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R. C. DAVIS
Switching Development

No. 5
The post-war crossbar

One of the important post-war switching projects of the Laboratories has been the development of the No. 5 crossbar system. This new switching system has a more extensive field of application than any previously developed. It meets the requirements of areas on the outskirts of large cities where at the present time calls to the metropolitan offices are handled manually because suitable equipment to permit direct dialing has not heretofore been available. It is quite possible that the No. 5 crossbar system may ultimately be used in the large cities themselves, in which case it would take the place of the No. 1 crossbar system.

The No. 5 system is capable of operating directly with all present local, tandem, and toll-switching systems. In addition, it is designed to serve as a tandem or toll-center switching office for moderate proportions of its traffic where this is advantageous. It is particularly well suited to the broad requirements of nation-wide operator toll dialing, and is arranged for automatic message accounting, which permits extended subscriber dialing of toll calls. In addition, there is sufficient flexibility in the system to enable it to be used in areas ranging from four-digit numbering plan operation to full eleven-digit operation. This permits it to be used in isolated communities where an office code is not required for local calls and yet to serve eleven-digit calls which require a three-digit national area code, a three-digit office code, and five digits for the numericals and station letter of the called number.

The No. 5 system takes advantage of some ten years of operating experience with the original No. 1 crossbar system and of the advances in theory and techniques that inevitably follow continuous research in telephone switching. As a result, cold cathode tubes together with improved relay designs and more extensive use of contact protection are employed, and these are expected to contribute to longer life, low maintenance, and better performance of the equipment. These and other features permit No. 5 crossbar offices to be operated on an unattended basis to a greater degree than heretofore without affecting the quality of service given. Such occasional failures of the equipment which may occur are detected by continuous monitoring of calls and by other self-checking devices, and these failures are automatically recorded on trouble record cards.

Many of its switching and apparatus units differ radically from those of the No. 1 system, but of particular economic importance is the fact that the number of different types of switching frames and units used in the No. 5 system has been reduced.

Since offices vary widely in size, one of the objectives of the No. 5 system has been to secure a switching plan having the desired flexibility which at the same time would permit it to serve both small and large offices economically. As a result, a new switching plan has been devised which permits the No. 5 system to handle effectively offices varying in size from somewhat less than two thousand lines to more than ten thousand lines. The switching plan used is shown in Figure 1. There are only two types of switching frames: the line-link and the trunk-link. This compares with four types of frames used in the No. 1 crossbar system: the line-link, district-link, office-link and incoming-link frames. Like those of the No. 1 crossbar system, the No. 5 frames use a primary and secondary switching network. All connections on these frames are established by the "common control" marker circuit.

The line-link frame of the No. 5 system has half as many secondary switch outlets as the No. 1 system, and yet it will serve as much traffic as the equivalent frame of the No. 1 system. This is made possible by the new switching plan which uses a different method of switching the calls. The basic line-link frame of the No. 5 system has a capacity of 290 lines, but by the use of 100 and 200-line supplementary bays, as many as 690 lines may be served by a single line group as in the No. 1 system. A maximum of forty line-link frame groups can be accommodated by a No. 5 crossbar unit which compares with an eighty line-link frame capacity for the No. 1 crossbar unit. Each line-link frame has one hundred outlets known as junctors which are used to connect the line-link frame to all trunk-link frames—approximately an equal number of junctors connecting to each trunk-link frame.

The trunk-link frame provides the means for connecting the line-link frames to all of the outgoing and incoming trunks as well as to all of the subscriber dial registers. This frame, in addition to having a capacity of 200 junctors to all of the line-link frames, has 160 outlets to which trunks and registers can be connected. When more than twenty line-link frames are required in an office, a supplementary bay is added to each trunk-link frame, thereby increasing the number of junctors for connecting to line-link frames from 200 to 400. In this case, each junctor from a line-link frame connects to two trunk-link frames. This arrangement is necessary to provide a minimum of ten junctors from each line-link frame to each trunk-link frame so that satisfactory call-carrying capacity is insured.

One of the major cost items in any common-control system is the "sender," which in the No. 1 crossbar system records the number dialed by the subscriber and controls the out-pulsing signals needed to complete the connection automatically in the office serving the called subscriber. Since the No. 5 crossbar system will be used to a large extent in towns having only one central office, most of the calls will be to other lines in the same office and thus do not require pulses to be sent to any other office. A simpler control unit called the subscriber register is therefore employed for recording the number dialed, and the marker is used to complete all calls terminating in the same office. Senders are required only on outgoing calls to other offices, and are provided only in sufficient quantity to handle this traffic.

When a subscriber places a call, a common marker locates the calling line and connects it via the line-link and trunk-link frames to an idle subscriber register, which gives dial tone and records the number dialed. The marker establishes this connection in less than half a second, and is then dismissed to serve other calls. After the register has recorded the call, it seizes a marker. Operating in the usual manner, the marker finds a suitable idle trunk, causes the initial connection to the subscriber register to be released, and establishes the connection from the calling line to the trunk, after which the marker is dismissed. This action also occurs within about half a second. If the call is to another subscriber of the same office, an intra-office trunk will be selected. Such trunks have two connections to the trunk-link frame—one for connecting to the called subscriber and the other to the calling subscriber. After the connection to the trunk is completed, ringing the called line is done by the trunk. If the call is to a subscriber in another office requiring pulses to establish the connection, an inter-office outgoing trunk is used. This is connected by a direct-access crossbar switch to a sender having the desired type of signaling. The marker imparts the necessary signaling information to the sender, and then releases. From this point on, the sender takes over control of the call.

For incoming calls, the incoming trunk seizes a register which records the called number as a result of signals transmitted to it from the distant office. Immediately after, a marker is seized momentarily to establish the connection to the called line.

Besides providing for the ordinary local, outgoing, and incoming calls, the No. 5 system is arranged to serve as a tandem office or a toll switching center to switch calls through it to other distant offices. Tandem and toll trunks have connections to both line-link and trunk-link frames. When a call on such a trunk is passing through the office, the connection on the line-link frame will be used, and the call will be carried through the office in the same general manner as for a local subscriber making an outgoing call. For a call served by a tandem or toll trunk that is to be completed to a subscriber in the No. 5 office, the trunk connection to the trunk-link frame will be used, and the call will be handled as for an incoming call. To give greater assurance that toll calls will be completed without encountering busy paths through the line-link and trunk-link frames, each toll trunk connects to two line-link frames as well as to a trunk-link frame.

The No. 5 system uses only one type of marker and only one trouble recorder instead of the originating and terminating markers and their respective trouble indi-

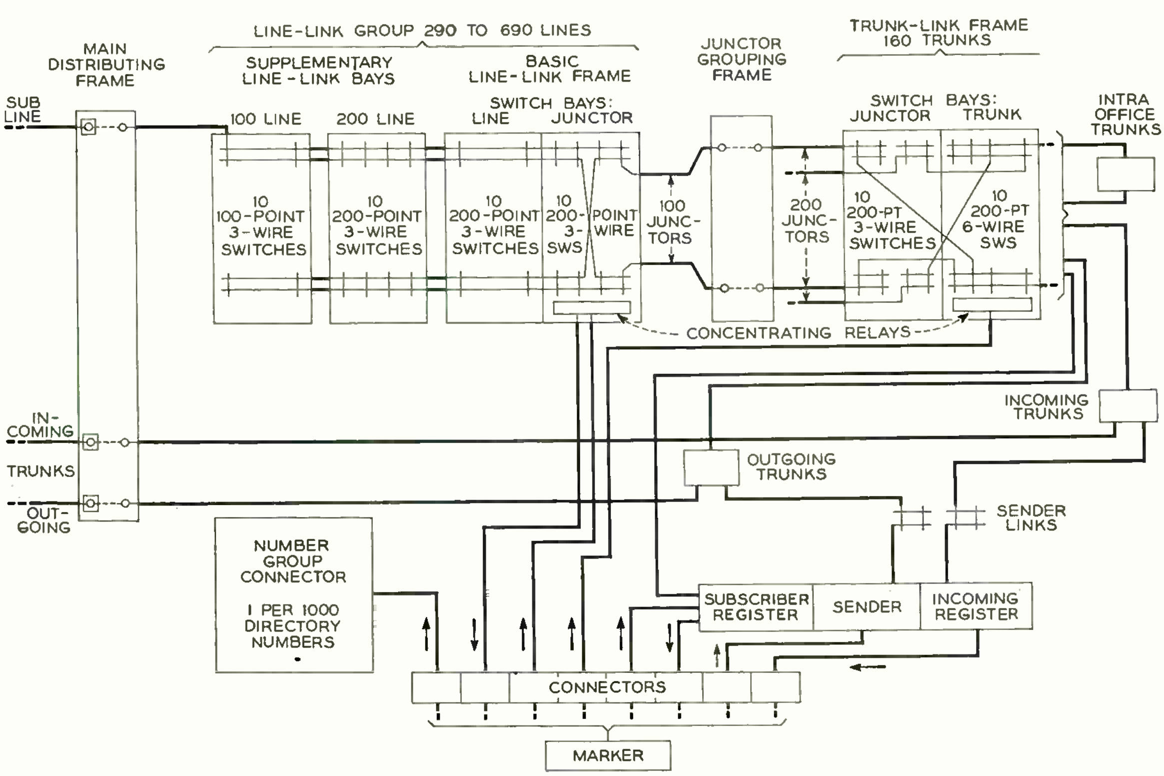


Fig. 1—Simplified diagram of a No. 5 crossbar central office showing only one each of the line-link and trunk-line frames and of the various units of common control equipment

cators of the No. 1 system. This is another example where fewer different types of equipment permit larger scale production of the type used. Another is the use of only one junctor-grouping frame instead of the three of the No. 1 system: district junctor, office junctor, and line junctor.

Many other new and interesting features will be included in the No. 5 system. It may be arranged, for example, to automatically test the insulation resistance of lines during wet weather, and automatically record all lines having less than the critical insulation resistance. In addition, a line-link group can serve as many as thirty different classes of subscribers. Complete flexibility in the assignment of ringing codes to directory numbers is available without restriction for all types of ringing including individual, two-party, four-party, eight, and ten-party lines. Automatic alternate routing up to three possible routes is provided. The fundamental signaling plan between No. 5 offices is multi-frequency pulsing using two out of five frequencies. This plan is self-checking and avoids wrong numbers due to signaling errors.

The first installation of the No. 5 crossbar system is at Media, Pa., a suburb of Philadelphia, and was placed in service on July 11, 1948. This is a typical metropolitan fringe office of about 4,000 lines. It is equipped with automatic message accounting facilities, and will interconnect directly with step-by-step offices and with the No. 4 toll crossbar office* in Philadelphia. Through the latter office, it may also interconnect with panel and crossbar offices.

*Record, *November*, 1943, *page* 101; and *October*, 1945, *page* 368.

THE AUTHOR: R. C. Davis was associated with the Indiana Bell Telephone Company in their Plant and Engineering Departments from 1912 until 1921 when he came to these Laboratories. For the next four years he participated in the development of circuits for manual switchboards, and in 1925 became a supervisor of one of the manual circuit development groups. From 1927 to 1942 he had charge of various groups engaged in the development of circuits for panel and crossbar dial systems, and much of the early crossbar development was done under his supervision. During World War II he had charge of the group which developed the aircraft Crew Trainers for the Navy. In 1945 he was placed in charge of the group developing the No. 5 crossbar circuits, and in 1947 was appointed Switching Development Engineer in charge of switching apparatus studies, automatic message accounting center, and step-by-step circuit development.

The Type-A Transistor

R. M. RYDER, *Electronic Apparatus Development*

When used as a solid state triode amplifier, the Transistor exists in several forms. One form may be thought of as a varistor of the point-contact type* with a second point placed very close by in order to control the reverse characteristic of the first point. Figure 1 is a diagrammatic illustration. One point, called the collector, is biased strongly in the low-conducting direction. The other point, called the emitter, is biased slightly in the highly conducting direction. The third electrode, called the base, is a large non-rectifying contact to the body of the semiconductor. By virtue of the interaction between the points, the Transistor has transfer properties that can be used for amplification and other effects commonly thought of as associated with electron tubes.

Since the first announcement of the invention of the Transistor,† a form known as the Type A has been developed. Arranged in a small cylinder slightly under a half inch long and less than a quarter inch in diameter, it is shown with a 6AK5 tube above and in a cut-away view in Figure 2. The base is connected to the cylindrical shell, while the two points come out on leads. To differentiate these two leads, that from the collector is bent twenty degrees from alignment with the other as indicated in the upper part of the diagram. A convenient schematic symbol for use in wiring diagrams is shown at the right of the cross-section. The base in this latter diagram is indicated by a horizontal line with a vertical connection to it from beneath, and the emitter and the collector by two short lines making contact with it at equal angles from above. The arrow indicates the emitter, and shows the direction of easy current flow. Although shown in Figure 2 with the base horizontal, the symbol may be used in any convenient orientation.

In the application of Transistors, it is helpful to keep in mind the well-developed methods used for electron tubes. Two kinds of data are of interest in both cases. The static characteristics, detailed plots of electrode voltages and currents, are useful for large-signal applications which may involve the entire operating range of the device. On the other hand, for small-signal applications they are cumbersome. Instead, one uses small-signal parameters analogous to transconductance or plate resistance for low-level amplifier problems, such as those involving noise, feedback, and the onset of oscillations.

Because of the inherent differences between electron tubes and Transistors, the methods of presenting the characteristics for the latter are not quite the same as those used for electron tubes. Tubes, for example, usually are operated with fixed bias voltages, and the static characteristics are plotted with voltage as the independent variable and current as the dependent variable. With Transistors, on the other hand, which may oscillate when measured in that way, it is more convenient to use constant current sources as power supplies and to

*Record, *December*, 1948, *page* 485.
†Record. *August*, 1948, *page* 321.

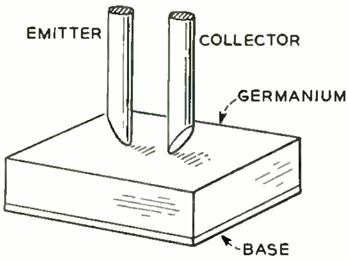


Fig. 1—Two electrodes make point contacts to one surface of a germanium plate. A third electrode makes contact to the other side of the germanium

give the static characteristics with current as the independent variable and voltage as the dependent variable. Electrode voltages are measured relative to the base and, in general, vary with the current in both the collector and the emitter.

In analytic form, the static characteristics may be expressed as:

$$V_\epsilon = f_1(I_\epsilon, I_c)$$
$$V_c = f_2(I_\epsilon, I_c) \qquad (1)$$

where the subscripts ϵ and c represent emitter and collector. It is convenient to express the static characteristics by means of four sets of curves, which show each of

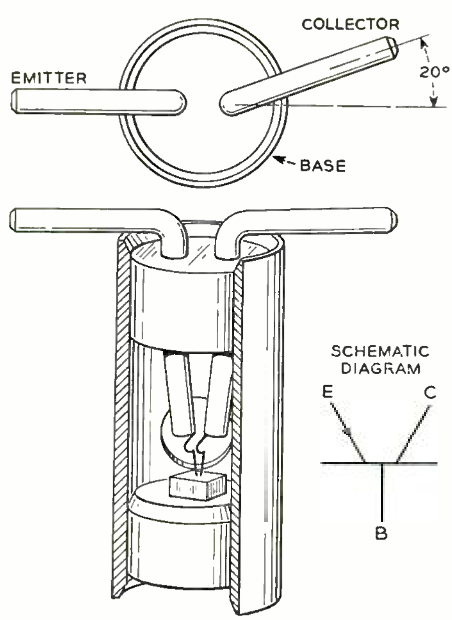


Fig. 2—Two views of the Type-A Transistor. The schematic diagram at the right is used to represent the Transistor in circuit drawings

the voltages as a function of each of the currents, with the other currents held at a fixed value. Four such sets of static characteristics are plotted in Figure 3.

Although the static characteristics give a complete picture of the low-frequency behavior of Transistors, for small-signal applications it is much easier to use the characteristics in differential form, or in other words, to find an equivalent circuit valid for small signals. With small letters to represent differential currents and voltages, these small-signal relations, obtained by differentiating the static equations, are:

$$v_\epsilon = i_\epsilon \frac{\delta f_1}{\delta I_\epsilon} + i_c \frac{\delta f_1}{\delta I_c}$$
$$v_c = i_\epsilon \frac{\delta f_2}{\delta I_\epsilon} + i_c \frac{\delta f_2}{\delta I_c} \qquad (2)$$

Since the static characteristics give the relationship of voltages to currents, their derivatives are impedances; that is, the differential coefficients in the equations for the small-signal characteristics are merely the open-circuit impedances of the Transistor. Thus equations (2) may be rewritten as:

$$v_\epsilon = \mathcal{Z}_{11}\, i_\epsilon + \mathcal{Z}_{12}\, i_c$$
$$v_c = \mathcal{Z}_{21}\, i_\epsilon + \mathcal{Z}_{22}\, i_c \qquad (3)$$

These equations are represented by the equivalent circuit (a) of Figure 4. Amplification may be possible if $\mathcal{Z}_{21}$ is sufficiently greater than $\mathcal{Z}_{12}$. The exact values of the impedances for a particular unit depend upon the d-c biasing currents, just as electron tube admittances depend on the biasing voltages. At low frequencies, where the impedances reduce to resistances, the symbol $\mathcal{R}$ is used for them.

Many other equivalent circuits may be set up. All give exactly the same results in circuit computations; the choice between them is a matter of convenience. The one having most use at the present time is that of (b) of Figure 4, having three resistors arranged in a T and only one voltage generator. It has been found that at low frequencies, the elements of this equivalent circuit are all positive resistances, and vary fairly slowly with d-c bias conditions. The variation with bias is illustrated for a particular unit in Figure 5. A preliminary data sheet for the Type-A Transistor is given in Table I.

One way to arrange a Transistor as an amplifier is to ground the base, use the emitter as input electrode, and take the output from the collector as indicated in Figure 6. Working from a 500-ohm generator

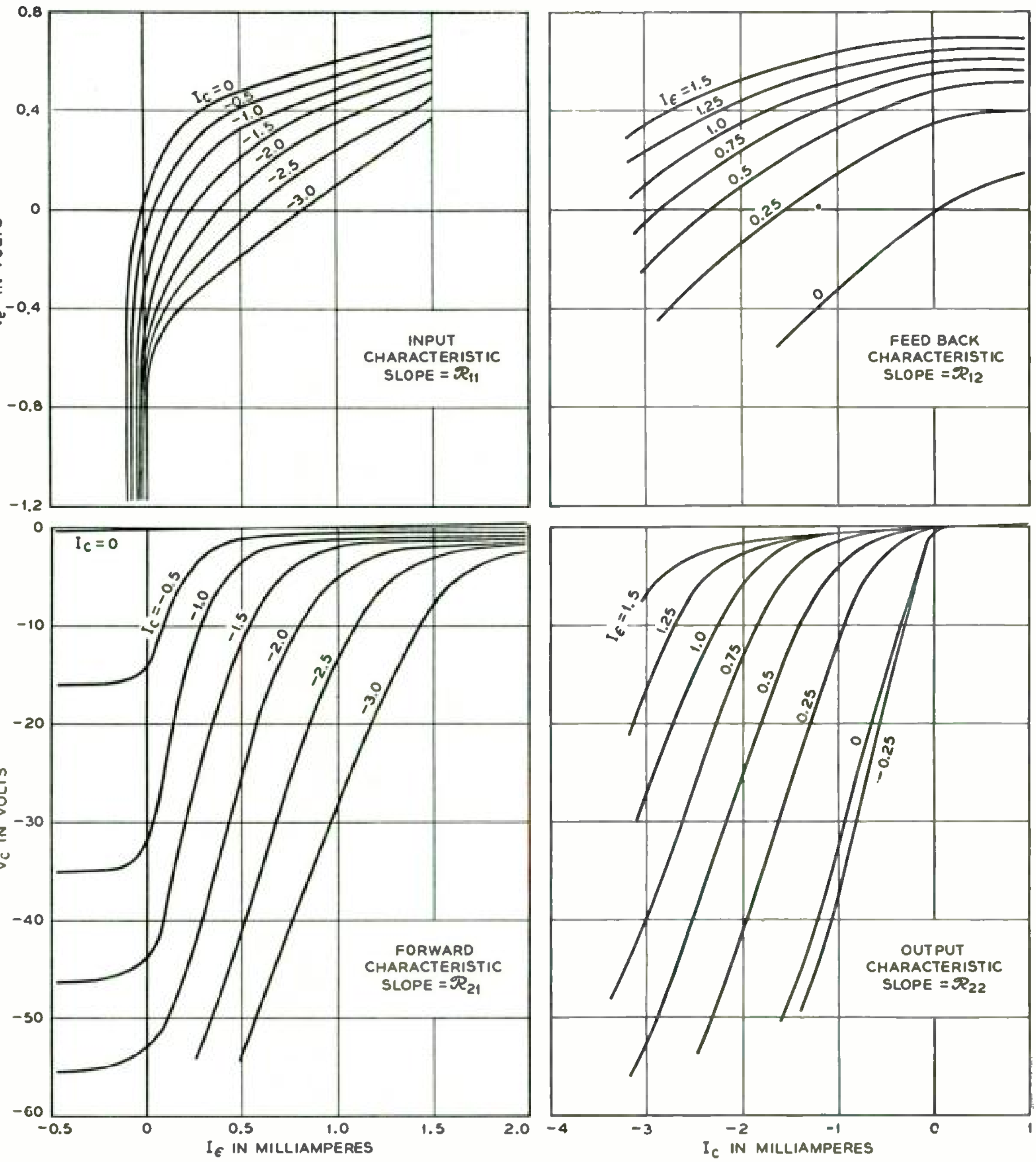


Fig. 3—Four sets of static characteristics for the Type-A Transistor

TABLE I—PRELIMINARY DATA SHEET FOR A TYPE-A TRANSISTOR

Maximum Ratings

Not to be exceeded in continuous operation. Voltages are measured relative to the base.

Collector Voltage	−70 V
Collector Dissipation	0.2 watt

Typical Operating Conditions

Emitter Current	0.6 ma
Emitter Voltage	0.7 V
Collector Current	−2 ma
Collector Voltage	−40 V

Average Equivalent Circuit Parameters

Emitter Resistance r_e	240 ohms
Base Resistance r_b	290 ohms
Collector Resistance r_c	19,000 ohms
Mutual Resistance r_m	34,000 ohms

Grounded Base Operation

Class A, working from 500-ohm generator into 20,000-ohm load.

Operating Power Gain	17 db approx.
Power Output	5 mw approx.

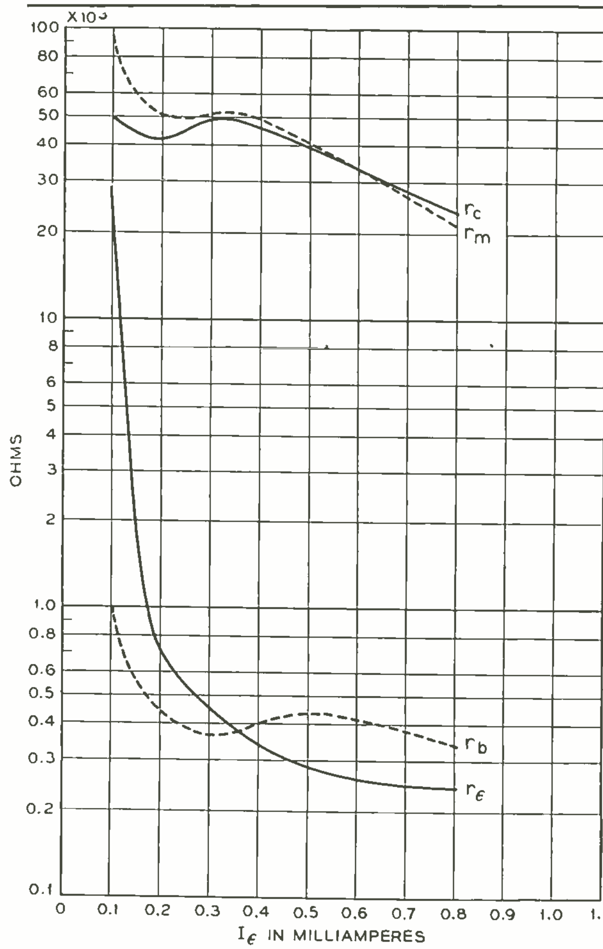


Fig. 5—Variations in parameters with bias. $I_c = -1.5$ ma

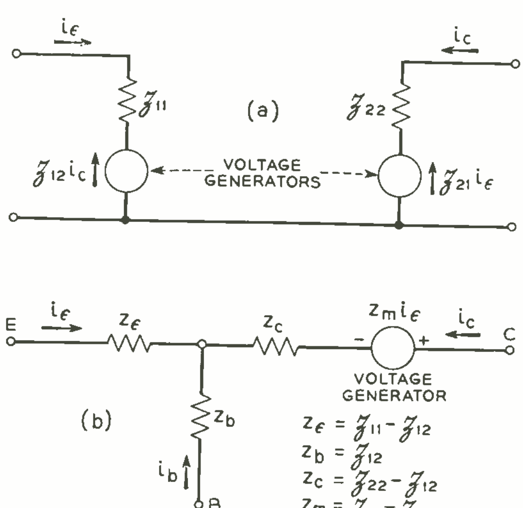


Fig. 4—Two equivalent circuits for a Transistor

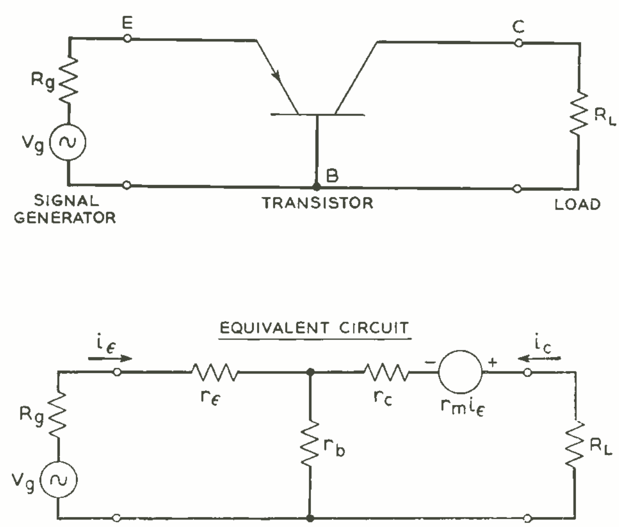


Fig. 6—A Transistor as a grounded-base amplifier

into a 20,000-ohm load under Class A conditions, the typical Transistor of Table I would have the following properties:

Input Impedance Z_{11}	280 ohms
Output Impedance Z_{22}	9,400 ohms
Operating Power Gain	17 db
Power Output	5 milliwatts
Noise Figure*	65 db

The figure given for power output is the approximate limit of operating power, which still gives good waveform as estimated from an oscilloscope. The noise figure given is the value per unit band width at 1,000 cycles, in db above thermal noise. It varies approximately inversely with frequency. As for frequency response, in a grounded-base video amplifier, the unit has a cutoff frequency of about 5 megacycles.

The grounded-base Transistor amplifier, with comparatively low input and high output impedance and with no change of signal polarity in transmission, is somewhat reminiscent of the grounded-grid electron tube amplifier. In such an analogy, the emitter becomes equivalent to the cathode, the collector to the plate, and the base to the grid. Although this comparison is not exact, still it is suggestive and fruitful. On investigation of the analogs of the other common triode tube connections: grounded cathode and grounded plate (or cathode follower), it turns out that broadly the analogy holds. The grounded emitter connection is similar to the grounded cathode in having relatively high impedance input and output, high gain, and a reversal of polarity in transmission. The grounded-collector connection acts like a cathode follower in having high input and low output resistance and in having no phase reversal in transmission. This tube analogy, even though inexact, serves as a guide by which the very extensive electron tube technology may be carried over to the various applications of the Transistor.

*For definition and discussion of Noise Figure, see H. T. Friis, *Proceedings of the I.R.E.*, 1944, page 419.

THE AUTHOR: Robert M. Ryder graduated from Yale in 1937 with a B.S. degree in physics, followed three years later by a Ph.D. degree in physics from the same university. He joined the Laboratories in July, 1940, to work on microwave amplifier circuits, and during most of the war was a member of a group engaged in studying the signal-to-noise performance of radars. In 1945 he transferred to the Electronic Development Department to work on microwave oscillator and amplifier tubes for radar and radio relay applications. Last year he joined the group engaged in the development of Transistors.

Transmission features of the V3 repeaters

R. L. CASE
Transmission Development

In view of an expected demand of considerably over 15,000 voice-frequency repeaters a year, it seemed worth while to take advantage of experience in producing miniature apparatus to develop a less expensive voice-frequency amplifier. With the development of the V1 repeater* some years ago, the size of these amplifiers was radically reduced, but the V3 repeater, now in production, has an amplifier only one-sixth the size of that of the V1. Its appearance and many of its structural features have already been described in the RECORD.†

The circuit of the amplifier for the V3, shown in Figure 1, provides a gain, reaching a maximum of 36 db, that is substantially flat over the voice band as indicated in Figure 2. With the standard 130-volt plate battery, an output of 20 db above one milliwatt can be obtained before overloading takes place. This is sufficient power-carrying ability for any application in the telephone plant.

Feedback is applied from the output to the input from a winding on the output transformer, coil F in Figure 1, through a cathode resistor in much the same manner as in the V1. The total amount of feedback is about 14 db, and is independent of the gain. This is 6 db more than that of the V1, and permits better stabilization of the gain against tube and battery variations.

Since the V3 is to replace the V1, its characteristics had to be made essentially the same. The basic feedback provided in the V3 gives the nominal output impedance of 600 ohms of the V1, but in the latter amplifier the output impedance rises at the lower frequencies. This characteristic has been essentially duplicated in the V3 by a resistor and capacitor network in the grid circuit evident in Figure 1. The nominal input impedance of 600 ohms is independent of feedback, and is made up of the input transformer with a 1,200-ohm resistor bridged across its primary winding and a gain control potentiometer bridged across its secondary. This gain potentiometer is logarithmically tapered and gives continuous control over a range of 40 db. With the V1, on the other hand, the gain dial had a range of only a few db, and for greater adjustment, soldered taps had to be changed on the input transformer. The gain and impedance characteristics of the V3 are so close to those of the V1 that the existing equalizers and line equipment can be used without change.

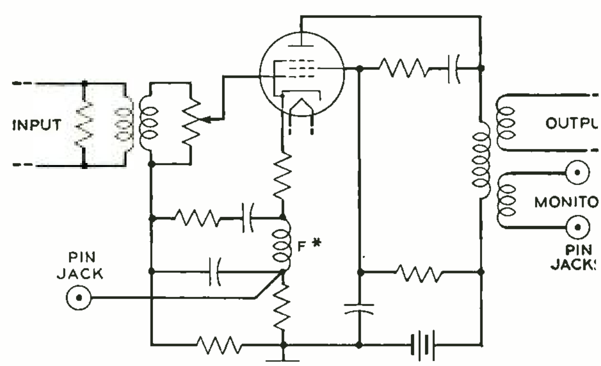


Fig. 1—Circuit of the amplifier of the V3 repeater

A number of features have been included in the new amplifier to simplify its maintenance, and some of the new maintenance techniques and apparatus provided will be described in a forthcoming issue. With both the V1 and V3, cathode activity was determined by measuring the voltage across the cathode resistor. With the V1, however,

*RECORD, *September*, 1941, *pages* 20 and 24; *June*, 1943, *page* 352.

†RECORD, *February*, 1949, *page* 45.

the activity was determined by making two measurements with different heater currents. With the V3, on the other hand, a single reading is made when the amplifier is first installed, and the value is recorded on a small roughened area on the front of the amplifier. Subsequent determinations are then compared with this original one, and when the voltage has decreased a specified amount, the tube is replaced. A connection from the high-voltage end of this cathode resistor is brought out to a small pin-type jack on the front of the amplifier, and to make a measurement, the point of one of the meter leads is inserted in this jack, and the other lead to ground.

Two additional pin-type jacks on the front of the amplifier connect to an auxiliary winding on the output transformer, and are used for monitoring. These monitoring jacks may also be used for measuring the output level with a test set that forms part of the equipment for maintenance.

The plug-in feature of the amplifier not only permits a defective amplifier to be replaced rapidly, but facilitates testing of the amplifiers at a central location. When an amplifier is removed, moreover, the socket provides a convenient point of access for transmission tests on the incoming and outgoing circuits.

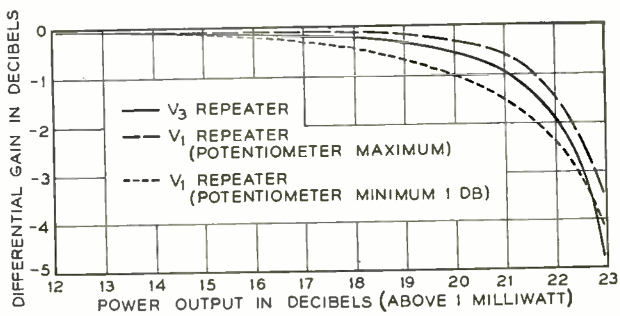


Fig. 3—Gain-output characteristics

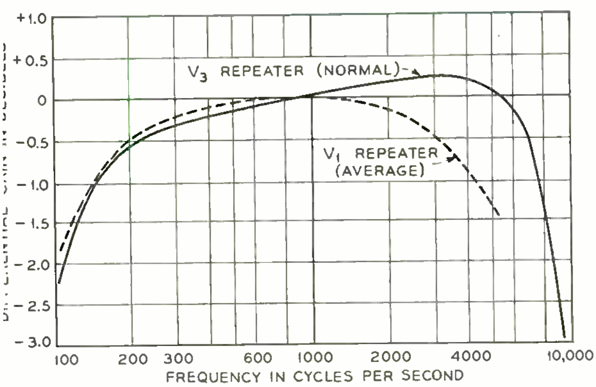


Fig. 2—Gain-frequency characteristics

With the use of the 408A miniature tube, the plate power drain is the same as that of the V1, but the heater drain is reduced to one-third. Although designed principally for voice-frequency repeaters, the V3 should be attractive for any use requiring voice-frequency amplifiers such as for carrier terminals, for four-wire switching, and as blocking amplifiers for signaling circuits.

THE AUTHOR: R. L. CASE received the A.B. and B.S. degrees from Denison University in 1921, and joined the Laboratories in July of that year. In 1926 he received his M.A. degree from Columbia. During his early work at West Street, he engaged in the transmission design of two and four-wire telephone repeaters, echo suppressors, and the terminal equipment for the first transatlantic radio circuits. In 1929 he was placed in charge of a group responsible for the design of repeaters, and later of amplifiers and associated equipment for voice-frequency program broadcasting facilities. In World War II he was responsible for voice and carrier wire-line facilities for the Armed Forces. Since then he has been concerned with the transmission design of radio control terminals and voice-frequency repeaters of which the V3 amplifier is a recent development.

Testing repeaters with circulated pulses

A. C. BECK
Radio Research

Television, facsimile, frequency modulation and pulse modulation place new and more stringent distortion requirements on communication systems. In general, distortion may arise both over the transmission path itself and in the equipment at the repeaters and terminals. With radio relay systems, however, inherent distortion over the transmission path is essentially zero. For such systems, therefore, the design effort is directed toward reducing the distortion introduced by the amplifiers and modulators.

In the repeaters designed for the radio-relay system between New York and Boston,* the distortion caused by one repeater is so small that it is difficult to measure. Many of these repeaters may be used in tandem, however, and before completing the design, it was necessary to know whether or not the distortion in a long chain of repeaters would build up to objectionable values.

To build a large number of repeaters and measure the cumulative distortion in a single circuit would have been an expensive and awkward procedure. It was made unnecessary, however, by a suggestion of G. W. Gilman that the same signal be successively passed through a single repeater a great many times, and distortion measured after any desired number of such transits. This method was adopted and successfully carried out in developing components for the Boston-New York radio relay system, and its further application seems promising.

The essential features of the circuit set up at Holmdel for measurements of this type are shown in Figure 1. The transmission circuit under test is inserted in a loop including a delay line, an attenuator, and an auxiliary amplifier indicated by the box marked "gated amplifier." The test pulse is introduced into the loop at the input to the equipment under test, and a sample of the output is removed from the loop and connected to the viewing circuit. The major portion of the output is fed through the delay line, attenuator, and gated amplifier back into the input. The delay in the loop circuit is made greater than the duration of the test pulse, and the gain around the loop is made unity. Under these conditions, a single pulse inserted in the loop will circulate around the loop indefinitely, and the viewing oscilloscope will show a succession of pulses spaced along the sweep. Each successive pulse on the oscilloscope shows the original pulse after another trip around the loop, and, therefore, another trip through the apparatus under test.

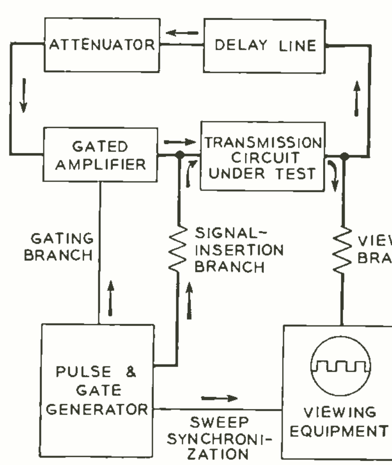


Fig. 1—Simplified block diagram of circuit set up at Holmdel for measuring distortion by circulating pulses

*RECORD, *December,* 1947, *page* 437; *March,* 1948, *page* 97; and *May,* 1948, *page* 193.

Since the pulse of signal lasts only about one microsecond, it is necessary to send a succession of pulses that superimpose on the oscilloscope to secure a continuously visible trace. The spacing of the successive input pulses is such that each may travel around the loop more than a hundred times before the arrival of the next new pulse. At the time a new pulse is started in the loop, the remainder of the previous one must be entirely erased. This is accomplished by the gated amplifier, which is periodically blocked for a short period just before the new pulse is applied. Timing is under control of the pulse and gate generator which generates and times the signal pulses applied, generates a gating pulse that holds the gate open until just before a new pulse is applied, and generates another pulse to start the sweep of the oscilloscope.

A more complete diagram of the circuit employed is shown in Figure 2. A relaxation oscillator operating at about 3,000 damped oscillations per second controls the sequence of operation. In the gate generator it starts a pulse of adjustable length that opens the gate long enough to permit the desired number of trips to be made by the test pulse; in the pulse generator it generates a one-microsecond pulse that amplitude-modulates the output of the signal oscillator to form a one-microsecond pulse of oscillator frequency for application to the test circuit; and in the sweep synchronizing-pulse generator it forms a pulse to start the sweep of the oscilloscope at the proper point. By adjustment of a delay circuit, the sweep may be made to start after any number of trips of the test pulse, and the speed of the sweep may be made such as to display only one or any number of the pulses, each of which represents the signal after a different number of trips.

One of the obvious requirements of such a circuit is that the auxiliary elements—the delay line, the attenuator and the gated amplifier—must not introduce sufficient distortion to produce appreciable change in the circulating pulse. So far as the amplifier is concerned, this requirement can be met by sacrificing gain and by other refinements that, although giving an uneconomical amplifier for a commercial system, achieve the desired objective. Two types of delay line have been used: one is a coaxial line that is used for frequencies in the vicinity of 65 megacycles, and the other a waveguide line that is used for frequencies of the order of 4,000 megacycles. A distortionless line for a video band is very difficult and has not been built.

In existing radio relay systems, transmission is at a frequency in the neighborhood of 4,000 megacycles, but at each repeater station this frequency is demodulated to 65 megacycles for amplification and the greater part of the amplification is done at this intermediate frequency. For testing 4,000-megacycle amplifiers, the circuit shown in Figure 2 using the waveguide delay line is satisfactory. For testing I-F amplifiers, the same circuit is used with 65-megacycle components and the coaxial delay line. Figure 3 shows the appearance of a typical pulse after it has made 1, 3, 10, 30, and 80 trips around the loop. This illustration also shows the original pulse, while with the circuit of Figure 2 the pulse could be shown only after at least one trip through the amplifier under test. In this

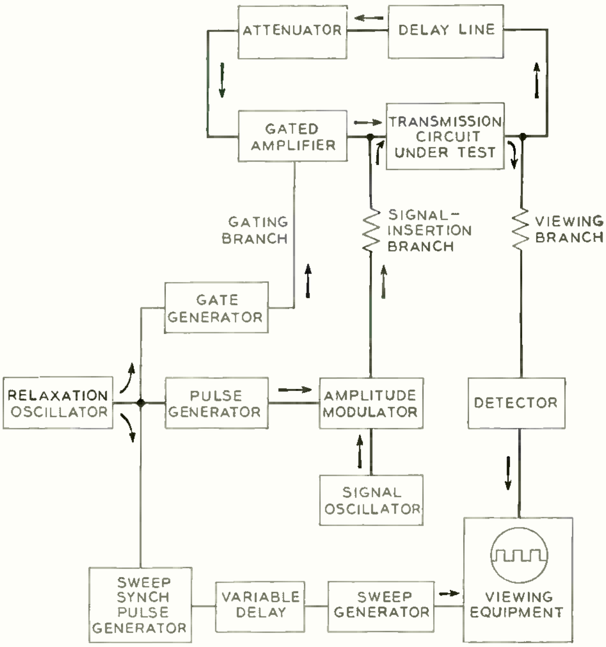


Fig. 2—Block diagram of circuit used for measuring distortion by circulating pulses

diagram, the signal is inserted at a low-level point in the loop, so that relatively small pulse voltage is required. The viewing branch is shown connected to a high-level point, so that less amplification is necessary to get a satisfactory oscilloscope deflection. If enough high-quality amplification is provided in the viewing branch, both branches can be connected to the loop at the same point, and the test pulse can be monitored directly.

Only the I-F amplifier was under test when the oscillograms of Figure 3 were made, but the complete repeater may be tested with the same circuit. Instead of merely inserting the 65-megacycle amplifier in the test circuit, this amplifier, the 65 to 4,000-megacycle modulator, the 4,000-megacycle amplifier, and the 4,000 to 65-megacycle demodulator may all be connected in tandem and tested as a unit. The same 65-megacycle signal pulse could then be used, but it would undergo distortion in all four units. The waveguide delay line of the coaxial delay line can be used for this.

A similar method was suggested by W. M. Goodall to make the test circuit applicable to the video band. A modulator following the video equipment being tested would raise the band to 65 megacycles for passage to the delay line and the gated amplifier, while a demodulator following the gated amplifier would restore the signal to the video range.

Tests of non-linearity or compression have been made by using a stepped test pulse having two or more levels, and observing the relative change in levels after a number of trips through the equipment under test.

Observations of signal-to-noise ratios as the noise builds up after many trips have been made by operating at levels where the noise can be observed on the viewing scope.

This system is used for FM testing by shifting the frequency to a different value, determined by the desired deviation ratio, and back again during the test pulse. This signal then circulates around the loop the desired number of times. An FM detector is used in the viewing branch to determine the response of the circuit under test.

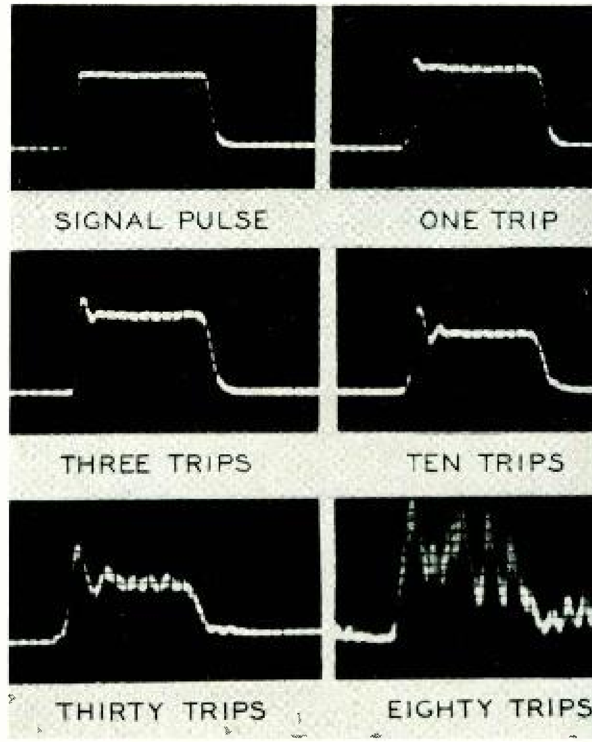
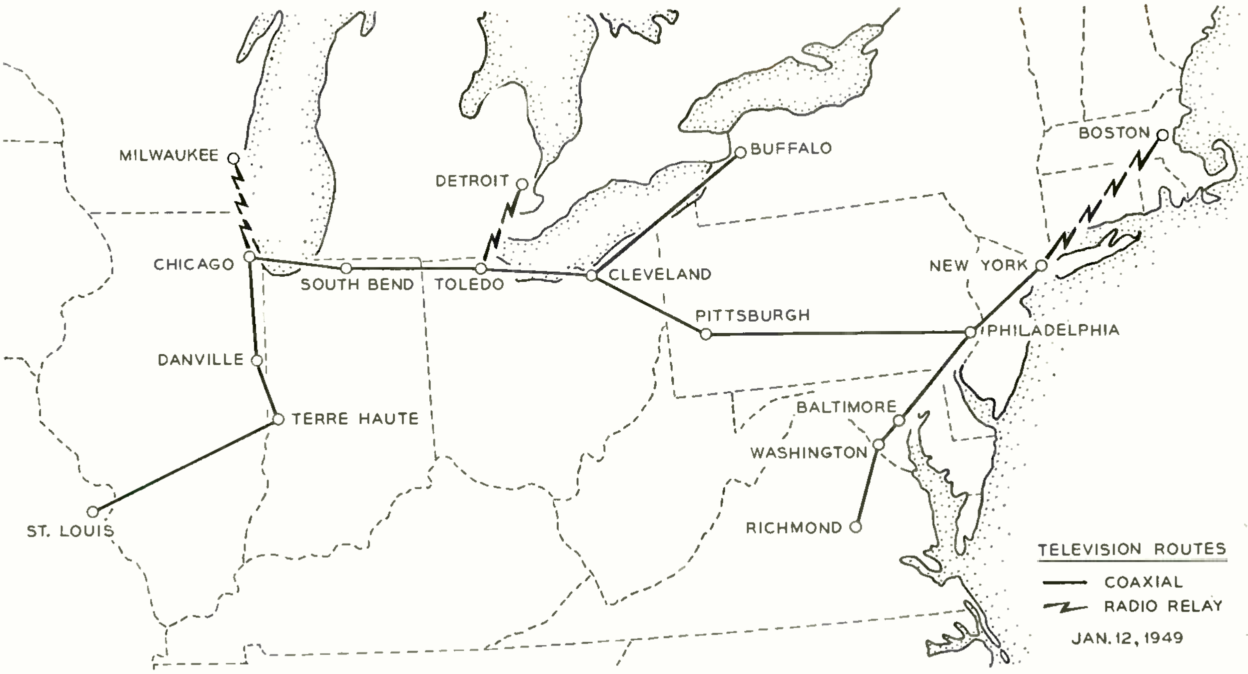


Fig. 3—Appearance of signal pulse as originally sent and after 1, 3, 10, 30 *and* 80 *trips*

THE AUTHOR: A. C. Beck, after receiving the E.E. degree from Rensselaer Polytechnic Institute in 1927, remained there as instructor in mathematics for the following winter. At the end of the term in 1928, he joined the technical staff of these Laboratories. With the Radio Research Department he has since been engaged in the development and design of short-wave and microwave antennas. During the war he was chiefly concerned with radar antennas and the waveguide structures and fittings associated with them. At the present time he is working on microwave antennas.



H. A. LEWIS
Transmission Development

Operating control of television networks

To meet the rapid expansion of commercial television broadcasting since the war, the Bell System has been called upon to provide many new transmission facilities to carry video program material. Because of the wide frequency bands employed for television, and of the need for associating audio with the video circuits, many of the problems raised are exceedingly complex. Local video wire* and TE radio systems have been provided to connect pickup points with studios, and studios with transmitters. Intercity circuits to link the various television transmitters and studios into networks have also been provided by the Bell System for the eastern half of the country, as shown above. Except for radio relay links between New York and Boston, between Toledo and Detroit, and from Chicago to Milwaukee, all of these are coaxial channels, although a radio relay system between New York and Chicago is under construction.

Besides these various local and long distance circuits for the transmission of television, it has been necessary as well to provide for rapidly setting up and rearranging the intercity links and local loops into flexible networks. At such switching points, facilities must be provided for monitoring both the picture and sound programs

*Record, *May*, 1948, *page* 201.

and for quickly locating and clearing trouble when it occurs. A switching center to provide these various facilities has been developed by the Laboratories, and the first one was installed in Philadelphia in time for the Republican National Convention in June of last year.

A view of the Philadelphia switching center just before it was cut into service is shown in Figure 1. The complete equipment for such a center consists of: amplifiers and accessories for equalizing and adjusting the level of transmission on the various local incoming and outgoing lines; audio and video patching bays where both the local and intercity lines appear for trunking to specific control positions; control positions where each network is monitored and switched; video distribution amplifiers and audio program bridges which are required when lines must be multipled; and order-wire facilities to permit quick communication within the control center, to various points along the television networks, and with the customer.

Connections are made at the patching bays to provide any combination of required circuits in the various control positions. Network arrangements as required are then established on cue or at predetermined times by connections at the control positions.

Typical connections at a television control center are shown in abbreviated form in Figure 2. Here the audio and video loops from studio A are shown patched at the patching bays to a control position. There they are patched to the video distribution and program amplifier bays where two outgoing channels are derived. Outgoing trunks from these amplifiers are then patched back to the patching bay, where, through patches already set up, they are connected to a coaxial and radio relay system.

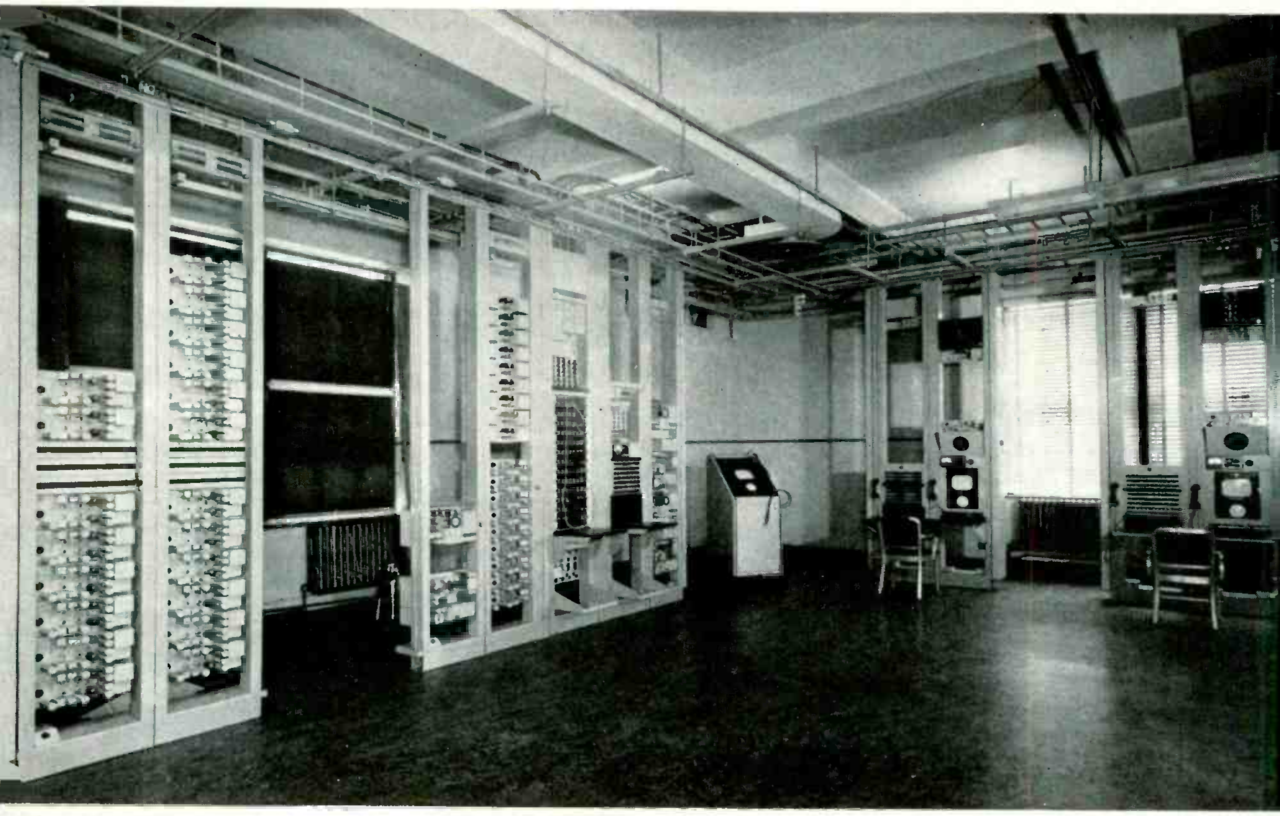


Fig. 1—The televison switching center in Philadelphia

Two control positions were provided at the Philadelphia center. These are evident at the right of the photograph, while the rest of the equipment is on the bays at the left. The second and third bays from the right, in the group of five bays on the left wall of Figure 2, are the audio and video patching bays, and are shown in greater detail in Figure 3.

Incoming and outgoing video channels, both local and intercity, with necessary video amplifiers and associated equipment, are terminated in jacks in the video patching bay at the left of center in Figure 3. Incoming and outgoing audio channels, both local and intercity, are terminated on jacks in the audio patching bay shown to the right of center in Figure 3. At these patching bays are also jacks for trunks running to the various control positions. Double patching is thus required at the patching bays; incoming circuits are patched to trunks to the proper control positions, and trunks from the various control positions are then patched to the required outgoing lines.

At the control positions, shown in greater

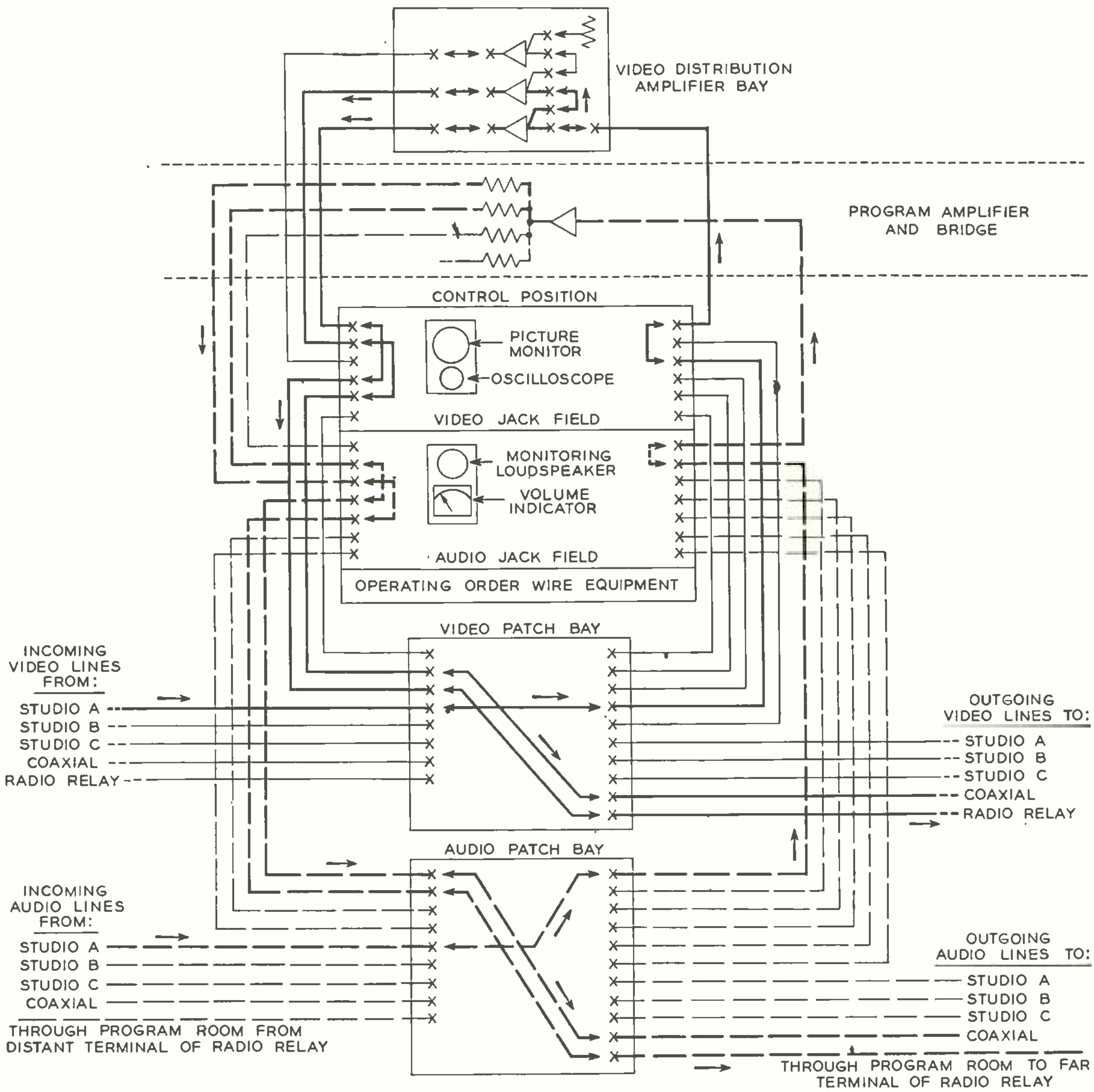


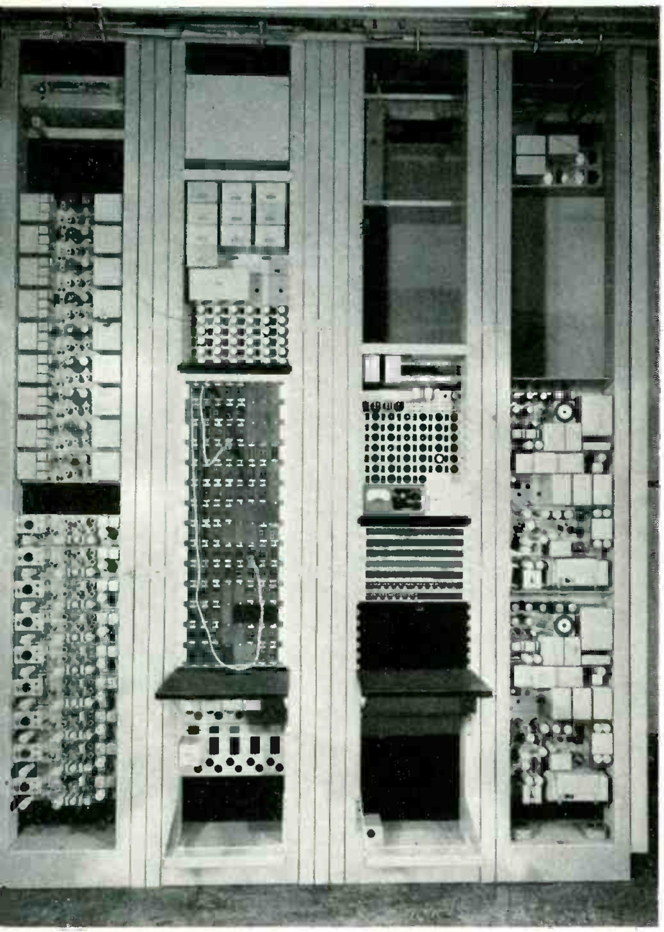
Fig. 2—Simplified circuit schematic showing patching arrangements at the switching centers

detail in Figure 4, are jacks for the circuits from the patching bays and also jacks for trunks running to and from the video distribution amplifiers and the audio program bridges. The attendants at these positions patch the incoming circuits to program and video distribution amplifiers to provide the required number of outgoing channels, which are, in turn, patched to form the networks required for the various programs.

Beside the jack field at the control position is the master monitor (manufactured by R.C.A.) which provides facilities for observing the picture and the wave form of the television signal on the upper and lower cathode-ray tubes, respectively. This unit is the same type as used by the broadcasters and therefore provides for comparison on a similar basis. Above the monitor

Fig. 4—One of the control positions at the Philadelphia television switching center

Fig. 3—The video and audio patching bays are in the second group from the left in Figure 1



is a standard program volume indicator and a loudspeaker for monitoring the audio portion of the television program. Other equipment in this bay includes the power supply for the master monitor and for the clamper and bridging amplifiers which are essential parts of the video monitor. Orderwire facilities are located just above the writing shelf in the left-hand bay.

The video distribution amplifiers, which permit an incoming video circuit to be branched to supply several outgoing circuits, are a recent development of the Laboratories, and have a flat frequency characteristic. Their design is such that the input terminals of two or more amplifiers may be connected in multiple, with the output of each amplifier transmitting over a different outgoing leg. The ability to introduce an audio program to a number of circuits simultaneously is obtained through use of standard 14-type program amplifiers* and associated G-type bridges.

Monitoring of video circuits is accomplished by cords which patch the monitor outlets of the circuits to the video monitors.

*Record, *August*, 1940, *page* 362.

In the audio circuits, keys permit selection of either headset or loudspeaker monitoring, and the association of the monitor and the volume indicator with either of the two audio bridges provided in a position. All incoming video circuits are of 110-ohm impedance and balanced to ground, and are adjusted so that the peak-to-peak level of the standard RMA television signal is one volt. Since the video switching center circuits are flat and provide zero gain, the output level of all circuits is also one volt.

The present equipment makes no attempt to utilize the specialized push button and relay-switching methods developed for sound programs,* since it is felt that actual field needs must be more crystallized before relay-switching methods for television can be introduced. However, work on this phase of the problem is now going on in Bell Telephone Laboratories.

Television control centers have now been equipped on a standard basis in Chicago and Philadelphia, and work on a center for New York is under way. Somewhat less elaborate arrangements have been installed in Boston, Baltimore, Washington, Richmond, Buffalo, Cleveland, Toledo, Detroit, South Bend, Milwaukee, Danville (Illinois), and St. Louis. At Chicago, in addition to the Long Lines switching center that has been referred to above, the Illinois Bell Telephone Company has installed a local center for handling the switching of loops around the city.

*Record, *February*, 1942, *page* 142.

THE AUTHOR: H. A. Lewis graduated from Cornell University in 1926 with the degree of E.E., and immediately joined the Equipment Development Department of the Laboratories. Here he worked on a variety of projects, including the design of equipment for manual and dial central offices, PBX's, and broadband carrier installations. During the war he was concerned with the development of equipment for Government agencies. Subsequently transferring to the Transmission Development Department, he is now responsible for the equipment aspects of the coaxial line and of television transmission over coaxial cable and local video loops.

Excerpts from the Annual Report of the A T & T

The Bell System set new records of achievement during 1948. The quality of telephone service was raised to the best level since pre-war years, and new facilities required to further improve the service and to meet demand were installed at the highest rate in history.

New demand for service maintained its record-breaking post-war pace. Approximately 2,860,000 telephones were added and the volume of calls reached a new high of 177,000,000 a day. Recent rapid growth reflects the success achieved by the System in providing fast, convenient service at attractive prices well within the reach of millions. The gain in telephones since the war now totals 9,500,000, which is more than the total gain in the 20 years before the war. At the end of 1948 there were nearly 31,400,000 Bell System telephones in service.

Research Yields New Devices and Techniques

Improvements in telephone service rest on a foundation of continuous Bell System research. Progress since the war has been tremendous and there is more to come. Even as new developments like nation-wide operator dialing are being introduced, scientists at Bell Telephone Laboratories continue to open up still further opportunities for the years ahead.

Fundamental research at the Laboratories on the flow of electricity in semi-conductive materials has brought discovery of a new principle, and with it a new device of great promise—the Transistor. This is a new type of electronic amplifier completely different from the well-known vacuum tube. It is so simple, so tiny and so economical in using electrical energy that it should ultimately find many important uses in telephone service.

Electronics plays an even more important rôle in communications. As research makes new knowledge available, improvements are introduced and the field of application is widened. Newly developed voice amplifiers will be used to improve transmission on relatively long local circuits and also on short toll circuits. Another important new development provides an economical means of carrying many more conversations on existing short toll cables.

A new electron tube, precise in construction as a watchmaker's masterpiece, and a new lens to focus beams of microwaves have made possible improvements in radio relay systems and have increased their carrying capacity for speech and television channels. These improvements are going into the radio relay system now projected between New York and Chicago.

Thanks to research, we are no longer entirely dependent on the limited supply of natural quartz for the crystals used in carrying many conversations simultaneously over the same wires. Recently the Laboratories have developed synthetic crystals that can be substituted for quartz and they have now succeeded in growing quartz crystals identical with those found in nature.

Lead for sheathing telephone cables is another scarce material. Our research has developed a new type of cable—called Alpeth cable—using a thin layer of aluminum covered with a layer of polyethylene plastic, as a substitute for the lead-covered type. By the end of 1948 there had been produced 3,100 miles of the new cable containing 3,600,000 miles of wire, and most of this has gone into service.

Western Electric Production at All-Time High

The value to telephone users of a manufacturing and supply unit integrated in the Bell System has never been more readily apparent than in the post-war years. Much of the System's post-war accomplishment is due to our having an experienced manufacturer-supplier with the same service objectives as the Telephone Companies.

Western Electric sales amounted to $1,132,-972,000, an increase of 13.8 per cent over 1947, the previous high year. Sales to the Bell Telephone Companies accounted for about 90 per cent of total sales. Non-Bell sales included $59,978,000 of direct sales to the Federal Government, principally of equipment useful for the Nation's defense.

Television Networks Greatly Expanded

In keeping with the rapid growth of the television industry, the System last year substantially increased the number and extent of its facilities for carrying programs from city to city, and from pick-up points to television studios and transmitters. Some 5,000 circuit miles of special facilities are now in use, serving 32 television broadcasting stations in areas where 40,000,000 people live.

More Traveling Telephones

Mobile telephone service was provided in 1948 to an increasing number of automobiles, trucks, trains and other vehicles, in more cities and along more highways. At the end of the year there were 6,000 mobile telephones, in 129 areas, which could be connected via radio and wire lines with any other telephone in the Nation. Service is now available to passengers on fourteen trains running daily between New York and Washington, Boston, Pittsburgh and Buffalo. Railroads are showing increasing interest in radio telephone service both for passenger and operational use; about 20 railroad companies are now using such service furnished by the Bell System.

Service to ocean and harbor vessels and on inland waterways also continues to increase. Some 11,000 vessels are now registered for this telephone service, which like the mobile service permits them to talk with any telephone in the Nation. Also 150 airplanes are registered for this service.

The Future Holds Great Promise

Neither chance nor mere good fortune has brought this Nation the finest telephone service in the world. The service Americans enjoy in such abundance is directly the product of their own imagination, enterprise and common sense.

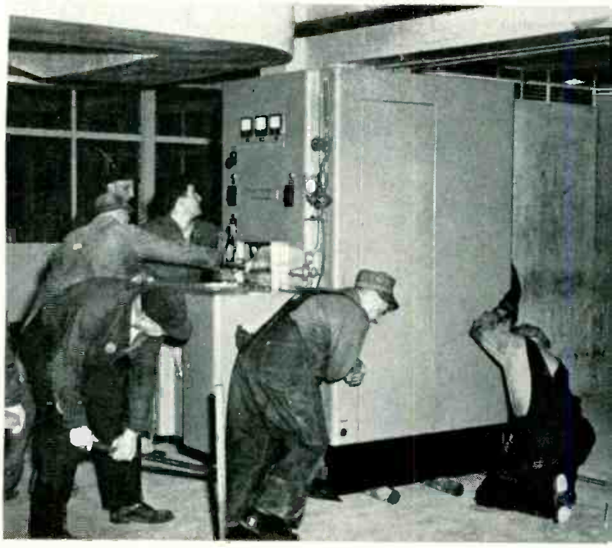
The people of America have put billions of dollars of their savings into building their telephone system. They have learned more and more ways to use the telephone to advantage, and have continuously encouraged invention and initiative to find new paths toward new horizons. They have made the rendering of telephone service a public trust; at the same time, they have given the Telephone Companies, under regulation, the freedom and resources they must have to do their job as well as possible.

In this climate of freedom and responsibility, the Bell System has provided service of steadily increasing value to more and more people. Our policy, often stated, is to give the best possible service at the lowest cost consistent with financial safety and fair treatment of employees. We are organized as we are in order to carry that policy out. Bell Telephone Laboratories leads the world in improving communication devices and techniques. Western Electric Company provides the Bell operating companies with telephone equipment of the highest quality at reasonable prices, and can always be counted on in emergencies to deliver the goods whenever and wherever needed. The operating telephone companies and the parent company work together so that improvements in one place may spread quickly to others. Because all units of the System have the same service goals, great benefits flow to the public.

Similarly, the financial good health of the Bell System over a period of many years has been to the advantage of the public no less than the stockholders and employees. It is equally essential and in the public interest that telephone rates and earnings now and in the future be adequate to continue to pay good wages, protect the billions of dollars of savings invested in the System, and attract the new capital needed to meet the service opportunities and responsibilities ahead.

There is a tremendous amount of work to be done in the near future and the System's technical and human resources to do it have never been better. Our physical equipment is the best in history, though still heavily loaded, and we have many new and improved facilities to incorporate in the plant. Employees are competent and courteous. The long-standing Bell System policy of making promotions from the ranks assures the continuing vigor of the organization.

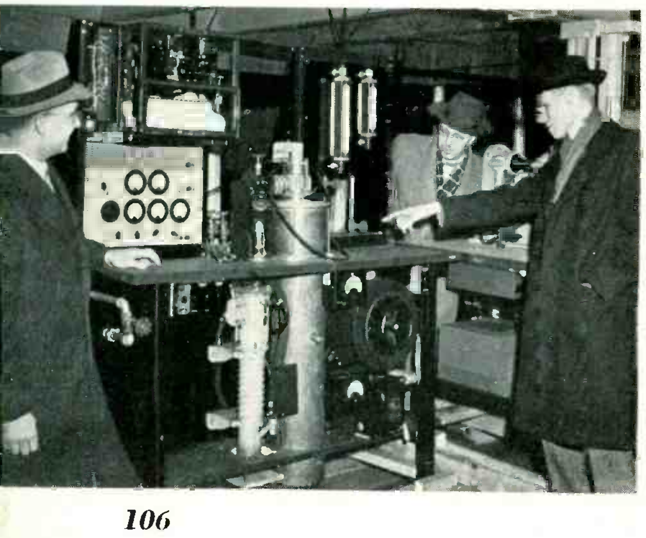
With these assets, with the traditional spirit of service to get the message through, and with confidence that the American people understand the need for maintaining on a sound financial basis the essential public services performed by the Bell System, we look forward to providing a service better and more valuable in the future than at any time in the past. We pledge our utmost efforts to that end.



A Typical Move to Murray Hill

Moving entire laboratories from one location to another are major operations that involve fine coördination of effort and scheduling among several Laboratories departments. Final aspect of any particular job is the physical transfer of apparatus, and these photographs indicate the "heave-ho" side of the business.

Professional riggers one day in January were given the green light to move certain equipment of the electron dynamics group from Building T at West Street into a tube construction laboratory at Building No. 2, Murray Hill, newly created with temperature and humidity control, electrostatically cleaned air and light at 120 foot-candles at the working surface. Two truckloads included a huge high-frequency generator, the handling of which exemplifies the movers' art, and other items lesser in bulk which nevertheless had to be carefully guided from truck to loading platform, to freight elevator, along corridors and through partitions that were removed to allow ingress into a niche prepared in advance with the appropriate plumbing and electrical facilities. In these views of the heave-ho, the top left is the generator's afternoon start on Bethune Street; then its arrival at Murray Hill. Lower left is J. B. Pierce, whose equipment it is, pointing out an interesting detail on a vacuum oven assembly to J. B. Little, left, and L. S. Hulin, center, of Plant Engineering. The other picture was taken just as a grid-winding machine was being eased through the entry for the last few feet of its journey.




William H. Martin (*right*), *director of Apparatus Development II, has been elected a vice-president of the Laboratories. In addition to his present responsibility for the Station Apparatus, Outside Plant, and Quality Assurance Departments, Mr. Martin will assume responsibility for apparatus specifications, standardization, and apparatus development staff functions*

Donald A. Quarles (*above*), *vice-president of the Laboratories, has relinquished his duties as director of Apparatus Development I and has been named vice-president in charge of Staff. He will have over-all supervision of the Laboratories' Patent, Legal, Personnel, Publication and General Staff Departments. He will continue his general responsibility for the Laboratories' military and commercial products programs*

James W. McRae (*below*) *has been named director of Apparatus Development I to succeed Mr. Quarles. He will have direct supervision of the Transmission Apparatus, Switching Apparatus and Electronic Apparatus Development Departments*

Suit filed to separate Western Electric from Bell System

The Department of Justice on January 14 filed a civil suit against the Western Electric Company and the American Telephone and Telegraph Company, charging a violation of the anti-trust laws.

At the same time the Attorney General issued a statement that "The suit does not seek to interfere with the American Telephone and Telegraph Company except to separate it from Western Electric and will not disturb the operating efficiency of telephone service in this country." He also said that the resulting competition in telephone manufacturing would lower the costs of telephone equipment and afford an opportunity to reduce telephone rates to subscribers.

Leroy A. Wilson, president of the A T & T, immediately commented on the suit as follows:

"Western Electric has been a part of the Bell System for over sixty-five years, having manufactured the System's telephone equipment since 1881. Over these years, it has been the telephone users who have benefited most from this relationship. Moreover, this relationship has been of extreme importance to the country's national defense in World War I and especially in World War II.

"I am sure that when all the facts are known, the existing arrangement will be found to be in the public interest. Telephone calls go through faster, people hear each other better and service is more dependable because of the quality of Western Electric equipment which is in general use throughout the Bell System. Looking at the record, it is obvious that it would be the public and the telephone users who would suffer most if there were to be any change.

"It is, of course, in the interest of everyone that telephone equipment continue to be the best obtainable and that it be bought at the lowest possible prices. The Western Electric relationship makes these objectives possible and is a major contributing factor as to why Bell System service is the best in the world, and the cost to the users of over 31,000,000 Bell System telephones the lowest possible."

Mr. Wilson's comment that the Western Electric relationship helps to keep the cost of service to telephone users as low as possible is illustrated by the following examples.

The price the Bell Operating Companies pay Western for the telephone instrument is about half the price charged by other suppliers to their customers. Other manufacturers' prices for lead-covered cable are about one-third more than Western's and for central-office apparatus parts they are about 60 per cent more. Where it has been possible to compare complete central office units, Western's prices average lower.

Products manufactured by Western Electric for the Bell System have gone up in price on the average less than 20 per cent since pre-war years, while manufactured goods in general have increased over 75 per cent.

In short, there is nothing to support the belief that taking Western out of the Bell System could reduce the cost of service to telephone users. The opposite is true. Western's policy of providing quality equipment at low prices is one of the important reasons why telephone rates are increasing far less than the general rise in the cost of living.

As part of the Bell System, Western has the same service goal as the Telephone Companies. Its foremost consideration in making telephone equipment is always to meet the customer's service needs. The result is equipment of the highest quality that will give the best service in the most economical way. This result is exactly what the telephone customer wants and we are, therefore, confident as Mr. Wilson says, that "the existing arrangement will be found to be in the public interest."

Changes in Organization

H. C. Atkinson has been appointed Whippany Area Manager. In this capacity Mr. Atkinson will be responsible for the operation of the Whippany Staff Department in addition to his present duties as New York Area Manager.

Until his retirement on February 28, 1949, O. M. Glunt has continued as Director of Whippany Staff, in which capacity he advised Mr. Atkinson concerning Whippany Staff operations.

The following organization reports to Mr. Atkinson as Whippany Area Manager:

J. F. Kearns, Service Operation Manager. Reporting to him are: E. C. Weiss, Commercial and General Staff Services; G. J. Seltzer, Superintendent—Development Shop; Mrs. H. B. Filmer, Office and Transcription Service; and A. L. Johnsrud, Photographic and Instrument Service.

R. H. Kendall, Plant Operation Manager. Reporting to him are: E. I. Bulman, Superintendent—Building and Grounds Operation and

Maintenance; Miss C. B. Honeycutt, Supervisor—Restaurant Service; and H. D. Douglas, Test Laboratory.

Mr. Kendall also reports to S. H. Willard, General Plant Engineer, as Whippany Plant Engineer.

Coincident with the above changes, W. W. Schormann, formerly the Whippany Service Operation Manager, was transferred to the Personnel Department, reporting to Morton Sultzer, Personnel Planning Director.

M. E. Mohr Honored by Eta Kappa Nu

At a dinner held during the Winter Convention of the A. I. E. E., the Eta Kappa Nu awards to Outstanding Young Electrical Engineers for 1948 were presented. M. E. Mohr of the Laboratories received honorable mention "By virtue of his important contributions to the application of electron tubes to telephone switching circuits, and his extraordinary leadership in the church and in civic life." Dr. A. M. Zarem, Director, Los Angeles Division, Stanford Research Institute, received the main award and J. W. Forrester of M. I. T. the other honorable mention. During the dinner, entertainment was furnished by the Murray Hill Male Quartet consisting of R. N. Larson, B. Vierling, F. L. Crutchfield and W. E. Mathews.

The awards are made annually by Eta Kappa Nu to electrical engineers who have been graduated not more than ten years and who are less than thirty-five years old, for "meritorious service in the interest of their fellow men."

Mr. Mohr, of Electronic and Television Research, received his B.S. degree from the University of Nebraska in 1938 and immediately joined the Laboratories. He was first concerned with automatic switching, to which he contributed various cold-cathode gas tube circuits, and supervised the trial of electronic devices on the crossbar machine switching system. His electron beam studies led to special structures for signal analysis and coding for pulse code modulation, and for high-speed computers. His work in this field during World War II is still on the secret list. More recently, his work has been in the field of use of negative resistances and of the newly developed Transistor.

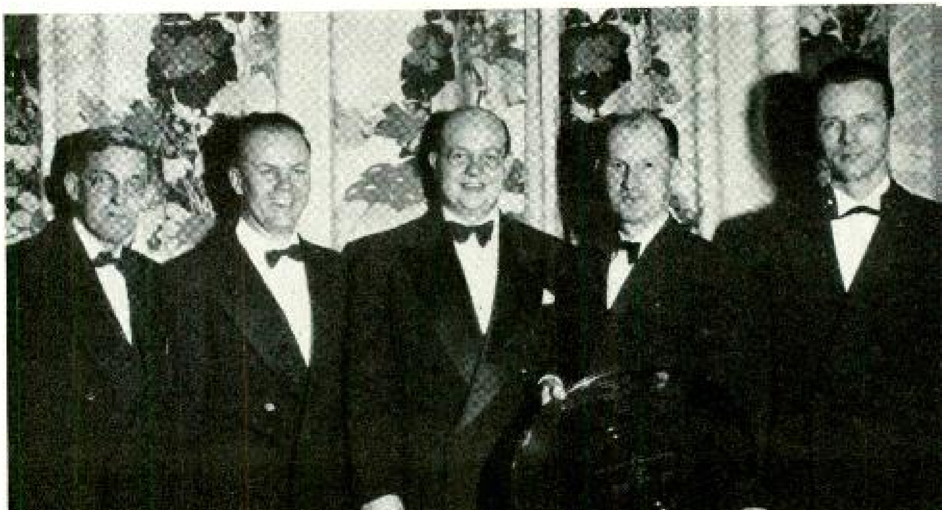
New Out-of-Hour Courses in Spring Term

Beginning late last month, an out-of-hour course is being given in electronic circuits with J. O. Edson as instructor. It is planned to make this the first term of a three-term course. Classes are being held in New York.

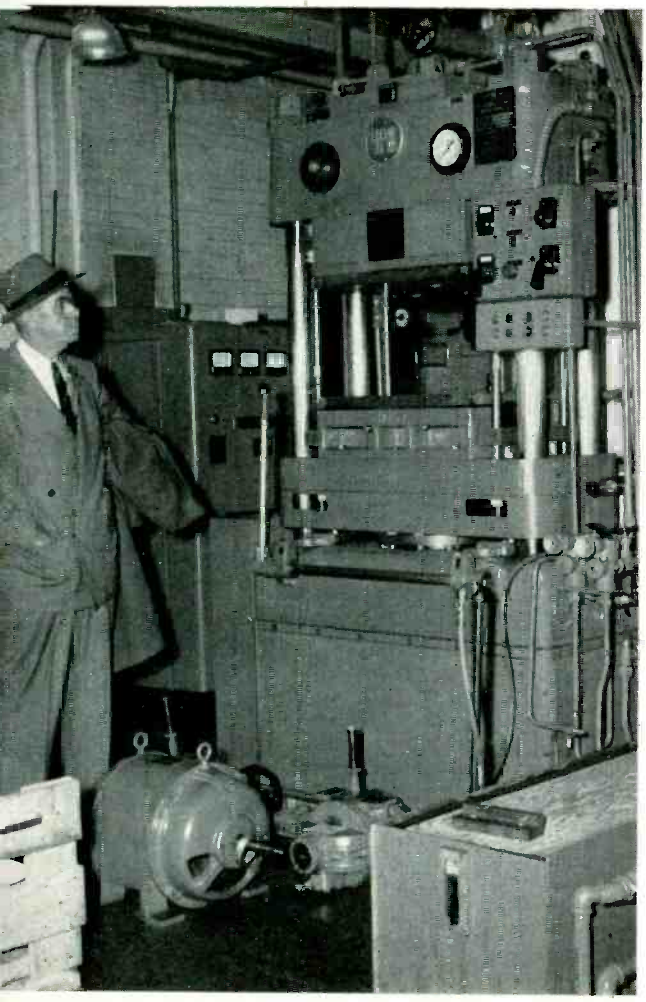
A course in oscillations and waves is being presented by S. P. Morgan at Murray Hill. Present plans are to continue this course also for three terms.

Other courses are being presented—one a broad outline of the Laboratories' philosophy of development for Bell System manufacture and service, by James G. Ferguson and W. W. Werring; and a course on Laboratories staff operations, by members of the Staff Department. Both courses will be given in New York.

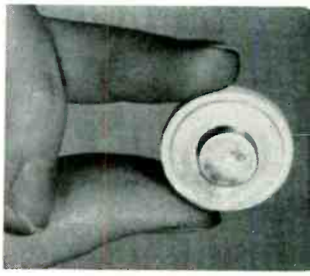
These courses are in addition to the second term of the courses in Scientific Russian Translation (B. J. Kinsburg); Manufacturing Methods (R. H. Gertz); Engineering Materials (Chemical Staff); and Telephone Switching (Switching School Staff).



At the 13th annual award dinner of Eta Kappa Nu, left to right: Everett S. Lee, President of the A.I.E.E.; M. E. Mohr, B.T.L.; Dr. A. M. Zarem, Stanford Research Institute; T. W. Williams, President of Eta Kappa Nu; and J. W. Forrester, M.I.T.



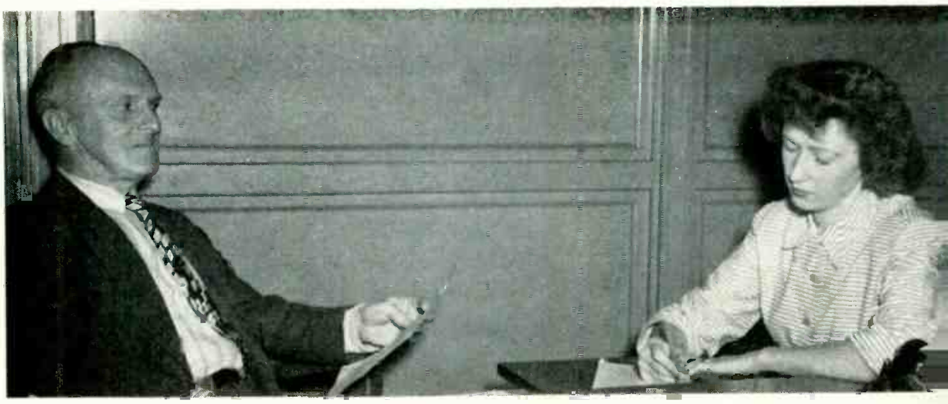
HIGHLIGHTS OF THE PURCHASING DEPARTMENT



From the massive sixty-ton plastic extruding machine which L. R. Shropshire (above, left) recently purchased for the Laboratories to the minute quantities of precious metals such as the gold on the transmitter button (above) is the gamut of items secured by the Purchasing Department at Fourteenth Street.

Receptionist Virginia Chaya (left) is admitting W. W. Gunther, coming to call on one of the buyers on company business, and J. F. Hunter (top, opposite page) is shown dictating to Agnes Killeen, a member of the Purchasing secretarial group. The buyer must know a great deal about the firms which supply our needs, what they make, how promptly they can deliver, how their prices compare; the buyer must also be on the lookout for new materials so as to keep the engineers informed and he must keep abreast of market trends.

Requisitions coming to Purchasing are checked for proper expense approvals, in this



case by Dolores Koelsch (right), before being forwarded to the buyer responsible for the particular type of purchase. He in turn checks his sources of supply, makes the necessary inquiries and selects the firm from which the material will be purchased.

Coded, marked and annotated by the buyer, the requisition is then forwarded to the group of which Augusta Welsh (below) is a member, who are qualified by experience to realign at sight the information on the requisition and to type the data into an order form. The formal order is then returned to the buyer for his signature before being routed to the supplier.

Requisitions for purchases from the Western Electric Company are checked by G. J. Wolters (below, right) as to the source of supply in the various Western units and locations before he edits the order, has it typed and transmits it to the proper unit.

RETIREMENTS

Retirements this month include O. M. Glunt, Director of Whippany Staff, with forty-two years of service, and W. L. Heard, Systems Drawing Engineer, with thirty-seven years of service.

O. M. GLUNT

W. L. HEARD

OMER M. GLUNT

Mr. Glunt was graduated by Ohio State University in 1906. He then entered the Bell System via a course given for engineers by Western Electric in Chicago which involved some two years of shop and installation work. In 1911 he was transferred to West Street to become an apparatus designer in the Engineering Department, predecessor of the Laboratories. His ability as a leader won recognition, and during World War I he directed a score of engineers who were designing telephone apparatus for many military applications.

At the end of the war Mr. Glunt was placed in charge of radio apparatus design. Broadcast transmitters and associated audio systems, radio for airplanes and other mobile units, as well as public address systems, were a major concern of his group right up to World War II. In 1926 sound pictures were added to his responsibilities, and his leadership and guidance were major factors in the creation of that new technical art. Incident to that work, he guided the design and construction of our Sound Picture Laboratory, with its complete facilities for taking, processing and reviewing sound films.

Initially the broadcasting transmitter work was carried on at West Street, but it soon became apparent that testing of the apparatus should be done at a location more remote from the city. A site at Whippany was selected, and Mr. Glunt gave a great deal of attention to its development. Here was tested the first 5,000-watt Western Electric set, and there followed successively larger sets up to 50,000 watts. From Whippany was the world's first broadcast of television, in 1927; there was, however, but one set to receive it—in the Auditorium at West Street.

When the problems of World War II were presented to the Laboratories, Mr. Glunt had a group of about 180 engineers, with supporting shop and testing facilities. All were soon committed to the development of military equipment, particularly radar, and the group, centered at Whippany, grew to nearly 700. In this group were developed the first mobile radar for anti-aircraft warning and fire control; airborne search radar which located and helped eliminate many enemy submarines; the SJ submarine radar that was responsible for the sinking of a greater part of the Japanese shipping; and the Navy's Mark 3 and Mark 4 radars for ships' main batteries and anti-aircraft fire control which were finally succeeded by the Mark 8 and Mark 12 radars for ships' main and secondary batteries, all of which made important contributions to the Navy's brilliant record in the Pacific.

A dairy barn came with the Whippany property and was remodeled into offices and laboratories; from that, the plant was expanded as occasion warranted. Additional property at Whippany was bought in 1931; a tract near Mendham* was used for study of field-strength instruments and radio receivers. During the war a radar laboratory was built at Atlantic Highlands,† while at Whippany the building area was increased tenfold by the erection of five major buildings in addition to many smaller temporary ones to house individual projects. One of the permanent structures houses the administrative offices, cafeteria, lounge, and laboratories; in another is an exceptionally well-equipped laboratory for vibration, shock, high-altitude, and humidity tests. Also during the war, Mr. Glunt established outposts in various Western Electric works to maintain close contacts with the people who were putting Whippany's design into production.‡

In January, 1947, with retirement only two years away, Mr. Glunt took an opportunity to try out a new idea. Relinquishing the technical direction, he became Director of Whippany Staff, with responsibility for all types of service there. That the experiment was successful is evident from adoption of that method for the New York and New Jersey operations of the Laboratories as a whole.

It is not surprising that Whippany, from its inception so closely identified with Omer Glunt, should today reveal many of his personal attributes. There are the clean simple

*RECORD, *April*, 1932, *page* 279.

†RECORD, *May*, 1946, *page* 203.

‡RECORD, *October*, 1946, *page* 365.

lines of the buildings; the general air of thrift with adequacy; the diamond with its intramural games of softball, the well-run cafeteria. There remain, too, the organization he assembled, and some scores of engineers who in varying degree have caught a spark from his personality and have profited both themselves and the Laboratories from the fire it kindled.

William L. Heard

A good engineer can turn his hand successfully to many things, and in an organization as big as the Laboratories, he can get the chance to try. Such an opening came to Mr. Heard in 1927 when he was asked to take over the drafting rooms in Systems Development. Looking back, he saw an electrical engineering degree from Kansas State in 1911, the student course at Hawthorne which he entered in 1912, equipment work there until 1918, and after that at West Street where he did mechanical design on switchboards, including the historic "Mulberry" and Kansas City projects.

In his new job, Mr. Heard's immediate problem was to weld the isolated drafting groups into a single organization which would serve the entire Systems Development Department. He had been a draftsman himself, and as an engineer had used draftsmen to get his ideas into working drawings. One of his early concerns was with the symbols which are the vocabulary of both engineer and draftsman. There was no general agreement even as to the older symbols; a new one might be introduced by anyone, without much regard to the prior art. Mr. Heard had prepared drawings of suitable symbols and persuaded all groups of engineers to adopt them. As an outgrowth, he was designated the Laboratories member and later chairman of a Committee of the American Standards Association which eventually procured agreement of all organizations on a single set of symbols.

Concurrently, Mr. Heard was at work on cost-saving techniques for the drafting room. The Record, from 1927 to 1931, carried eight articles describing such improvements as the use of vandyke prints instead of the original tracings for blueprinting; photo methods of combining parts of tracings; a transparent guide for rapid production of symbols; making perspective line drawings of apparatus by drawing over a photo, then bleaching it to a white background; perspective photographs made from engineering drawings; pencilled drawings blueprinted either direct or after intensifying by photography; and the "highway" technique of circuit drawings which greatly reduces the number of lines needed for a complicated circuit, and the application of typewriters to lettering on drawings.

Two of Mr. Heard's ideas have found widespread acceptance—one, the Bell System Drawing made in his organization has replaced the practice of having circuit and equipment drawings made by all companies interested; availability of the "vandyke" negative for distribution has greatly helped in this regard. The other is that part of "Bell System Practices" which serves the Associated Companies and Western Electric as a catalog of available equipment.

World War II was just about the busiest time in Mr. Heard's career. His force grew to about four hundred. He recruited scores of draftsmen from Bell System Companies and from nearby public utilities. Many others were architectural draftsmen, then unemployed, and women who had had drafting experience before marriage or who had taken short courses in it. One of his big activities was the preparation of about 500 textbooks on war developments for the Armed Forces.

The Heard family has a strong Bell System tinge. His wife, the former Adelia Swanson, was working at Hawthorne when they met; and his niece once worked here and married a Western Electric man. For retirement Mr. Heard has no definite plans beyond an extended trip across the country to California, where he can practice at leisure two of his hobbies—golf and photography.

March Service Anniversaries of Members of the Laboratories

40 years
W. L. Casper
W. G. Knox

35 years
L. E. Coon
T. L. Dowey
E. H. Goldsmith

30 years
C. P. Bartgis
P. W. Blye
Orfeo Cesareo
R. A. Horsburgh
P. F. Jones
R. A. Ogg
H. C. Rubly
M. K. Zinn

25 years
Charles Depew
D. J. Hendrick
C. L. Karthaeuser
Gladys Kettles
L. F. Koerner
C. W. Koons
S. O. Morgan
A. A. Noel
R. V. Rice
H. J. Smith

20 years
L. R. Bell
Rulon Biddulph
N. W. Bryant
James Crabtree
H. M. Craig
V. W. H. Dobler
H. B. Ely
R. D. Fracassi
D. M. Jones
E. M. Julich
W. C. Kleinfelder
T. E. Lenigan
A. A. Lundstrom
L. DeK. Mann
F. H. Martin
Frank McGlynn
R. L. Miller
R. C. Miner
E. D. Morris
A. A. Roetken
Thomas Rushetski
Ethel Sauter
G. H. Snyder
P. G. Uppstrom

15 years
W. F. Armson
H. P. Bender
G. W. Eckner
J. V. Elliott
Mary Goette
Aristede Pellegrinelli

10 years
J. J. Emmons
C. W. Muccio
S. E. E. Sundstrom

BELL LABORATORIES CLUB REPRESENTATIVES

←E. R. Casey of the Davis Building, a member of the Patent Staff, is associated with its switching group. Recently married, he attends Night Law School at N.Y.U. with his bride.

W. E. Grutzner represents the Equipment→ Engineering Department. Second time as representative, he has been active in the Club's tennis, bridge and bowling leagues. He is Assistant Cub Master of the pack to which his son Ronald belongs.

←A. J. Kuczma, representative for Personnel and Publication, handles relocation services in connection with the Murray Hill move. He organized the West Street Softball League, basketball and gymnasium classes.

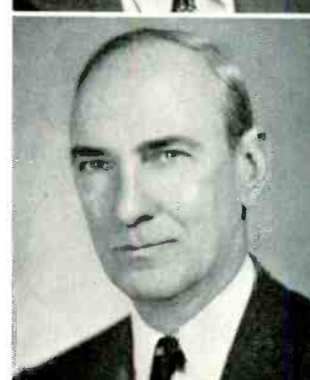
G. H. Reuble, Murray Hill representative→ and member of the Chemical Service Department. He has a flair for cooking and carpentry and has recently completed a desk for his younger daughter Robin.

←G. E. Perreault of Apparatus Development works on the mechanical design of small apparatus. His recreational interests are badminton and bridge. He's the father of four little girls, all under eight.

James Marshall of the Building Shops, → who is a member of the Club's Bowling League, bowls with the *Relays* in the A League. He represents his own department and the Development Shop at West Street.

←E. W. O'Hara of the Financial Department who represents all Department 7000 excepting the Shops. Mr. O'Hara is chairman of the Bowling League for the New York locations.

C. H. Haynes represents the Research De-→ partment. Until his recent transfer to Murray Hill in charge of drafting in Department 1500, Mr. Haynes was responsible for similar services in Research at West Street.



←R. B. Miller is a member of the Quality Assurance Department. The Hudson Valley is Mr. Miller's home territory and he is chairman of the Scouts' Board of Review in the Hendrik Hudson Council.

F. E. DeMotte of Radio Development at→ Whippany is active in the baseball, volleyball and softball teams. He also sings with the Whippany Men's Glee Club.

News Notes

F. B. JEWETT has been appointed to the Board of Trustees of Battelle Memorial Institute, Columbus, Ohio, to succeed the late Dr. Rolland C. Allen.

O. E. BUCKLEY was in San Francisco in January to testify in a hearing before the Public Utilities Commission of California, and he later testified in Salem, Oregon, before the Oregon Public Utilities Commissioner, in the Oregon Budget Case. Between these two occasions, he visited the Atomic Energy Commission's operations at Albuquerque and Los Alamos, New Mexico. Returning via Washington, D. C., he attended a meeting of the General Advisory Committee of the Atomic Energy Commission.

O. E. BUCKLEY and M. J. KELLY visited the laboratories of the General Electric Company in Schenectady during December.

M. J. KELLY's recent speaking engagements include his discussion of his trip to Europe at a meeting in the Holmdel Laboratories of the Deal-Holmdel Colloquium; his talk to the Chemical and Mechanical Engineering Departments of the Missouri School of Mines; and his talk in Chicago before the Western Society of Engineers on *Organized Creative Technology*. Dr. Kelly also addressed the Directors of Industrial Research on *Industrial Research Administration* at their evening meeting on January 20 at the University Club.

In December Dr. Kelly visited the Philco Corporation at Philadelphia, and in January, with A. B. CLARK, the Federal Telephone and Radio Corporation in New York and their laboratories at Clifton, New Jersey. He also visited Harvard University and Massachusetts Institute of Technology in Cambridge and the Raytheon Manufacturing Company at Waltham, Massachusetts. From January 11 to 13 he attended the Operating Vice-Presidents' Conference in New York.

A. B. CLARK and David R. Hull, Assistant Technical Director of the I. T. and T. Corp., conducted a symposium on *Communications Development and Research* in Washington before a group of officers from the Industrial College of the Armed Forces.

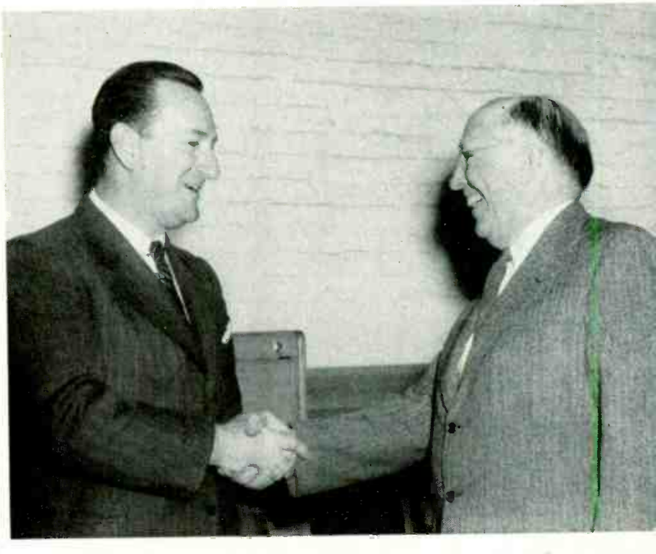
D. A. QUARLES gave a talk before the Air War College at Maxwell Field, Montgomery, Alabama, and also before the Communication and Electronic Division of the U.S.A.F. Special Staff School at Gunter Air Force Base, Montgomery, Alabama.

S. A. SCHELKUNOFF is the author of the article on *Electromagnetic Waves* in the current revised printing of the Encyclopædia Britannica.

Oregon Statesman Photo

Testimony regarding services performed by the Laboratories under the license contract was given by Dr. Buckley in hearings at Salem, Oregon, before the Oregon State Public Utilities Commissioner. From left are: Dr. Buckley, Harold S. Osborne, chief engineer, A T & T; and F. D. Tellwright, vice-president and general manager for Oregon for the Pacific Company

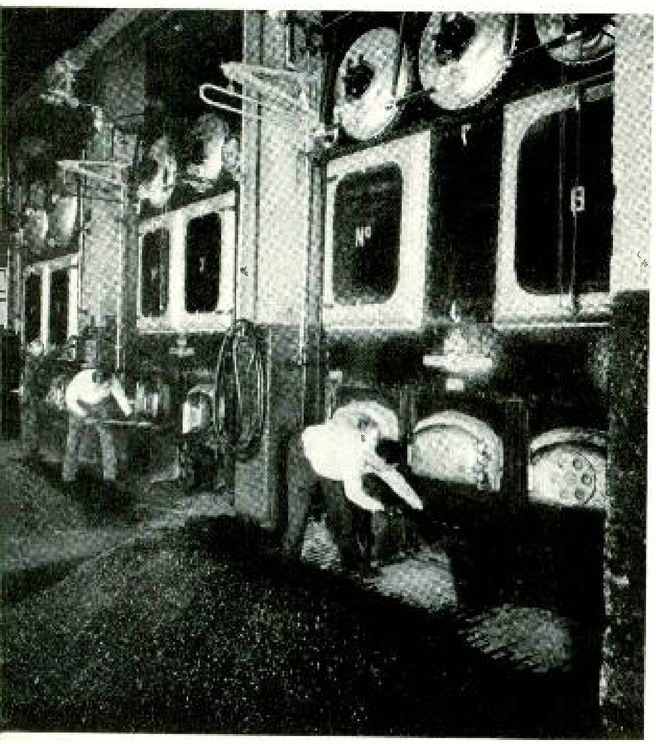
J. W. MCRAE and J. R. WILSON paid a two-day visit to the Electronic Apparatus Development Department and the Western Electric Company in Allentown. Mr. McRae also visited the Naval Research Laboratory as a member of the Navy Industrial Association Visiting Committee.



G. A. Brodley extends a welcome to G. B. Thomas, retired Personnel Director, during his visit to West Street in the early winter

R. K. HONAMAN spoke on *Microwaves for Your Telephone* before the Chicago Section of the A.I.E.E. on January 27. He was assisted by H. J. KOSTKOS. Mr. Kostkos visited the Health Museum in Cleveland and the Science and Industry Museum in Chicago.

K. K. DARROW spoke at the University of New Hampshire in Durham on *The Development of American Physics* at the installation of the Society of Sigma Xi at that institution. He also spoke on *Internationalism in Physics* before the International Relations Group at Murray Hill. At the annual meeting of the American Physical Society, Dr. Darrow was reëlected secretary of the Society.



On the firing line at West Street, a scene which few members of the Laboratories ever witness. This huge steam generating plant, with four water tube boilers, furnishes heat and process steam for the building. Left to right are P. Higgins, controlling the water level; E. Yacunski, firing; and H. McCabe, removing ashes from the pit

H. D. HAGSTRUM, J. A. HORNBECK, J. P. MOLNAR and A. H. WHITE participated in discussions of gaseous electronic problems at the M.I.T. Research Laboratory for Electronics.

G. E. MOORE was reëlected secretary-treasurer of the Division of Electron Physics of the American Physical Society.

DURING THE AMERICAN PHYSICAL SOCIETY meeting in New York from January 26 to 29, ELIZABETH WOOD presided over the session on *Non-Metallic Crystals;* G. E. MOORE over the session on *Miscellany in Electron Physics;* and R. M. BOZORTH over the session on *Ferromagnetism, Ferroelectricity, Order-Disorder*. W. P. MASON, W. O. BAKER, H. J. MCSKIMIN and J. H. HEISS presented a paper on *Measurements of the Mechanical Properties of Polymer Liquids by Ultrasonic Methods;* and W. O. BAKER, W. P. MASON and J. H. HEISS a paper on *Dynamics of Polymer Solutions and the Deformation of Separate Macromolecules.* During Symposiums of the Division of Electron Physics, J. J. LANDER spoke on *Polymorphism and Anion Rotational Disorder in Alkaline Earth Carbonates;* W. SHOCKLEY on the *Electronic Theory of the Transistor;* and J. R. PIERCE on *A Broadband Oscilloscope Tube.*

SIDNEY DARLINGTON spoke on *The Potential Analogue Method of Network Synthesis* on January 6 before the Basic Science Division of the American Institute of Electrical Engineers with M. E. MOHR presiding.

W. SHOCKLEY presented a paper on *The Electronic Theory of the Transistor* at a joint meeting in Boston of the A.I.E.E. and I.R.E. He also spoke on the same subject at the Thayer School of Engineering at Dartmouth.

R. M. BOZORTH and C. KITTEL have accepted a request to serve on the *Advisory Committee on Ferromagnetism* of the Office of Naval Research. Dr. Bozorth and ELIZABETH WOOD attended meetings in Columbus, Ohio, of the American Society for X-Ray and Electron Diffraction.

J. R. TOWNSEND was reëlected Chairman of the Board of Review of the American Standards Association, Inc.

H. A. BIRDSALL has been elected councilor of the New York Section of the American Chemical Society.

W. L. HAWKINS presented a paper entitled *Preparation of Substituted Ethylene Diamines* at the "Meeting in Miniature" of the North Jersey Section, American Chemical Society.

H. T. FRIIS recently attended a meeting in Washington of the Committee on Electronics of the Panel on Basic Research, Research and Development Board.

I. V. WILLIAMS, C. C. LAWSON and J. B. DIXON visited Pittsburgh to discuss aluminum-coated line wire and strand. Mr. Williams also attended meetings of A.S.T.M. Committee A-1 on Steel while in Pittsburgh.

Modern Telephone Booth

A telephone booth recently designed by Station Apparatus Development has a number of new features. One is a simple but highly effective ventilator in the ceiling, which changes the air in the booth several times a minute with a refreshing but gentle circulation.

The new booth has a new lighting system which concentrates four times as much light on the writing shelf and the telephone instrument. An improved floor has been designed of molded perbunan rubber. To date only a few preproduction models have been constructed, but full-scale manufacture is getting under way at the Western Electric Company.

Credit for the development goes to a group headed by D. H. King and including J. R. Erickson, J. H. King, A. K. Smith, J. W. Ericsson and T. Z. Takacs.

This telephone booth features a ventilator and an improved lighting system. Miss Rae E. MacEvoy of the research secretarial staff tries it out

American Red Cross

Georgia Jipp of Philip, South Dakota, flew a hundred mercy missions for the American Red Cross, taking food and medical supplies to persons isolated by the severe blizzards in the northwestern states

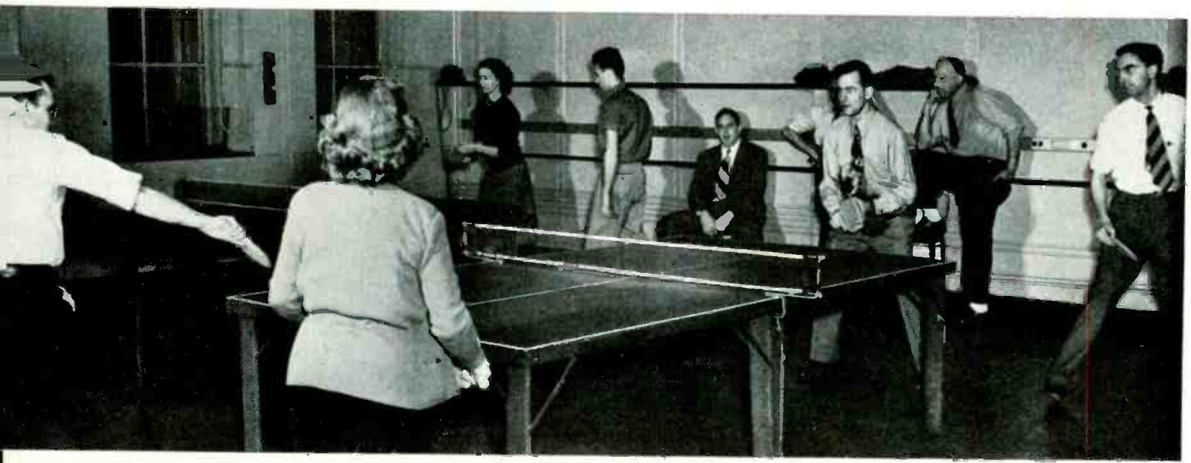
Give to Your Red Cross

With unbelievable swiftness during the chaos of disaster, the American Red Cross becomes the nucleus organization and with other community agencies working either within the Red Cross or in coöperation with it, it is possible to feed, clothe, and provide shelter within a few hours after a catastrophe occurs.

When the spectacular "feedlift" operation of the United States Air Forces dropped hundreds of tons of feed to blizzard-bound, starving cattle in the West in January, many thousands of pounds of food were dropped to the isolated farmers also.

Within a few days after the West's snowbound plight, the Army, Civil Air Patrol and National Guard had provided planes, weasels and trucks to distribute approximately $50,000 worth of Red Cross food, fuel and medical supplies to the stranded farmers. In addition, the organization allocated $250,000 in anticipation of further needs there and in twelve states subjected to unusually severe weather conditions and their aftermath.

The Red Cross spent $12,171,000 for relief and rehabilitation of approximately 312,400 persons in 303 domestic disasters throughout the year. Indicating the growth of the disaster service, it gave aid in 619 disasters during the two-year period ended last June 30—more than in any comparable period in the 67-year history of the Red Cross in this country.



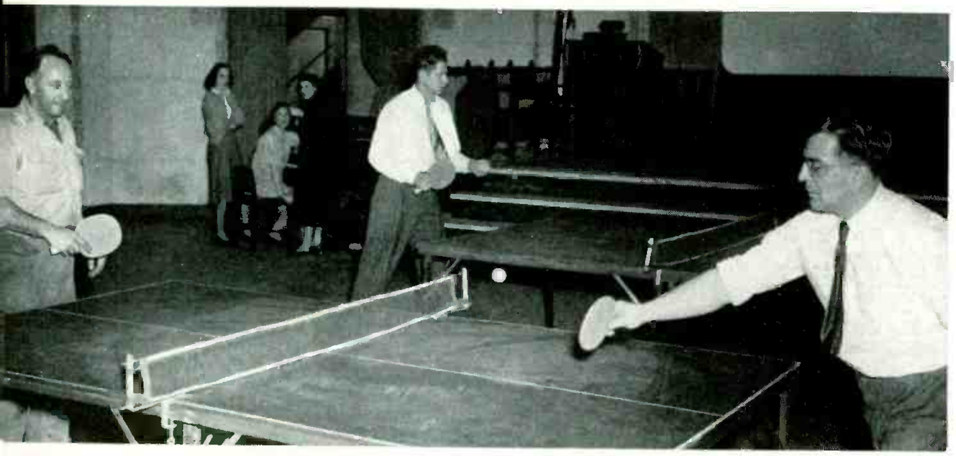


Table tennis enthusiasts enjoying a few lively games at Murray Hill (above) where two rooms have been set aside temporarily for the sport and at West Street (left) in the auditorium where, left to right, C. J. McDonald, C. B. Swenson and H. L. Holley are shown in action

News Notes

R. R. Newton's article on *Space Charge Effects in Bombardment Conductivity Through Diamond* has been published in the January 15 issue of *The Physical Review.* The Letters to the Editor section of the same issue contains *Interpretation of Dependence of Resistivity of Germanium on Electric Field* by E. J. Ryder and W. Shockley; *Additional Ferromagnetic Resonance Absorption Measurements on Supermalloy* by W. A. Yager; and *Ferromagnetic Resonance Absorption in Heusler Alloy* by W. A. Yager and F. R. Merritt. Résumés are given of papers by Conyers Herring, *Some Simple Theorems on the Free Energy of Crystal Surfaces;* by G. L. Pearson, J. D. Struthers and H. C. Theuerer, *Correlation of Geiger-Counter and Hall-Effect Measurements in Alloys Containing Germanium and Radioactive Antimony;* and by G. E. Moore, H. W. Allison and James Morrison, *The Production of Free Alkaline Earth Metal in Simple Vacuum-Tube Filaments.*

At Hawthorne, W. B. Graupner discussed common control equipment for the No. 5 crossbar system; W. L. Tuffnell and R. R. Stevens, handset coin collectors; H. Peters, rubber flooring for telephone booths; H. C. De Valve, problems of wire used in step-by-step equipment; F. W. Clayden, step-by-step solderless banks; and L. G. Fitzsimmons, current engineering problems on orders for No. 5 crossbar equipment.

G. R. Gohn addressed the Cleveland Chapter of the American Society for Metals in Cleveland and the New Haven Chapter in Waterbury, Connecticut, on *Fatigue and Its Relation to the Mechanical and Metallurgical Properties of Metals.*

E. E. Schumacher attended a meeting in Washington of the Metallurgy Panel of the Research and Development Board.

W. C. Ellis presented a talk on *Principles and Purposes of Age Hardening* in the series of educational lectures of the New York Chapter, American Society for Metals, in New York City.

M. B. McDavitt discussed switching problems in San Francisco, Los Angeles, Portland, Oregon, and Seattle, Washington.

At Tonawanda, V. T. Wallder discussed switchboard and inside wiring cable jacketing problems; H. V. Wadlow, causes of discoloration of tinned wire; and D. R. Brobst and R. W. Bogumil, switchboard cable and enameled wire.

G. T. Kohman presented an invited paper on *Synthesis of Quartz Crystals* at the Third Annual Symposium on Recent Developments sponsored by the New York Section of the American Chemical Society.

No. 5 Crossbar problems took C. F. Bischoff, F. E. Blount, S. C. Del Vecchio, T. F. Egan, A. E. Gerbore, H. W. Hermance and E. A. Kuenzler to Media; G. A. Hurst and W. I. McCullagh to Ambridge, Pa., and Willoughby, Ohio; R. B. Bauer to Cincinnati; H. W. Flandreau to Vineland, N. J.; and K. M. Fetzer and J. G. Ferguson to Troy, N. Y., and Towson, Md.

During the A.I.E.E. Winter General Meeting, January 31 to February 4, in New York, the following papers were presented by members of the Laboratories: *Clampers in Video Transmission* by S. Doba, Jr., and J. W. Rieke; *The Transistor, a New Solid State Amplifier* by J. A. Becker and J. M. Shive; *The Coaxial Transistor* by W. E. Kock and R. L. Wallace, Jr.; *Vibrating Reed Selectors for Mobile Radio Systems* by A. C. Keller and L. G. Bostwick; *Vibrating Reed Selective Signaling System for Mobile Telephone Use* by H. M. Pruden and D. F. Hoth; *Application of Multifrequency Pulsing in Switching* by C. A. Dahlbom, A. W. Horton, Jr., and D. L. Moody; *Recent Advances in Magnetic Theory* by R. M. Bozorth; *A Carrier System for 8,000-Cycle Program Transmission* by R. A. Leconte, D. B. Penick, C. W. Schramm and A. J. Wier; *Delay Equalization of 8-KC Carrier Program Circuits* by C. H. Dagnall and P. W. Rounds; *Band-Pass Filter, Band Elimination Filter and Phase Simulator Network for Carrier Program Systems* by F. S. Farkas, F. J. Hallenbeck and F. E. Stehlik; *Protective Grounding of Electrical Installations on Customers' Premises* by A. H. Schirmer; *Close-Spaced Triodes for Operation as Broadband Amplifiers at 4,000 MC* by J. A. Morton and R. M. Ryder; *Application of High Speed Photography to Research* by J. H. Waddell; and *Transconductance as a Criterion of Electron Tube Performance* by T. Slonczewski. Public relations for the meeting were directed by R. K. Honaman.

U. B. Thomas observed Diesel engine starting tests with nickel-cadmium batteries at Hartford, carried out by The Southern New England Telephone Company. Mr. Thomas has recently been appointed to the Editorial Board of the Electrochemical Society.

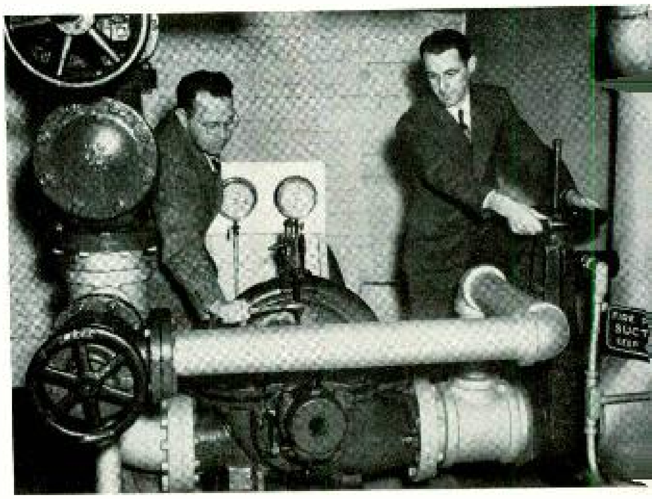
C. M. Hill visited the plant of H. H. Buggie and Company in Toledo in connection with manufacturing difficulties with respect to molded cable connectors. He presented a paper entitled *Behavior of Rubbers at Low Temperatures* to the High Polymer Division, North Jersey Section of the American Chemical Society in Newark.

G. H. Williams attended a meeting of the Society of Plastics Engineers in Philadelphia.

J. J. Martin and W. Orvis visited the Waldron Manufacturing Company in New Brunswick in connection with coating machines for phenol fibre processing.

R. K. Potter's article on *Objectives for Sound Portrayal* appeared in the January, 1949, issue of *The Journal of the Acoustical Society*. In the Letters to the Editor section of the same issue, F. M. Wiener has written on *Diffraction by Rigid Desks and Rigid Squares*.

G. E. Peterson was chairman of a section on Experimental Phonetics at the joint meeting in Washington of the Speech Association of America and the American Speech and Hearing Association.



Fire prevention at West Street centers on the fire pump room above, where M. E. McGraw of the Power Service Group is shown testing the pump with A. B. Whitley. Mr. Whitley, a retired captain in the New York Fire Department, assumed duties as fire prevention inspector in New York following the death of William Wissel

W. F. Smith, Jr. 1896-1949

Walter F. Smith, Jr., of Station Apparatus Development, died on February 9. He entered the Western Electric Engineering Department as a laboratory assistant in 1914 where he was concerned with the testing of telephone transmitters and receivers. During World War I he assisted in the development of microphones for aircraft radio equipment for the Signal Corps and fire control equipment for the Navy. He then participated in the design and construction of equipment used in the development of methods for testing transmission instruments and also assisted in the development of methods for testing transmitters and receivers. During that period he was attending Cooper Union, from which he received the B.S. degree in 1922 and the E.E. in 1930.

Later, in what is now the Transmission Instruments Development Department, Mr. Smith engaged in the design and development of telephone instruments including anti-noise microphones and special acoustic devices. Following that, until 1942, he was in charge of a group concerned with the development of special transmitters and receivers including those used in aviation and mines by the U. S. Army and Navy. A Major in the Engineer Reserve, he was called to duty with the Signal Corps in March, 1942, at Fort Monmouth.

Most of his military service was with the Office of the Chief Signal Officer where he was responsible for the activities of the Ground Signal Maintenance Agency, two years in Washington and later in Philadelphia. He was promoted to Lieutenant Colonel in October, 1943. He transferred to Camp Crowder where he organized and trained the engineering and technical personnel of a group which moved to the mid-Pacific theater of war in 1944. As Director of the Engineering and Technical Division of that group, his work in the Pacific had to do with signal equipment used by the ground forces and with the development of special signal equipment for tactical units.

He was overseas until November, 1945, and was promoted to Colonel on relief from active duty in December of that year. In November, 1948, he was appointed Commanding Officer of the 181st Organized Reserve Signal Group, with 600 officers and 600 enlisted personnel.

After leaving the service he returned to the Laboratories and joined Station Apparatus Development engaged in the study of station maintenance, for which his prior experience so well fitted him. He took an active part in field trials of the new telephone set, and was responsible for studies of dials and ringers.

Mr. Smith was an active member of the First Baptist Church of New York City, where he served as Trustee for fifteen years.

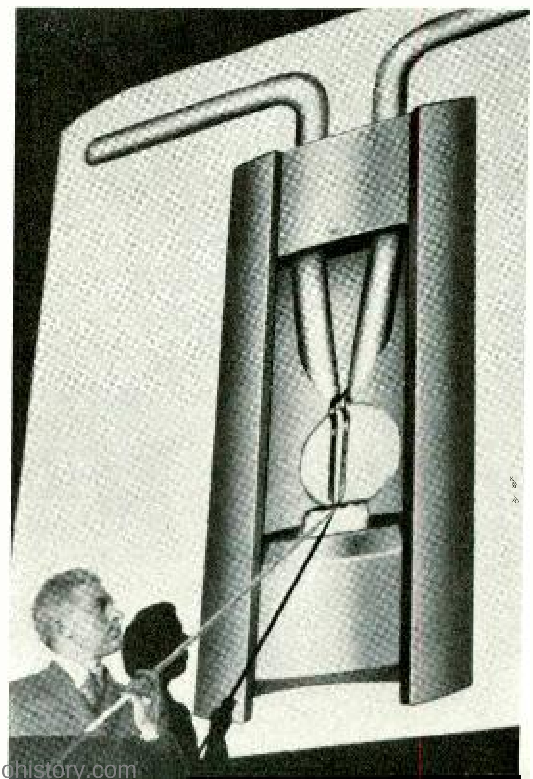
News Notes

L. A. WOOTEN attended a *Symposium on Analytical Chemistry* at Pittsburgh.

W. E. KOCK has been elected a Fellow of the Acoustical Society of America. On January 12, Dr. Kock presented a paper, *Measurement of Artificial Dielectrics for Microwaves,* at the Conference on High Frequency Measurements, A.I.E.E., held in Washington. He also spoke on *Broadband Microwave Lenses* before a meeting of the Northern New Jersey I.R.E.

B. F. LEWIS, R. H. VAN HORN, R. E. COLEMAN, JR., and K. H. MULLER discussed the development of photoelectric cells at the General Electric Company in Lynn.

This angled shot of J. A. Becker was taken when he described the Transistor to the Hawthorne Science Club



R. B. HEARN, H. M. PRUDEN and L. A. WEBER visited stations along the El Paso-Dallas route in connection with testing the first installation of the B1 alarm and control system for the Type-L carrier.

C. A. WEBBER, at Point Breeze, attended a meeting of the Committee on the Reduction of Codes of Cords. He also was at Hawthorne for discussion on cords. Mr. Webber and O. C. ELIASON, at Chicago, attended the annual convention of the American Society of Heating and Ventilating Engineers and also the meeting of the Technical Advisory Committee on air filter test codes of which Mr. Eliason is a member.

B. F. LEWIS presided over the *Symposium on Ferromagnetic Circuits* on February 9. The lecture was the fourth in a series of six sponsored by the A.I.E.E. Basic Science Group.

P. T. HIGGINS and J. O. JOHNSON visited a number of step-by-step central offices in Connecticut in connection with maintenance.

L. O. SCHOTT visited the University of Michigan at Ann Arbor in connection with the visible speech program.

J. C. STEINBERG attended the dedication ceremonies of the Administration and Main Laboratory Building of the U. S. Naval Ordnance Laboratory at White Oak, Maryland.

E. L. NELSON, J. W. SMITH, F. E. NIMMCKE and B. H. NORDSTROM went to the Bureau of Ordnance in Washington for conferences on fire control equipment.

C. R. TAFT, H. A. BAXTER and N. W. BRYANT held consultations on submarine electronic equipment at the Portsmouth Naval Shipyard, Portsmouth, New Hampshire.

J. W. Tengstrom, Superintendent of the Building Shops, gave the opening talk in the course on Household Repairs sponsored by the Women Pioneers of the Laboratories. Following this first general session, the women went into the Shops to study electricity under Mr. Tengstrom, plumbing under W. Flagge, painting under J. Grygotis and carpentry under F. Prachnaik

H. A. FREDERICK and A. C. KELLER addressed a group of manufacturing engineers at Kearny on *Laboratory Development Procedures* and on *Relays*, respectively. Their talks were illustrated by colored slides and motion pictures.

L. N. HAMPTON, J. M. MELICK, A. H. MILLER, F. M. PEARSALL and R. A. HUBBERT assisted the Teletype Corporation in the production of special perforators.

E. D. MEAD, C. G. MCCORMICK, W. G. LASKEY and R. W. MACDONALD were at the Kolmar Avenue Plant of the Western Electric Company in connection with manufacturing problems concerning message registers.

P. H. SMITH supervised the installation of deicing equipment on the 54A antenna of Radio Station WINC, Winchester, Virginia. Mr. Smith attended the conference on High Frequency Measurements in Washington.

C. H. SWANNACK witnessed the field trial installation in Toledo of a new monitor for mobile telephone land station transmitters.

H. A. BAXTER's trip to General Mills, Inc., in Minneapolis, concerned electronic equipment for submarines.

L. S. INSKIP attended the Inductive Coördination Protection and Foreign Wire Relations Course at Colorado Springs, conducted for engineers from the Mountain States and Pacific Coast areas and Long Lines by the Operating and Engineering Department of A T & T.

AT WINSTON-SALEM recently were C. B. MCKENNIE, E. L. NELSON, J. W. SMITH and F. E. NIMMCKE. Mr. McKennie also visited Wright Field, Dayton.

P. V. WELCH and F. W. TREPTOW, with F. J. Ward of A T & T, conferred on PBX problems in Atlanta and Richmond.

Shockley Discusses the Development of the Transistor

Before large and receptive audiences, at West Street on January 10 and at Murray Hill on January 13, W. Shockley delivered another in the series of general out-of-hour lectures. His subject was *The Transistor—An Outcome of Semi-Conductor Research,* and the marked interest in this field was evidenced by a group remaining to question the speaker further after the formal lecture period.

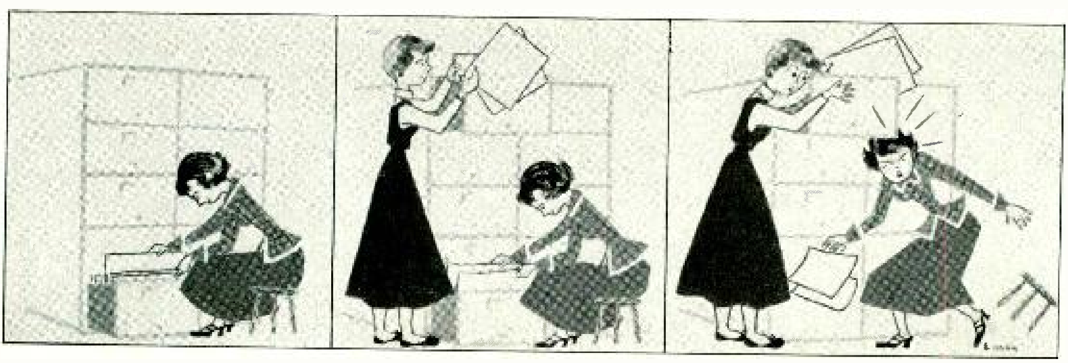
Following an introduction by F. D. Leamer, Personnel Director, Dr. Shockley explained the broader research program of the solid states physics group which he and S. O. Morgan have guided. The program led, among other paths, to the invention of the Transistor by two of the group members—Drs. Bardeen and Brattain. Emphasizing several important details of earlier semi-conductor developments at Bell Laboratories which caused thinking to focus on the possibilities of using semi-conductor material for oscillation and amplification by electronic rather than thermal means, the speaker described early experiments in that endeavor, and how an ultimately successful goal was reached. He dwelt upon the theory of transistor current conductivity wherein *holes,* or absence of negative electrons, are introduced by the input point and modify the electronic structure in its neighborhood in such a way as to give useful control of current in the output or collector point. Blackboard sketches, slides and effective demonstrations were used for topical illustrations during the lecture.

Long Lines 1948 Highlights

Telephone calls handled by Long Lines broke all previous records last year with a 7 per cent increase over 1947. About 580,000 overseas calls were completed—roughly ten times the pre-war volume.

Teletypewriter exchange service now reaches 23,000 stations, a 13 per cent increase over 1947. Private line telephone service increased nearly 20 per cent, private line telegraph nearly 15 per cent and program channels about 15 per cent.

Last year's Long Lines construction program of $91,000,000 included 1,600 miles of new coaxial cable.



We See by the Papers

Recognition for an Amateur

"Tall, broad-shouldered Joseph Harley has been making amateur movies since 1937. This month he received professional recognition. The Bell Telephone Company is distributing his film, *Crystal Clear,* throughout the country. The 16-mm sound movie in Kodachrome tells how Bell Laboratories outpaces nature by growing artificial crystals in a very short time (SI, April, 1948). These crystals are used as electronic filters in apparatus on long-distance telephone lines.

"*Crystal Clear* is the second Harley film to be saluted by experts. His *In His Own Judgment* won him the Hiram Percy Maxim Award in 1944, a prize comparable to Hollywood's 'Oscar.' Your local Bell Telephone office rents *Crystal Clear* without charge. The running time of this film is 10 minutes."—*Science Illustrated, January,* 1949.

Moves to Murray Hill

F. E. Radcliffe, J. L. Wenger, Al Hopper and H. A. Stein of Research Engineering moved on February 1 from West Street to 2D-504 at Murray Hill.

C. A. Webber and members of his group (cords, batteries and air filters) moved on January 26 to 2D-417 and 419 at Murray Hill. At the same time E. B. Wood, transmission apparatus engineer, moved to 2D-433, and

W. L. Casper, apparatus staff consultant, moved to 2D-435.

J. G. Ferguson, transmission apparatus engineer, and his group moved to Murray Hill on February 9. Their new quarters are as follows: E. P. Felch and associates in 2D-249 and 2D-253; A. W. Clement, 2D-252; W. J. Means, 2D-245; S. J. Zammataro, 2D-317. Mr. Ferguson's office is 2D-248.

F. G. Buhrendorf, H. A. Henning and engineers reporting to them in Switching Apparatus Engineering have moved from Murray Hill to J-60 and J-64 at West Street.

A. J. Gaborc of Apparatus Drafting has moved to Murray Hill with five draftsmen who will report to him there. All will be in Room 2D-404B.

J. M. West and his group in Radio Development have been transferred from Murray Hill to Whippany. With them went the Apparatus Drafting and Development Shop men who are part of that team.

Prof. Daunt and Dr. Brillouin Speakers at Murray Hill

Professor John C. Daunt of Ohio State University spoke in the Arnold Auditorium on January 26. His subject was *Liquid Helium II.* Well known for his work in low-temperature physics, Professor Daunt has worked at

the Clarendon Laboratory of the University of Oxford with Simon and Mendelssohn on superconductivity and other properties of liquid helium. Ohio State University has just announced that the group now working under him has attained the lowest temperature yet reached in this country, 0.05 degree, absolute, by means of the adiabatic demagnetization of a paramagnetic salt.

Dr. Leon Brillouin visited Murray Hill on February 3. At an informal late afternoon meeting in the Arnold Auditorium, he spoke on *Propagation of Waves in Periodic Structures.* Known for his theoretical work in physics and engineering, Dr. Brillouin is Gordon McKay professor of applied mathematics at Harvard University.

Advisory Committee Will Plan Communications Mobilization

At the Government's request, five Bell System men are serving on an advisory committee which is helping in the advance planning for mobilization of the Nation's communications system in the event of a war emergency. The committee, called the Domestic Communica-

tions Operating Industry Advisory Committee (Telephone and Telegraph Operations), is working with the National Security Resources Board and the Munitions Board. The group also may be called upon to give advisory assistance to the Joint Communications-Electronics Committee of the Joint Chiefs of Staff.

The five Bell System men are: Wilfred D. Gillen, vice-president, Bell Telephone Company of Pennsylvania; H. T. Killingsworth, general manager of Long Lines; Graham K. McCorkle, president, Illinois Bell Telephone Company; Keith S. McHugh, vice-president, A T & T; and J. B. Rees, vice-president, New Jersey Bell Telephone Company.

The remaining ten members of the committee represent independently owned telephone companies and the Western Union Telegraph Company.

News Notes

W. H. B. Perry, W. Earl and J. J. Butler of Winston-Salem were recent visitors at Whippany.

P. H. Smith is author of *R-F Transmission Line Nomographs* in February, 1949, issue of *Electronics.*

J. N. Shive gave a lecture-demonstration on *The Transistor* at a meeting of the I.R.E. in the G. E. Consumers' Institute in Boston.

A. A. Hansen witnessed the pre-service testing of the single-frequency signaling equipment being installed in the Cleveland toll office for operation with the new No. 4 toll equipment. He also made field studies relating to the use of the 2A signaling test set at the Canton, Massillon and Bogart, Ohio, toll offices.

S. P. Shackleton was in Philadelphia and Media in connection with automatic message accounting.

R. F. Massonneau, R. A. Miller and H. W. Augustadt, with W. D. Mitchell of A T & T, studied announcing facilities in Atlanta.

R. L. Young discussed motor control equipment with the chief inspector of the Eastern Division of the National Board of Fire Underwriters in Philadelphia.

V. T. Callahan conferred with engineers of the General Motors Corporation at Detroit and the Duplex Truck Company in Lansing, Michigan, upon recent engine developments.

H. T. Langabeer visited Boston to observe the new toll power plant in use there.

E. Von Der Linden and engineers of The Chesapeake and Potomac Telephone Company, Western Electric Company, Hawthorne, and the Audichron Company discussed, at Richmond, orders for Audichron time announcement equipment to be installed at Richmond, Lynchburg, Roanoke and Norfolk.

"The Telephone Hour"

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

March 14	*Ferruccio Tagliavini*
March 21	*Jascha Heifetz*
March 28	*Cloe Elmo*
April 4	*Jussi Bjoerling*
April 11	*Nelson Eddy*
April 18	*Lily Pons*
April 25	*Cino Franescatti*

"Before we buy, my husband wants to make sure how long it will take him to get down to the Murray Hill bus in the mornings"

R. H. Miller discussed contemplated orders for A4A equipment and the current order for crossbar tandem with Chesapeake and Potomac Company engineers in Washington. While in Washington, he attended the retirement dinner of G. L. Weller, Building and Equipment Engineer.

W. J. Farmer conferred on the production of reinforced rubber tubing at the Boston Woven Hose Company.

G. Q. Lumsden went to Gainesville, Florida, in connection with experimental greensalt treatments of southern pine poles.

Crossbar in Slow Motion →

Running a machine which pictures in slow motion the "busy hour" antics of a crossbar system takes an unusual team of "operators." In front you see Catherine Durnan as she takes a peg from a group of incoming trunks, before starting a call through the system. Under her arm is the card on which Mary Tracy in the rear will record the case history of the call. From her the card passes behind scenes to Emma Allen, who spins an electrical roulette wheel which tells how this particular subscriber will act. Behind the peg board the job is completed by Mildred Brosnan, who sets up the connection and then takes it down again when the call is through.

Minutely picturing a system's operations in intervals shorter than the working time of the fastest relays, the machine takes a week to display what an actual system does in one minute. Thus it applies a "time-microscope" which allows scrutiny of the briefest event in the history of the call.

An article on the traffic study machine will appear in a forthcoming issue.