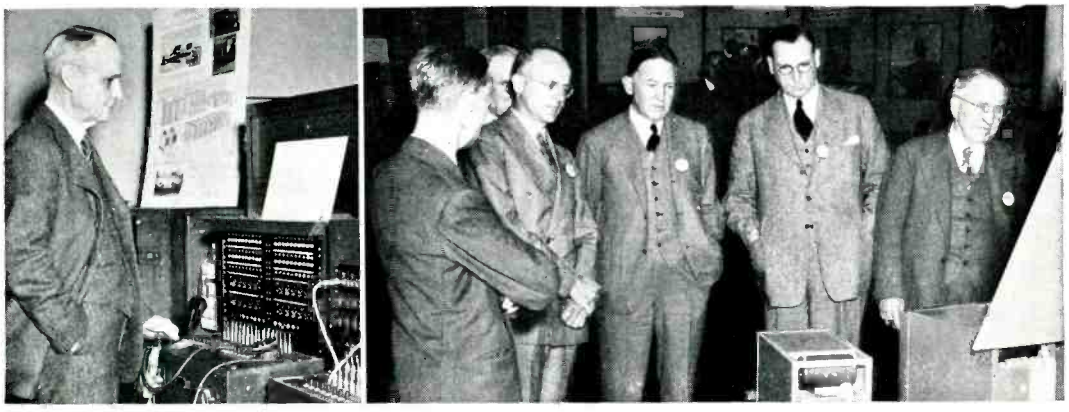
New York-Boston
Washington-Charlotte
Chicago-Terre Haute-St. Louis
Los Angeles-Phoenix

1947

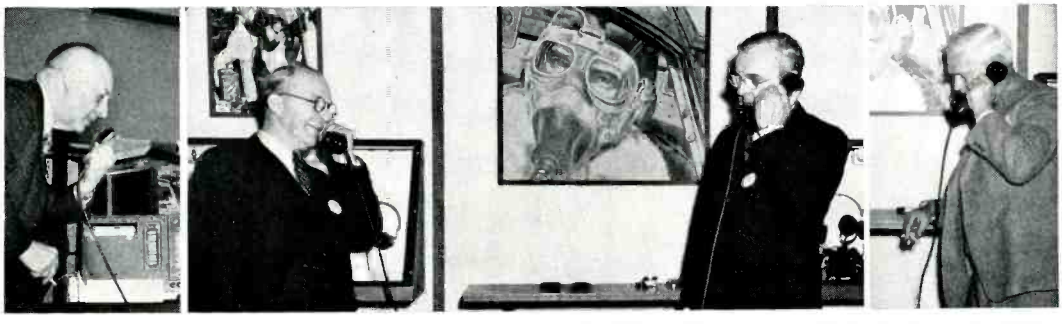
Chicago-Toledo-Cleveland-Buffalo
Southern Transcontinental Route (a large part), will include Charlotte-Columbia-Atlanta-Birmingham-Jackson-Dallas-El Paso-Tucson-Phoenix



*Presidents of Operating Companies visit the Laboratories. Left to right—J. H. Ray, A T & T; R. J. Hopley, Northwestern Bell; J. W. Pollio and J. G. Nordahl, B. T. L.; J. F. Carroll, Indiana Bell; G. M. Welch, Michigan Bell; R. K. Honaman, B. T. L.; C. F. Sise, Bell of Canada; and W. R. McGovern, Wisconsin Bell*



*Left to right—N. R. Powley, Pacific Tel.; J. G. Nordahl, B. T. L.; J. H. Ray, A T & T; H. S. Dumas, Southern Bell; A. F. Brooks, Southern New England; R. J. Hopley, Northwestern Bell; and A. C. Stannard, Southwestern Bell*



*Left to right—F. P. Ogden, Mountain States; A. J. Allen, Cincinnati & Suburban; R. Eide, Ohio Bell; and A. H. Mellinger, Illinois Bell. Not shown but also present were J. E. Harrell, New England Tel.; J. W. Hubbell, New York Tel.; and P. C. Staples, Bell of Pa.*

1948-1950

Southern Transcontinental (complete)
Washington-Pittsburgh-Cleveland
St. Louis-Memphis-New Orleans
Kansas City-Omaha
Des Moines-Minneapolis
Atlanta-Jacksonville-Miami
Los Angeles-San Francisco

The routes indicated above are subject to review just prior to the time construction would be started. The list does not include additional sections which might be advanced into this period should important television requirements arise which would warrant routes or sections being installed well ahead of telephone requirements.

## Presidents of Operating Companies Visit Laboratories

The presidents of Bell System companies visited the Bell Telephone Laboratories School for War Training on April 10 and 14 during their spring meeting in New York. O. E. Buckley outlined to them the war development work of the Laboratories and R. K. Honaman explained the school.

An exhibit of military communications equipment was displayed, including tank and airborne radios, quartz crystals, Spiral-4 packaged carrier and repeater, portable information center, army switchboards and military telephone instruments.

During the week, P. W. Spence, registrar of the school, arranged for showing the exhibit to nine groups of Army and Navy students and to the patent organization, totalling 270 people. Talks were given on the various items by J. R. Erickson, J. A. Coy, R. L. Case, J. W. Pollio, J. G. Nordahl and G. G. Lavery.

The exhibit was coördinated and erected by Henry J. Kostkos, assisted by J. R. Erickson. J. E. Conwell and H. W. Schaefer handled procurement and shipping.

## Post-War Prospects

Addressing the annual meeting of A T & T stockholders on April 19, President Gifford spoke as follows on post-war prospects: " . . . There is every indication that we, in the Bell System, will have plenty to do when the war is over. We have the very agreeable prospect of welcoming back our employees who are in the Armed Services—there are now more than 55,000 of them. Some I regret to say can never come back. Already

*During a recent visit at Murray Hill, Brigadier A. C. Sykes, Chief Signal Officer, British Army Staff, and R. P. Ross, British Ministry of Supply Mission, were shown, among other things, the Command Set exhibit which was in the restaurant lounge. From left to right are H. J. Kostkos, Mr. Ross, Brigadier Sykes, R. K. Honaman and M. B. Long*

there are three hundred and eight gold stars on our flag. Some—very few I hope—will have been disabled and will need special attention to fit them into jobs they can fill.

"We look forward to a record post-war construction program and we have many new things we expect to do. We expect to provide intercity networks—ultimately Nation-wide in extent—for television. We plan to try out short-wave radio relay systems for long distance telephone service and for television. We know that coaxial cable systems . . . work very satisfactorily but we do not know whether or not radio relay systems will work better or prove more economical. We are in the communications business and we intend to use the best and most economical means, whether wire or radio.

"As mentioned in the annual report, we expect to extend automatic long distance switching systems and the subscriber dialing of toll calls. We expect to extend overseas radio telephone service and to reduce its cost. We were the first to establish overseas telephone service and the United States leads the world in the extent of its world-wide international radio telephone service just as it does in its telephone service here at home. Incidentally, if an overseas submarine telephone cable should prove better or more economical than radio, we shall use it just as we intend to use the best and most economical means of telephone communications on land whether it be wire or radio.


" . . . The longer the war lasts, the greater the loss of life, the greater the number of wounded who will be permanently disabled, the greater the national debt, the greater the risk of dangerous inflation and the greater the danger of peacetime continuation of wartime governmental controls, for the longer these have to be in effect because of the war, the more they tend to become permanent, so, our post-war plans begin with doing everything we can to help win the war as quickly as possible."


*Toward the end of the drive a number of girls like Effie Ross helped the Red Cross War Fund by giving out literature and pledge cards to those who had not made their contributions*

## American Red Cross Fund

Members of Bell Laboratories contributed $23,180.77 to the American Red Cross during its recent campaign. Of this amount $10,678.36, the donations of 2,209 members, went to the New York Chapter, while 1,466 others designated $12,502.41 to be sent to their local chapters. The amount paid outright with the pledges was $18,286.27; the amount deducted by the Payroll plan was $4,894.50 at the request of 642 members.

## News Notes

FOUR RETIRED MEMBERS of the Laboratories have recently died. They are: WILLIAM B. WALLACE, formerly Treasurer of the Laboratories, who retired in 1938 after forty-eight years of service, on March 18; HARRY J. CHRISTOPHER, formerly of the Systems Administration Department, who retired in 1942 after forty-four years of service, on March 19; JOHN J. HUGHES, formerly of the Research Department, who retired in 1933 after thirty-three years of service, on March 31; and ARTHUR C. MAGRATH, formerly of the Switching Apparatus Development Department, who retired in 1943 after thirty-five years of service, on April 2.

AS OF FEBRUARY 1, the Bell System had 486 attended public telephone locations in service for the Armed Forces. There are 370 camp telephone managers who give full time to seeing that adequate service is given both on official and personal calls.

FRANK B. JEWETT attended Boston University's Founders' Convocation on March 13 at which he received the University's honorary degree of Doctor of Science. On March 16 he spoke before the Patent Lawyers' Club in Washington on the subject of *Patents and Technology*. At a preview of the Ninth Annual Exhibit of the Press Photographers' Association, held at the New York Museum of Science and Industry on March 24, Dr. Jewett, as President of the Museum, made the opening remarks.

*What Is Coming in Electrical Communication* was the subject of a talk by O. E. BUCKLEY to convalescent soldiers in Halloran General Hospital on April 4.

DR. BUCKLEY talked to students of Columbia High School, South Orange-Maplewood, on March 8, about engineering as a career. He outlined what the profession requires from those who would enter it, and what it offers to those who are successful.

W. E. CAMPBELL visited the Airplane Engine Research Laboratories of the National Advisory Committee of Aeronautics at Cleveland. Mr. Campbell also visited the Gulf Research Laboratories at Pittsburgh and the Naval Research Laboratory in Washington where he discussed lubrication research. He attended a meeting of the A.S.T.M. at Cincinnati.

STUDIES on panel-bank contact noise have recently taken H. W. HERMANCE to Cleveland, Cincinnati, Pittsburgh, St. Louis, Buffalo and Washington.

F. J. SCUDDER and J. W. CORWIN went to Washington with L. E. Kittredge of the A T & T. They discussed dial office problems with engineers of The Chesapeake and Potomac Telephone Company.

## April Service Anniversaries of Members of the Laboratories

### 10 *Years*

D. J. Brangaccio
R. F. Glore
J. A. Haunss
K. F. Hedel
S. P. Leahy
S J. McDermott
E. C. Mener
W. J. O'Neill
K. H. Schunke
J. W. Tengstrom

### 15 *Years*

S. M. Babcock
Viola Bauer
Emanuel Belek
G. J. Brown
A. W. Daschke
P. K. Dean
C. C. Fenwick
Daniel Gimenez
H. E. Haring
H. L. Herbert
E. A. Hollis
E. H. Kampermann
Nicholas Knapp, Jr.
Mildred Koser
A. J. Kuczma
Frank Kuepper
K. M. Martin
M. H. McCormick
Nannette Meade
E. J. Moravec
Anna Mulgrew
Colburn Olsen
R. T. L. Patterson
W. S. R. Smith
George Spilger
E. W. Waters
F. R. Wheeler
Mary White
I. E. Wood
M. N. Yarborough

### 20 *Years*

G. J. Bennett
C. R. Burrows
R. F. Dibble
A. C. Dickieson
Rafael Fontrodona
Miriam Harold
R. M. Hawekotte
G. Q. Lumsden
F. F. Merriam
R. H. Ricker
Laura Servoss
W. T. Wintringham
Eugenia Wyckoff

### 25 *Years*

Michael Bandura
Robert Burns
C. W. Green
A. L. Hogan
R. B. Miller
L. J. Stacy
P. V. Welch
George Wolff

### 30 *Years*

W. P. Albert
A. J. Wier

# Around the World With Our Armed Forces

### Lieut. Nils H. Anderson

LIEUT. NILS ANDERSON, winner of the Purple Heart, and one of the first Laboratories men to enter service, is back in this country. After eighteen months abroad and ten months of actual combat as Communications Officer with the Infantry in the Tunisian and Italian campaigns, he is now at the Walter Reed Hospital in Washington, undergoing treatment for wounds received when a mortar shell hit him in Italy.

When Lieut. Anderson visited his old gang in the Systems Development Department he was wearing stars for major engagements at Pichon, Fondouk and Hill 609 in the Tunisian Campaign and one for his combat period in Italy. As Communications Officer he naturally used a great many Western Electric products, phones, radios, wire and other equipment. His men were not Signal Corps men, but regular G.I. Infantrymen whom he trained for the work. According to him, Africa was a comparatively easy campaign compared to the gruelling mountainous travel for the Infantry in Italy. His most trying experience was the crossing of the Volturno River where along the river bed land mines were planted like corn seeds and many of his men suffered loss of limbs. A further account of Lieut. Anderson's activities as a Communications Officer in Italy may be found on page 398.

### Ernest F. Neubert

ERNEST F. NEUBERT of the General Service Department has been returned to this country from England after having completed thirty-six bombing missions over occupied Europe. Winner of the Distinguished Flying Cross, he qualified for aviation cadet while abroad and has been ordered to Keesler Field, Biloxi, Mississippi. Mr. Neubert was the tail-gunner on a B-26 Marauder and, despite the many breathless

*Ernest F. Neubert, extreme right, with other members of the crew of "The Lady from Hades," the B-26 Marauder which had carried them on thirty-six successful bombing missions before Ernest returned to this country*

moments amid the terrific anti-aircraft fire when he expected the worst, in all his missions he never had to bail out or make a forced landing. The Germans are not to be underestimated he thinks, but the Allies will win because of the preponderance of our air might and the scientific methods of our bombing. The missions on which he was sent varied from as few as two a month to as many as two a day. His closest call to disaster was over Amsterdam when a plane flying beside them was blown to bits and their ship, *The Lady from Hades*, had to fly through the flames at an angle to keep her gasoline supply from igniting.

### Colonel H. B. Ely

COLONEL H. B. ELY, Chief of the Field Service Division at Frankford Arsenal, is examining various Fire Control Spare Parts, of which there are approximately thirty thousand active items. The tiny capsule he is holding contains forty spare parts for

*Colonel H. B. Ely*

watches. The item on the right is a very carefully made differential for the Mechanical Director. The item on the left is a complex ocular prism for use in Range Finders. All of these parts must be carefully handled, packaged, protected against corrosion, identified, stored, and issued through a long pipe line to the maintenance soldier in the field, who requires them for all kinds of repair jobs.

### Lieut. Ernest G. Graf
### 1918-1944

**Lieut. Graf, a Navigator with the Army Air Forces in Italy, was killed in action on April 5. He is the first member of the Laboratories known to have lost his life in World War II.**

### John F. McCarthy

"Recent letters from the Laboratories have greatly interested me. I have been surprised to find so many girls working in the Shops, but war changes everything. I wish I could say something specific about the equipment they're helping to make and how we use it. However, since that's impossible, I can say from my own experience the Labs haven't been letting us boys down. Incidentally, I have had a letter from HERBERT BRAUN. Through the RECORD I contacted him and ELSIE PAVLIC, both old schoolmates of mine."

### Lieut. Col. Ward K. St. Clair

"India: I arrived back in this Signal Corps office the other day after a week's field inspection trip to find two pleasant items of interest. One was a package of BELL LAB RECORDS, the first I have seen

*Hugh Glynn (right) has had a fifteen-day furlough which he spent in Sydney, Australia. He is now back in New Guinea*

since last August, and the second a notification of my promotion to grade of Lieut. Colonel, my first during the war.

"Here in India the only thing which would surprise you would be to find something worked the way it should. You see beggars, snake-charmers and almost everything you have ever read about this country."

### Vincent J. Wycheck

"Somewhere in New Guinea: I am now working on something that I like—taking care of electric generators here. It's somewhat like the job I did in the Labs power room. My hours are eight to four, and it's day work. There's rain almost every day and yet the rainy season hasn't begun. We have plenty of cocoanuts, pineapples and bananas. Chow isn't bad. I have seen wild boars, many interesting kinds of birds, and a ten-foot python snake."

### Frank Monforte

"Books can be written on the subject of mail for servicemen, but none can really explain how a person feels to receive mail, personal and otherwise, such as the Laboratories send out. This is especially true when a person is tucked away from everything—isolated on the supposedly island paradise of New Guinea.

"The island itself isn't bad now that one of the most persistent pests has been nearly exterminated, namely our little yellow cousins. I am sure there must be others from 4C in the South Pacific and I'd sure like to meet them. The drop of rain beating on my head through the tent roof makes writing conditions rather trying, so I'll sign off."

### Lieut. Edward J. Bybel

"Just finished desert maneuvers in Southern California. I am now stationed at Camp Cook, where believe it or not the winter uniform is worn the year round. All talk about California having year-round sunshine is just so much propaganda spread by the California Chamber of Commerce.

"This division is strictly New Jersey, New York, and Pennsylvania, in fact the majority of the battery comes fom Bayonne, Jersey City, Newark and Manhattan."

### Major Harold T. King

"Thank you for the RECORD so promptly forwarded to me at my new address. I am able to say that I am in Italy and of course we are trying to give the Germans as much

## Leaves of Absence

There were 766 members of the Laboratories on military leaves of absence and 15 members on merchant marine leaves as of March 31, 1944:

**Army 474 Navy 217 Marines 27**
**Women's Services 48 Merchant Marine 15**

### Recent Leaves

*United States Army*

| | |
|---|---|
| William J. Behan | Henry Henkel |
| Martin Clohessy | Sarkis Karibian |
| Martin J. Corley | Frank Navratil |
| Sara Dolin | Eugene R. Pontecorvo |
| Frederick H. Engelman | Patrick J. Smith |
| Eugene E. Francois | Dietrich K. Wagner |
| Charles R. Hempel | Stanley M. Wojtaszek |

*United States Navy*

| | |
|---|---|
| Adele E. Aboutok | Louis A. Del Fabro |
| George C. Barry | Joseph A. Fairbrother |
| Wilfred Bauer | Elizabeth P. Kenny |
| William F. Blazure | John J. Nichik |
| Thomas J. Boland | Richard C. Ryan |

Thos. C. O'Sullivan, Jr.

| *U. S. Marine* | *Merchant Marine* |
|---|---|
| Joseph P. Reddington | David H. Freese |

hell as we can. You might possibly see some pictures of us in the *Times* as they took photographs at one of our gun positions some time ago. I'd like to add a good word for the Red Cross and urge all to contribute to it. They are doing a superb job for the lads fighting over here."

### John H. Stelljes

"I've just received my January issue of the RECORD and it is like a bit of home to see the familiar faces and places. In that issue of the RECORD you had a photo of J. M. BARSTOW. It was my good fortune to meet him several weeks ago and you may be sure I didn't allow him to escape till I got my fill of the home-town news."

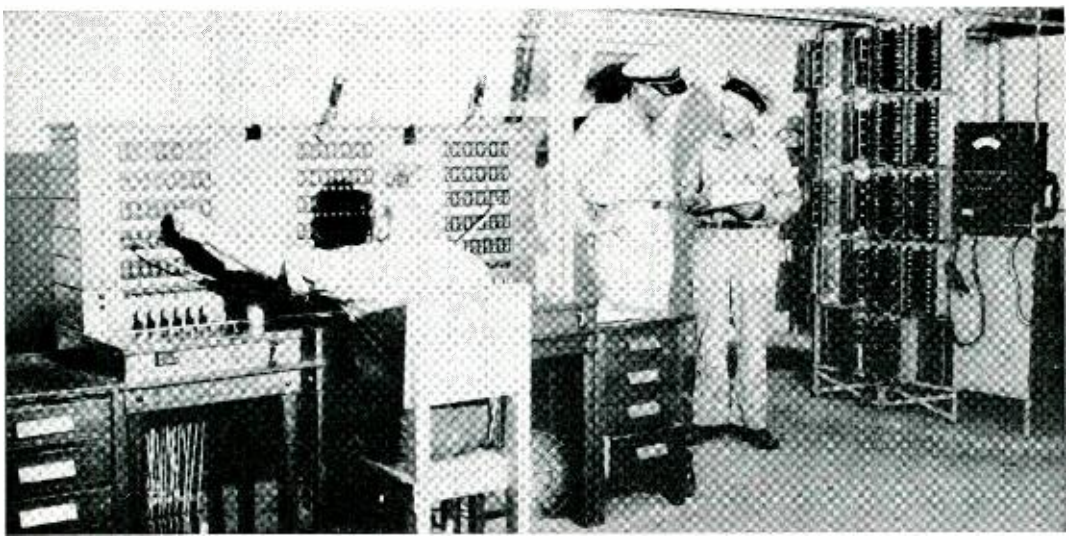
### James M. Cullen

"I left California September 21, and we landed in a town in Australia about a month later. We stayed there a few days but did not have much except a good fresh water shower and a few good meals. We then went to New Guinea and have been on the go since. It sure is hot and I would enjoy that breeze blowing up Bethune Street right now. I'm enclosing a picture of one of the telephone exchanges we built here. We are now building another base and expect to be finished wiring it soon. We are running M.C.M. cable on poles which we cut in the jungle and set. We then wire shops, mess halls and living quarters. Well, keep the equipment coming, especially like the electrical gun director, and we'll be home soon."

### Edward R. Clark

"It is, indeed, pleasant to dwell among the fond memories of the Labs a few hours each month through the medium of the RECORD. Although my leave of absence has outlived my actual stay at the Labs several times over, it seems as though it was yesterday that I packed up and left. My civilian industrial life was short, but sweet. I should like very much to hear of the latest developments in the old department. In particular I would like to inquire about S. C. HIGHT. 'Uncle Stew' was my guardian, teacher, and benefactor in general to me at the Whippany Radio Laboratory.

"After kicking around the States for a year being trained and so forth, I was loaded on a boat and shipped to North Africa. We landed on the Christmas Eve following the invasion and have been here ever since. I applied for some sort of work dealing with radio, but in true Army fashion I was assigned as an Aircraft Inspector. It's not much in the Bell Lab line, but I manage by reading to keep my hand in on my TA work and am looking forward to my return to the Labs at Whippany."



*This is one of the telephone setups which James M. Cullen helped to install in a Quonset Hut somewhere in New Guinea*

*Georg Eltze says that his* BT13A *with which he's shown seemed like such a complicated mess of gadgets—until he started to fly advanced trainers. His final sentence, "How's about more mail from the folks?" should start his friends writing*

### Andrew F. Bartinelli

ANDREW F. BARTINELLI was with the 5th Army in Italy—Black's army. After two or three months of combat duty, he was taken from the fighting front with swollen feet and ankles, taken to a hospital in Sicily and then to a hospital in North Africa where he was told his fighting days were over. He is now driving a truck in North Africa. He has a nice room with another boy and even a shower bath.

### Lieut. Robert C. Nance

"I participated in the battle of Kwajalein Atoll. It was quite an experience and much different from our Aleutian campaigns. I'll not attempt any descriptions of the affair as the newspapers have done a far better job of reporting than I could hope to accomplish.

*Andrew F. Bartinelli*

"Naturally we are all hoping that soon we will be given the opportunity to return to the States for awhile but there is plenty to be done yet on this side of the globe.

"The RECORD just caught up with me again and I really look forward to the arrival of that particular piece of mail. Regards to the old gang, the members of Systems Development Department."

### Major Allen L. Whitman

"After a delightful stay in the tropical paradise of New Guinea I am now on duty in Australia. The assignment promises to be a most interesting one with opportunities for a break in sight into many activities and probable chances for travel. I am at present associated with LIEUT. COL. H. N. MISENHEIMER, and there are numerous other Bell System men to carry on the traditions. While we all miss home and loved ones, there is compensation in the wide range of most unusual experiences. The arrival of mail from home is always a red-letter event—perhaps my good friends will take the hint."

### Flight Officer Stanley W. Erickson

"I've been assigned as Co-Pilot on a B17, and I'm in for combat crew training which will last three months. Although I wanted B25's and B26's, the powers that be thought different. Upon completion of my training here I will be assigned to the 8th Air Force in England, and from then on I hope I'm lucky. On my last leave, the one and only, I had just three days at home, but I managed to squeeze in an all too short afternoon at the Labs. I hope I get a leave before going across, as I'd like to say goodbye to my 'buddies' in 4B and to my other fellow employees."

### John Gris

"I no longer have to take basic field training, that's all finished with. A special order came through transferring me to the Army Clerical School to study Army Regulations and

Administrative Procedures. This transfer certainly came as a surprise to me."

## Military News

JOSEPH KELLY, Aviation Cadet, at Bunker Hill, Peru, Indiana, has had twenty hours of training in Stearmans, the Navy primary trainers. Most of his classroom time is devoted to navigation.

"I HAVE successfully completed the basic A.S.T.P. course," HARRY G. REIMELS writes, "and I have been transferred to the Field Artillery at Fort Bragg."

DANIEL F. O'SULLIVAN of the Marines has completed his training in the 40 mm-A.A. School and has been transferred to New River, N. C. "We are on beach maneuvers and at present I am 'co-owner' of a fire-making brigade. We have the pleasure of supplying hot water to the galley in the field kitchen and have just had our pictures taken. With our coloring from smoke the results will look like two negatives."

DONALD F. CUNEO is doing instrument work at Brunswick, Maine, where English cadets are introduced to their first fighter

JOHN GRIS

S. W. ERICKSON

planes. He has recently become the father of twins, a boy and a girl. "Tell all the gang I'll pass the cigars when I get back."

MAJOR F. A. COLES has been at Camp Evans since leaving Varick Street. As officer in charge of the Engineering Branch he sometimes sees old friends from the Bell Laboratories.

CENSORSHIP limits what JOHN R. NELSON can say about himself. He is an RT2/c with a New York Fleet Post Office address, and he finds a great amount of enjoyment in reading the interesting articles in the RECORD.

*William J. Perry of the Receiving and Shipping Department came back to visit his old gang when on furlough in March. Here he is shown with Ann Colosimo who is doing his work for the duration*

"I MET EDWARD FISCHER at Camp Wood," ROBERT T. LYNCH says. "He's the only Dept. 1420 man I've met and fortunately he and I are still together at this APO address."

CHARLES H. DALM is attached to a squadron of torpedo planes. His last letter reads: "In a few hours I leave for a spot in the Atlantic. I like my work and find it enjoyable. I have seen many pieces of *hush-hush* radio gear designed by the Labs. You must feel very important and proud."

"THANKS EVER SO MUCH for sending me the RECORD," writes PATRICK CONNOLLY who is with the Pacific Fleet. "It is nice to know Bell Laboratories have not forgotten me."

RUTH RYDBERG has been permanently assigned to the Marine Candidate Class Detachment at Quantico.

MAJOR WILLIAM R. LYONS' newest assignment is the Equipment Laboratory at Wright Field. "It is the first assignment in over three years that has used my engineering experience."

ROBERT G. KEMPLE had completed his boot training in the Marines before he visited the Laboratories on his last leave. He expects to see action shortly with the Fleet Marine Force—the men who land first and establish beachheads.

THE BEST part of RUTH MANDELL'S job as a Marine aerial gunnery instructor is her hops in the gun turrets of B25's. She is stationed at Edenton.

OLIVER C. KANOUSE and AUGUST UHL are at the same Pacific APO address.

JOHN MCGUIRE, who has been in service for over a year, is now at Fort Jackson.

"I'M STUDYING supply and disbursing at Cambridge, Massachusetts," ENSIGN ELOISE YOUNG writes. "I have enjoyed the many letters from the Labs and when this course is over I hope to visit my friends."

MORGAN F. HICKEY is stationed at a bomber base somewhere in England.

LETITIA LAUTEN of the Waves is working at the Chief of Naval Communication annex in Washington.

LAWRENCE B. JONES has been given a personal leave of absence to enter the Army Specialized Training Reserve Program. JOHN E. TWEEDDALE'S leave of absence (N.D.R. C.) has been terminated with his transfer to the Western Electric Company.

HELEN OLIN works for the Office of Chief of Medical Service in the Walter Reed Hospital, Washington.

MARGARET MACILVAINE, Pharmacist's Mate in the Waves, is at present working in the Bainbridge Naval Hospital in a surgical ward. "We are all delighted to be doing our part to make the boys comfortable while they are sick," she says.

AT MEMPHIS, GRACE WAGNER of the Waves is a base radio operator.

MARCAE D. BITOWF of the Marines attended radio school at Cherry Point and is preparing to work on airplane radios.

"OUR ACTIVITIES here at Camp Pickett keep me stepping," CHARLES D. BRIGGS writes. "We have had very limited time in which to do anything but train. However, I appreciate the various pieces of literature being distributed by the Labs to its members in the Armed Forces."

PATRICK S. BENNETT is in the engineering course at Clemson College.

FRANK A. KODITEK is quartermaster aboard an LST and is now training in the Gulf of Mexico.

"THE STUDENTS at the Naval Research Laboratories all realize the tremendous credit that goes to Bell Labs," H. S. GEISLER writes. He is instructing students at an Advanced Radio Material School.

BERNARD C. GUINTER is attending the Marine Aviation Ordnance School at Quantico, Virginia.

"I AM the Executive Officer of a battery here at Camp Bowie," LIEUT. CHARLES R. SCHRAMM writes. "We expect our equipment will include our approved weapon, a tractor-drawn 155-mm M.I."

"CALIFORNIA'S SUNSHINE" has a dripping effect on GEORGE J. THIERGARTNER who is at Camp Beale. However, he really enjoys the state and says it has the most beautiful countryside he has ever seen.

E. L. FISCHER G. J. THIERGARTNER


JOSEPH ONTKA R. G. KEMPLE

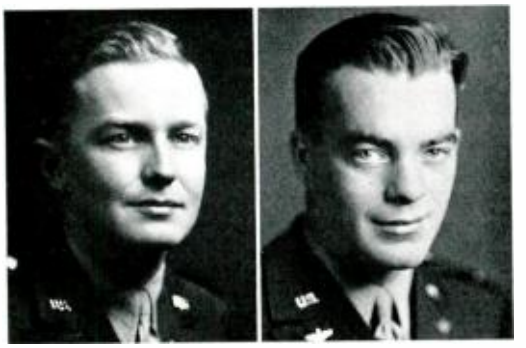
LIEUT. JAMES R. WALSH, recently commissioned pilot, called on friends at Fourteenth Street where he formerly worked in the Savings Bond Department. He is assigned to a tactical unit in an Army transition school.

WATSON RICHARDSON was home on his first furlough since leaving the Laboratories. A former Plant Department man, Mr. Richardson is a Code Clerk in a Headquarters Company at Camp Breckinridge.

Anthony J. Waraske has recently been promoted to Staff Sergeant; John F. McCarthy to Technical Sergeant; Helen Anisko to Seaman 2/c; George A. Bickard to Aviation Cadet; John Devereaux to T/4; L. A. Vabulas to Ensign.

Other recent promotions include Halsey A. Frederick, Jr., to Lieutenant (jg); Ward C. Heaton to Corporal.

"My Navy career so far has been short in time," Louis Munch says, "but long in sea travel and business. I wish I could tell you about the things I have seen and the grand job the Navy Pacific Fleet is doing. The newspaper men, however, have the telling of it, and perhaps you have read of it by now."



Lt. C. R. Schramm  Lt. J. R. Walsh

Joseph Ontka visited West Street and 14th Street buildings before being assigned to the Amphibious forces now in training somewhere in Florida.

Letters and cards say that J. F. Martin has started instrument flying at Pensacola; F. A. Brown, assigned to a newly commissioned ship; G. H. Reinhardt, awaiting shipment from Camp Reynolds; J. M. O'Neill, in La Garde General Hospital being treated for a broken leg; S. G. Reed, University of Illinois; J. C. Ptacek, Yale University; Ensign W. B. Schellerup, Lake City, Florida; N. A. Sorger, Camp Ruckner, Alabama.

Daniel Brady, Northern Ireland; P. R. Brockett, aboard a Canadian corvette doing convoy escort duty; W. J. H. Thoele, at Camp Reynolds awaiting overseas duty; R. W. McMurrough, Fort Jackson; T. J. McDonough, Webb Institute of Naval Architecture; and H. H. Hoffman at Camp Murphy, Florida.

P. S. Bennett  W. Richardson

Members of the Laboratories who have written recently are:

R. J. Seymour, G. E. Fuchs, E. J. Filipovits, A. J. Osinski, C. J. Osiecki, W. J. McKee, P. E. Watts, Capt. W. S. Gunnarson, W. P. Harnack, F. J. Howe, J. H. Devereaux, A. M. Doyle, G. A. Bickard, L. A. Bergdahl, H. A. Bennett, W. E. Archbold, J. R. Merchant, G. J. Wolters, R. H. Meuser.

D. W. Graham, R. G. Bussman, August Uhl, H. W. Menzel, Thomas Fox, David Webster, L. M. Cassano, Victor Silzer, W. F. Lynch, David Greenhagen, W. F. Wilson, Lieut. J. R. Walsh, R. W. Search, Clarence Anderson, R. E. Filler, Capt. L. G. Rainhart, W. R. O'Neill, Robert Klem, R. C. Lamont, Harold Jaffe, Capt. F. B. Monell, G. E. Tirone, Peter Wargo, M. V. Sullivan.

## News Notes

G. G. Winspear, at Cleveland on March 23 and 24, consulted engineers of the Ward Products Company on rubber problems.

G. Deeg and C. J. Frosch conferred with engineers of the Sharon Plant of the Westinghouse Company in connection with transformer treatments.

M. D. Rigterink studied ceramic production problems at the Lapp Insulator Company, Le Roy, N. Y., and at Lenox, Inc., at Trenton, N. J.

C. J. Christensen visited the Brush Development Company in Cleveland, Ohio.

A. R. Kemp and F. S. Malm attended a WPB meeting in Washington on March 22 where they discussed synthetic rubber insulation for wire and cable.

R. G. McCurdy and E. L. Schwartz went to Hawthorne and to Wright Field with members of the Western Electric Company to discuss moisture-proofing and production testing of transformers.

## Keep Up the Good Work!

**The Editors wish to thank all members of the Laboratories who returned their copies of the April RECORD when they had finished reading them. Requirements for servicemen's families were amply met and the response was such that further savings in paper consumption are contemplated.**

G. N. VACCA, G. G. WINSPEAR and H. PETERS attended an A.S.T.M. meeting on rubber at Cincinnati.

N. R. PAPE, R. W. WALKER and W. O. BAKER collaborated on reports given March 13 and 14 before the Research Conference of the Office of Rubber Director.

DURING THE week of March 19, E. E. SCHUMACHER discussed metallurgical problems with engineers at Hawthorne.

A. H. SCHAFER, at Hawthorne, studied manufacturing problems of resistances.

F. J. GIVEN and A. J. CHRISTOPHER assisted in the preparation of the American War Standard on Paper Capacitors.

R. P. MUHLSTEFF has been awarded the degree of Master in Mechanical Engineering from New York University.

IN CHICAGO during March A. J. GROSSMAN and T. R. FINCH conferred on the manufacturing problems of special networks.

P. H. RICHARDSON visited Hawthorne and the S. and W. Inductor Company in Chicago regarding networks.

R. E. DRAKE and M. WHITEHEAD discussed electrolytic condensers on March 15 at the Sprague Specialty Company.

R. T. STAPLES discussed cable designs with engineers of the Boston Insulated Wire and Cable Company.

J. ABBOTT, JR., attended a Dial Survey Conference in Hawthorne. He also discussed dials with the Manufacturing Department.

The drawing of DENNIS CRONIN in the April RECORD caused considerable interest among his friends. In answer to the many calls received asking who drew "Denny," it was LILLIAN GUBERMAN of the Apparatus Development Department.

H. H. STAEBNER conferred on cord development matters at Baltimore.

H. H. GLENN visited the Bureau of Ships, Washington, to discuss wires and cables.

C. A. WEBBER went to Chicago in connection with cable designs.

F. W. CLAYDEN made special contact studies at the Albany and the Scranton telephone offices.

THE SPRING meeting of the American Society for Testing Materials, held in Cincinnati, was attended by C. D. HOCKER, Chairman, and J. B. DIXON, Secretary of Committee on Corrosion of Iron and Steel.

W. H. S. YOURY visited the Plymouth Rubber Company in Canton, Mass., to discuss DR tape.

W. T. PRITCHARD recently consulted with engineers of the Highspeed Hammer Company of Rochester, N. Y., on the design of special riveting machines.

P. W. SHEATSLEY and C. V. TAPLIN with W. Rupp of the A T & T were in Cleveland to discuss unattended dial office problems with Ohio Bell representatives.

AT THE BUREAU of Ships in Washington, H. E. MARTING, H. A. LEWIS and C. C. HIPKINS, with members of the Western Electric Company, discussed moisture- and fungus-proofing of communication equipment.

J. A. WATTERS went to Chicago in connection with broadband carrier equipment and installations.

STEP-BY-STEP equipment studies took J. O. JOHNSON to Scranton and to Albany.

L. G. ABRAHAM and B. J. KINSBURG accompanied M. Barton, C. M. Edwards and R. L. Roemer of Western Electric, and W. S. Brown and C. E. Schooley of Long Lines on an inspection trip to the coaxial amplifier repair point at the Princeton repeater station. The purpose of the trip was to familiarize the Western Electric personnel with the coaxial amplifier repair testing procedures instituted there by the Long Lines.

* * * * *

WILLIAM H. SPAHN of the Switching Development Department retired on April 30 at his own request with a Class A pension upon the completion of over thirty-five years of service which began when he joined the New York Telephone Company in 1905. After three years of installation work, he was assigned to special work on PBX's,

and two years later he entered the central-office maintenance force. When he left in 1913 to join the engineering staff of the New York City Fire Department, he was a test deskman.

In the meanwhile Mr. Spahn had been studying at Cooper Union, and in 1912 had received the degree of B.S. in M.E. In 1915 he received the B.S. in E.E., and the following year the advanced degree of E.E. On joining the Engineering Department of the Western Electric Company in 1916 he engaged in circuit design work, and the following year took charge of a group analyzing all standard circuits to determine where No. 1 contact metal could be substituted for platinum. In 1917 Mr. Spahn was asked to teach physics at Cooper Union, an activity in which he continued until 1938. On transferring to the panel dial group in 1920 he worked for a year on sender circuit design. Since 1921 Mr. Spahn had charge of all time and traffic studies for automatic systems, and of the application of the theory of probability to automatic switching problems.

* * * * *

MORRIS LEBOFF of the Development Shop retired on April 16 at his own request with a Class B pension following a year of absence due to sickness. He joined the Engineering Department of the Western Electric Company as a machinist and bench hand in 1918. From 1936 to the time of his illness he was engaged as a supervisor in the New York Development Shops.

* * * * *

IN THE LONG LINES Chicago toll office D. B. PENICK is testing the first commercial installation of the A2 channel bank.

RECENT RECORD articles have been abstracted in issues of *Nature* (London). They are *Gas Tube Harmonic Generator* by L. G. Kersta, *How Well Do I Hear?* by M. B. GARDNER, and *Fastax, An Ultra-High-Speed Motion Picture Camera* by H. J. SMITH, all in the January 15 issue; *Noise Measurements in Vacuum Tubes* by J. J. DEBUSKE in the January 22 issue; and *Teletypewriter Test Sets* by W. Y. LANG in the February 5 issue.

AT THE CONVENTION of the High School Science Teachers of Rockland County, held at Suffern, New York, on March 24, P. B. MURPHY spoke on the subject *Science and Industry After the War.*

MORRIS LEBOFF W. H. SPAHN

THE MARCH issue of *Electrical Engineering* contains a paper by O. A. FRIEND entitled *Automatic Ticketing of Telephone Calls.* It was presented before the winter convention of the A.I.E.E.

BEFORE THE Radio Television Planning Board on March 16, J. F. WENTZ discussed the possibilities for post-war television networks over coaxial cables. The present and contemplated facilities of the A T & T for such a network were outlined.

A. F. MOTT has recently assisted the N.B.C. in transmitting video television signals from Madison Square Garden.

E. B. CAVE appeared before the Board of Appeals at the Patent Office in Washington relative to an application for patent.

F. D. LEAMER's appointment as a regular member of the Irvington War Manpower Appeals Committee was made recently by the Regional Director of Region III of the War Manpower Commission.

F. D. LEAMER, M. B. LONG and E. V. MACE attended an Army-Management-Labor Safety and Security Conference on March 21 at Trenton which was held under the auspices of the Trenton District Headquarters, Second Service Command.

THE ANNUAL DINNER of the Fifteenth Greater New York Safety Council Convention at Hotel Pennsylvania on March 29 was attended by G. B. THOMAS, S. H. WILLARD, DR. C. E. MARTIN, H. S. SHEPPARD, D. P. BARRY, J. E. CONWELL, L. E. COON, L. S. HULIN, M. JOAN MULHERIN, H. W. SCOVILL, H. E. CROSBY, M. E. ELLIS, R. W. GAST, J. R. P. GOLLER and G. B. TIMM. J. S. EDWARDS served on the Attendance Committee, and L. E. COON on the Arrangements Committee.

# Fighting by Nigh on the Home Front

*When it's bedtime for most members of the Laboratories, girls like these are just starting to work at West Street and at Fourteenth Street. Their hours, for the most part, are from eleven at night to eight in the morning, six nights a week*

# Women of the Laboratories

ELIZABETH INK is a member of the Laboratories Staff and manager of the Restaurant and Cafeterias at West Street. She prepared for her vocation at Skidmore College where she received her B.S. in Home Economics and at Teachers' College, Columbia University, where she was awarded a master's degree in Institutional Management. Before joining the Laboratories in January she was assistant manager of the John Jay Hall Dining Rooms at Columbia University.

With the heavy wartime schedule of the Laboratories it has become necessary to operate the Restaurant practically 24 hours a day. Under present food and employment market conditions and with increasingly strict O.P.A. regulations, this is a sizable job. Approximately four thousand members of the Laboratories eat in the Restaurant at West Street daily.

Although Miss Ink claims she does not excel in any, she participates in all kinds of sports. She is also adept at making her own clothes, but that accomplishment is out for the duration. In wartime her reading is limited to the *Reader's Digest*, to a few of the current best sellers, and to the magazines and latest literature of her profession. Her favorite form of relaxation is jewelry-making.

## Night Workers

AMONG the women of the Laboratories who work on the night shift are those shown on the opposite page. On the top row are ANGELA MCMAHON of the Reproduction Department, who runs a blueprint machine; and BETTY WAGNER of the tabulating service group in the Accounting Department, Fourteenth Street. The three girls in the center of the page are OLGA HORDECHUCK, VERONICA TRACEY and ALMA CARLSON, all working key punch machines in the Accounting Department, Fourteenth Street. Across the bottom of the page are: EDNA HERZOG, who is preparing to run a winding machine in the Coil Winding Department; MARION CHAMA, who is a cleaner in the Plant Department; and JOSEPHINE SETTICASE, who is adjusting resistances in the Coil Department's test room on the third floor.

* * * * *

MURIEL LAZEAR entered the Whippany Drafting Room with a background of education and experience which has been valuable to her in her work on some of the electronic devices which the Laboratories has developed for the Armed Forces. After a year at Morris Junior College and another at Limestone College in Gaffney, South Carolina, she entered the employ of a machine design company where, along with

*Elizabeth Ink consults Andrew Scaglione about the day's menus for the West Street Restaurant*

MURIEL LAZEAR

some stenography, she did drafting on small mechanical parts. At the same time she attended Rutgers University where she studied applied mathematics and basic drafting.

An all-around sportswoman, she enjoys the opportunities which Whippany affords for noon-hour athletic activities, particularly ice skating in winter and swimming during the summer months. Her training in the arts and costume design come to the fore in her leisure time. She does painting, sewing and leather craft, skills which have been of immense value in her Girl Scout activities.

* * * * *

PHOTOGRAPHY has always been EVELYN MEYER'S specialty. As a youngster out in Floral Park, Long Island, she spent her high school summer vacations working in the photo finishing establishment with which her father has been connected for many years. Upon graduation from Sewanaka High School in 1939, it was only natural that she returned there to work full time and, eventually, she was given charge of ten girls. Last June, when she decided to make a change, she came to the Laboratories' Photographic Department where she is responsible for the service on all photograph orders received. She checks in the orders, follows them through the various processes of development, makes certain that they are delivered on schedule, and assigns negative numbers to the prints selected.

Miss Meyer is a sports enthusiast. Until recently she was manager of a local girls athletic club and had her own softball and basketball teams. Strangely enough she is not a camera fiend, even though her fiancé, who is now in the Air Corps, was a photographer before he entered Service.

* * * * *

SYLVIA LEPOW of Transmission Networks told the students of Adelphi College at Garden City on April 13 about the Laboratories and her work here. Miss Lepow graduated from Adelphi in 1943. She is now studying at Brooklyn Polytechnic for a master's degree in electrical engineering.

EVELYN M. MEYER

BEFORE BECOMING a student in the Laboratories' first full-time training course for Technical Assistants, ANGELA SCANNELL had completed an academic course at Great Neck High School and three months' training at Stevens Institute. Miss Scannell works on special preproduction models of electronic devices in the Equipment Development Department. She acts as the contact between engineers and the mechanics in the Development Shops and their subcontractors working on the equipment. After helping to place

orders, she expedites them through the Shops to their completion and then checks the work against the blueprints before submitting it to the engineer concerned. To help her to better understand the problems she encounters in her work, she studies ultra-high-frequency techniques at Columbia two nights a week.

Miss Scannell's outside interests are horseback riding and swimming. Commuting to and from her home in Great Neck, she manages to keep up with her magazine reading, which includes the *Nation* and *America*. She prefers Thomas Wolff and thinks that *Look Homeward, Angel* is the best of his work she has read so far.

ANGELA F. SCANNELL

*Members of the Laboratories remember most of these girls as former messenger and mail clerks. Now they are working in clerical positions to which they were promoted and a new group of girls is wanted to fill mail and messenger jobs and to prepare for advancement in the Personnel Department's Training Program. If you know any High School Seniors who would be interested in working at Bell Telephone Laboratories, please refer them to the Women's Employment Department at 744 Washington Street, New York City.*

*The girls in this picture are: Marie Teschner, Patricia Phelan, Elsie Pavlic, Vivian Driscoll, Marilyn Daniels (standing), Catherine Sweeney, Marjorie Lapham, Lillian Sangberg (standing), Doris Middleton, Winifred Burke and Helen Schaefer*

## A T and T Girls Help the Laboratories

To help relieve the heavy load of Transcription work at the Laboratories, an average of twenty A T and T girl volunteers work Saturdays at 463 West Street on an overtime basis. These girls represent many departments at 195 Broadway and are not all engaged regularly in transcription work. They range from typists to secretaries whose spirit of service has prompted them to do war work elsewhere in the Bell System during their free time. Their willingness to serve in an emergency has helped to relieve the shortage at Bell Laboratories where every available source of manpower is being used.

* * * * *

MARY LOEFFLER has always been a sports enthusiast. Neither her convent training nor her subsequent marriage in her sophomore year at college dampened her enthusiasm for roughing it in the open and for competitive sports. She was born in St. Mary's, Pennsylvania, and educated in private schools in Alabama, Florida and Cuba. A few years after her marriage her husband died, leaving her with a small son to raise. Because she had majored in the fine arts and was without business training, Mrs. Loeffler became hostess in one of the restaurants of a well-known chain. Later she taught clerical work to girls in the same concern where she learned much about handling people that has helped her since she joined the Laboratories. As expediter to a buyer, she is responsible for following orders, checking deliveries, and, where necessary, helping to make substitutions on such items as printing services, stationery, paper products, office equipment, typewriters, calculating machines, textiles and uniforms for guards, nurses, and restaurant workers.

MARY K. LOEFFLER

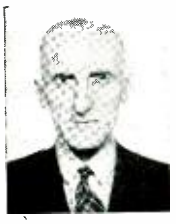
Mrs. Loeffler's son, who is just nineteen, has received his B.S. degree and has recently become an Army medical student. From the time he was a little tyke she shared the sports he and his pals enjoyed, raised animals and tamed wild pets with him. Their back yard was an archery range and a baseball diamond on which Mrs. Loeffler could play almost any position. Later on they went in for tennis, distance swimming and canoe tilting. Now that her son is in service, she lives on Manhattan near Columbia where she is studying psychology. Her free time for the most part is devoted to hospital work two evenings a week and Sunday mornings.

*A group of A T and T girls about to enter the Laboratories*

# Members of Bell System Companies Transferred to the Laboratories to Aid in War Work—October 1, 1943, to April 12, 1944

## Western Electric

Ruth Ammons.....2300
M. C. Biskeborn....2300
C. E. Brokenicky...3500
O. P. Clark.....1700
Leonora Daniel.....7100
Nadia Evanowicz...2300
D. J. Fefee.....2600
E. J. Hawes.....3200
J. D. Lawson.....7300
R. S. Newsham.....1400
W. C. Royal.....2300
R. A. Skepstedt.....3200
Elsie Sweitzer.....1100



*A. E. MacMahon* *Elsie Sweitzer* *J. A. Antola*

## Illinois Bell

R. A. Bina.....3200
A. R. Copley.....1700
G. F. Gould.....1700
L. D. Graham.....3200
A. G. Hochleutner..1700
E. J. Jedlicka.....1700
M. J. Larsen.....1700
S. G. Lehmann.....1700
R. K. Metcalf.....7400
J. K. Middaugh....1700
Mildred Middaugh..7100
J. R. Morris.....7400
J. E. Ottman.....1700
Stanley Pollenz.....1700
Theodore Reckling..1700
G. B. Ross.....6000
E. H. Scholz.....1700
W. C. Shaw, Jr.....1700
M. B. Umnitz.....1700
T. A. Williams.....7400

## A T & T

C. S. Borthwick....1600
C. R. Burchfield....2200

## Ohio Bell

A. L. Kiser.....1700
E. E. Wade.....3200

## Michigan Bell

Elizabeth Hart.....1200
J. C. Leffel.....3200

## Pacific Tel.

A. E. MacMahon...3500
E. C. Rohr.....1700



*C. R. Burchfield* *Gale Forssen* *C. R. Wilcox*



*R. S. Newsham* *E. E. Wade* *T. A. Williams*

## New York Tel.

J. A. Antola.....3200
S. J. Aronchick.....7100
Attilio Baltera.....1700
Mulford Beebe.....2600
B. J. Betkowski....7400
R. H. Boehm.....3200
S. O. Carleton.....3100
N. G. Carlson.....7400
R. W. Conklin.....7100
G. B. Crofutt.....3300
R. J. Cunningham...3100
L. E. Dever.....7100
C. D. Dixon.....7400
J. H. Durnan.....7400
C. G. Emery.....2600
Walter Fenner, Jr...7600
C. O. Fogelberg.....2600
R. O. Fraser.....7100
P. A. Gartman.....7100
E. E. Gillam.....7100
L. O. Goodman.....3200
A. A. Greenrose....3200
Kenneth Haynes....2600
J. J. Jacobs.....3200
E. A. Jones.....7400
T. C. Kraft.....2600
A. R. Nardi.....3200
J. I. Palmer.....3200
A. R. Parker, Jr.*..7400
R. B. Perkins.....6000
W. C. Pfrommer....2600
C. S. Rhoads.....3100
H. W. Risch.....3200
M. J. Robinson.....7400
E. W. Schmoll.....3200
Samuel Sempey.....7400
William Stevenson..2400
O. R. Strittmatter...7400
C. A. Walsh.....7100
K. E. Wheeler.....7400
Clement Winter....7100

*On Military Leave.



*E. W. Coyer* *A. A. Greenrose* *J. C. Leffel*

## Mountain States

E. W. Coyer.....3500

## New England Tel.

Gale Forssen.....1700
P. J. Hamill.....7400
A. H. Johnson.....1700
H. T. Sargent, Jr...7400

## New Jersey Bell

W. S. Irvine.....3200
H. G. Seifried.....7400
C. R. Wilcox.....7400

## Sou. New England

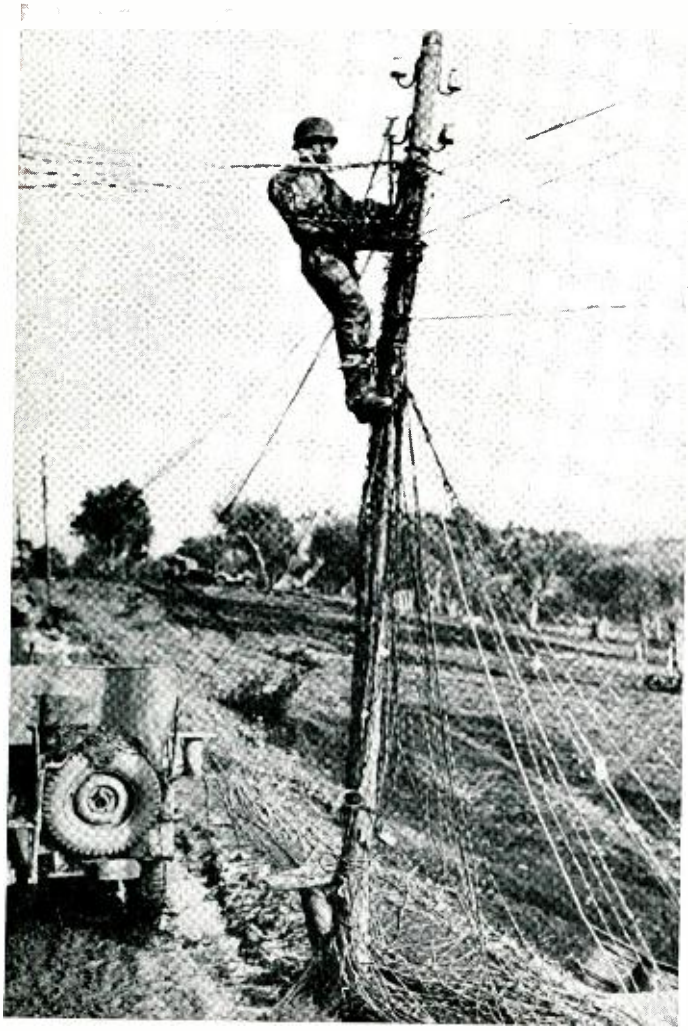
J. F. Cannon.....1600

1100 Physical Research (Harvey Fletcher)
1200 Chemical Laboratories (R. R. Williams)
1400 Electronics Research (J. R. Wilson)
1600 Radio Research (Ralph Bown)
1700 Commercial Products (O. M. Glunt)
2200 Switching Apparatus (H. A. Frederick)
2300 Outside Plant (R. A. Haislip)
2400 Station Apparatus (W. H. Martin)
2600 Apparatus Staff (H. S. Sheppard)
3100 Switching Engineering (H. M. Bascom)
3200 Equipment Development (H. H. Lowry)
3300 Switching Development (J. L. Dow)
3500 Transmission Development (D. A. Quarles)
6000 Personnel (G. B. Thomas)
7100 General Accounting (A. O. Jehle)
7300 General Service (R. H. Wilson)
7400 Commercial Relations (B. B. Webb)
7600 Development Shops (H. C. Atkinson)

## Experiences of Lieut. Anderson in Italy

After four years in the Laboratories, LIEUT. NILS H. ANDERSON left Systems Drafting in September, 1940, when his National Guard regiment was inducted. In June, 1942, he was sent to Officers' Candidate School at Fort Benning; he went overseas to the United Kingdom in October as a Second Lieutenant. In January, 1943, he went to North Africa and in September to Italy. Wounded in December, he arrived in the United States in March of this year.

Because of his Bell System background, Lieut. Anderson was soon put into communications work. From company up to regimental headquarters, facilities are furnished and operated by the infantry itself. In his last post, as a First Lieutenant, he commanded about thirty men who were responsible for the wire and written communications service, as well as for a message center of a battalion (two companies). For all-around reliability he preferred a wire line to radio whenever a line could be placed. Over rough terrain where vehicles could not be used, that was a hard job, for the field wire weighs eighty-two pounds on a half-mile reel. Wire must be laid off the trail, but even so it takes quite a beating. When wire is laid from a reel mounted on a truck, the reels are dropped off as they are emptied, so as to be handy for salvage. When the action moves forward, the infantry leaves its wire behind, to be salvaged and reissued by teams from the Division Signal Officer's outfit.



*British Combine Photo*

*Note on this picture from Italy, the reel on the back of the jeep and the three empties, one in back of the pole and two at the extreme right. An unlucky shell hit here could disrupt a lot of circuits*

Shell fire is very destructive to wire, and many casualties occur when repairmen dash in to fix it. One crossroad in Tunisia Lieut. Anderson remembers well because some thirty lines passed it, and every one was cut. Ten wire teams of two men each went in and began to test the broken wires; before all were repaired there were quite a few of those men killed or wounded.

Lines placed by Lieut. Anderson's men were served by six-drop and twelve-drop boards, and magneto field telephones. Some of the latter were of German make and well made, too. In the two machine gun companies there were some ten sound power telephones on a network which those outfits laid and maintained themselves.

On the night before the

Volturno River crossing, Lieut. Anderson laid a wire down to a thicket at the river's edge. The next night, testing back, he found the circuit open, and on inspection a half mile of pair was missing. By the time the break was repaired the assault wave had crossed, and the rifle platoon that the signallers were to follow had quite a few casualties.

Not long afterward, while in a relatively sheltered area, shelled only now and then, a shell came over which killed one of Lieut. Anderson's men and wounded him.

Signal Corps Photo

*Lieut. Anderson says this scene is as familiar to him as the* 9-H *Drafting Room. In the foreground, two soldiers get ready to eat a can of C ration heated over a gasoline stove. At the rear, a signal man answers a call on a switchboard captured from the enemy*

## Director of WPB Communications Division Visits Laboratories

Leighton H. Peebles, Director of the Communications Division of the War Production Board, and J. B. Rees of the American Telephone and Telegraph Company visited the Laboratories at West Street and Murray Hill on April 3. After meeting O. E. Buckley, O. B. Blackwell and M. J. Kelly, H. H. Lowry showed them some of the communications equipment that had been developed for the military services, including an inspection of the humidity rooms where moisture and fungus treatments for tropical use are tested on working systems. J. R. Wilson then took them on an inspection trip through certain sections of the vacuum-tube development shop.

They were taken to Murray Hill by R. L. Jones where they had lunch with Harvey Fletcher, R. A. Haislip, M. B. Long, W. H. Martin and R. R. Williams. Following this, F. L. Hunt escorted them on an inspection trip. A. R. Kemp described the work in the rubber laboratory; S. O. Morgan, the ceramic laboratory; F. S. Goucher and R. O. Grisdale, the carbon resistor laboratory; and W. C. Jones, the work being done on substitute materials, particularly in reference to transmission instruments and telephone booths.

## Telephone Pioneers Enrolled During February and March

C. H. Achenbach
A. J. Aikens
B. G. Bjornson
P. E. Buch
Elsie Burger
H. H. Buttner*
C. O. Cross
J. Denardo
Blanche Dooley
H. T. Douglass
R. F. Elliott
Mary Farmer
E. L. Fletcher
L. D. Fry
H. A. Giroud
J. R. P. Goller
E. V. Griggs
F. J. Hallenbeck
L. E. Herborn
C. L. Howk†
R. T. Jenkins
Kathryn E. Joyce
F. A. Lindeberg†
W. F. Malone
Florence Metz
C. C. Meyer
V. Montagna
E. C. Muller
C. C. Munro
D. S. Myers
O. Myers
J. B. Newsom‡
G. R. Odin†
G. T. Selby
E. R. Taylor
H. R. Vail
E. von der Linden
C. A. Walters†
W. K. Webster
Mary West
A. Westenberger

*Federal Tel. & Rad.
†Transferred from other Chapters.
‡On Military Leave.

Signal Corps Photo

*Only 100 yards from Jap positions on New Guinea, these three members of an Infantry unit pause in their task of cleaning a 4.2 mortar to read the all-important mail from home. This mortar has been in effective use since last summer in Sicily and Italy and in the South Pacific. It has a rifled barrel and is employed as a smoke and high explosive projector*

## Your Victory Garden Is Vital

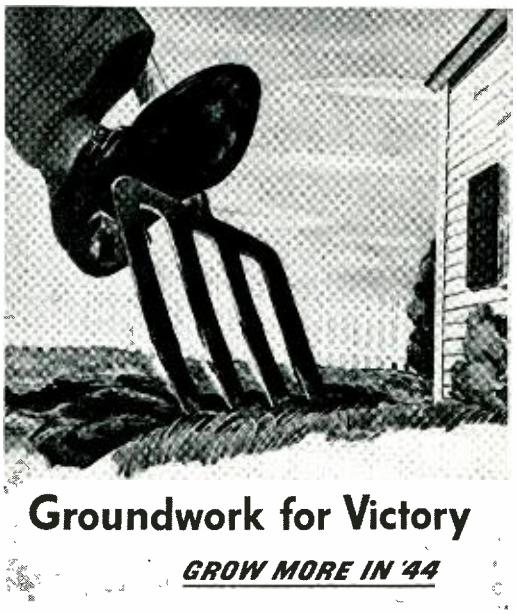
"The 1943 Victory Garden program was a success by all standards," according to Secretary of Agriculture Claude R. Wickard in an address he made in Boston recently. "Last year our goal called for 18 million gardens. It has been estimated that 20 million were actually planted and that as much as 40 per cent of last year's supply of fresh vegetables came from home gardens.

"Within the last two weeks I have been getting some very disturbing reports about Victory Garden prospects for this year. Reports from seed houses indicate that the number of Victory Gardens to be grown will be less this year than last year. Many of you, I am sure, are familiar with the National Poll on Victory Gardens which was carried recently in widely circulated newspapers. This poll showed that the overall number of gardens planned, as of March this year, was definitely below the Victory Garden goal. In fact, it was 10 per cent less.

"If these reports are true, it is simply because people are too complacent about the food situation. That is terribly unfortunate because the need this year is to top last year's fine Victory Gardening program by as much as possible. Take my word for that, current abundant supplies notwithstanding. The goal this year is 22 *million gardens—2 million more than were grown last year.* Pass that information along to your neighbor who is asking 'Is there really a serious need for Victory Gardens in 1944?' "

## High-Powered Loudspeaker for the Navy

The demand by the Navy for a loudspeaker that could rise to the occasion and satisfy the rigid requirements of today's great naval battles has been met in a new speaker designed by the Bell Telephone Laboratories and now being produced by the Western Electric Company. This high-powered unit has passed the rigid Navy tests to

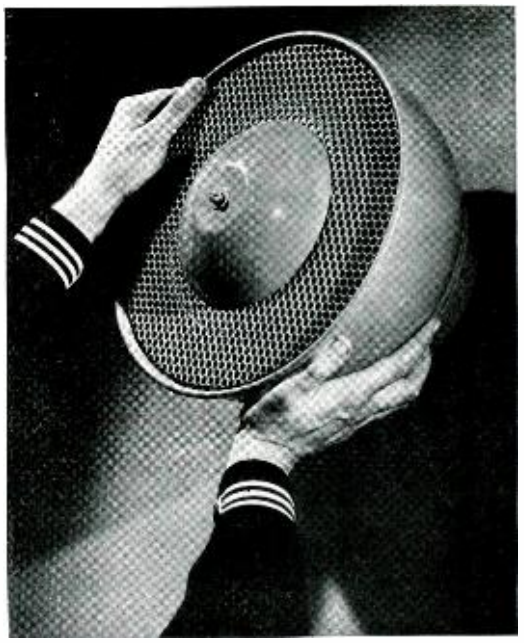


insure reliable operation under the wide geographical range necessary for the fleet's activities.

Designed for speech reproduction, this speaker has an outside diameter of 12½ inches and weighs approximately 25 pounds. The unit is composed of three principal sections: the base, which provides space for a transformer, and a terminal strip, and provisions for the lead-in cable; the horn, which is of the folded exponential type; and the magnetic unit which is fitted with a two-piece permanent magnet, diaphragm, and blast valve. The loudspeaker is constructed principally from formed sheet steel and molded plastic.

The voice coil impedance of the unit is approximately 7.5 ohms. The speaker develops the high sound pressure of 50 dynes per square centimeter when operated at the rated electrical input and measured at 10 feet from the speaker on the sound axis in open air.

Other features of this loudspeaker are that it is resistant to shock, vibration, salt spray, gun blast, and is extremely accessible for servicing due to its simple construction.



*Latest Western Electric high-powered loudspeaker for the U. S. Navy*

## Table Flatware and Mess Equipment From Rejected Stainless Steel

A substantial part of the Army's metal mess equipment such as mess kits, canteen cups and field knives, forks and spoons, mess trays and mess hall tableware is being obtained from stainless steel scrap left over from the manufacture of other articles, and from "off-heat" or rejected ingots.

The metal is useless for most military purposes, but contains the stainless qualities urgently required for Army mess equipment and can be worked almost as easily in the manufacture of this equipment as new metal.

This rejected metal and the scrap eventually have been made available to manufacturers of Quartermaster Corps equipment, and as a result, the Quartermaster Corps was able to obtain the most suitable tableware and individual mess equipment without using the production facilities for steel so urgently required for the manufacture of vital arms and ammunition.

A nice job of salvaging, you'll say; so then ask yourself these salvage questions:

**Do *you* cut up partly used sheets of paper for your small memoranda?**

**Do *you* use both sides of the sheet for manuscript and rough figuring?**

## BLOOD DONORS

| | |
|---|---|
| *R. H. Bedell | R. G. McCoy |
| J. F. Brennan | Laurette McDonnell |
| Matilda Chvastik | O. S. Mesch |
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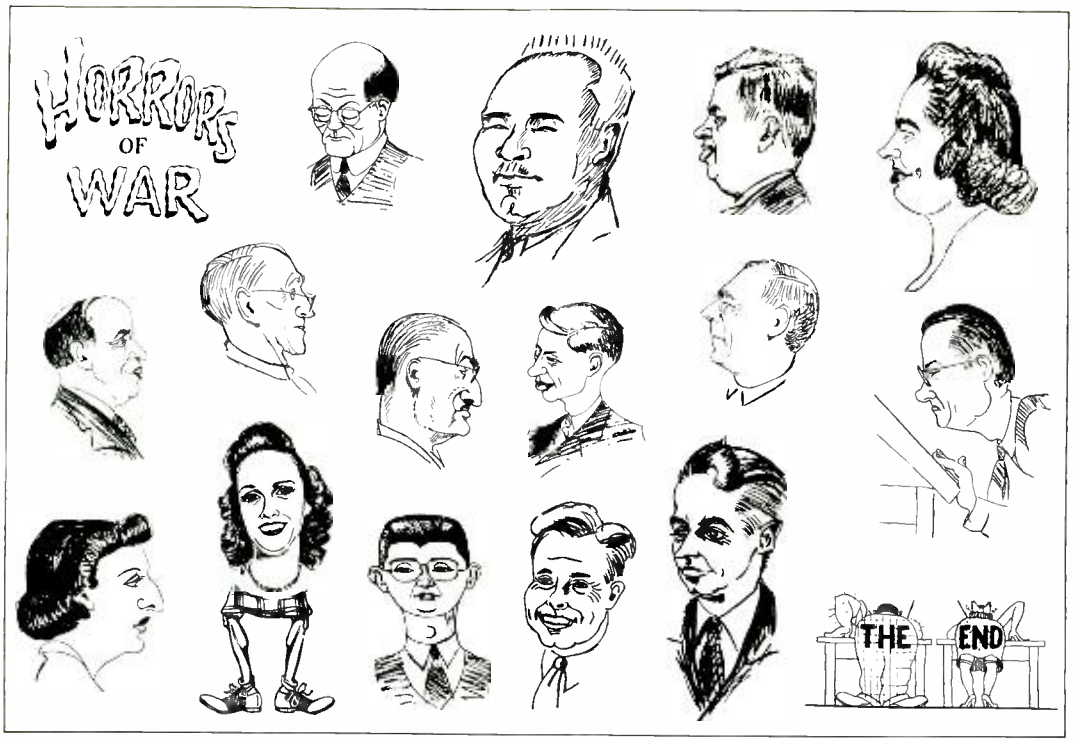
| H. W. Cosgrove | *P. Pfister |
| *J. Gordon | *E. J. Phillipps |
| *J. Harrigan | *T. Portanova |
| Maryrose Hanavan | *O. Rappe |
| Anne Iwaniw | F. A. Schulz |
| Helen Kelly | W. J. Snyder |
| W. J. Kindermann | E. T. Stammer |

R. W. Widman

*Western Electric men stationed at the Laboratories.

## Bell Chorus to Give Concert

The Bell Chorus will present their Spring Concert at Town Hall on Tuesday evening, May 9, at 8:30 P.M. The Chorus has prepared an interesting program which includes




some delightful American folk tunes and several contemporary numbers by William Schuman. Mrs. Elsie Urban, soprano, will be the guest artist for the evening.

Tickets may be purchased at $1.10 from Miss Hilda R. Muller, Extension 1902, at West Street, and Mr. Allen E. Blackman, Extension 2024, Graybar-Varick.

## "The Horrors of War"

Servicemen from the Apparatus Development Drafting Department now have an excellent idea of how the drafting room is faring in their absence. In a thirty-six-page booklet of caricatures and verse, called *The Horrors of War*, the drafting group from its head, H. J. DELCHAMPS, to its messenger girl, takes a lampooning, but it's all in fun. Drawings in the booklet are the work of LIZZIE BAUER, LILLIAN GUBERMAN and G. J. STEINACKER. Both the subjects and the artists worked on their own time. The verses were contributed by various members of the department; the booklet was edited by Mrs. Guberman. Extra copies of *The Horrors of War* are available in Section 4C and are being sold to swell Apparatus Drafting's fund for servicemen.

## We See by the Papers, *that*

For the first time since 1937, a change occurred in the board of directors of the First National Bank and Trust Company of Tuckahoe when five new directors were named. They are: . . . ARTHUR O. JEHLE, chief auditor, Bell Telephone Laboratories, New York. . . .—*Herald-Statesman*, *Yonkers*, *N. Y.*, *January* 12, 1944.

A. PAUL MOORE, Bell Laboratories, 463 West Street, New York, former Daytonian, has been proposed for membership in the Ohio Society of New York.—*Journal*, *Dayton*, *Ohio*, *February* 2, 1944.

Buffalo motorists would prolong the life of mufflers and exhaust pipes on their cars if they painted these parts as a safeguard against rust caused by the calcium chloride used to melt the ice on the streets, DR. R. M. BURNS declared Thursday evening before a joint meeting of the Western New York Section, American Chemical Society, and the Niagara Chapter, Electrochemical Society. —*News*, *Buffalo*, *N. Y.*, *February* 18, 1944.

Soviet engineers have put to good use the system of "statistical quality control" invented by the mathematician, DR. WALTER A. SHEWHART, consultant for the Bell Tele-

phone Laboratories. This method is applied to mass production techniques and widely used in this country, and Great Britain combines the statistical approach with the science of engineering to effect both the economy and uniformity of production in industry.—*Daily Worker, New York, N. Y., April* 13, 1944.

To encourage employees of the Bell Telephone Laboratories to write to fellow workers now in the Nation's Armed Forces, writing facilities with pens, ink, V-mail forms, and a list of those in the service has been installed in the lounge of the Laboratories building on West Street, New York City. It isn't even necessary to know the address. All the writer has to do is put the addressee's name on the envelope, stamp it, drop the letter into the box provided, and the personnel department fills in the latest address and mails the letter.—*News, Ironton, Ohio, January* 31, 1944.

Last week we saw the new Bell Telephone Laboratories at Murray Hill, New Jersey, and now we know that all other industrial buildings are second rate.

There was an air of unreality about the place, a kind of Shangri-la atmosphere. . . . Here at Murray Hill is a building, or mass of buildings, designed for research scientists, and it achieves its purpose. Indeed it could well be a monument to glorify the dignity of scientific research. . . .

There is no contest between industrialism and the beauties of nature at Murray Hill. Perfect balance exists between them and the resultant edifice is successful because it is completely functional with absolute harmony between its needs and style. There is a thrilling beauty about it which must be inspiring to the lucky twelve hundred persons who work there. The remaining sixty-five hundred who work in the more orthodox building in New York must be very envious. —*From "One Point of the Compass," Northport Journal, April* 14, 1944.

William L. Bell and Ray R. Scoville, employed in special development work at Bell Telephone Laboratories, received yesterday the award of the *S.M.P.E. Journal* for their article describing design and use of equipment for reducing background noise in film sound recording systems.—*New York Times, April* 20, 1944.

## "The Telephone Hour"

(NBC, Monday Nights, 9:00 P.M., Eastern War Time)

**MAY 8, 1944**

Song of Songs — *Moya*
Surrey with the Fringe on Top — *Rodgers*
James Melton
Old-Fashioned Wife — *Kern*
Orchestra
Il Mio Tesoro from "Don Giovanni" — *Mozart*
James Melton
The Enchanted Lake — *Liadoff*
Orchestra
David and Goliath — *Malotte*
James Melton

**MAY 15, 1944**

Floods of Spring — *Rachmaninoff*
Orchestra
Minuet — *Beethoven*
Redwoods at Bohemian Grove — *Templeton*
Impression — *Templeton*
Alec Templeton
Andante Cantabile — *Tschaikowsky*
Orchestra
Concerto No. 2—First Movement — *Rachmaninoff*
Alec Templeton and Orchestra

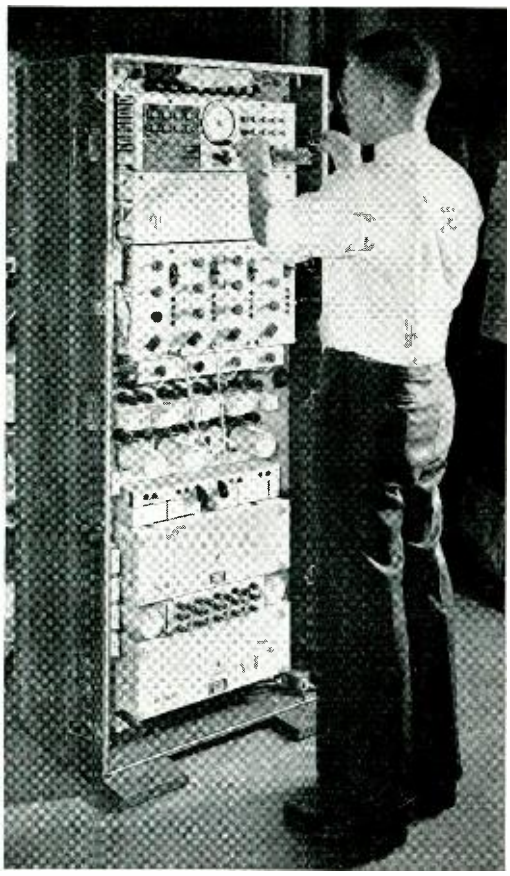
**MAY 22, 1944**

Furiant — *Weinberger*
from "Schwanda, the Bagpipe Player"
Orchestra
Iris — *Wolf*
Deep River — *Spiritual-arr. Burleigh*
Song of the Open — *LaForge*
Helen Traubel
Valse Triste — *Sibelius*
Orchestra
A Perfect Day — *Bond*
Helen Traubel
Le Carillon — *Bizet*
from "L'Arlésienne Suite No. 1"
Orchestra
Du Bist der Lenz — *Wagner*
from "The Valkyrie"
Helen Traubel

**MAY 29, 1944**

Nelson Eddy will be the guest artist

**Bell Laboratories' Club has no more tickets for these programs because its limited supply has already been distributed to applicants.**



# Portable Carrier Telegraph for the Signal Corps

By C. A. DAHLBOM
*Systems Development*

WITH the fast moving pace of modern warfare, the need for reliable telegraph equipment, which can quickly be transported and set up for operation, is of prime importance. To meet this demand, Bell Telephone Laboratories, in coöperation with the Signal Corps Laboratories, has developed a four-channel voice-frequency carrier telegraph system with terminal equipment mounted in wooden cabinets suitable for rapid transportation and installation. The original design, the CF-2-A telegraph terminal, consists of two cabinets, each containing terminals for two channels complete with a-c operated power supply. Each cabinet is 5½ ft. high, 27½ in. wide and 19 in. deep and has removable front and rear covers. It weighs 530 pounds and is equipped with six handles so it may be carried by six soldiers. A new design now available, known as the CF-2-B telegraph terminal, provides terminals for four telegraph channels complete with a-c operated power supply in a single cabinet of the same size as for the CF-2-A equipment, and weighs only 30 pounds more.

This new terminal is shown under test in Bell Telephone Laboratories in the photograph at the head of this article and in Figure 1. The entire equipment assembly is attached to a floating framework suspended in the wooden cabinet by rubber cushions. All external connections except those to the a-c power supply are made by binding posts at the top of the bay.

The four telegraph channels are arranged for simultaneous two-way operation. Transmission between terminals utilizes voice-frequency carrier currents of eight different frequencies between 595 and 1,955 cycles. The system is designed primarily to operate over one channel of the carrier telephone system comprising the CF-1-A* telephone terminals and the CF-3-A repeater, interconnected by lines made up of Signal Corps cable assemblies CC-358, more commonly referred to as "Spiral-4" cable.† Figure 2 is a simplified schematic of a system layout. The telegraph terminal is connected to channel 3 of the telephone terminal on a two-wire basis, just as telephone sets are connected to the other three channels. It may, however, be operated over any telephone circuit having the required stability and freedom from interference and a net loss not exceeding 25 db over the required frequency range. Although the earlier telegraph terminal, the CF-2-A, was arranged only for two-wire operation—both sending and receiving frequencies being transmitted over the same connecting pair—the new CF-2-B unit is arranged for either two- or

*RECORD, *Dec.*, 1943, *p.* 168. †RECORD, *April*, 1943, *p.* 251.

four-wire operation. With four-wire operation two CF-2-B units at each terminal can provide eight transmitting channels over one connecting pair and eight receiving channels over another connecting pair.

The local side of each telegraph channel is arranged to operate to outlying teletypewriter stations, telegraph repeaters, or switchboards over d-c extensions or loop circuits. Since the various types of outlying equipments require different circuit constants and arrangements for the particular method of transmission used, a multicontact switch is furnished in each channel. When operated, this switch provides arrangements for any of six conditions: either half or full-duplex neutral operation to equipments terminated in either positive or negative battery, half-duplex polarential operation, or full-duplex two-path polar operation.

When using half-duplex operation, there is only one d-c loop or extension per channel, and transmission to and from

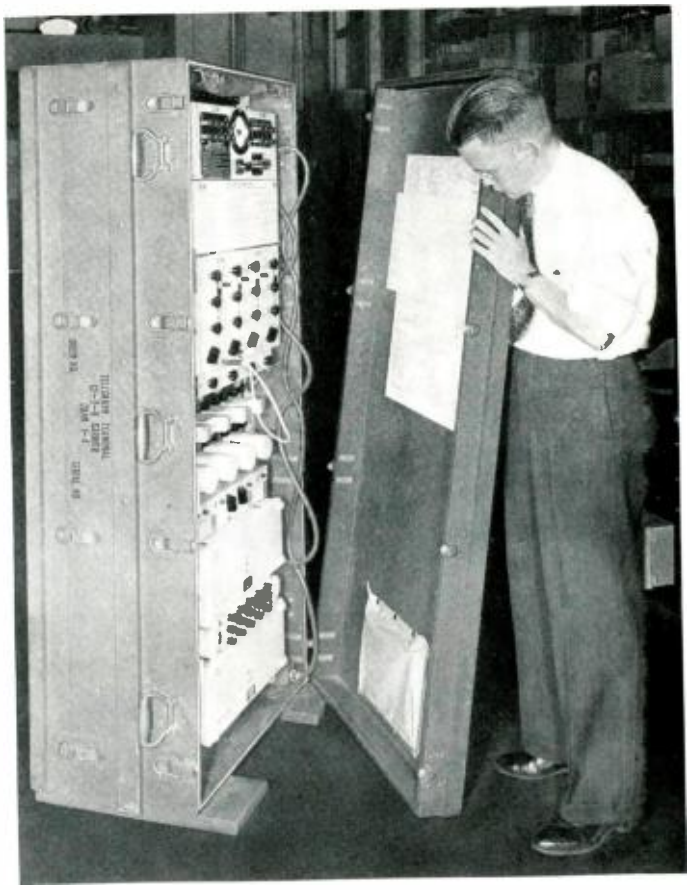


*Fig. 1—Covers may be placed on the terminal in a very few moments without the aid of special tools*

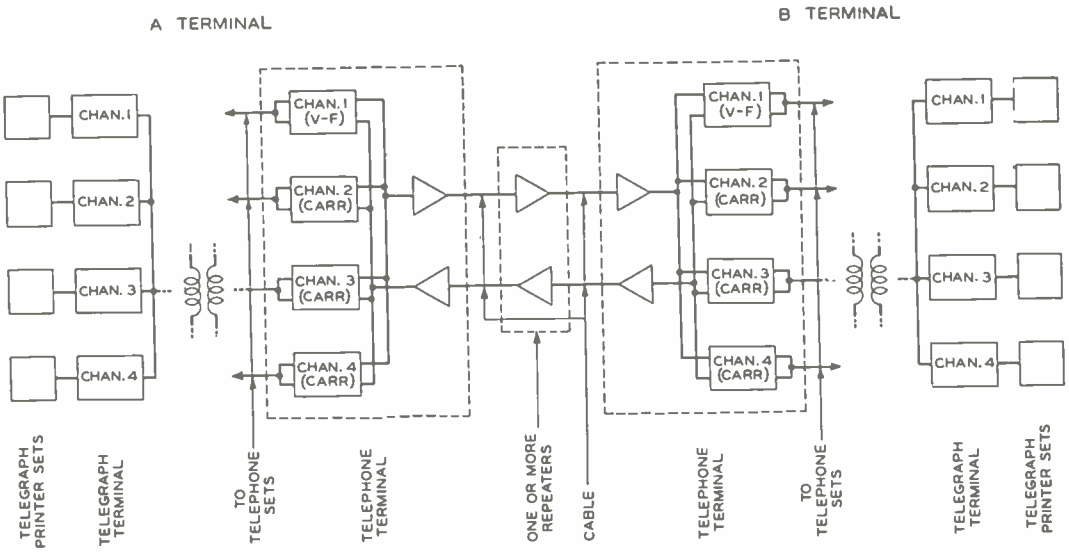
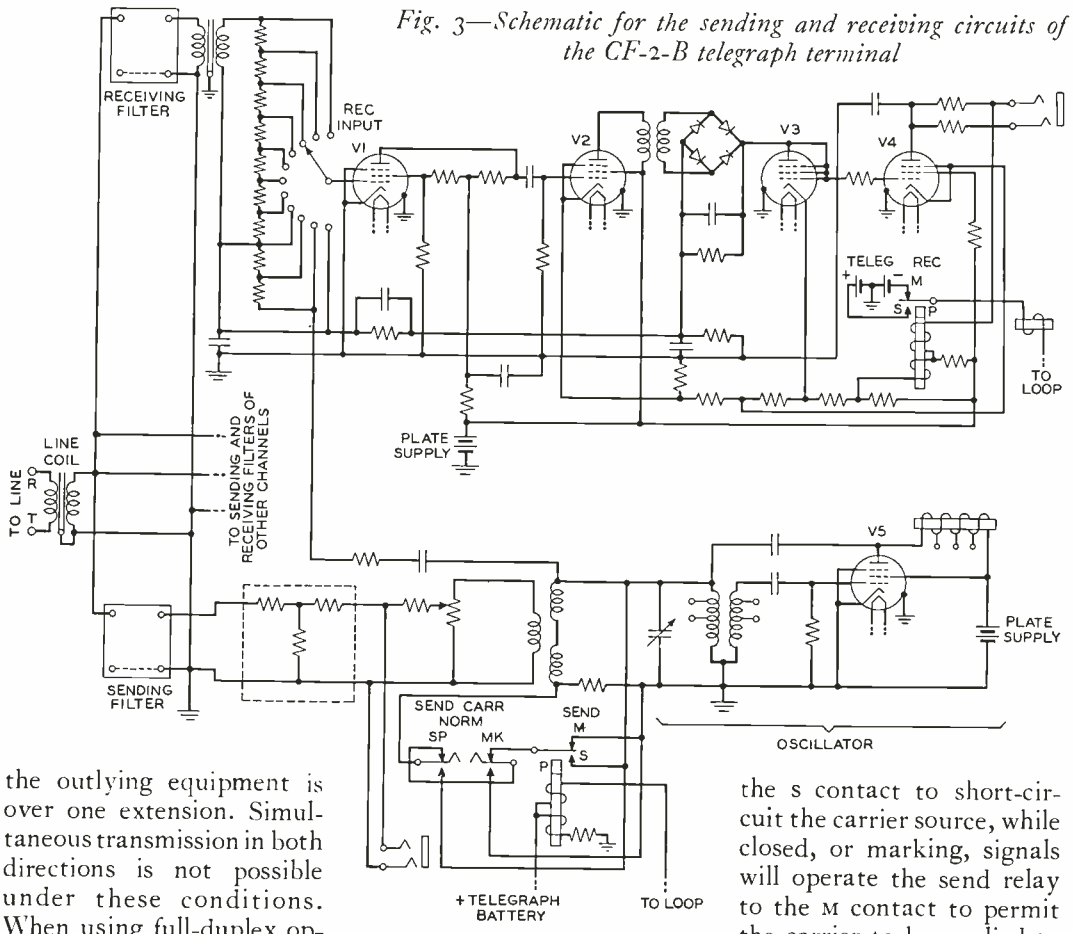



*Fig. 2—Schematic for the CF-2B telegraph system*

*Fig. 3—Schematic for the sending and receiving circuits of the CF-2-B telegraph terminal*




the outlying equipment is over one extension. Simultaneous transmission in both directions is not possible under these conditions. When using full-duplex operation, there are two d-c loops or extensions, and transmission to the outlying equipment is over one extension, while transmission from the outlying equipment is over the second extension. The latter condition permits transmission in both directions at the same time.

The d-c current in the extensions may be adjusted to the proper value by rheostats on the loop control panel.

Each telegraph channel terminal consists of a sending and receiving circuit as shown in Figure 3. The sending circuit consists of the d-c extension or loop circuit, an oscillator to generate the proper channel carrier frequency, and a sending band-pass filter. Teletypewriter or manual telegraph signals originating in the extension circuit will operate the sending relay, which will in turn interrupt the channel carrier in accordance with the pattern of the signals. Open, or spacing, signals operate the sending relay to the S contact to short-circuit the carrier source, while closed, or marking, signals will operate the send relay to the M contact to permit the carrier to be applied to the line through the sending filter and common line coil. These carrier signals are prevented from entering the other telegraph channels at the same terminal by their respective band-pass filters.

Each receiving circuit contains a receiving band-pass filter to select one set of carrier signals from the distant terminal, and a two-stage amplifier to amplify these signals. The amplified signals are rectified by a copper-oxide rectifier, and then finally amplified to operate the receiving relay. The receiving relay repeats the signals to the printer in the receiving loop or extension circuit. The amplifier-detector is equipped with an automatic gain control to provide protection against reasonable changes of the input carrier level. This feature is usually referred to as a level compensator. The gain of the amplifier-detector is under the control of the REC INPUT switch. The attendant, knowing the level of the incoming carrier

signal, can set the switch to the proper point, and when this is done the receiving circuit operates at its optimum point without further adjustment.

Frequency allocation for each terminal is set up by operating multicontact switches. If a terminal is assigned to be the A terminal (usually the terminal of higher command), these switches are operated to the A (HIGH) position, which arranges the terminal channels to transmit frequencies as shown in Table I for *Terminal A Sending*. The terminal will then receive carrier frequencies as shown for *Terminal A Receiving*. The same switches at the distant terminal will be set to the B (LOW) position, and the terminal will send and receive the opposite group of frequencies. Either terminal can be arranged to be an A or B, but once a terminal is designated as the A terminal, the remaining one must be the B terminal. The oscillator of each channel is arranged to generate either of the two frequencies assigned to the channel. There are likewise two band-pass filters for each channel, either of which may serve as a sending filter while the other serves as a receiving filter. The multicontact switches control the selection of the oscillator frequency and the proper association of the filters with the sending and receiving circuits. Figure 4 shows the allocation of carrier telegraph frequencies for A and B terminals together with typical band-pass filter characteristics.

Each cabinet is equipped with two a-c operated regulated rectifiers of the thyratron-tube type, which supply positive and negative telegraph battery and positive plate potential for the vacuum-tube circuits. Filament current supply is also available from the same power units. The rectifiers can be operated from 50/60-cycle, 115- or 230-volt a-c power supply, and require approximately 250 watts of a-c power. The regulation efficiency of the rectifier is such that a plus or minus 10 per cent change in the a-c line voltage from zero to full load and a change in temperature over the full range expected will together cause only a plus or minus 2 per cent change in the output d-c telegraph voltage.

TABLE I—FREQUENCY ASSIGNMENT FOR THE A TERMINAL

| *Channel Number* | *Terminal A Sending Frequency* | *Terminal A Receiving Frequency* |
|---|---|---|
| 1 | 1445 | 1105 |
| 2 | 1615 | 935 |
| 3 | 1785 | 765 |
| 4 | 1955 | 595 |

In designing this new telegraph terminal, every effort was made to simplify its operation and maintenance as well as to reduce its size and weight. The various front panels may be tipped forward on hinges, as shown in Figure 5, to give access to the wiring and apparatus behind them, and complete circuit diagrams are furnished on the inside of the front and rear wooden covers. Technical manuals applying to the terminal are furnished in two pockets, one located in the front cover and the other attached to the top of the cabinet. A summary of the operating instructions is provided on the front of the next to the top panel, where it is always in plain sight. These instructions are intended to help the operating personnel in setting up working circuits in a minimum amount of time, even if the men are not too familiar with the technical details of the circuit operation.

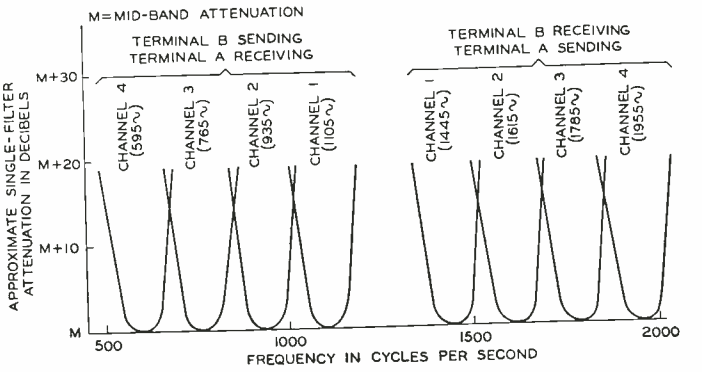



*Fig. 4—Channel frequencies and filter characteristics for the four-channel carrier system*

A complete set of spare tubes is carried in dummy sockets at the top of the cabinet in front and back, and two spare telegraph relays are carried in sockets located on the fuse panel between the power units. Spare fuses, a screwdriver for making various adjustments, and adjusting tools for the relays are carried in clips along the sides of the cabinet. A relay test set socket and associated test set keys are provided at the lower right of the upper panel, where the relays may be quickly tested and adjusted. This test set circuit is similar in design to that used in standard Bell System test sets. The meter located in the middle of the top panel is a special combination a-c and d-c meter, and is equipped with a cord and plug. A number of jacks are provided to permit connecting the meter into the various terminal circuits for measuring the loop or extension currents, the bias of the signals being sent, the voltage of the power rectifiers, and the level of the output carrier supply.

To secure the approximate fifty per cent reduction in size and weight as compared to the earlier terminal, many of the component parts were drastically redesigned. Many other simplifications were made such as the use of a single meter instead of the twelve of the earlier terminal. Besides securing the specific objective sought, many of these changes have resulted in the saving of strategic materials.

Although it is recommended that the terminals be set up with some form of protection against the weather, all the equipment is weather-proofed and capable of withstanding reasonably rough treatment to which it might be exposed under combat conditions. The edges of the cabinet are fitted with rubber gaskets to seal them against water during transit.

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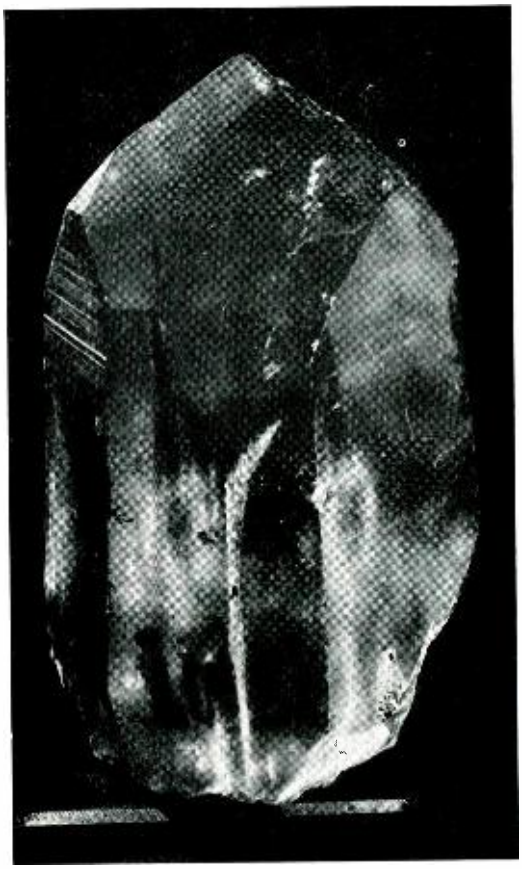
THE AUTHOR: C. A. DAHLBOM, shown below, joined the Laboratories in 1930 and since that time has been with the telegraph group of Systems Development. His work here has been chiefly on investigation and development of telegraph transmission and switching circuits. He received his B.E.E. degree from Brooklyn Polytechnic Institute in 1941. His work at present is entirely on war projects.

*Fig. 5—Panels carrying various components of the circuit may be tipped forward to give access to all apparatus and wiring*

# Quartz Crystal Model

By F. CAROSELLI
*Apparatus Development*



WHEN the faces of a plate cut from a quartz crystal are subjected to electrical charges, the plate changes shape and the deformation which results depends on the cut and how the charges are applied. Most quartz plates can be deformed in several ways. They may expand when a potential gradient is applied through them in one direction and contract for one in the reverse direction. The charges and cut may also make a plate flex, shear or experience some more complex distortion. If the charges alternate, the plate deforms in unison and it vibrates in mechanical resonance when the dimensions of the plate are correctly proportioned. This response, which is extremely selective to frequency, acts electrically as an inductance in series with a capacitance. The ratio of reactance to resistance of this inductance may be from 10,000 to 250,000, depending on the medium in which the crystal vibrates. This high "Q" is the property that makes the quartz crystal resonator so valuable in filters where high discrimination over a narrow band of frequencies is required. The frequency of resonance is also very stable, which makes the crystal resonator useful in oscillators when their frequencies must be accurately maintained.

Different types of deformation extend the range of frequencies that quartz plates can cover and a single plate may be used for totally different ranges when vibrated in different modes. This flexibility also results in an economy of material. To obtain most of these various modes of vibration the plates have to be cut from the mother quartz at different angles with respect to the electrical, mechanical and optical axes of the quartz crystal. There are also special orientations which provide better frequency stability in cases of temperature changes and these orientations are used where stringent temperature requirements apply.

To visualize more clearly, for those interested in research, design and manufacture, the angular relations of the various cuts of plates to the original mother crystal, the model shown in Figure 1 was constructed in August, 1938. It has an outer shell about two feet high that shows the typical shape of quartz as it grows in nature and an inner display of crystal plates. The shell and display tiers are made of sheet lucite and the plates are lucite which has been roughened to appear like etched quartz. The plates include those used for oscillators and filters.

About the vertical axis the outer shell shows an array of faces that repeat three times in exact symmetry. This axis is called the optical axis because it is the only direction through quartz along which a light ray will travel without dividing into two rays of different velocities which are refracted by different amounts. The shell can be rotated with respect to the inner display so that its faces can assume three identical orientations with respect to the crystal plates. Three pairs of X and Y axes are marked on the

apron of the model to demonstrate the trigonal symmetry of quartz.

The six vertical faces of the model meet in edges, three of which are modified by pairs of s and x faces. These faces also modify each of the three major apex faces R and each of the three symmetrical minor apex faces z. The electrical axes are the ones that pass through the vertical edges and positive charges appear at any one of the edges which are terminated by s and x faces, if a stress on the quartz causes it to expand along the axis that passes through that edge. The direction in which the pair of s and x faces slopes with respect to the vertical edge, which they terminate, may be used to determine whether the crystal is left or right hand. The model shows a left-hand crystal,* and its mirror image would be right hand. In nature, the faces of a quartz crystal grow at exactly the angles shown but they are rarely complete. The specimen in the headpiece has an unusually well developed R face and an indication of an s face but it has no x faces. It is usable for making crystals, however, since quartz plates could be cut from it that are clear, free from such imperfections as bubbles, needles or any foreign matter and from twinning, one form of which is the occurrence of right and left-hand quartz in a single specimen.

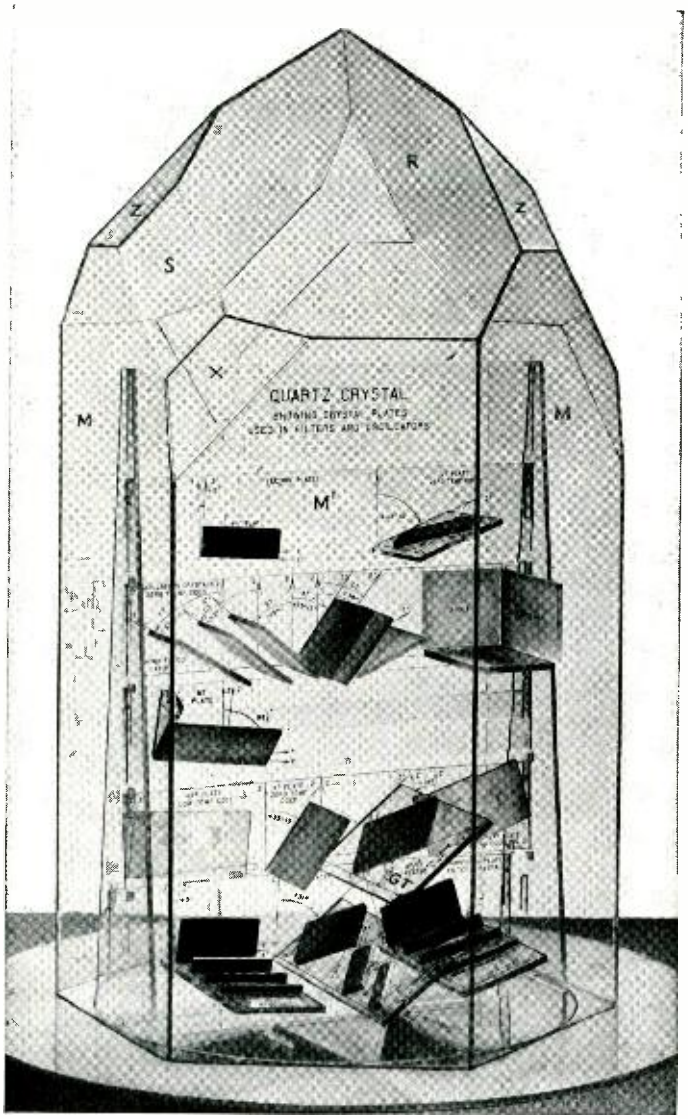



*Fig. 1—Model of a quartz crystal constructed in 1938 by the Laboratories to illustrate the locations of the plates commonly used as vibrators in electrical apparatus*

Before constructing the outer shell of the model, formulas were developed to compute the angles between adjacent faces from published crystallographic data. All identical faces were made the same size by having the major apex faces R meet in the vertical axis of the model. Minor apex faces z were located at an arbitrary distance from this central axis. In cementing the parts together, Acryloid B7 was used and the bracing, Figure 2, was disposed to apply pressure externally and at the joints. Felt pads protected the lucite from scratching and localized the pressure, which was applied by rubber bands. The removable display tiers are supported by small lucite wedges and stays.

The model illustrates cuts used in ranges varying from

*This definition is in accordance with the recommendation of a committee reporting in the *Proceedings of the I.R.E.*, November, 1942.

less than 1 kc to 24,000 kc and each one is particularly suited for a definite range of frequency. In addition, there are several different cuts operating over the same range but having some specific characteristic. The GT, DT, AT and CT cuts are those which remain highly stable over wide temperature changes. By selecting the cut and dimensions of a plate, the desired resonant frequency and electrical impedance can be obtained.

On the top tier of the display there is a plate whose coating is divided so that it will vibrate by flexing the major surfaces; and on the bottom tier are a number of plates of the same cut but with the coating divided to excite the third, the fifth or seventh harmonics of a longitudinal mode of vibration. The flexure plate has practical dimensions when used in the frequency range from about 4 to 60 kc. The fundamental longitudinal mode can be used from about 50 to 550 kc. When there is desired a lower impedance than can be obtained with fundamental longitudinal modes, crystals that vibrate in the third and fifth harmonics are generally employed. Although the harmonic crystal is a single quartz plate, it can thus be made to simulate the characteristics of a number of crystals operating in parallel by division of its surface plating. Third harmonic crystals can be used from about 150 to 550 kc, or higher, and have approximately one-third of the impedance of a single plate vibrating at the same fundamental frequency.

To provide identical electrical resonances in two arms of a network, the surface coating may be divided and part connected into each arm. The crystal still vibrates as a whole but the associated electrical inductance in each arm may be different, depending upon how the electrode is divided.

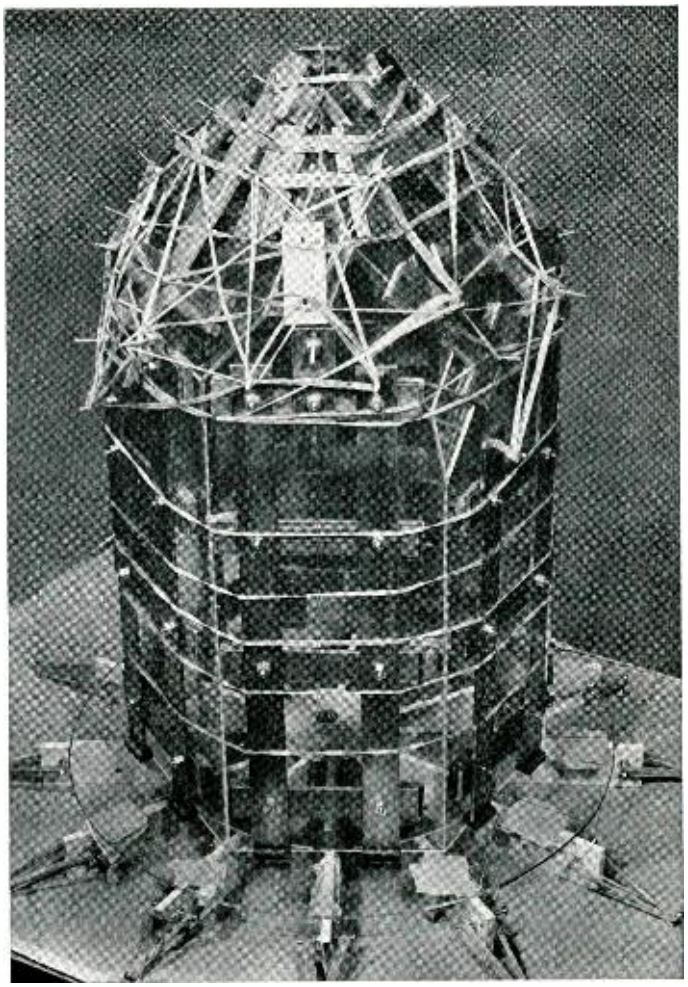


*Fig. 2—In constructing the model, the bracing was located entirely on the outside so that pressure could be applied externally to the joints*

When vibrating in one mode, the distortions of a crystal in a given direction may be accompanied by distortions in other directions which will be in mechanical resonance at other frequencies. This mechanical coupling between modes is often undesirable. It can be avoided by cutting the plates in selected directions. For instance, one cut perpendicular to the X axis and at −18 degrees to the Y axis is used for channel-filter crystals in broadband carrier systems because of this characteristic.

A coupled mode may be made useful, moreover, because its temperature characteristic can be made to compensate for those of the main mode. The best crystal in this

respect is that obtained by the GT cut. It has two coupled longitudinal modes; one along its width and a secondary mode along its length. This crystal may be adjusted to have a temperature coefficient for the main mode of less than 0.10 part per million per degree Centigrade over a range of 100 degrees. It is shown in the display on the second tier from the bottom and rests on its own plane, which extends from the tier.

To meet war demands, the facilities for cutting quartz crystals have had to be expanded by the Western Electric Company and by other manufacturers. New men have had to be educated in the intricacies of cutting a rectangular plate from a rough piece of quartz in such a way that the plate is accurately oriented to the principal axes. In the training necessary, this model and pictures of it have been widely distributed to manufacturers and have proved valuable.

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*Precision measurements of the temperature coefficient of resistance of experimental wire for resistors in communications equipment. Betty Kent is the observer*