BELL LABORATORIES **RECORD**

VOL. XXVII • NO. 6 • JUNE 1949

Air-conditioned electron tube laboratory

R. L. VANCE
Electronic Apparatus Development

Electron tubes are particularly sensitive to foreign substances on the surface of their active elements, and many of the component parts have to be carefully cleaned before assembling. Air-conditioned rooms for the preparation of coated cathodes are frequently required. A tube designed for the radio relay system between New York and Chicago, however, called for even greater care.* With grid wires only one-tenth the diameter of an average human hair, and spacing between these wires and the electrodes of only a few ten-thousandths of an inch, even invisible dust particles in the air can settle on the parts during assembly and cause serious trouble. Early work with these tubes indicated that if a satisfactory yield was to be maintained, the assembly and the fabrication of some of the parts would have to be carried out in specially air-conditioned rooms.

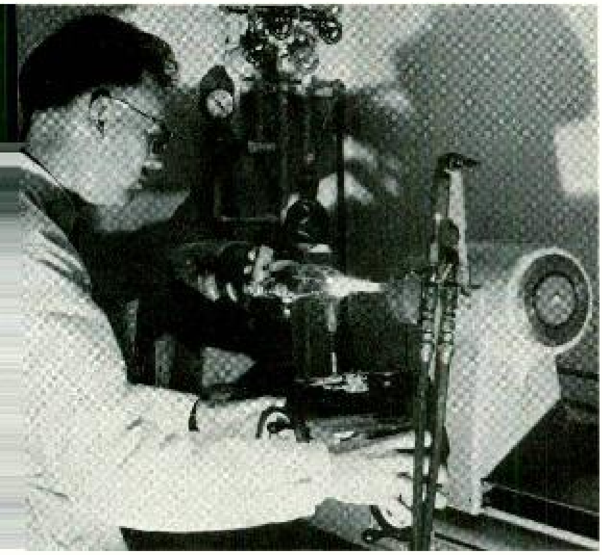
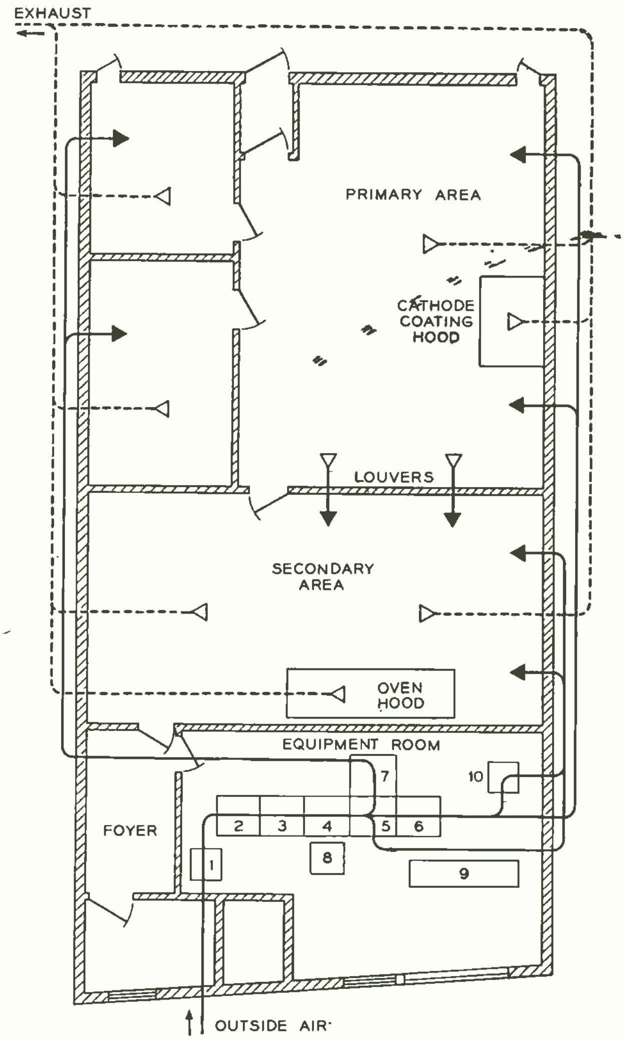


Fig. 1—Shaping a bulb on a glass lathe in the glass-working room

After a survey of possible locations and layouts, approximately 2,700 square feet was made available in a part of Building T basement that at one time was the coal-bin. The location was considered advantageous in that it was isolated by heavy brick walls below ground level, with only one service entrance, and therefore subject to a minimum of external influences. Space and equipment planning was carried out with the recognition that there were certain operations and processes which inherently required the utmost in air conditioning, while other work could tolerate some departure from these ideal conditions providing a suitable sequence of operations

*RECORD, *May*, 1949, *page* 166.

was established. It was also believed that some initial work, principally of a parts-fabrication type, required no special atmospheric conditions, since parts would be cleaned and then brought into the primary restricted area for further work and subsequent cleaning. It was thus possible to divide the available space into areas of maximum and medium cleanliness and to use general service equipment external to the area for the less critical operations.



1. PREHEATER
2. GLASS-WOOL ROUGHING FILTERS
3. "PRECIPITRON", ELECTROSTATIC FILTER
4. CARBON DE-SULFURIZING FILTERS
5. COPUS-CLOTH FINAL FILTER
6. YORK CONDITIONING UNIT
7. YORK CONDITIONING UNIT
8. MAIN AIR BLOWER
9. COMPRESSOR
10. PRIMARY-SECONDARY MIXER

Fig. 2—Floor plan of the air-conditioned area used for the making of exacting electron tube models

Contamination of the parts can come not only from moisture and foreign particles in the air, but from perspiration, which contains sodium chloride, on the hands of the laboratory people. Chlorine is a known enemy of thermionic emission. Proper conditioning thus requires not only that the air be kept clean, but that it be kept at a temperature and humidity that will least conduce to perspiration.

An analysis of the heat-generating sources necessary to use in the laboratory indicated that a turnover of 8,000 cubic feet of air per minute would be required. Recognition of the primary and secondary cleanliness conditions, however, permitted some economies since the air from the primary area could be passed to the secondary area before extraction. One-fifth of the total 2,700 square feet available was required for the conditioning equipment. Over a half was then set aside for the primary area, divided into an assembly area of approximately one-third the total, seal-in and glass working areas of one-tenth, and another one-tenth for washing and chemical cleaning. This allowed one-quarter of the space for the secondary area. The small remaining space was set up as an "air-lock" entrance to the secondary area, leading thence to the primary area.

The specifications finally established for air conditions in the primary area dictated a system capable of providing forty per cent relative humidity at 70 degrees F. in winter and 80 degrees F. in summer, with temperature regulation to $\pm$ 2 degrees F. Under such conditions, perspiration, moisture, and other related sources of contamination were expected to remain at a minimum. Temperature regulation is obtained through automatic relays in the three sections of the primary area. The air flow plan is shown schematically in Figure 2, while the cut-away view of Figure 3 shows some of the constructional features and work space layout. It will be noticed from Figure 2 that none of the air from the glass working and seal-in, and chemical rooms is recirculated. This precaution was taken largely as a safety measure because of the gases and the products from chemical operations which might be expected in these areas. Also, the cathode-coating hood and heat-treatment oven were locally exhausted. One of the special air flow problems, as might be expected, was encountered in the glass-working room, where it is essential there be no drafts to interfere with the gas flames. By the use of low velocities and specially located air channels, it was found possible to reduce drafts on fires to a negligible level. Two types of glass-sealing set-ups used in making the tubes are illustrated in Figures 1 and 6.

The area was finished off with false walls, providing space for service and duct channels, and a false 8½-foot ceiling, plastered smooth throughout. Uniform general lighting was obtained by sealing fluorescent fixtures flush with the ceiling to provide an average of 65 to 70 foot-candles at the bench level. All individual bench lighting was eliminated except for small work, such as assembly with the microscope and fine grid winding. The upper walls were coated with a light green pastel to the bench level, while the lower walls, to the edge of the upturned floor covering, were painted an orange-red. This color combination has provided a restful background for the eyes, and red linoleum on the floor has added warmth to the green background. Bench legs are painted red-orange

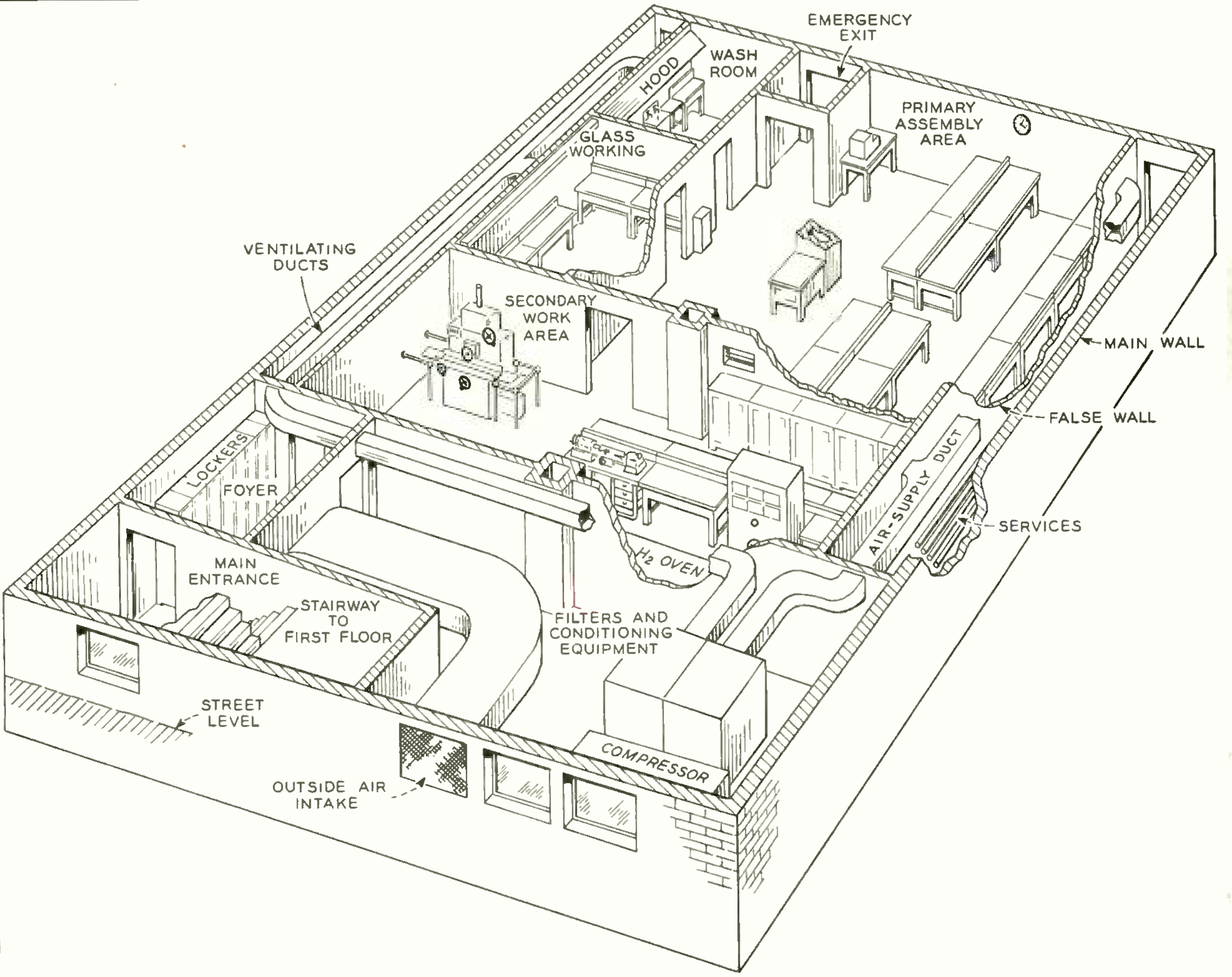


Fig. 3—Perspective view of air-conditioned area showing the relation of the various work rooms and the filtering and conditioning equipment

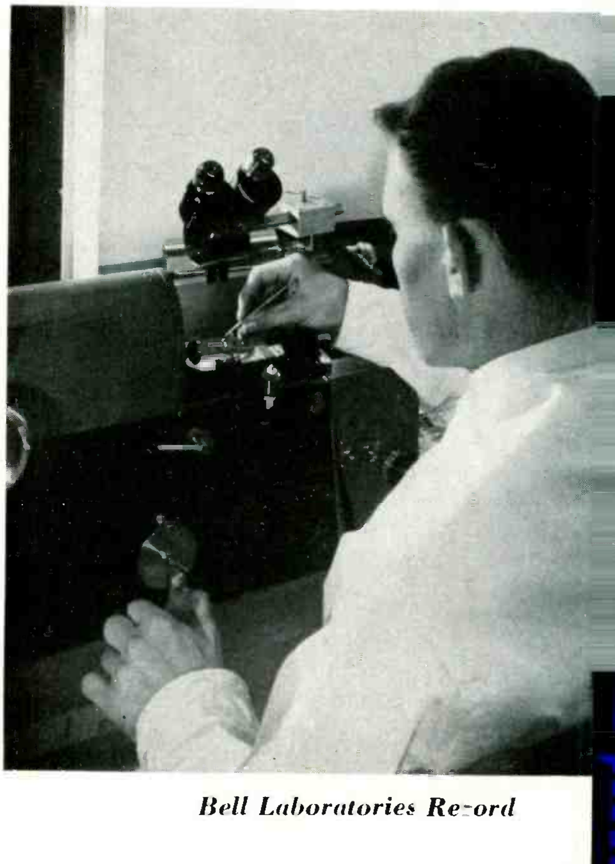
Fig. 4—View of the primary assembly area looking toward the emergency exit

and the equipment is painted a gray-green and ivory. The benches were covered with a very light-colored linoleum as an aid to cleanliness and to provide a good background for handling small parts. Special precautions were taken in the chemical cleaning room in this respect. Here the benches were provided with white structural glass tops and splash backs, and the sink was obtained in porcelain rather than the usual alberine, so as to minimize dust and to facilitate the maintenance of the highest degree of cleanliness possible.

It is not to be concluded that the air-conditioned laboratory just described is entirely free from foreign particles. Even with the careful cleaning of all air entering the area by the ventilating system, dust gradually accumulates as the result of certain work processes, although such dust may not be as detrimental as true foreign particles. If dust is allowed to accumulate within the area, it settles on the floors, benches, shelves, and other horizontal surfaces so that any movement of persons or objects stirs it up, thereby undoing some of the careful work of cleaning the incoming air supply.

The remedy is systematic and painstaking maintenance of the cleanliness of the area. Each person is made responsible for

Fig. 5—Winding a grid for a BTL 1553 tube in the air-conditioned laboratory. Only one-third of a mil in diameter, the wires are wound on one-mil centers as described in last month's Record



maintenance of cleanliness on his or her own bench. Benches are cleaned daily with a damp chamois. Assembly tools are washed daily with acetone and all tube parts are kept in covered containers until required. Regular daily and weekly out-of-hour cleaning schedules are maintained by the Local Service and the Plant Department. At longer intervals, the air-conditioning system itself is given a thorough cleaning; also the walls, ceilings, floors, and grilles are thoroughly washed and rinsed and some of the bench tops are given a hard, smooth waxed surface.

Operators wear lint-free nylon smocks and avoid the use of dust-producing face powder or chemically contaminating hand creams within the area. Newspapers or paper towels are not brought into the area. Clean lint-free gloves are used for all assembly work on tube parts to avoid possible contamination from natural or foreign particles which might adhere to the skin and then be transferred to the work.

Such careful precautions have been proven necessary by actual experience in the air-conditioned assembly area in Building T. The experience in operating this area has provided a test on a small scale of similar tube assembly operations planned for the new electronics laboratories in the Murray Hill II building. There will be six such areas altogether; four for tube assembly in the Apparatus Development Department, one for similar work in the Research Department, already in operation, and one for the associated electron tube work of the Chemical Laboratories.

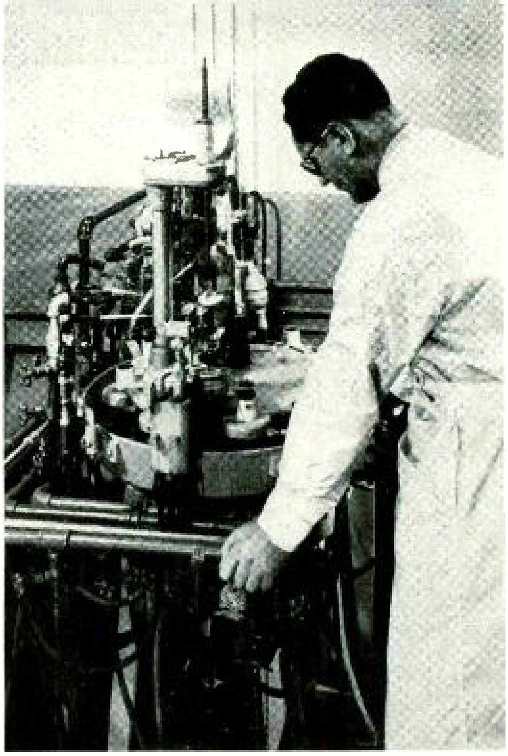


Fig. 6—A vertical seal-in machine in the glass-working room

THE AUTHOR: R. L. VANCE joined these Laboratories in 1930 following graduation from Stevens Institute of Technology with an M.E. degree. Until 1936, he worked in the Acoustical Research Department on methods and equipment for speech and other sound analysis. Transferring then to the Research Staff, he engaged in special budget and expense accounting studies. In 1939 he transferred to the electron tube development group, where he was associated with the mechanical design of numerous experimental and coded tubes for radio communication systems, especially in the ultra-high-frequency range. At the outset of World War II, he transferred temporarily to the Western Electric Company to engineer the manufacture of the first klystrons to be made in their plant. Returning to the Laboratories' tube group in 1943, he engaged in the development of new high-frequency devices for radar and point-to-point radio systems. In 1948 he assumed responsibility for the final development and design of gas tubes scheduled for manufacture by the Western Electric Company, and is now occupied in this work at the Allentown plant.

The B4 radio control terminal

V. J. HAWKS
Transmission Development

Satisfactory operation of a radio-telephone circuit requires that the ratio of signal-to-noise be held as high as possible at all times. To accomplish this economically, the transmitter is kept fully loaded, and a gain control in the transmitting path compensates for the range in the talker's volume, which may vary as much as 30 or 40 db. As a result of the large gains required, the radio loop may operate at a zero net loss or even at a net gain, and singing would occur if steps were not taken to prevent it. This is accomplished by the Vodas,* which is incorporated in the radio control terminal to maintain either the transmitting or receiving path open at all times.

In the course of twenty years of development in radio telephony, many different types of control terminals have been provided to meet different classes of service and to incorporate new developments. A number of these have already been described in the RECORD.† Terminals for the Bell System's transoceanic services, such as the C2, are largely automatic, and include complicated circuits that require skilled maintenance. However, for many uses to which these systems are ordinarily put, an expensive, completely automatic terminal is not warranted. A much simpler semi-automatic terminal has therefore been developed and is known as the B4.

A radio control terminal reduced to its major elements is shown in Figure 1. When the circuit is not in use, or when the distant end is talking, the receiving side is kept closed and the transmitting side open. Acting on speech from the local talker, the Vodas reverses this situation—closing the transmitting path and opening the receiving path through the upper relay chain of Figure 1. Although comparatively little of the incoming signal passes across the hybrid coil at the left of Figure 1 to enter the transmitting path, the amount that does may be great enough, because of the high gains in the circuit, to operate this relay train and thus cut off the incoming speech. This is avoided by a chain of relays connected to the receiving side of the circuit

*RECORD, *November*, 1927, *page* 87.
†Type A, *September*, 1929, *page* 15; B1, *November*, 1932, *page* 62; B2, *August*, 1933, *page* 369; C1, *January*, 1939, *page* 157; and C2, *April*, 1942, *page* 204.

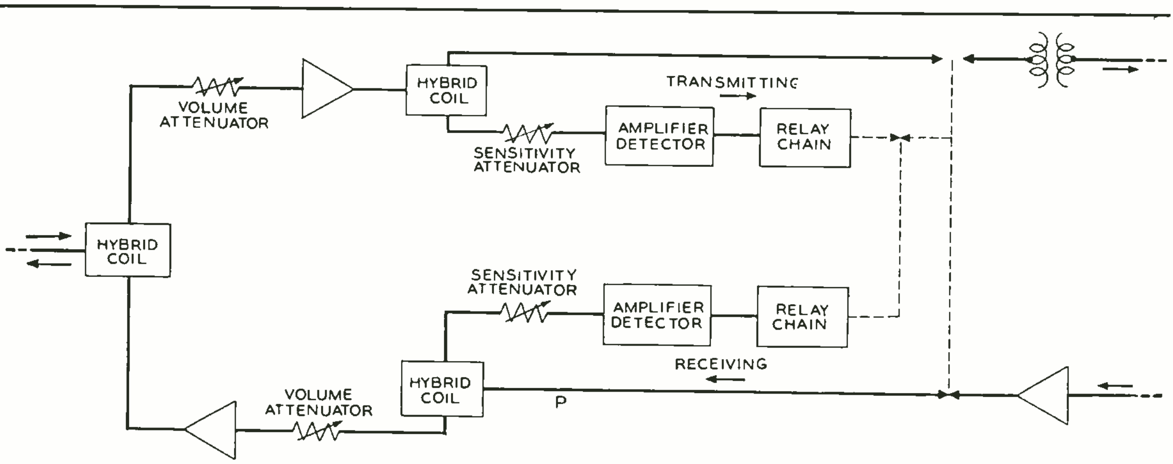


Fig. 1—Simplified block schematic of a radio control terminal

that opens the circuit of the transmitting chain so that it cannot act. Because of the wide range of transmission and noise conditions, however, both of these relay chains include attenuators that permit adjustment of their sensitivity so as to insure satisfactory operation under all conditions.

So far, three of the attenuators shown in Figure 1 have been accounted for: the transmitting volume attenuator, which permits compensating for the variation in talker volumes, and the two sensitivity attenuators. Adjustment of the transmitting sensitivity attenuator depends on the noise in the land lines. The transmitting relay chain must be sensitive enough to act on comparatively weak speech, but not sensitive enough to act on noise. When the noise is low, therefore, comparatively little loss will be required in the attenuator, while as the noise increases, more loss must be inserted in the attenuator to insure that the noise alone will not block the incoming path. The receiving sensitivity attenuator is similarly adjusted to meet noise conditions over the radio link: high noise requires considerable loss in the attenuator, and low noise, little.

Each of these three attenuators is independently adjusted to meet its particular objective, but by these adjustments alone it is not possible to secure satisfactory operation. Assume, for example, that the land line is quiet, and that a low-volume talker has just finished using the transmitting channel. As a result of these conditions, there would be little or no loss in either of the attenuators in the transmitting path. Assume further that the radio link is noisy at the moment, and that as a result considerable loss has been put in the receiving sensitivity attenuator. If talking now began at the distant end, the portion of the speech that crossed the hybrid at the left of Figure 1 would be sufficient because of the small loss in both of the transmitting attenuators to actuate the transmitting relay chain of the Vodas and block the incoming speech. To avoid such a situation, the receiving volume attenuator is inserted in the circuit as indicated in Figure 1, and sufficient loss must be inserted by it so that from point P on the incoming channel there is more loss in the path to the transmitting relay chain than in that to the receiving relay chain. If this situation is maintained under all conditions encountered, incoming speech can never block itself.

In the path from point P to the transmitting relay chain there are three attenuators and a certain amount of fixed loss and gain: the receiving volume attenuator, V_R; the transmitting volume attenuator, V_T; the transmitting sensitivity attenuator, S_T; and a fixed loss, K, which is adjustable since it includes the two amplifiers as well as the losses across the hybrids and other losses not indicated in Figure 1. Between P and the receiving relay chain there is only one attenuator, S_R, and a fixed loss, L, which includes the loss across the hybrid coil and other unindicated losses. The requirement for the loss between point P and the two relay chains may thus be written:

(1) $S_R + L < V_R + V_T + S_T + K$

The amount by which the right side of this inequality should be greater than the left is called the echo margin. It should never be less than some value M, but may be greater. By adding M to the left side of the above expression, therefore, the inequality may be converted to an equation:

(2) $S_R + L + M = V_R + V_T + S_T + K$

Since K and L are constant, they may be

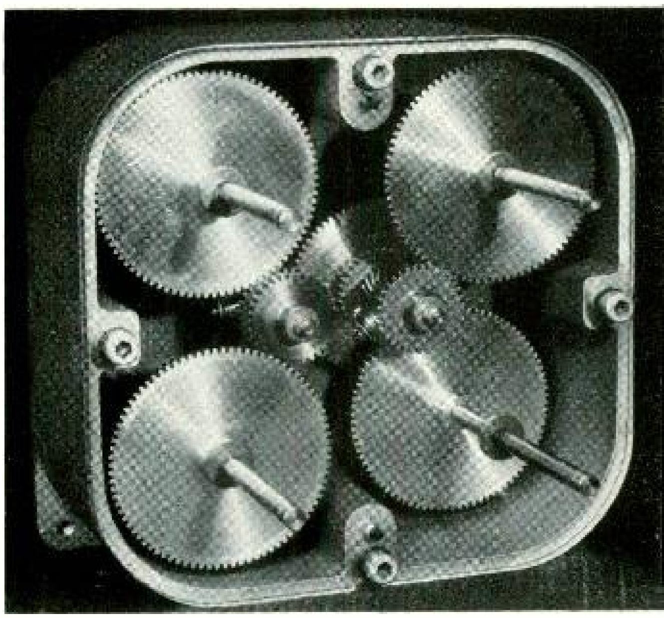


Fig. 2—Gear train used in the B4 radio control terminal

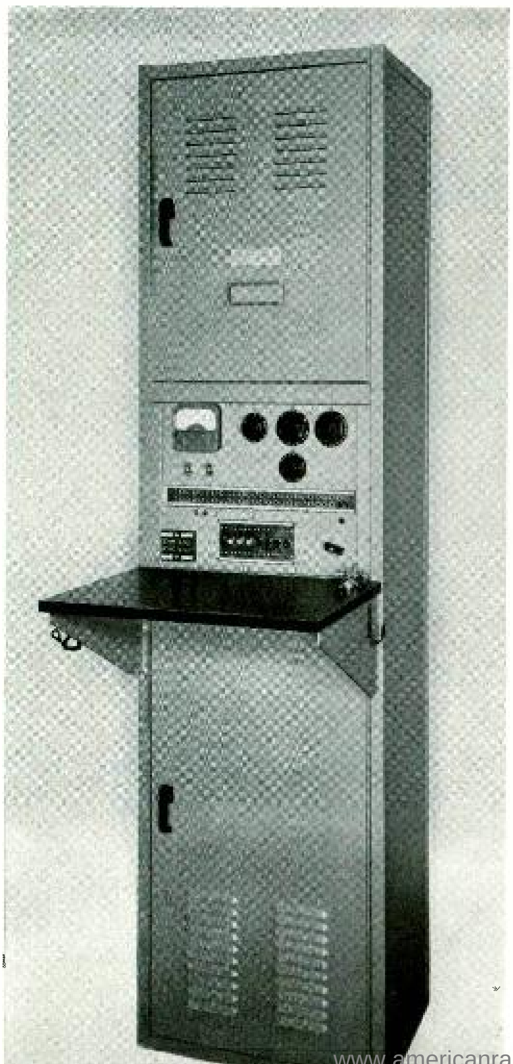
combined with M into a single constant N, and when this is done, the requirement for satisfactory terminal operation becomes:

(3) $S_R + N = V_R + V_T + S_T$

S_R, V_T, and S_T are all adjusted independently to meet the conditions already described, and one of the major problems of terminal control is to adjust V_R to compensate for any changes made in any of the other three attenuators. If either V_T or S_T is increased, V_R must be decreased by the same amount, while if S_R is increased, V_R must be increased by the same amount.

This is accomplished by a gear unit associated with all four attenuators. This unit is shown in Figure 2. It is mounted just behind the three dials evident at the right of the meter panel of the B4 terminal shown in Figure 3. The upper left of the three dials controls the transmitting volume, the upper right controls the receiving sensitivity, and the lower left, the transmitting sensitivity. No dial is provided for the receiving volume attenuator which, through the gears, is automatically adjusted to compensate for changes made in the settings of the other three.

Fig. 3—The B4 radio control terminal



The gears shown in Figure 2 by which these various changes are made are shown diagrammatically in Figure 4. The two transmitting controls and the receiving sensitivity may be adjusted to any value desired by the dials on the panels without affecting the other two, but a change in any of the three produces the proper compensating change of the same number of db in the receiving volume. To prevent a rotation of any of the three dials from causing a rotation in any of the others, two sets of differential gears are connected into the train as indicated. They each consist of four bevel gears associated as indicated in Figure 5. Bevel gear D is connected to a spur gear Z, while gears A and B are idling gears free to turn on the common shaft S. The fourth gear, R, is connected by the shaft P to an adjacent spur gear X. A second shaft, T, is attached rigidly to the idler shaft S and passes through bevel gear R, shaft P, and spur gear X to drive gear Y. Either X or Z is always the driving gear, while Y is always the driven gear.

If D is rotated clockwise, looking from left to right, gears A and B will both be rotated, the former clockwise looking upward and the latter counterclockwise. If the idler shaft S were held fixed, the result of the rotation of A and B would be to rotate R in the counterclockwise direction. If R were held fixed, on the other hand, gears A and B and their connecting shaft S would rotate around it in a clockwise direction. If X were the driving gear, a similar train of thought shows that D would be driven in the opposite direction if the shaft S were held fixed, while if D were fixed, A and B and the shaft T would be driven in the same direction.

All of the three dials on the front of the panel have a detent mechanism associated with them that locks them in position except when enough turning force is applied by the hand to override the force of the detent. The attenuators, on the other hand, are free to turn in either direction. It will be noticed from Figure 4 that gears x and z of both differentials are held fixed by connections through spur gears to one or the other of the dials. When the transmitting volume dial is driving, therefore, shaft T of both the L and M differentials is rotated and drives the receiving volume attenuator. Both the transmitting and receiving sensitivity attenuators are held by the detents. When the transmitting sensitivity dial is driving, a similar action takes place by driving from gear x of differential L rather than from gear z. The receiving sensitivity dial drives the receiving volume attenuator directly through spur gears. Regardless of which dial is doing the driving, therefore, only the attenuator controlled directly by the dial and the receiving volume attenuator will be moved, and in each case the direction of rotation will be such as to compensate according to the equation (3).

The amount of attenuation per step is the same for all the attenuators since one step by v_R must compensate for one step of any of the other three. The number of steps in the attenuators, however, will necessarily not be the same since the number of steps in v_R must be equal to the sum of the number of steps in the other three. In the B4 terminal, s_R has twenty loss steps; v_T, eighteen; s_T, four; and v_R thus has the sum of these numbers of forty-two loss steps. The loss occasioned by each step is 2½ db, but since all steps are equal, it will be more convenient to refer to loss in terms of steps, even when referring to the constant N of equation (3).

To determine the loss in the v_R attenuator for various settings of the other attenuators, equation (3) may be solved for v_R giving:

(4) $v_R = s_R + N - v_T - s_T$

As may be seen from this equation, v_R will

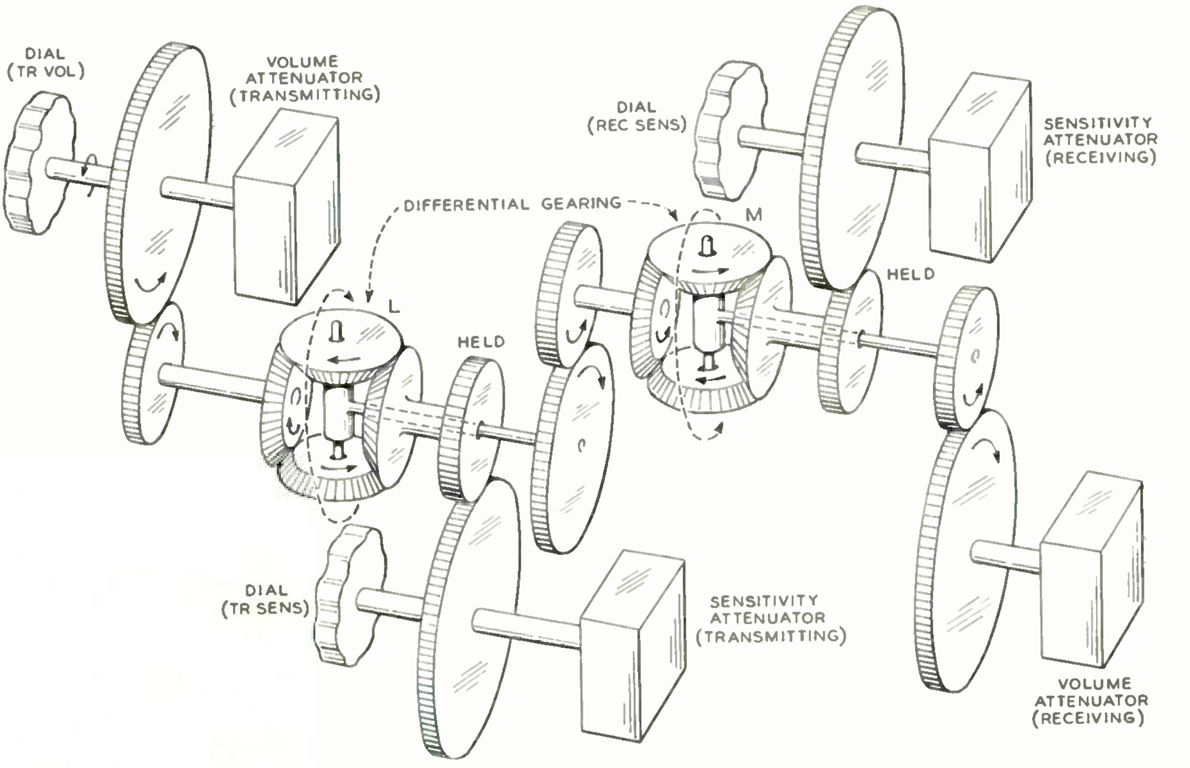


Fig. 4—Diagrammatic representation of the gear train in the B4 terminal. The two transmitting controls and the receiving control may be adjusted to any value without affecting the other two, but a change in one produces the proper compensating change of the same number of db in the receiving volume

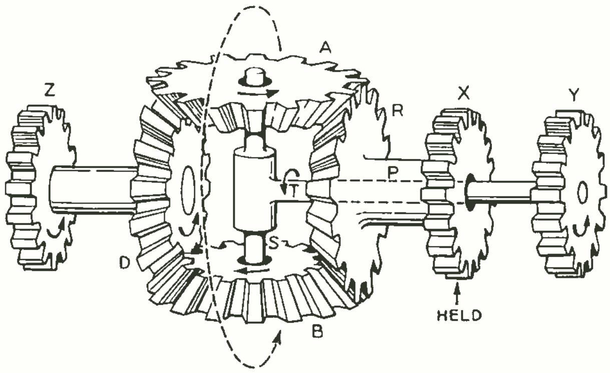


Fig. 5—Diagram of the differential gear arrangement used with the B4 terminal

be greatest when s_R is maximum, and v_T and s_T are zero. Since the greatest value of s_R is 20, the maximum value of v_R is given by the equation:

(5) $v_R\,(\text{max.}) = 20 + N$

If N were 22, the maximum value of v_R would be 42, which corresponds to the number of steps required on the v_R attenuator to permit it to move one step for each step of any of the other attenuators. With equal loss in all 42 steps, however, v_R would have 105 db loss in its maximum position.

There is another factor, however, that affects the value of v_R, and that is the received speech volume delivered to the land lines, which will naturally vary with the loss in v_R. To give satisfactory operation, this speech volume should never be greater than −9 VU. This requirement can be met if the gain of the receiving amplifier is adjusted to deliver −9 VU when v_R is 0. Point P is kept essentially at a constant volume by the radio receiver.

The value of the constant N is 4 in the actual circuit, and if this value is substituted for N in equation (5), the maximum value of v_R becomes 24. Since the highest step on the v_R attenuator must be 42 to take care of the mechanical requirement, steps 0 to 18 are all arranged to give zero loss, and loss will be inserted by v_R only in the 24 steps above step 18. The effect of this may be seen by inspecting equation (3), which is repeated here for convenience:

(3) $s_R + N = v_R + v_T + s_T$

At its highest step, v_R introduces a loss of 24 which will be reached only when s_R is at its highest step and v_T and s_T are on their zero steps. Under these conditions, since N is 4, equation (3) becomes:

$$20+4=24+0+0$$

If s_R is left undisturbed and v_T and s_T are increased to their highest steps of 18 and 4, respectively, equation (3) becomes:

$$20+4=2+18+4$$

with v_R decreasing one step for each step of increase in v_T and s_T. Further motion of v_R toward the lower end can be brought about only by decreasing s_R. As this is done, v_R decreases 2 steps and then no change in the loss takes place on the right-hand side of this equation, since all the lower steps on v_R give zero loss. To keep the equation in balance, therefore, N increases as s_R decreases: when s_R is 0, N becomes 22. The effect of having the 18 lowest steps of the s_R attenuator give zero loss, therefore, is to increase the echo margin when the sum of v_T and s_T is greater than s_R.

Besides these control features, the B4

THE AUTHOR: V. J. Hawks received the B.S. degree in Electrical Engineering from the University of Michigan in 1925 and immediately joined the Transmission Development Department of these Laboratories. The various projects upon which he has worked include: long-wave transatlantic radio, band splitting and speech inversion types of privacy devices, the C2S, CF1, CF4 carrier telephone systems and radio control terminals. In 1937 he was sent to Honolulu to install an A1 control terminal and the first model A3 privacy for operation on a radio link between Honolulu and San Francisco. At present he is engaged in work on the type N carrier telephone circuits.

terminal also includes its own power supplies and the necessary transmission testing equipment. The volume indicator shown on the front of the panel is normally connected to the receiving branch of the circuit, but is automatically transferred to the transmitting branch for outgoing speech, and thus always indicates the volume of the speech passing through the control terminal at the time. For testing purposes, this same instrument is used for measuring power, and the transmitting volume attenuator is used as a measuring attenuator. Jacks are associated with the circuit to permit these changes to be readily made. Another novelty in this new terminal is the use of sealed mercury relays.*

Besides the testing facilities, provisions are made for ringing between terminals with 1,000-cycle interrupted current, and between the terminal and other local points by 20-cycle current. It is arranged also to permit the use of a noise reducer† and of privacy equipment. It includes all of the features required of a radio control terminal, and with careful attention can provide as high a grade of service as any other terminal at present available.

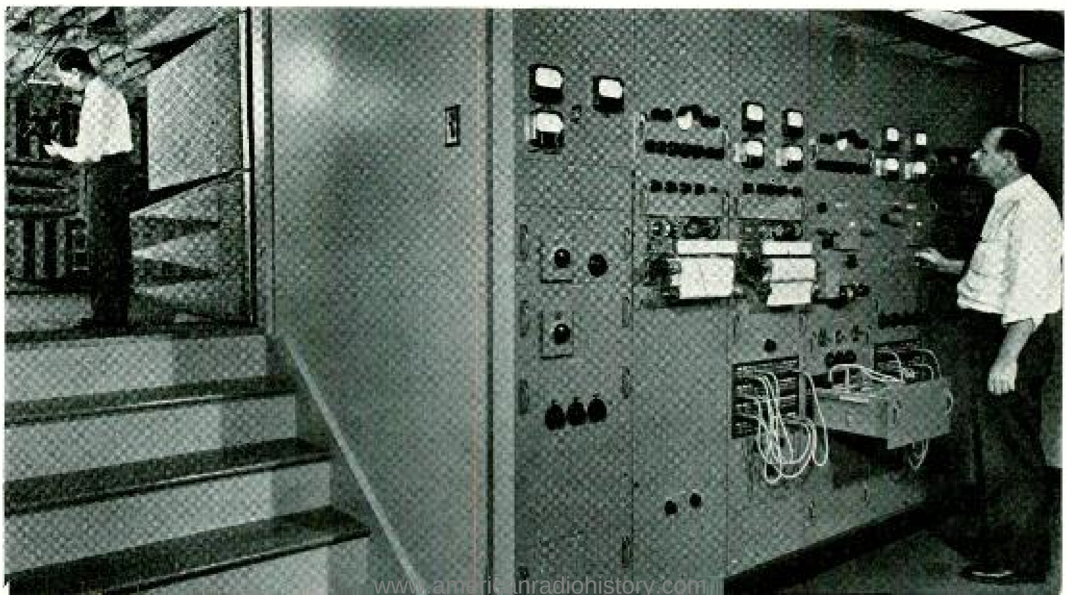
*Record, *September*, 1947, *page* 342.
†Record, *May*, 1937, *page* 281.

The sound measurements reference laboratory

Recently added to the testing facilities of Station Apparatus Development at Murray Hill is the sound measurements reference laboratory. Walls, floor and ceiling of the test room at the left of the illustration below are treated with sound-absorbing material. Sound instruments to be measured are mounted, as P. Kuhn is doing, from supports in the ceiling. The measurements system is mounted in the seven bays at one of which E. Hartmann is making an adjustment.

Facilities for the continuous automatic recording of data are provided, such as: (1) frequency response characteristics from 20 to 100,000 cycles per second with continuous or pulsed test signals; (2) noise analyses with a variable band width filter; and (3) harmonic and modulation product measurements for fixed frequency input signals as well as continuous fixed order harmonic analyses. A curve follower type of equalizer automatically adjusts circuit gain to compensate for deviations from response uniformity of sound instrument standards. The calibration of any sound instrument, therefore, may be recorded directly and subsequent calculations and transcriptions or data are unnecessary.

All component circuits are drawer-mounted to facilitate the adjustment of infrequently used internal controls and for maintenance accessibility. Flexibility of operation is provided by the installation of central jack fields where circuits may be interconnected as required.



Dynamic impedance of regulated power supplies

J. H. HERSHEY
Radio Development

Regulated rectifiers to supply d-c power for electronic apparatus are used in considerable number in the Bell System. With advancing techniques and improved apparatus, their performance has become highly satisfactory. A rectifier* that became available during the early war years gives a variation in output voltage of less than one-quarter of one per cent from no load to full load, and a ripple voltage of less than one-hundredth of one per cent for all normal variations in load and input voltage. In attempting to apply such rectifiers to radar apparatus, however, certain difficulties were encountered in spite of the good characteristics of the rectifiers. Such operations as scanning and pulsing make periodic demands for current at frequencies ranging from about half the power supply frequency to several thousand cycles per second, and it was found that there was coupling, largely through the rectifier, between the various radar circuits. As a result, the cyclic current in one circuit affected the operation of the other circuits.

Whenever several circuits are supplied power from a common source, there is always coupling due to the impedance of the common supply. A calculation of this impedance from the usual type of tests, however, was found to be too low to account for the couplings obtained. Such tests have usually been made with the circuit as shown in Figure 2. Output voltage is measured for various loads and line voltages by readings of the three meters shown, and the characteristics of the ripple voltage are obtained from the three pieces of measuring apparatus along the upper line of the diagram. The vacuum-tube voltmeter gives the rms value of the total ripple, the wave analyzer permits any one component of the ripple to be singled out and measured, while the oscilloscope permits the general character of the ripple

*Record, *July*, 1947, *page* 273.

Fig. 1—The author making a measurement on dynamic impedance at the Whippany Laboratory in New Jersey

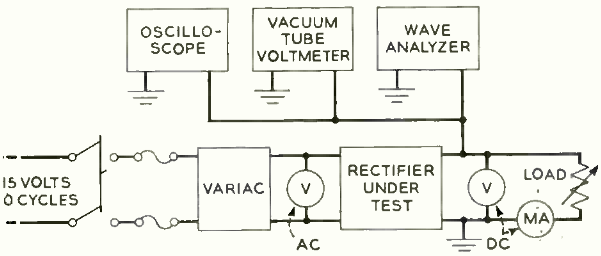


Fig. 2—Schematic of the circuit usually employed for determining rectifier characteristics

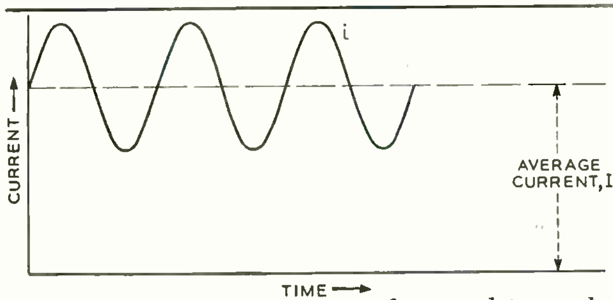


Fig. 3—Load current of a rectifier supplying radar equipment

to be observed. Measurements of this type, however, give characteristics under static conditions because the output is always constant for any one set of readings.

Since the impedance of the rectifier discoverable from such static tests was not high enough to account for the coupling being experienced in the radar circuits, it was obvious that a different impedance was present when the output current was varying cyclically because of the pulsing character of much of the radar load. The output current of a rectifier supplying radar equipment is of the type shown in Figure 3. Only a single sinusoidal current is indicated here, but under actual conditions there might be variations of several frequencies giving a more complex wave shape. Regardless of the frequency and amplitude of these variations, the average current remains constant, and the d-c output voltage would also be constant, since the voltage excursions due to the pulsing load will vary by equal amounts above and below the average value. A static determination of the rectifier characteristics, therefore, would give no indication of the presence or magnitude of these fluctuations, and yet it is these variations that cause coupling between the various radar circuits.

That the impedance of the rectifier to oscillating current would be different from its impedance to direct current is evident from the fact that the rectifier circuit includes coils and capacitors as well as resistors and electronic tubes, and at some frequencies the impedance may thus be much larger than the resistance component. To determine whether a rectifier is suitable for supplying circuits carrying varying currents, therefore, it is obvious that a dynamic method of test should be devised

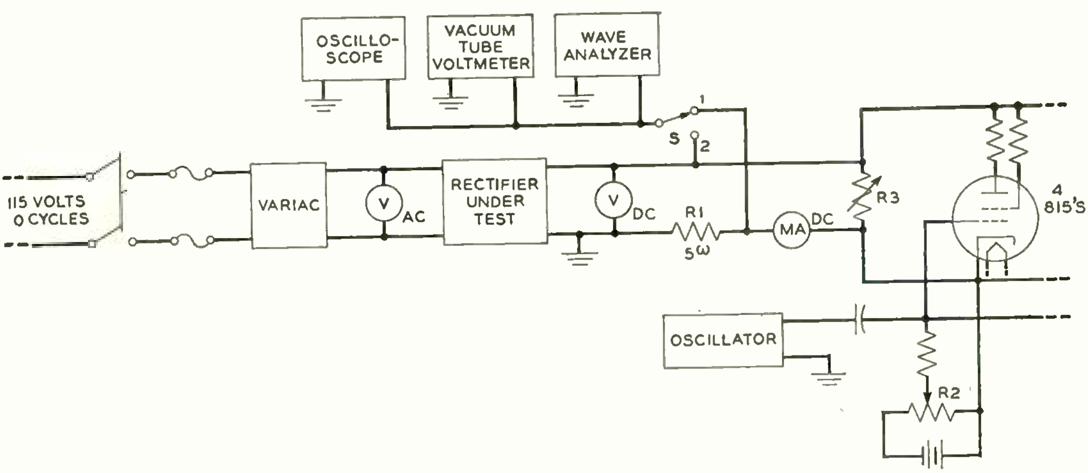


Fig. 4—Testing circuit used for measuring dynamic impedance

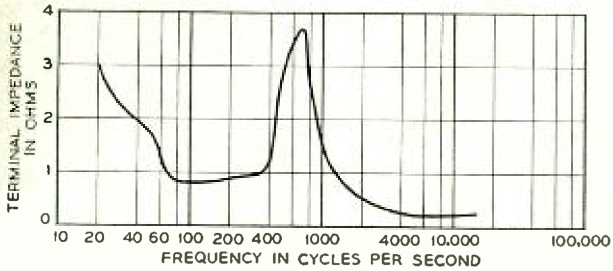


Fig. 5—Dynamic impedance of a 300-volt, 1-ampere rectifier designed as a radar power supply

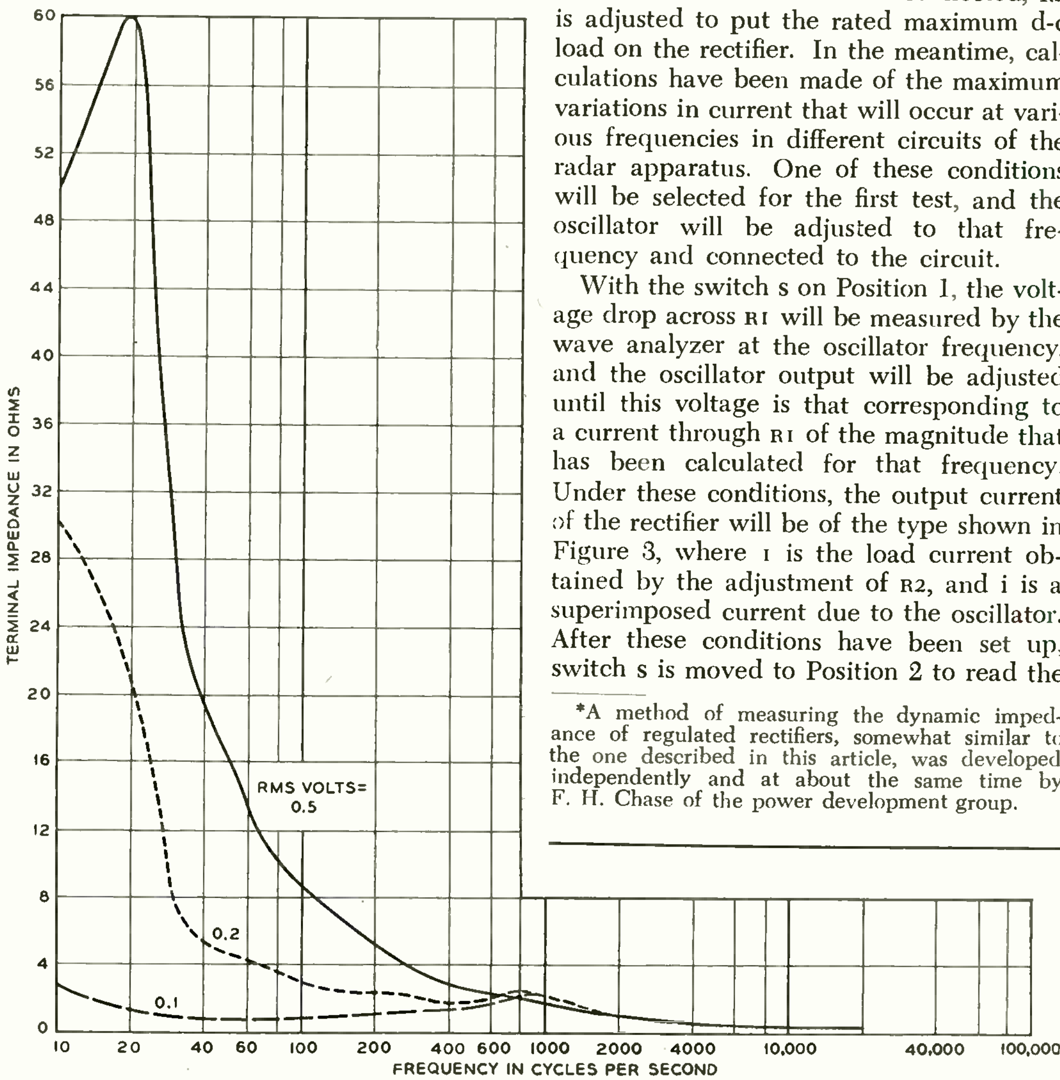


Fig. 6—Dynamic impedance of another type of 300-volt, 1-ampere rectifier for three values of pulsing current. Note high values of impedance at the lower frequencies

that would indicate the total value of the rectifier impedance instead of only its resistance component.*

With this objective in mind, the testing circuit shown in Figure 4 was designed. Load for the rectifier is provided by four type 815 vacuum tubes which may be adjusted by the potentiometer R2, with additional load available when needed from the slide-wire potentiometer R3. Superimposed on the voltage to the control grids of the tubes is the output of an oscillator which may be adjusted in frequency and amplitude. With the oscillator disconnected, R2 is adjusted to put the rated maximum d-c load on the rectifier. In the meantime, calculations have been made of the maximum variations in current that will occur at various frequencies in different circuits of the radar apparatus. One of these conditions will be selected for the first test, and the oscillator will be adjusted to that frequency and connected to the circuit.

With the switch S on Position 1, the voltage drop across R1 will be measured by the wave analyzer at the oscillator frequency, and the oscillator output will be adjusted until this voltage is that corresponding to a current through R1 of the magnitude that has been calculated for that frequency. Under these conditions, the output current of the rectifier will be of the type shown in Figure 3, where I is the load current obtained by the adjustment of R2, and i is a superimposed current due to the oscillator. After these conditions have been set up, switch S is moved to Position 2 to read the

*A method of measuring the dynamic impedance of regulated rectifiers, somewhat similar to the one described in this article, was developed independently and at about the same time by F. H. Chase of the power development group.

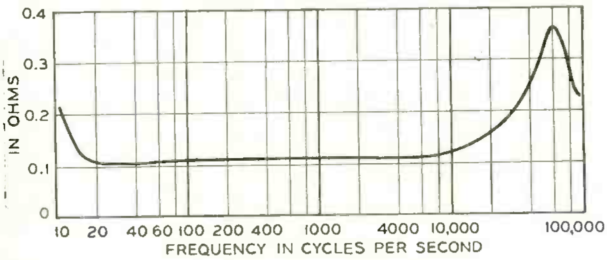


Fig. 7—Dynamic impedance of a 300-volt, 500-milliampere rectifier designed particularly to keep the dynamic impedance low

voltage across the output terminals of the rectifier at the same frequency. Using the wave analyzer set to the oscillator frequency, the rms value e2 of the superimposed voltage may be determined directly. The dynamic impedance at this frequency and load will be this value of e2 divided by the value of i determined from the previous test. Current i was not measured directly, however, but as a drop, e1, across the resistance R1, and the value of i is thus equal to el divided by R1. Dividing e2 by this expression for i gives as the dynamic impedance at the frequency of the oscillator $Z=(e2/e1)R1$, and thus it may be calculated directly from the two voltages read on the wave analyzer and the value of R1 used for the test. By making a series of such tests over the range of frequencies encountered in the radar equipment, it is possible to plot a curve showing the dynamic impedance of the rectifier at all frequencies.

A curve of the dynamic impedance of a 300-volt, 1-ampere rectifier with a d-c regulation of 0.25 per cent is shown in Figure 5. From 70 to 300 cycles, the dynamic impedance is less than one ohm, but at twenty cycles it is up to three ohms, and at 600 cycles it is up to 3.7 ohms. Figure 6 shows the impedance characteristics of a rectifier of different type, but of the same rating. It will be noticed that for some values of fluctuating current, the dynamic impedance may reach very high values at certain frequencies—running as high as sixty ohms for one set of conditions. The d-c impedance of this rectifier, as calculated from the rated load and regulation, is 0.75 ohm, which is far below the dynamic impedance found at certain frequencies. The particularly good regulation at all frequencies above 2,000 cycles is due to the fact that currents demanded by the load at these frequencies are readily furnished by the output capacitor of the rectifier.

In contrast to the curves of Figures 5 and 6, Figure 7 shows the impedance of a rectifier particularly designed to keep the dynamic impedance low. From 20 cycles to 10 kc, it is only slightly over 0.1 ohm.

Fig. 8—The new test set in use in the Western Electric plant at Winston-Salem

It is not the absolute value of the dynamic impedance that is of significance, since its coupling effect depends on the output voltage and current of the rectifier as well as on the impedance. It is some-times desirable, therefore, to employ a unit called coupling factor (CF) which would take into account all three parameters. The significant relationship is the value of the voltage variations appearing at the terminals of the rectifier because of the varying current in the dynamic impedance relative to the d-c output voltage. To express this relationship on a logarithmic basis as are other couplings such as crosstalk, CF is defined as 20 log E/i Z, where E is the d-c output voltage of the rectifier, Z the dynamic impedance, and i the rms value of the varying load current. For a 300-volt rectifier with a dynamic impedance of five ohms and a load current variation of 100 milliamperes, the CF would be:

$$20 \log[300/(0.1 \times 5)] = 55.6 \text{ db.}$$

Had the dynamic impedance been only 0.1 ohm, the CF would have been 89.5 db. The higher the value of the CF, the less will be the coupling between the circuits.

To permit measurements of dynamic impedance to be made in production, a test set has been developed that gives the dynamic impedance in a single reading. It is thus unnecessary to make a reading with switch s in Position 1 and then in Position 2, and to divide the latter by the former as is done with the circuit of Figure 4. With the new test set, e_2 is divided by e_1 directly, and the value of R_1 is taken into consideration in the scale provided. In Figure 8, this test set is shown in use in the Western Electric plant at Winston-Salem for testing regulated rectifiers used in Navy radar equipment. On top of the test set cabinet is seen the variable-frequency oscillator. The rectifier under test is shown in place in the lower portion of the test set. Any one of a number of rectifiers used in the same radar, but having different current and voltage ratings, can be tested in the same set. A feature built into the test set is the reversal of all d-c metering leads when a rectifier having a negative output voltage is inserted into the impedance testing unit.

By lifting the cover over the vacuum-tube portion of the rectifier under test, the tubes may be observed or replaced when necessary. The test set is mounted so that the front edge overhangs the test bench to permit tilting of the rectifier tube panel out and down for inspection of wiring or clearing of trouble. Thus the set is well equipped with conveniences for rapid production line testing.

THE AUTHOR: John H. Hershey joined The Ohio Bell Telephone Company in 1928 on a work assignment of the Coöperative Engineering School of the University of Akron. During the next fourteen years he held a number of positions, including plant supervisor, transmission inspector, inductive-coördination engineer, and foreman in the Installation, Testing, and Repair Departments. He was licensed as a commercial radio operator first-class in 1936 and as a professional engineer in the State of Ohio in 1940. In 1942 he came to Bell Telephone Laboratories on loan and in 1945 he transferred to the Laboratories.

Coaxial attenuation standards

J. S. ELLIOTT
Transmission Measurements

One of the primary requirements for an attenuation standard is that its loss remain constant over the frequency range of its use. For the lower frequency ranges, many satisfactory types of attenuators have been built, using open wiring between the resistance elements and between these elements and the input and output connections. However, the parasitic reactances introduced by this wiring and the reactance of the resistive elements themselves produce changes in loss that become greater with increased frequency. As a result, this type of attenuator is limited to frequencies up to approximately 10 megacycles. The trend toward the use of higher frequencies during and since the war, however, brought about the need for the development of attenuators that would maintain their loss constant to much higher frequencies.

To apply to this extended frequency range, a radically different attenuation unit was developed in which the series and shunt resistive elements are arranged in the configuration of a coaxial line. A variation in loss with frequency is usually caused by the presence of reactive elements, since the impedance of such elements varies directly with frequency. In a properly designed coaxial line, however, the capacitances and inductances counteract each other in such a way as to make the net reactance zero, and thus there is no reactive component to produce a loss that varies with frequency. It is necessary, however, to insure also that the resistances do not change with frequency. As frequency increases, the current in a wire tends to concentrate more and more in the surface layers, and thus the resistance of the con-

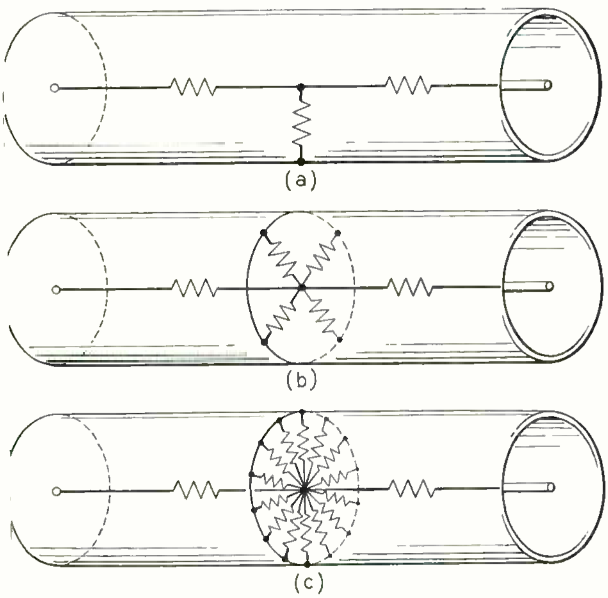


Fig. 1—Possible forms of T resistance networks in a coaxial structure

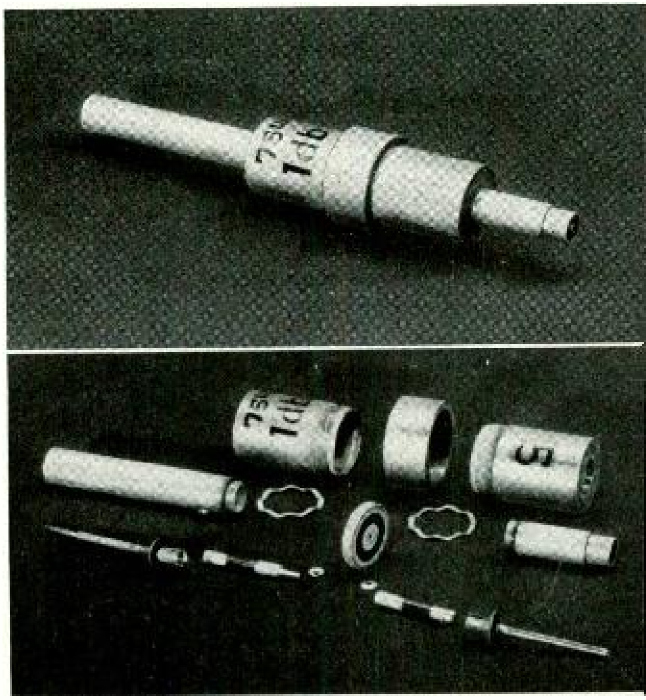


Fig. 2—A 1 db coaxial attenuator; assembled above; and component parts below

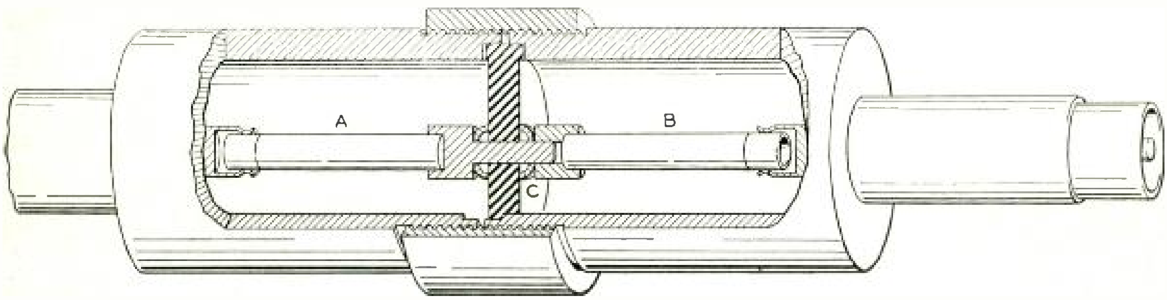


Fig. 3—Cross-section of attenuator unit shown in Fig. 2. Standard coaxial jacks and plugs have been used as terminals to maintain symmetry of units

ductor increases with the frequency. By using deposited carbon units* for the component elements, however, it has been possible to hold the resistance component constant with frequency. Thus, attenuation standards have been developed that are satisfactory for use up to 1,000 megacycles.

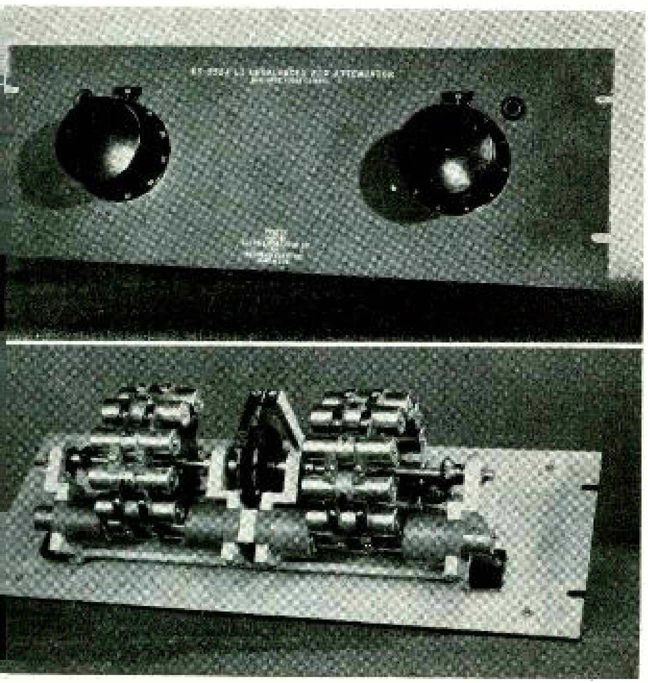
In its simplest form, a loss network of the coaxial type would be as indicated in the upper diagram of Figure 1. This is of the T type, with two deposited carbon rod resistances for the series elements and one for the shunt element. Many of the desirable characteristics of the coaxial structure, however, depend on circular symmetry. This requires, among other things, that the inside of the outer or grounded conductor be at the same potential relative to the center conductor at all points of the circumference. With only a single shunt element as at (a), this requirement is not met.

If only rods were available for the shunt elements, a much closer approximation to the ideal conditions would be possible by using four shunt rods arranged as shown in (b), and attenuators of this type were built. They showed considerable improvement over the open-wire type, and may be used with fair accuracy up to approximately 100 megacycles.

To improve the frequency performance still further, the symmetry of the line must be more nearly perfect, and this called for a still further division of the shunt arm, as shown approximately in (c). The effect of an infinite number of such arms was attained by using a ceramic disc with the face carbon coated in a continuous film, thereby providing a continuous shunt path. New designs of attenuation units were developed, using the elements shown in Figure 2 and in cross-section in Figure 3. Due care was taken in the assembly to minimize mechanical instabilities and to provide low and constant electrical contact resistance between the elements while permitting easy replacement of the resistive elements. The series arms are deposited carbon ce-

*RECORD, *October*, 1948, *pages* 401 and 407.

Fig. 4—An adjustable coaxial attenuator; front view of panel, above; rear view showing rotatable units below



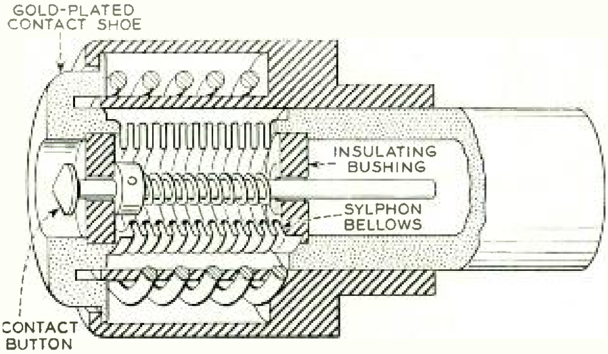


Fig. 5—Cross-section of fixed head used in attenuator shown in Fig. 4

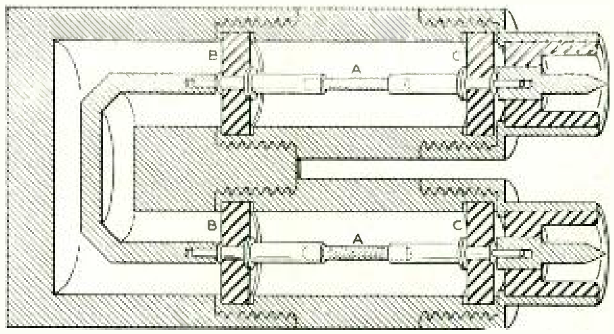


Fig. 6—Cross-section of U-shaped coaxial loss unit to have but one direction of motion

ramic rod resistances and the shunt is a ceramic disc with carbon deposited on one side only. Although discs coated on both faces would be easier to adjust and less expensive to manufacture, it was found that the parasitic reactances introduced were too great to be satisfactory. Standard coaxial jacks and plugs have been used as terminals to maintain symmetry of the line.

In using the standards shown in Figure 2, it is necessary each time to plug a pad of the desired value in the circuit. When the value of the pad must be changed frequently, it is desirable to have a faster means of making this insertion, even at some sacrifice of accuracy. For this reason, a dial-operated, adjustable coaxial attenuator was developed, which is shown in Fig. 4. Individual pads, similar to those of Figure 3, but with small metal buttons at the

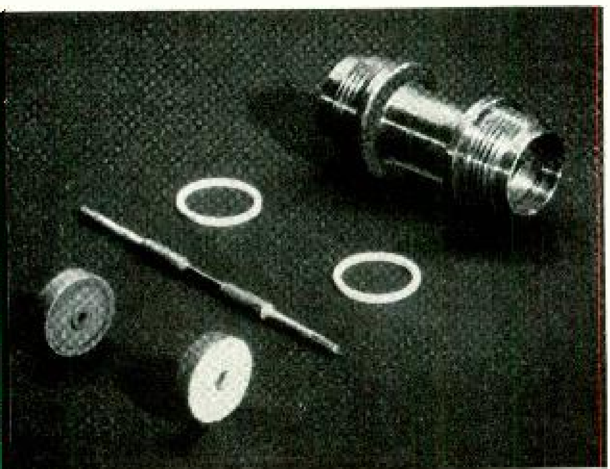


Fig. 7—Component elements of a π type attenuator

ends instead of plugs and jacks, are mounted on two drums, which are driven through gears from shafts with knobs and indicating dials. To connect the pads into the circuit, contacting heads, as shown in Figure 5, are used.

These heads must make independent contact in proper alignment with both the central conductor and the sleeve of the loss unit. A section of the sleeve between the contact end and the jack end is made in the form of a bellows, so that it can contract and expand within the fixed section of the contact head. A coiled spring normally holds it in its most expanded position. The central rod of the head is free to slide longitudinally, guided by two insulating bushings; one supported by the fixed part of the head and the other by the end of the sliding sleeve section. A collar on the central conductor fixes its maximum outward position, and a coiled spring—exerting pressure between this collar and the inner bushing—holds it in this position. When a loss unit is rotated into position between two such heads, the sleeve and center conductor move independently and maintain good contact. Connections from one pad to the next and from the end of the second pad to the output jack are accomplished in a like manner.

Although considerable improvement over the open-wire type was accomplished by this design, its performance was limited to loss changes of approximately 0.1 db for a change in frequency from 0 to 200 megacycles and of 1.0 db from 0 to 500 megacycles. Over the length of the head, the

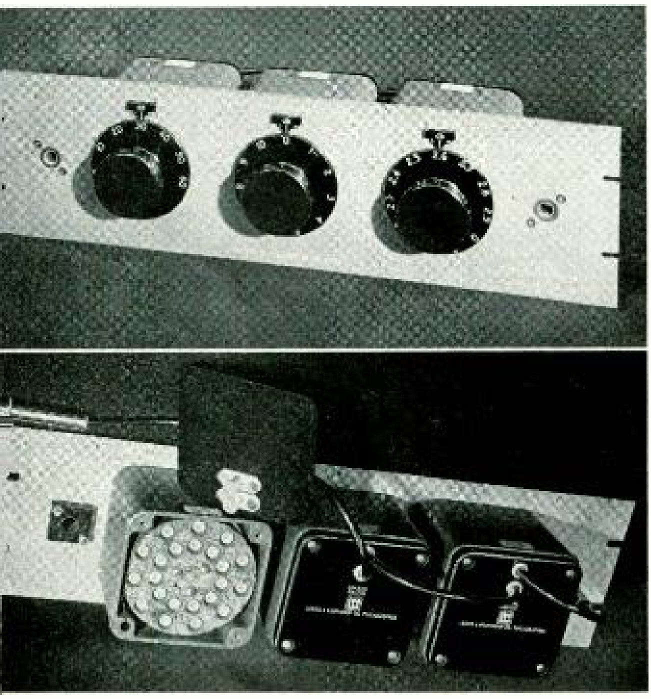


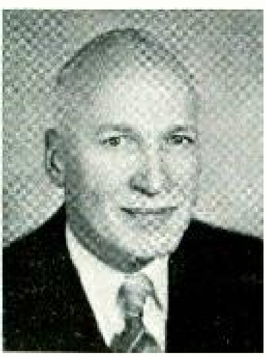
Fig. 8—A coaxial attenuator using the U-type units

simple symmetry of the coaxial structure is somewhat lost. The length of the head is great enough so that this reduction in symmetry introduces appreciable parasitic reactances which result in these limitations.

To secure a further increase in the frequency range, it seemed desirable to make the connection to the line unit with a coaxial plug, as was done with the units of Figure 2. With the unit of this construction, motion in two directions is required to insert the coaxial plugs in the two ends, and two directions of motion are awkward to provide in a multiple unit with some form of dial selection. To provide coaxial plug terminations and still have only one direction of motion, the pad was made in two parts to form a U, as shown in Figure 6. A reduction in the size of the pads was accomplished by developing smaller resistors and by using a π structure, which reduces the length of the single pad by approximately the length of one of the rod resistances. In the π structure, the series arm is a rod, A, and the shunt arms are discs, B and C. Carbon-deposited units of very high resistance are difficult to adjust, and thus for the higher loss units, half the loss is put in each of the halves comprising the complete unit. For losses from 1 to 20 db, however, where the resistance values are readily obtained, all the loss is in one half of the unit, while the other half consists of uncoated discs and a metallic rod and has essentially zero loss.

One of the component units is shown in Figure 7. Improved adjustment techniques have made it possible to use very small elements. By eliminating the relatively large connecting head and by using these small units, it has been possible to mount eleven of the units in the small dial-controlled drum, as shown in Figure 8. Besides its rotary motion used in selecting the particular unit, the dial has an in and out motion to permit one unit to be disengaged from its plugs before turning to another unit. To change units, therefore, the dial is pulled out, turned to the desired position and then pushed back in. The complete

---



THE AUTHOR: J. S. Elliott received a B.S. degree from Pennsylvania State College in 1922, and at once joined the Technical Staff of the Laboratories as a member of the Physical Laboratory. After a brief period spent in routine measurements and then in the design of condensers, he has engaged in the development of precision testing equipment and apparatus used in measuring the various electrical constants of transmission apparatus. In addition, during the war, he was responsible for the production of numerous direct capacitance test sets urgently needed by vacuum-tube manufacturers in controlling the performance of vacuum tubes.

drum assemblies are small enough to permit three of them to be mounted in a row on a relay rack panel. Leeds & Northrup have actively coöperated in the development of this attenuator and are responsible for its mechanical design and manufacture.

There has been a considerable demand for attenuators having 0.1 db steps from 0 to 1.0 db. The development of resistors of the necessary values, however, is still in progress. In the meantime, attenuators are being constructed with one dial having pads of 0, 2.0, 2.1, and so on up to 2.9 db.

A considerable number of pads like those shown in Figure 2, and the coaxial drum attenuators, as shown in Figure 4, have been constructed for use in testing circuits for the various radar systems, radio relay systems, mobile radio-telephone systems, and television systems over coaxial lines. The pads have been made in all loss values from 1 to 50 db, and their change of loss for frequencies up to 1,000 megacycles is within 1 db. The coaxial drum attenuators of Figure 8 are being built, having a loss range from 0 to 70 db in 1 db steps, or from 2 to 72.9 db in 0.1 steps. Measurements on model attenuators of this type indicate that their change of loss for frequencies up to 1,000 megacycles is within 1 db. All types may be made with a nominal impedance of either 50 or 75 ohms.

The Vail Medal

In order to establish a memorial to Theodore N. Vail, former President of the American Telephone and Telegraph Company, a permanent plan for giving recognition to the loyalty and devotion of Bell System employees in the public service was provided in 1920, and the Theodore N. Vail Memorial Fund was established. Income from this fund is used to provide three types of medals—bronze, silver, and gold, each with accompanying cash awards—which are awarded from time to time to employees of the Bell System in recognition of unusual acts or services which conspicuously illustrate the high ideals which governed the policy of Mr. Vail as to public service. Bronze medals, accompanied by cash awards of $100, are available for award in each Bell System Company. Silver and gold medals, accompanied by cash awards of $500 and $1,000, respectively, are available for award in the Bell System. These medals are also accompanied by a citation of the circumstances which occasion the award and a replica, in the form of a pin or button, of the medal.

Bronze medal award cases in the Laboratories are selected by our Vail Medal Committee of Award, appointed annually by the President and usually consisting of our Board of Directors. Fundamental characteristics considered in judging a case for a bronze medal award are:

(a) The case under consideration should show some identification with, or relation to, the telephone business;

(b) The proposed recipient must have exercised good judgment in combination with one or more of the elements of initiative, resourcefulness, courage, or fortitude; and

(c) The act accomplished or attempted must have been worth while and outstanding, and beyond that which would be expected of an employee, through his telephone training, as a part of the day-to-day job.

Silver and gold medal award cases are chosen from the bronze medal award cases in all of the Bell System companies by the National Committee of Award.

All cases which have any potential qualifications for bronze medal awards should be submitted to J. W. Farrell, Secretary of the Laboratories Vail Medal Committee of Award, through the regular channels of organization as such cases occur. Cases which are meritorious but which do not have any potential qualifications for bronze medal awards should also be submitted, in order that consideration may be given for other suitable recognition.

Because of the kind of work we do, members of the Laboratories seldom meet emergencies of the sort encountered by telephone company people. Only two Vail Medals are held in the Laboratories. One was awarded to E. J. Reilly, who, while on duty with the New York National Guard in 1926, showed courage in the face of personal injuries in connection with the explosion of a phosphorus grenade bomb. The other medal was awarded to R. W. Burns, in 1932, while with the A T & T, for a waterfront rescue near his home on Long Island, in which he saved a life. Members of the Laboratories who hear of any incident which might qualify for a Vail Medal award should report it through organization channels.

A T & T and Western File Answer to Government Suit

A vigorous denial that anti-trust laws are being violated by the Bell System was filed on April 27 in U. S. District Court at Newark, N. J., in answer to a Government complaint charging restraint of trade and monopoly in the manufacture and sale of telephone equipment. Western Electric Company, for more than 65 years the manufacturing unit of the Bell System, and the American Telephone and Telegraph Company are defendants in a Government civil suit seeking to separate Western from the System and divide it into three companies. Here are some of the points brought out in the answer:

Since all the operating units of the System have common problems, there are many things that can be done better and more economically in their behalf by a central organization. The American Company has undertaken to do these things, either directly or through its subsidiaries. To that end it develops and recommends technical standards and operating methods to enable the operating units of the System to work together effectively; it provides and makes available to the operating units the research and development facilities of Bell Laboratories and the manufacturing and supply facilities of Western; it assists the Bell Operating Companies in matters of finance and provides services and advice with respect to many phases of their operations; and it acts in behalf of the companies concerned in handling numerous problems affecting the System as a whole. Thus all the units of the System are parts of a single enterprise.

Manufacture and Supply

Western has been the manufacturing unit of the System continuously since 1882, when it became a subsidiary of one of the predecessors of the American Company. It is also the purchasing and supply unit; these activities were undertaken during the period from 1901 to 1913 in response to the need of the various operating units of the System for economical purchasing and inspection of materials manufactured by others than Western. Its functions in the System include the following:

It coöperates with Bell Laboratories and the American Company in the development and design of new and improved equipment needed by the operating units of the System;

It conducts research and development on manufacturing processes, methods and facilities;

It manufactures equipment to be furnished to the operating units upon their orders;

It purchases other equipment not of its own manufacture to be furnished to the operating units upon their orders, and makes technical and engineering inspections thereof;

It maintains stocks of equipment in distributing storehouses so located as to serve the convenience of the operating units;

It prepares complete engineering specifications for central-office equipment for the operating units, and maintains a nationwide organization which installs such equipment upon their orders;

It accepts equipment returned by the operating units and, according to their orders, either repairs it for them or arranges for its economical disposition by junking or otherwise.

Research and Development

Research and development in the communications field has always been an important part of the activities of the Bell System and has resulted in constant improvement in the telephone service and lower costs to the public.

The work of Bell Laboratories, which is undertaken only upon authorization of the American Company or Western, includes: (a) fundamental research in scientific problems in the communications field; (b) the development of equipment and operating systems; (c) the design of equipment and the preparation of specifications for its manufacture; and (d) collaboration with Western in the development of manufacturing methods. Although this research and development is primarily directed to the field of telephony, its by-products have been useful in other fields. During the war, the work of Bell Laboratories was almost entirely directed to aiding the military effort.

It is the practice to apply for patents upon inventions made in the course of the research and development work of the Bell System. By this means, the System is protected in the use of its own inventions and is enabled to realize part of their value through licenses to others. Non-exclusive rights under patents considered to be useful for the operations of the System are obtained from others in exchange for licenses under System patents, and, in some cases, by purchase. It is the policy of the System to make available upon reasonable terms to all who desire them non-exclusive licenses for any use under any of its patents.

Effect of the Integration

There is close collaboration between the American Company, Western and Bell Laboratories at all stages of research, development, design and manufacture and a close working relationship between their personnel. The American Company assembles and analyzes data as to problems arising in the course of telephone operation, as to the results of such operation, as to the need for particular developments and improvements and as to the prospective requirements for equipment. Bell Laboratories draws upon Western's manufacturing experience for assistance in designing equipment so that it may be economically manufactured, and makes tests of trial equipment in the plants of the operating companies. Western, in turn, draws upon Bell Laboratories' engineering experience for assistance in the best utilization of materials and in the development of processes and machines for manufacture and testing.

The unification of research and development, manufacturing and operation within the Bell System is made possible by the American Company's ownership of Western and Bell Laboratories. This unification is an important factor in promoting the efficiency, economy and dependability of the telephone service. It makes available to the operating telephone companies equipment of advanced design and high quality at prices substantially lower than would be obtainable in the absence of such unification. It facilitates the standardization of equipment which is essential to efficient operation of an interconnected telephone system. It enables the manufacturing and supply unit to adapt its production and planning to the anticipated needs of the System, and to mobilize its entire manufacturing capacity, stocks of equipment and installation forces for the restoration of service in time of emergency. And it assures that all steps in the development and production of the equipment are planned and carried out with intimate knowledge of the needs of the operating units of the System and with a common incentive to fulfill those needs most effectively. The ultimate beneficiaries of this unification are the users of telephone service, who thereby obtain better service at lower cost.

Summary of Defendants' Position

The defendants deny that the Bell System has been developed or exists for the purpose of acquiring or controlling a market for equipment of any kind or that such is the purpose of any policy or practice of the System. They deny that trade and commerce are restrained or monopolized in violation of the Sherman Act by the fact that the Bell System includes a manufacturing and supply unit which makes or procures equipment to be furnished to the operating units as ordered by them for the construction or maintenance of their telephone plant. They deny that the unification of research and development, manufacturing and operation in the Bell System is used or intended to be used to restrain or monopolize trade and commerce, to produce unreasonable or excessive profits for the defendants, or to accomplish any purpose contrary to law or the public interest. On the contrary, they allege that it is necessary for the Bell System to include a manufacturing and supply unit if nation-wide telephone service is to continue to be of the highest quality at low cost; that the Bell System maintains and uses its own manufacturing and supply unit solely to accomplish that result; and that it would be contrary to the public interest to disrupt the existing organization and manner of operation of the Bell System.

The integration of the Bell System companies, and their collaboration and singleness of effort, have been of great importance in the provision of adequate nation-wide telephone service in time of peace and vital to the national effort in time of war.

Palmerton Head of Western's Public Relations

The Western Electric Company has announced the appointment of Paul L. Palmerton as director of public relations succeeding Fred B. Wright who retired under the Retirement Age Rule on May 31.

Mr. Palmerton joined Western in 1929 as foreign manager of its subsidiary, Electrical Research Products, Inc. He was later appointed ERPI's European manager and ERPI's sales manager following that company's merger with the parent company in 1940. Mr. Palmerton subsequently served the Western Electric Company successively as radio merchandise manager, assistant manager of the company's radio division, and as assistant to the president of the company until last year when he became comptroller of the purchasing and traffic division.

Leroy A. Wilson, president of the A T & T, points out to a group of stockholders a model of Alexander Graham Bell's first telephone at the exhibit of new telephone developments presented at the company's annual meeting

"Looking Ahead With the Bell System"

An exhibit of some of the new devices, new systems, and new services being introduced by the Bell System has been prepared by A T & T with the collaboration of the Laboratories, to give telephone employees and telephone users a better understanding of developments that are just beginning to come into use. It was opened at 195 Broadway early in April, and is now being routed to other telephone centers throughout the country.

Under the general title "Looking Ahead With the Bell System," the exhibit brings together operating displays of toll dialing, radio relay transmission, Transistor amplifier circuits, and automatic message accounting; and descriptive displays of apparatus developments and long lines networks or "voice highways."

A display board showing progress in speeding up long-distance calls over the last thirty years, and an operating switchboard position, are included in the toll dialing display, which was planned by H. D. Hocker and his associates at Long Lines. The radio relay display, also supervised by Long Lines, is a stylized contour map of the route between Boston and New York, complete with towers, three of which are activated—two terminals and a relay. This display, which was shown at the I.R.E. convention in 1948, is an elaboration of a miniature microwave set produced by C. D. Hanscom for Bell System lecturers, based on a unit originated by W. E. Kock.

Possible future use of the Transistor in the telephone plant is demonstrated in the Transistor display, which compares amplified and unamplified transmission over a fifty-mile artificial line having an 18 db loss. The line has two branches with amplification, one using a transformer-couple Transistor circuit, and the other a vacuum-tube line amplifier in common use in the System. This display was planned by H. J. Kostkos and Milton Sapan, with the cooperation of members of the technical staff.

Extension of customer toll dialing through the use of automatic recording and accounting is demonstrated by an operating AMA exhibit which simulates two of the steps in an actual system: recording at the central office and

Vannevar Bush, one of America's foremost scientists and an A T & T director, listens intently to Amos Joel's description of the automatic message accounting equipment

printing toll slips at the accounting center. Standard perforators, reader, and printer are used with a relay circuit designed to fit the needs of the demonstration. The AMA display was planned and put together by members of the Systems Department under the general supervision of John Meszar. S. L. Eppel and A. E. Joel, Jr., designed the relay circuits; A. A. Burgess and E. M. Smith did the equipment design; and N. H. Thorn, apparatus procurement and construction.

Descriptive displays showing Bell System "voice highway" networks by means of illuminated maps, and the development of several types of apparatus since the original invention of Alexander Graham Bell, were planned by H. J. Habley of A T & T.

The entire project was prepared under the general direction of R. A. Nixdorf of A T & T, with Mr. Habley serving as coördinator for the many people who had a part in preparing the displays for the project. The architectural design and construction of the exhibit were by Bertell, Inc., who have carried out a number of similar commissions for the Laboratories and the Western Electric Company.

Brig. Gen. Reichelderfer

Brigadier General Reichelderfer, the newly appointed head of the Signal Corps Engineering Laboratories at Fort Monmouth, visited the Murray Hill and Whippany Laboratories on April 29. The purpose of the visit was to become acquainted with the work that the Laboratories is doing for the Signal Corps and with some of the things that are being done in the way of research and development work in the Bell Laboratories that are applicable to problems and purposes of the Signal Corps.

Last Out-of-Hour Lecture

For the final of the six 1948-49 series of informative out-of-hour lectures designed to acquaint employees with various areas of Laboratories' work, Brockway McMillan, research mathematician, spoke in the respective auditoriums at West Street and Murray Hill during the week of April 18. His subject was *An Introduction to Modern Automatic Computing Machinery*. In the single hour available for such an intricate subject, the speaker competently developed the background of the history for the analog and digital types of computers sufficient to bring his subject into the field of present practice. He then described the work being done on the digital type at the Laboratories, International Business Machines Corporation, R. C. A., Harvard and other organizations.

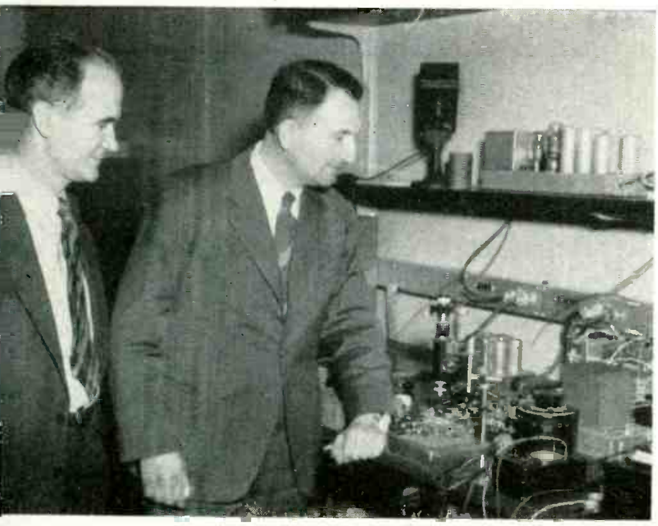
The wonders of the Transistor are demonstrated to a group of Bell System employees visiting the exhibit

Convertible Debentures Offered A T & T Stockholders

Stockholders of the American Telephone and Telegraph Company, at their annual meeting on April 20, voted to authorize a new issue of ten year, 3⅛ per cent convertible debentures to be dated June 20, 1949, and to be offered to stockholders of record on May 6, 1949, for subscription in the ratio of $100 principal amount of debentures for each six shares of stock held on that date. The amount of the issue is expected to be approximately $395,000,000.

The debentures will be convertible into common stock beginning September 1, 1949. From that date until June 20, 1951, they will be convertible at $130 per share, payable by surrender of $100 of debentures and payment of $30 in cash for each share of stock to be issued upon conversion. On and after June 20, 1951, they will be convertible by the surrender of $100 of debentures and the payment of $40 in cash. The debentures will not be callable until June 20, 1951, but will be callable thereafter, in whole or in part, on 30 days' notice, the initial redemption price being $106.

Each stockholder of record on May 6, 1949, has received rights to subscribe to the new issue. These rights may be used to subscribe or may be assigned or sold. They were sent to stockholders on or about May 16, and subscriptions will be accepted by the company up to and including June 20, 1949.



Dr. Egon Orowan (right), head of the Metal Physics Group of the Cavendish Laboratory, University of Cambridge, discusses with W. Shockley experiments on injected holes in germanium carried out by J. R. Haynes. Dr. Orowan spoke on Creep in Metals *in the Arnold Auditorium on April 4*

Through this gate will pass some of the most valuable treated wood specimens that have ever been produced for experimental purposes. The new road leads through the pines to the newest test plot, recently established by the Laboratories with the coöperation of the Western Electric Company and the Southern Bell Telephone Company, just south of Jacksonville, Florida. This new field laboratory is similar in purpose to those at Chester, N. J., Gulfport, Miss., and Limon, Colo.—The photograph was taken by G. Q. Lumsden

300,000 Participating in Stock Plan

Approximately 300,000 Bell System people are now purchasing some 2,300,000 shares of A T & T stock by payroll allotments under the two offerings of the Employees' Stock Plan. Under the first offering, about 220,000 employees were purchasing some 1,200,000 shares of stock at the end of 1948.

In the Laboratories, 76 per cent of eligible employees are now making payments under either the 1947 or 1948 offering, or both, for a total of 68,000 shares.

Relocations

H. M. Gessner, J. J. Doody, and F. M. Hodge, of Accounting, have moved from Murray Hill to Room 819, Graybar-Varick.

J. E. Ballantyne and F. P. Gilliland have transferred to Plant Engineering—Murray Hill, and are located in Room 2D-261 there.

F. F. Merriam and A. L. Zitcer of Research Engineering are now located in Room 2D-528. A. A. Roetken and D. M. Black of the same group are in 2D-530.

The Shop Planning group reporting to F. W. Brunnengraber is now in 2C-153.

W. Patterson has transferred from New York Shops to Murray Hill Shops and is now in 2C-138.

Julia Goeltz, who had been supervising a computing group in Switching Engineering, now has similar responsibilities in Transmission Network and is located in 2C-379 at Murray Hill.

T. A. McCann Honored

One of the few Laboratories men to be decorated by the British Government is T. A. McCann, of Maintenance Facilities. Early commissioned from the Laboratories, Mr. McCann eventually became Colonel and chief of the Signal Information Section, SHAEF, where he was responsible for intelligence on military and civil communications in enemy-held territory in anticipation of the European invasion. While abroad he was awarded the Order of the British Empire, and now has received the warrant of an officer's rank in that order.

News of the International Relations Group

Among the recent speakers at the International Relations Group in the Arnold Auditorium were E. E. Thomas, whose talk on *English Life* described his observations during a visit to his native land; Rev. Rudolf Kiviranna, pastor of the Estonian Lutheran Church in New York, who spoke on *The March of Events in Estonia;* P. B. Findley, editor of Bell Laboratories Record, who presented a travelogue illustrated by colored movies and slides of *Glorious Guatemala;* and Prof. E. F. E. H. Velander, managing director of the Royal Academy of Engineering Sciences in Stockholm, who spoke on *Scandinavia in the Post-War World.*

H. H. Lowry Elected Pioneer President

At the annual business meeting of the Frank B. Jewett Chapter of Telephone Pioneers of America, held at noon on April 29 at West Street, H. H. Lowry was elected president, M. J. Kelly first vice-president, and Hazel Mayhew, second vice-president, for the coming year. The secretary and treasurer, appointed by the president in accordance with the amended constitution of the chapter, are Hattie Bodenstein and A. O. Jehle.

J. F. Kearns, A. G. Jensen and Dorothy Storm were elected to serve from 1949 to 1951 on the Executive Committee on which R. J. Nossaman, P. W. Spence and C. E. Swenson are serving until 1950.

R. A. Haislip, President of the Pioneers, conducts their annual meeting in the West Street Auditorium, at which H. H. Lowry was elected to succeed him for the coming year

Laboratories Chauffeurs Had No Accidents in 1948

For operating its passenger fleet without an accident from January 1 to December 31, 1948, the Laboratories has received an Award of Merit Certificate in the Inter-Fleet Accident Reduction Contest conducted by the Commercial Vehicle Section of the Greater New York Safety Council. Presentation was at an annual luncheon of the Section during the 19th Annual Safety Convention-Exposition of the Council at the Hotel Statler, New York City. Members of the Laboratories responsible for safety of its personnel during employment visited the displays and attended technical sessions.

D. P. Barry, L. E. Coon, T. J. Crowe, J. S. Edwards, W. S. Gorton, M. M. McKee, G. J. Seltzer, W. C. Somers, W. B. Vollmer and Dr. W. W. Widdowson attended the Annual Dinner of the Convention on March 31.

Changes in Organization

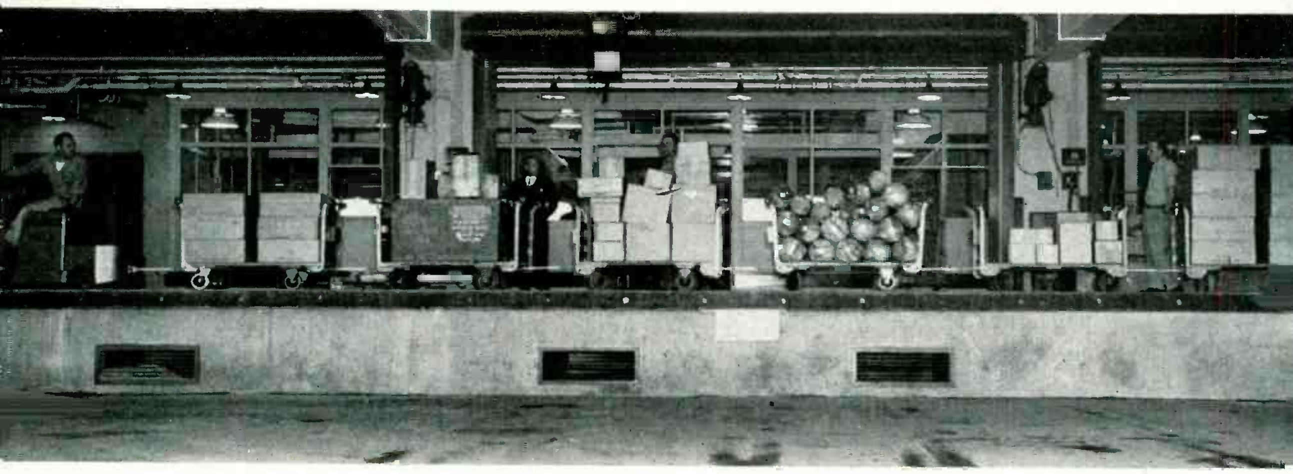
Functions of Apparatus I and II Specifications and Drafting Department, under the supervision of H. J. Delchamps, Specifications Engineer, are now organized on an area basis as follows:

L. E. Parsons, Specifications Engineer, New York, is responsible for all phases of specification, drafting, and associated work in the New York area.

W. A. Bischoff, Specifications Engineer, Murray Hill, is responsible for all phases of specification, drafting, and associated work in the Murray Hill area.

Retired But Active

A clipping from the Fort Myers (Florida) *News-Press* of April 29 brings the news that L. S. O'Roark has caught his first tarpon after an hour's battle. The fish was a 40-pounder.



Bulk Business at Murray Hill

A vast business is carried on during every working day at the Murray Hill receiving, shipping and salvage divisions. The photographs on these two pages show some of the people, the apparatus and the environment involved in the immediate scene.

Above—For this picture, the vehicles were temporarily removed to show the train of six hand trucks about to leave the receiving platform in tow of the electric horse which is operated by N. J. Flynn. C. A. Grant stands in the center. J. J. Dowd is behind the middle packages and D. Mahoney at the right

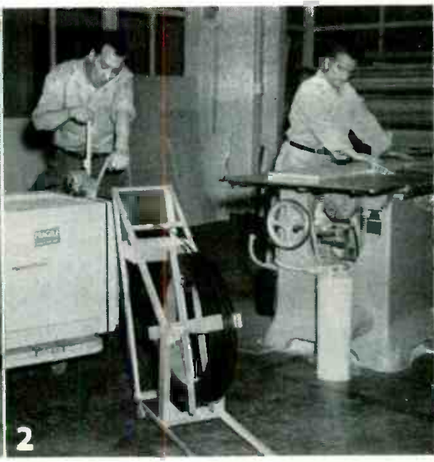
Below—In the office area, left to right, typist Marie Giambrone and clerk Eileen Gilburn; traffic supervisor F. J. Ficken; office and salvage supervisor F. J. Shiel; and receiving and shipping supervisor C. A. Grant

1—Since truck tailboards are at different levels from ground, a portion of the receiving floor may be elevated, as shown, to accommodate all varieties of tailboard heights. Upon completion of unloading, the levelator is raised to platform height. J. A. Pecca is bending over the truck and George Flourni is to the right

2—In this shipping room scene, W. A. Notte, left, is using a strapping machine and A. J. Sandor a power saw

3—J. A. Pecca, left, and A. J. Maldonato are checking the contents and applying receiving department copies of orders to packages received via parcel post. Use of these types of portable trucks makes it possible to work near files and to place packages on trucks for further delivery without unnecessary handling

4—A typical scene of a truck being unloaded and its contents checked. In the foreground, A. J. Maldonato is checking receipts from a laundry delivery and, at extreme left, J. J. Dowd positions a flat truck, which will be made up into a train of trucks, as shown in other pictures. In the center, D. Mahoney is readying a second truck for the chain, and the Western Electric Company boxes and cables in

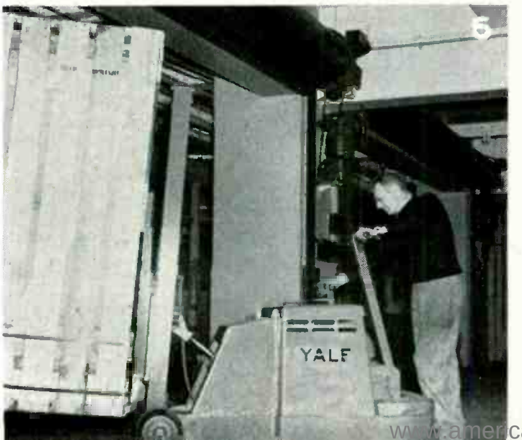


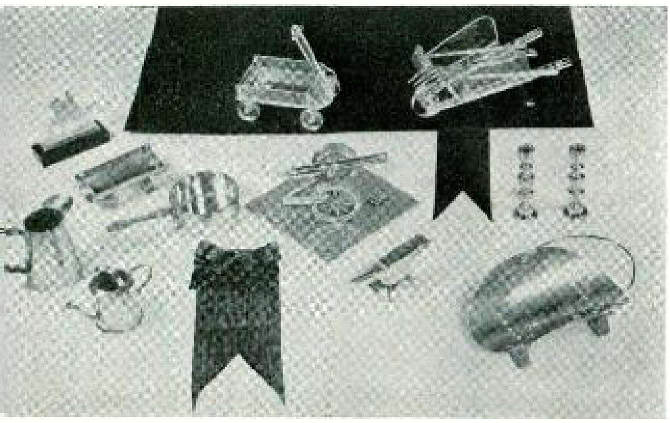
the middle foreground are to be noted on a pallet, which will be transported efficiently by an electromechanical forked truck

5—Liquid air is placed on a skid-type truck, having a specially designed tow bar attached for the tow which permits trailing a truck series around corridor corners. J. J. Dowd is the operator

6—This 2,600-pound box was received at Murray Hill freight station for storage locally. The forked truck was loaded on a motor truck which went to the railroad, and there one man and the truck chauffeur removed the box from the freight car. J. U. Meats is operating the forked truck in the final stages of what would previously have required a millwright crew for a trip to the freight office

7—A regular two-ton manual chain hoist is shown operated by A. J. Sandor. In the background, a fireproof metal bin for excelsior is to be seen





Copper and plastic miniatures that were made by G. C. Whittles received the "Best of Show" award at the recent Hobby Exhibit at Whippany

Whippany Hobby Show

Your chance of enjoying any number of fascinating hobbies is greater when you live and work in a rural area, if the recent Hobby Show at Whippany is any indication. Following the Model Railroad Show, the people at Whippany submitted one of the finest displays of handicrafts, miniatures, models and collections that has yet been shown anywhere in the Laboratories. The accompanying list of the winners gives you an idea of the scope of the Show.

Coaxial Cable's 20th Anniversary

The twentieth anniversary of the invention of the coaxial cable system (May 23, 1949) found the two Laboratories' engineers who invented it comparing their first experimental model with the newest type of cable (see cover). Lloyd Espenschied, left, holds a section of the experimental cable which was installed at Phoenixville, Pennsylvania, late in 1929. His colleague, Herman A. Affel, holds a section of the modern, eight-tube cable now being installed in the Bell System's expanding coaxial cable network. By the end of 1950, approximately 12,000 miles of coaxial cable are expected to be installed, furnishing heavy-capacity communication pipe lines between virtually all the large cities of the East, Middle West and Pacific Coast. Today's cable can carry 600 conversations or two television programs on each pair of the eight tubes, and recent advances are expected at least to double, and possibly triple, this capacity.

News Notes

M. J. KELLY spoke on *Industrial Research and Development—Its Problems, Organization and Personnel Requirements* before the M.I.T. section of the American Institute of Electrical Engineers and the Institute of Radio Engineers. Dr. Kelly spent two weeks at the Los Alamos Laboratory of the Atomic Energy Commission in New Mexico.

Awards for Whippany Hobby Show

BEST OF SHOW

1. Copper and Plastic Miniatures—G. C. Whittles
2. Needlepoint—Betty Engstrom
3. Model Electric Locomotive—A. A. Currie

BEST OF CLASS

Collections

1. Stamps—E. C. Weiss
2. Indian Arrowheads—W. D. Kitchell
3. Spoons—Betty Engstrom

Handicrafts

1. Needlepoint—Betty Engstrom
2. Bedspread—Harriet Filmer
3. Sweater—Helen Benz

Miscellaneous

1. Copper and Plastic Miniatures—G. C. Whittles
2. Microscope Head—R. F. Lane
3. Lamps—U. S. Berger

Utilities

1. Home Mixer—R. F. Lane

BEST OF SUB-CLASS

Stamps

1. E. C. Weiss

Coins

1. J. Kovac

Miscellaneous Collections

1. Indian Arrowheads—W. D. Kitchell
2. Spoons—Betty Engstrom
3. Hippopotamuses—T. W. Winternitz

Antiques

1. Civil War Items—W. Smith

Art

1. Painting—F. E. DeMotte
2. Drawing Railroad Train—J. G. Matthews

Scale Models

1. Covered Wagon—P. Albrecht
2. Ship in Bottle—C. Bengsten
3. Fire Engine—P. Albrecht

Crocheting

1. Doilies—W. D. Kitchell
2. Afghan—W. D. Kitchell

Leather

1. Saber Case—W. Bachmann

Miscellaneous

1. Index Milling Vise—R. F. Lane
2. Meters—D. Cotte

HONORABLE MENTION

Kodachromes—R. H. Kreuder
Photographs—A. L. Johnsrud
Model Airplanes—E. Babcock

WILLIAM FONDILLER sailed for Le Havre on April 25 aboard the *Nieuw Amsterdam* to visit relatives in Paris and later to fly to Israel where he will give three lectures during his visit. Mr. Fondiller will return on June 20.

R. J. NOSSAMAN has been appointed Director of Outside Plant Development to succeed R. A. HAISLIP who has retired.

HARVEY FLETCHER has been elected an honorary member of the Acoustical Society of America of which he was one of the founders and its first president. The only previous honorary member was Thomas A. Edison. Dr. Fletcher was granted honorary membership "in recognition of his outstanding contributions in acoustics as attested by his own successful researches in the fields of speech, music and hearing, and his effective direction of the researches of others in various fields of acoustics, and in appreciation of his able leadership as the Society's first president and his wise counsel during the intervening years."

DR. FLETCHER gave the *Messenger Lectures* at Cornell University. As a member of the Advisory Board of the Rutgers Research Council, he attended its annual meeting on April 29. He also attended meetings of the National Academy of Sciences and the American Physical Society at Washington. Dr. Fletcher was appointed a member of the Standing Committee on Meetings of the National Academy of Sciences to serve for three years commencing July 1, 1949.

J. W. SCHMIED appeared before the Board of Appeals of the Patent Office and R. T. HOLCOMB before the Primary Examiner and the Examiner of Interferences.

THE CAREER of "Judge" Kiesel is no doubt recognizable in the biography which the RECORD (regrettably) captioned as WILLIAM C. KIESEL. Under his real name of "Walter" he will be glad to greet his friends in his home at Coral Gables.

F. H. CHASE conducted tests on 100-ampere 24-volt rectifiers at the Detroit plant of the Power Equipment Company.

Sir Henry Tizard of the United Kingdom Ministry of Defense spoke informally during his recent visit to Murray Hill. Present at a luncheon tendered in his honor were, seated, left to right: J. A. Becker, J. W. McRae, Sir Henry, W. O. Baker and Harvey Fletcher. Standing, left to right: W. H. Martin, R. Bown, W. Shockley, M. J. Kelly, C. Kittel, R. M. Burns and H. B. Ely

R. MARINO visited the Patent Office during the month of April.

A. BURKETT visited Chicago and Genoa, Illinois, to discuss community dial office problems with Automatic Electric, Kellogg Switchboard and Supply Company, and the Leich Electric Company.

A. J. PASCARELLA and A. A. HANSEN conducted tests of mercury relay performance in single-frequency signaling circuits at the new Chicago toll office.

H. T. LANGABEER visited Willoughby, Ohio; Vineland, New Jersey, and St. Louis, Missouri, in connection with power plants for No. 5 crossbar offices.

F. P. WIGHT and A. E. GERBORE inspected the installation of observing equipment for use with trial installations at Media.

G. E. Bailey Retires

The Laboratories' files are full of drawings and specifications that tell *how* things were done in past years, but to find out *why*, you will have to talk to one of the old-timers, like G. E. Bailey. Realizing how important it is to know why, Mr. Bailey will go out of his way to explain, and so has guided many a young engineer away from pitfalls of the past.

Mr. Bailey joined the Laboratories in 1919, after five years in central-office engineering at Hawthorne, preceded by the usual student course. In 1919, the panel system was as hot a project as automatic message accounting is now, and Mr. Bailey went to work on the development of testing equipment for this system. After four years, he was given charge of some of the manual group in Equipment Engineering and was associated with the development of the call indicator, straightforward trunking and the No. 11 switchboard. In 1929 he transferred to Toll Equipment where he played a part in the equipment engineering of the No. 8 test and control board, in the redesign of toll switchboards for increased capacity; the introduction of lamps for busy and idle line indication; and the simplification and improvement of pneumatic ticket distributing systems.

During the war, toll and local manual equipment work was consolidated under Mr. Bailey and his group had a number of Government projects. More recently, he has been concerned with the No. 3CL manual toll board, with certain manual features of the No. 4 toll crossbar system, such as switchboards and test positions, and with multi-frequency key pulsing for nation-wide toll dialing.

A thrifty Yankee—he was born in Vermont and educated at Norwich University—Mr. Bailey is known for his cost-consciousness and for the care with which he tucks in the loose ends before he says the job is done. Long residents of the Oranges, the Baileys will continue there, except perhaps for winters which they plan to spend in Florida.

News Notes

L. A. Leatherman conferred on storage battery problems with the Electric Storage Battery Company at Philadelphia.

R. H. Ross conferred with the A. W. Haydon Company at Waterbury, Connecticut, regarding motor designs for radio equipment.

H. J. Berka studied toll operating room lighting with the Long Lines' engineers at the Bourse Building in Philadelphia.

A. H. Smalenbach was in Richmond, Virginia, in connection with the trial installation of single frequency tone signaling equipment.

R. A. Miller, F. A. Coles and C. A. Nickerson visited Burlington for discussions with the Western Electric on the 1304A reproducer set.

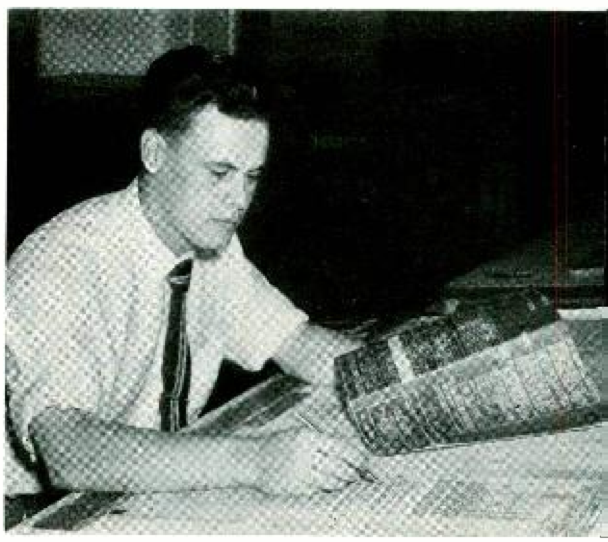
W. B. Sage and E. T. Ball supervised the installing of dust control equipment on the marker frames in the No. 5 crossbar at Media.

R. B. Bauer and Allan Dixon of A T & T made a trip to Albany to study A4A toll training problems.

R. A. Miller, W. J. Brown, H. W. Augustadt and L. B. Cooke attended the RMA-IRE Spring Meeting at Philadelphia. Mr. Augustadt presented a paper on *Longitudinal Interference in Audio Circuits.*

E. L. Owens' visit to Media concerned the use of voice recording on service observing equipment for the reed keyset trials.

G. B. Clark, junior draftsman of Systems Development Department, is one of the large group of veterans who are taking on-the-job training at the Laboratories to become full-fledged draftsmen



J. C. Davenport, Jr., assisted the New England Telephone and Telegraph Company in the solution of an inductive coördination problem at Chester, Vermont.

J. M. Dunham visited Oklahoma and Kansas in connection with lightning troubles on M1 carrier systems.

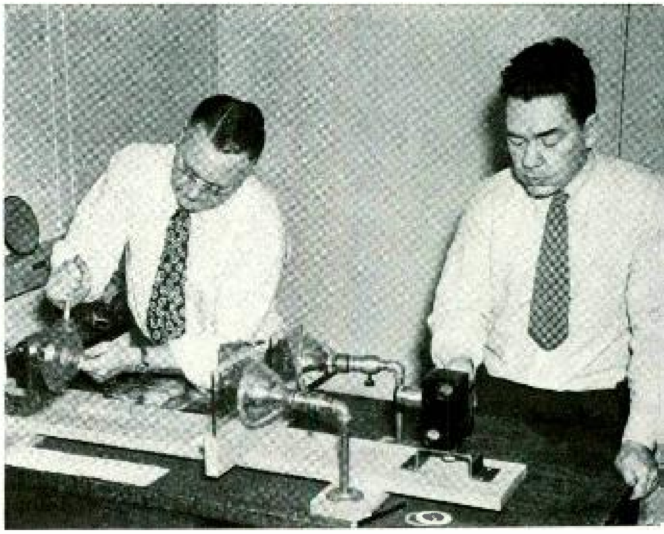
V. L. Ronci and J. M. Barstow with T. A. Taylor and R. H. Henderson of A T & T and R. Bright, Jr., and H. D. Wilson of Western Electric made a ten-day trip into the areas of Southwestern Bell Telephone Company and The Mountain States Telephone and Telegraph Company to evaluate the performance of the M1 carrier telephone system. They visited St. Louis, Oklahoma City, Dallas and Denver.

A. J. Aikens and R. M. Hawekotte have been investigating noise in the Milwaukee-Madison type-N carrier trial.

W. C. Ball, J. H. Harding and P. A. Jeanne, with representatives of the Edison Electric Institute, A T & T and local power and telephone companies, spent several days near Rocky Mount, North Carolina, investigating and trying out measures for reducing low frequency and noise induction on toll and local telephone circuits between Raleigh and Rocky Mount, North Carolina.

H. B. Noyes has been investigating coupling between single-pair television cables in Washington, D. C.

C. F. Seibel, D. H. Pennoyer and S. P. Shackleton met with engineers of A T & T, Western Electric Installation and the Bell of Pennsylvania at Philadelphia to plan for tests prior to the cutover next fall of a new No. 1 crossbar office.



N. R. Pape and I. L. Hopkins making biaxial stress and strain tests on polyethylene in the chemical laboratories at Murray Hill

F. W. Amberg and Esther Renthrop are participating in a trial of new open-wire carrier transpositions between Albuquerque, New Mexico, and El Paso, Texas.

G. H. Huber and L. Pedersen attended the third annual convention of the Armed Forces Communications Association in Washington.

A. P. Jahn and C. C. Lawson made inspections of samples in the A.S.T.M. Committee A5 exposure test sites at Bridgeport, Connecticut; Sandy Hook, New Jersey; State College and Pittsburgh, Pennsylvania. J. B. Dixon was present at the Sandy Hook inspection.

June Service Anniversaries of Members of the Laboratories

40 years

H. H. Lowry
R. L. Quass
H. C. Spryer

35 years

F. J. Boyle
H. C. Harrison
H. L. Lundberg
C. G. Von Zastrow
R. H. Wilson

30 years

G. C. Berndt
B. O. Browne
H. E. Coffin
Chas. Gittenberger
J. M. J. Harriot
C. M. Hemmer
H. J. Kostkos
D. H. Mann
A. S. Miller, Jr.
V. L. Ronci
H. O. Siegmund
R. F. Squires

25 years

J. F. Chaney
A. R. D'Heedene
E. K. Eberhart
E. B. Ferrell
R. M. C. Greenidge
J. K. Jones
L. L. Lockrow
R. E. Poole
F. W. Reynolds
Dorothy Storm
Barth Vander Els
Wendelin Weisser
W. E. Whitworth

20 years

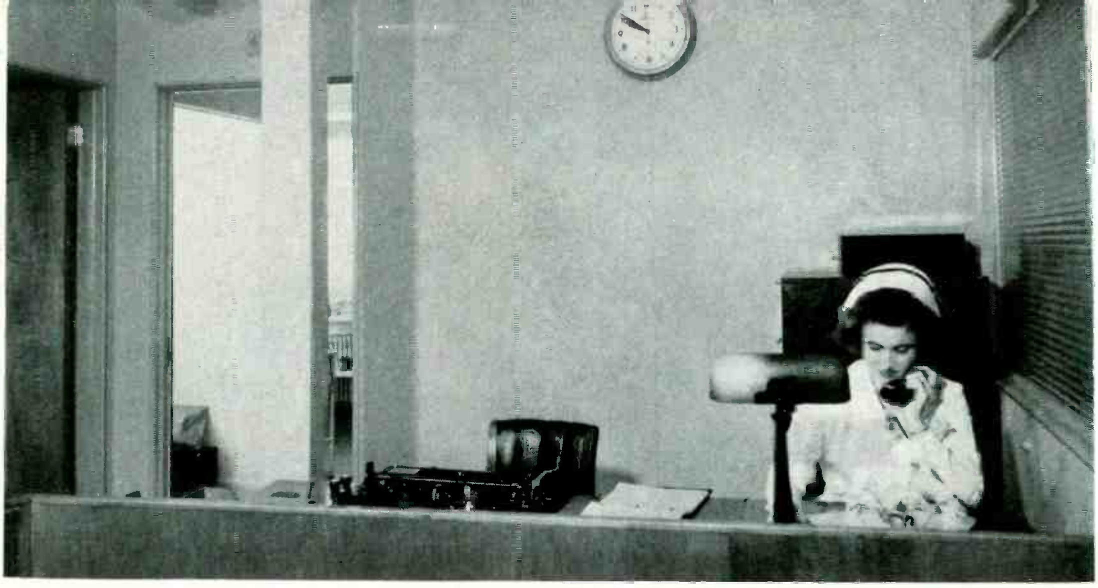
W. J. Albersheim
H. L. Barney
J. C. Blank, Jr.
M. E. Campbell
R. A. Cushman
W. H. Doherty
N. S. Ewing
I. E. Fair
W. P. Fengler
G. W. Galbavy
Polo Grafal
W. G. Hensel
R. J. Hluboky
Clara Imler
J. A. Kater
James Keegan
L. M. Klenk
W. R. Lyon
W. J. Lyons
Neil McLaughlin
D. A. McLean
James Meehan
A. F. Pomeroy
W. C. Prendergast
Alice Reilly
Julius Rohr
P. W. Rounds
W. H. Scheer
Fred. Schrepfer
J. G. Segelken
J. J. Shindle
A. H. Smalenbach
R. R. Stevens
W. J. Thompson
W. H. Tidd
Alice Todd
C. T. Wyman

15 years

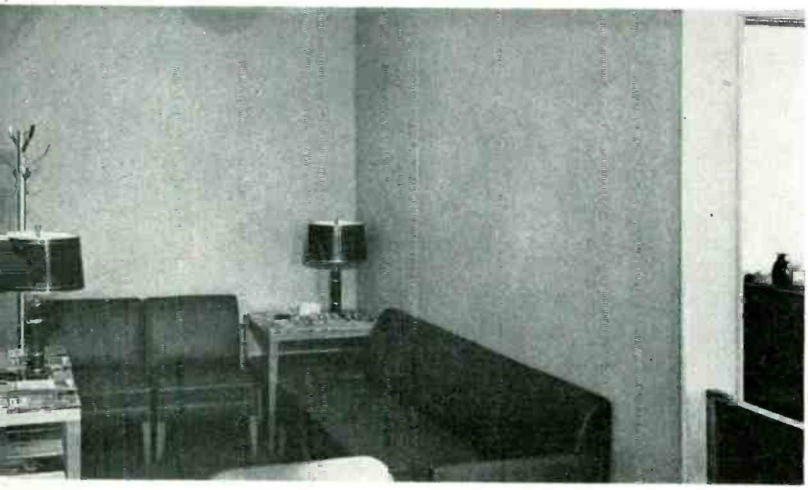
C. F. Chapman
C. I. L. Cronburg, Jr.
R. A. Desmond
T. J. Dorsey
Sigmund Fronczak
J. H. Heiss, Jr.
W. A. Jakob
Viggo Marcussen
E. J. Yacunski

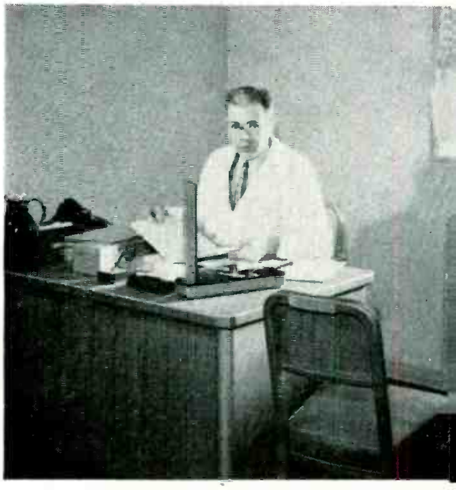
10 years

W. B. Callaway
E. L. Chinnock
Patricia Feeney
H. P. Kelly
J. P. Messana
R. S. Skinner
J. N. Walter



THE MEDICAL DEPARTMENT AT WHIPPANY





Whippany's Medical Department

A model in every respect, Whippany's new Medical Department is being featured in a current medical journal. Redesigned and in a new location, the medical facilities, shown on the opposite page, were built around Nurse Anne Sprink's station (top) in such a way that she has a view of the entrance, the reception room (center, left) facing her, Dr. W. W. Widdowson's office (center, right), rest rooms at her right, and the surgery and treatment room (bottom). Gray walls and green synthetic leather upholstery on the furniture, including the doctor's table, are used as the color scheme for all rooms except the surgery, which is white, even to its white synthetic leather window seats. Another special feature is a modern-fold door between one of the rest rooms and the surgery, which folds accordion style to allow great ease of access for a stretcher patient should the need occur.

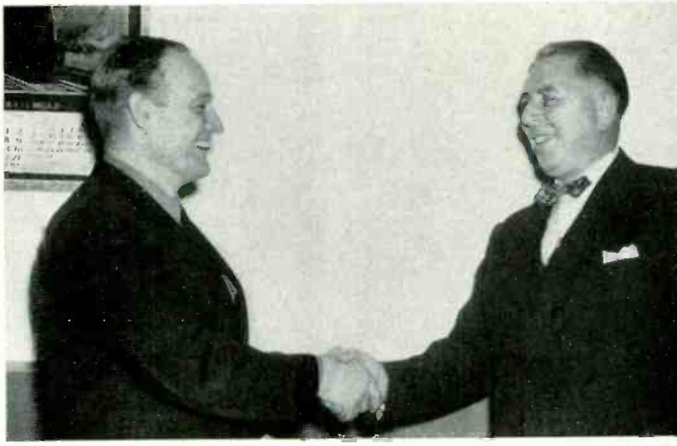
Laboratories Table Tennis Wins "World Series"

The Table Tennis group of Bell Laboratories Club, under chairmanship of J. V. Elliott, won the "World Series" of the commercial table tennis leagues of New York in an exciting round robin which was not decided until the last game of the match, when the Laboratories team upset the Federal Reserve team. As champions of the league, the Laboratories won fourteen matches and lost four, the individual records being T. J. Doherty 5-1, J. V. Elliott 5-1, and L. G. Kersta 4-2.

Stamp Club Exhibit

Bell Laboratories Stamp Club at West Street, under the chairmanship of P. W. Blye, held its annual exhibition April 4-6 in the auditorium. Nineteen members of the Club submitted thirty-two frames for exhibit in six groups. Winners in the United States group were, first prize, M. E. Esternaux's *Trans-Mississippi-Omaha* collection, also judged Best in Show, and P. H. Betts' *Miniature Panes*, second prize; in the British and British North America exhibit, P. W. Blye's *Newfoundland* collection, first, and P. H. Betts' *Bermuda* collection, second prize; and in the Other Foreign stamps, W. Kuhn's exhibit entitled *Why I Collect German Stamps*, first prize, and M. A. Specht's *Korea* exhibit, second prize. Mr. Kuhn's frames were voted *Most Interesting* in the popular poll. In the *Covers* exhibit, P. W. Blye's *China Air Mails* was awarded first prize and L. S. C. Neeb's *Air Mail Covers*, second; in the Topicals and Miscellaneous exhibit, J. Blanchard's *Postage Currency*, first prize, and W. Kuhn's *Variety of United States Collecting*, second; and in the Single Pages exhibit, W. S. R. Smith's *Bridges on Stamps*, first prize.

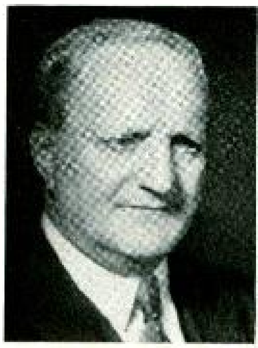
The exhibit committee consisted of L. S. C. Neeb, M. A. Specht and J. M. Watson. Collectors interested in joining the Club are invited to their luncheon meetings at 12 noon on Mondays in the cafeteria conference room at West Street.

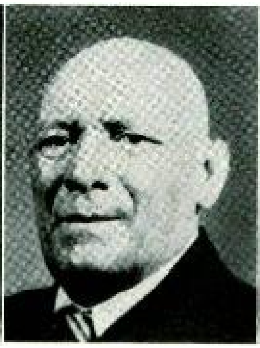


P. W. Blye (right), chairman of the West Street Stamp Club, congratulates M. E. Esternaux upon his first prize in the United States class and best in show prize

Under the Laboratories' stock control method, when items reach an ordering point, their control cards are forwarded to F. A. Graziano, who is responsible for determining by formula the quantities to be ordered and the new ordering point for each item

RECENT DEATHS





George Wismar 1874-1949 Carmine Scognamillo 1879-1949 Pasquale Levigne 1862-1949

George Wismar, April 21

At the time of his retirement in 1932, Mr. Wismar was a Technical Assistant engaged in conducting noise tests on transmitters in what is now the Station Apparatus Development Department. He entered the Bell System in 1895 and for thirty-four years before transferring to the Laboratories had been concerned primarily with the repair of transmitters in the New York Repair Shop of Western Electric. His son, George J. Wismar, is in charge of the photo reproduction group.

Carmine Scognamillo, April 16

A former cleaner in the West Street building, Mr. Scognamillo was retired on February 15, 1939, after nineteen years of Bell System service.

Pasquale Levigne, April 20

Mr. Levigne had been a member of the Building Shops Department and was a building service hand at the time of his retirement in July, 1930.

Capt. O. F. Crankshaw, February 23, 1945

The body of Captain Crankshaw, attending physician of the Murray Hill Laboratories in 1942, was buried on April 13 with full military honors at Arlington National Cemetery. He had been granted a military leave of absence in 1942 to serve with the Yale Medical Unit and with that unit went to the South Pacific, where he participated in the battle of Guadalcanal. After returning to this country in 1944, he was sent to Europe where he served with the Medical Corps of the Sixth Armored Division until he was killed in action. Captain Crankshaw's awards for gallantry in action include the Bronze Star Medal, the Croix de Guerre with Silver Gilt Star, the Legion of Merit, the Silver Star, and the Purple Heart on two occasions.

News Notes

R. Black attended a meeting of the Microphone Committee of the RMA in Philadelphia, and H. F. Hopkins the meetings of the Sound Equipment Section Committee at the Joint RMA-IRE Transmitter Section conference.

S. M. Sutton conferred at the Brazil Hollow Brick and Tile Company, Brazil, Indiana, on the production of vitrified conduit.

T. C. Henneberger, L. S. Inskip and O. B. Cook made arrangements in Boston with representatives of the New England Company for field trials of protected distribution cable terminals and surge-resistant fuses.

A. W. Dring and O. B. Cook were at Point Breeze in connection with the manufacture of cable terminals and E. V. Kosso on cable development problems.

R. E. Alberts, of Point Breeze, visited Murray Hill, Kearny and Chester to confer on cable specification matters.

J. B. Dixon attended the A.S.T.M. Committee B1 meetings in New York.

C. C. Lawson has been appointed to membership on A.S.T.M. Committee A5, Corrosion of Iron and Steel, and to Subcommittees XII and XV.

A. Herckmans, H. R. Clarke and O. L. Walter visited Western Electric at Chicago in connection with the new telephone set dial.

H. I. Beardsley, J. M. Hayward, C. A. Johnson and C. L. Krumreich discussed problems of the new telephone set at Chicago during March and April.

G. A. Wahl, F. A. Hoyt, D. W. Mathison and R. K. Thompson were at Chicago in connection with the coin collector.

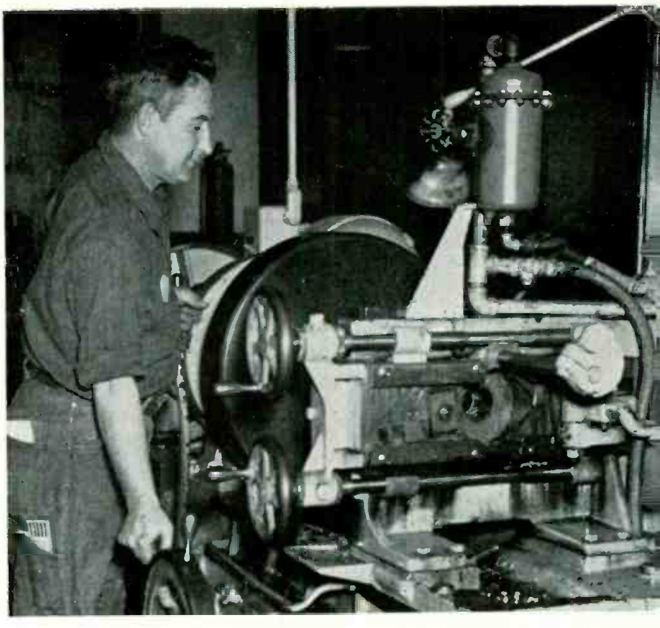
B. O. Templeton and O. A. Shann discussed coin collector problems at Hawthorne.

An exhibit of ceramic work done by Jule Haege, who first became interested in the art less than two years ago through the Bell Laboratories Club arts and crafts courses. Miss Haege's exhibit, above, was displayed in one of the Club Store windows

Wendel Cernik, who holds first place in the New York Bell Laboratories Archery Club, recently won the C. N. Hickman Trophy from the New York Archers. Mr. Cernik's spectacular rise in the archery field began last fall after he had attended a lecture-demonstration of the sport in the auditorium. Joining the Archery Club, he began climbing the "Place" ladder steadily and now is at the top with the highest scores that have ever been made. He is also taking first place in outdoor contests. His latest victory was at Rahway, N. J., where he captured the championship of the New Jersey Archery Association

H. A. Bredehoft, T. H. Crabtree, M. S. Richardson and W. Pferd were at Hawthorne in connection with the ringer of the new station telephone set.

R. T. L. Patterson has been elected President of the Princeton Engineering Association and Doren Mitchell, a member of the Executive Board. Mr. Patterson, a great-great-grandson of the Franklin Institute's first chairman, was an invited guest at the Institute's 125th Anniversary exercises.



Threading a length of pipe is easier for Robert Molloy of the Building Shops now that the new Landers pipe threader and cutting machine has been installed in Section 2H in New York

R. M. Bozorth gave an invited paper on *Recent Advances in the Theory of Ferromagnetism* at the national A.I.E.E. convention in New York City on February 1.

H. O. Siegmund, B. F. Runyon, C. N. Hickman and D. C. Koehler visited Hawthorne to discuss problems relating to design and cost of the general purpose relay.

F. M. Thomas, at the Teletype Corporation, conferred on manufacturing problems in connection with readers for automatic message accounting equipments.

H. N. Wagar was at the Tonawanda Plant of the Western Electric Company in Buffalo in connection with magnet wire problems.

E. B. Wood and D. R. Brobst were at Tonawanda to discuss enameled wire.

"It's certainly a change of atmosphere from Murray Hill"

O. M. HOVGAARD, S. J. ELLIOTT and F. P. BALACEK visited Allentown April 7 and 8 in connection with glass-sealed switches.

B. B. MANN consulted the General Electric Company at Pittsfield, Massachusetts, on soldering copper questions–engineering design.

J. H. WADDELL delivered the report of the High-Speed Photography Committee and with M. L. Sandell of Eastman Kodak Company presented a paper *How to Take High-Speed Pictures* during the 65th semi-annual convention of the Society of Motion Picture Engineers, April 4-8, in New York.

A. J. CHRISTOPHER drafted RMA Standards for Capacitors at the RMA Committee meetings on April 26 and 27 in Philadelphia.

H. A. BAXTER'S visit to General Mills, Inc., at Minneapolis, concerned the coördination of various submarine projects.

E. L. NELSON, A. K. BOHREN, S. C. HIGHT, J. B. BISHOP, G. D. JOHNSON, W. T. REA and C. FLANAGAN visited Coles Signal Laboratory for conferences on transmission systems.

J. D. SORROS, H. T. BUDENBOM and R. A. CUSHMAN attended a *Tracking Symposium* at the National Research Laboratory.

A. A. LUNDSTROM, R. G. STEPHENSON, P. H. THAYER, G. D. JOHNSON and R. W. SEARS made a survey of digital computer techniques at several organizations, including Massachusetts Institute of Technology, the Raytheon Corporation, the Electrical Research Laboratory in Boston, the Naval Research Laboratory and the Bureau of Standards.

W. SHOCKLEY spoke on *The Transistor* before the M.I.T. Physics Colloquium on April 14.

W. H. MACWILLIAMS has been appointed to the Ad Hoc Panel on Air Defense of the Research and Development Board.

J. G. NORDAHL and W. E. REICHLE attended the RMA-IRE Spring Meeting in Philadelphia on April 25. Mr. Nordahl is a member of the Transmitter Subcommittee of the Committee on Emergency Services; Mr. Reichle, a member of the Subcommittee on Selective Calling.

R. C. NEWHOUSE conferred with the Bureau of Aeronautics' representatives in Washington on development plans for aircraft radio communication equipment.

R. M. RYDER spoke on *Engineering Aspects of Transistor* and *A New Microwave Triode* before the American Institute of Electrical Engineers, Arrowhead section, in Duluth, and before a joint meeting of the Minnesota section and the Institute of Radio Engineers on *A New Microwave Triode*.

O. C. ELIASON attended a meeting in Cleveland of the Subcommittee on Dusts of the American Society of Heating and Ventilating Engineers.

C. A. WEBBER was in Atlanta and New Orleans in connection with field trials of cords.

R. H. VAN HORN and R. E. COLEMAN were at the General Electric Company, West Lynn, Massachusetts, to discuss lead sulfide photocells for the card translator.

M. SALZER and F. M. PEARSALL visited the Willoughby-Cleveland and the Ambridge-Pittsburgh central offices relative to automatic trouble recorder studies.

"Her boy friend is a mathematician"

J. BARDEEN and W. H. BRATTAIN attended the Conference on Physical Electronics, April 6-9, at Massachusetts Institute of Technology at which Mr. Brattain was chairman on one of the sessions on thermionics and semiconductors. Mr. Bardeen participated in a special discussion on semiconductors.

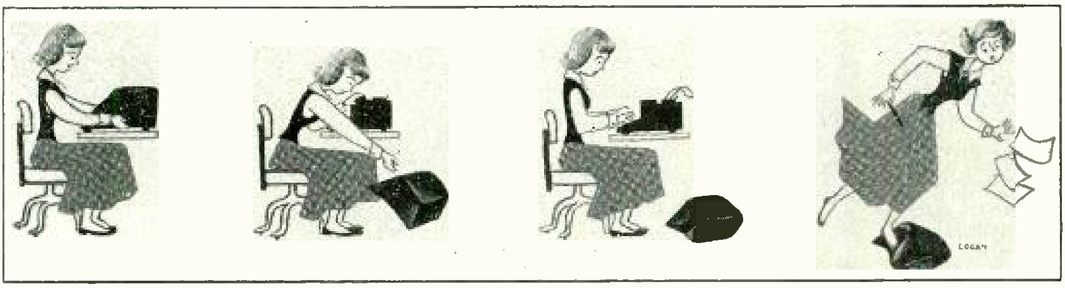
G. L. PEARSON and P. W. FOY visited the Magnetic Laboratory of Massachusetts Institute of Technology on April 14.

J. BARDEEN and W. H. BRATTAIN have written on *Physical Principles Involved in Transistor Action* in *The Physical Review*, April 15, 1949.

K. K. DARROW spoke on *Linguistics of Solid State Physics* at the University of Illinois on April 4 and on *Magnetic Resonance* at the University of Notre Dame on April 6. While in Chicago, he also visited the University of Chicago. Dr. Darrow attended the Electronics Conference at Cambridge, the American Philosophical Society Meeting at Philadelphia, and the American Physical Society meeting at Washington.

DURING THE WASHINGTON meeting of the American Physical Society, April 28-30, papers were presented by B. T. MATTHIAS, ELIZABETH A. WOOD and A. N. HOLDEN on *New Ferro-Electric Crystals* and by CHARLES KITTEL on *Gyromagnetic Ratios and Splitting Factors of Ferromagnetic Substances.* At other sessions, papers were also presented by G. L. PEARSON on *Electron and Hole Mobilities in Germanium Single Crystals;* W. SHOCKLEY, G. L. PEARSON, H. R. MOORE and M. SPARKS, *Current Flow Across n-p Junctions;* H. SUHL and W. SHOCKLEY, *Concentration of Holes and Electrons by Magnetic Fields.* Among those who attended the meeting were J. BARDEEN, J. K. GALT, W. H. BRATTAIN, A. H. WHITE, J. B. JOHNSON, G. H. WANNIER, H. D. HAGSTRUM, G. K. TEAL, and P. W. ANDERSON. R. M. BOZORTH was on the nominating committee for the election of officers.

A. N. HOLDEN spoke on *Growing Single Crystals from Solution* before the Conference on Crystal Growing of the Faraday Society, April 12-14, at Bristol, England.



A. H. WHITE, C. HERRING, J. B. JOHNSON, J. P. MOLNAR, K. G. MCKAY, G. H. WANNIER and L. H. GERMER attended the Electronics Conference April 8-9 at M.I.T. at which Mr. Herring spoke *On the Reflection of Slow Electrons by Patch Fields;* Mr. Molnar on *Vacuum Measurements With Nottingham Flash-Filament;* and Mr. McKay on *Pulse Techniques for Bombardment Conductivity.*

W. E. CAMPBELL has been awarded the degree of Doctor of Science by the University of the Witwaters-Rand, Johannesburg, South Africa, for his published researches on surface reactions of metals.

C. E. SHANNON spoke on *Communication in the Presence of Noise* before a meeting of the New York Sections of the A.I.E.E. and I.R.E.

W. L. BOND addressed the meeting of the Crystallographic Society in Ann Arbor, Michigan, April 7-9, on the subject *Electrical Evidence on the Class of Some Triclinic Crystals.*

W. A. SHEWHART was chosen by Secretary of the Interior Krug to present a paper at the United Nations scientific conference at Lake Success in August on the conservation and utilization of resources. The purpose of the conference is to have outstanding world authorities exchange ideas and experiences in the field of resource development and conservation. It is the first such meeting called by the United Nations.

H. M. CLEVELAND, J. P. AHRENS and F. J. BIONDI spent several days in Allentown on electron tube materials and processing.

G. T. KOHMAN and H. W. HERMANCE were in Cincinnati on central-office noise studies.

N. B. HANNAY presented a paper on *The Electrical Conductivity and Thermionic Emission of Barium Oxide and Strontium Oxide* at the M.I.T. Physical Electronics Conference in Cambridge. L. A. WOOTEN, J. J. LANDER and J. A. BURTON also attended this conference.

C. HERRING and J. A. BURTON conferred at the General Electric Laboratories in Schenectady on semiconductor problems.

W. E. CAMPBELL and F. HARDY attended the annual meeting of the American Society of Lubrication Engineers, April 11-14. Mr. Campbell presided at the opening session.

A. MENDIZZA and K. G. COMPTON visited Steubenville, Ohio, to discuss a proposed outdoor exposure test site with Ohio Bell Telephone engineers.

H. PETERS has been elected a committeeman of the Lackawanna Group of the North Jersey Section of the American Chemical Society.

A. W. TREPTOW and M. D. RIGTERINK discussed tests for porcelain enamel finishes at the Bureau of Standards and the Porcelain Enamel Institute in Washington. With G. T. KOHMAN and J. R. FISHER, they attended the American Ceramic Society Convention in Cincinnati.

J. J. HARLEY and A. C. WALKER showed the film, *Crystals While You Wait,* at Drew University. Mr. Walker also gave a general talk on *Crystals.*

LLOYD ESPENSCHIED was a guest speaker at the Annual Old-Timers' Nite of the Delaware Valley Radio Association, Inc., on April 9, in Trenton. He spoke on *From Sparks to Tubes or Men and Waves in the Little Port of New York.*

J. M. DUGUID and V. T. CALLAHAN witnessed the installation of new Diesel engine alternator sets at Providence and Pawtucket. Mr. Callahan also discussed new engine designs with the Kohler Company of Kohler, Wisconsin, and the Duplex Truck Company at Lansing, Michigan.

W. E. KOCK spoke on *Acoustic Lenses for Audio Frequency Applications* before the Institute of Radio Engineers, New York section, on April 18.

"The Telephone Hour"

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

June 6	*Lee Fairfax*
June 13	*Maggie Teyte*
June 20	*Gladys Swarthout*
June 27	*Jascha Heifetz*
July 4	*John Charles Thomas*
July 11	*Claudio Arrau*
July 18	*Polyna Stoska*
July 25	*Lucile Cummings and Edwin Steffe*

Engagements

*Margaret Bindewald—Leonard R. Kasper
*Irene Chapman—Thomas Foley
*Rosario Giorgianni—Michael S. Primeggia
*Louise Magliaro—Samuel J. DeMasi
*Joan Marciano—Raymond James
*Eleanor Maynard—Kenneth Spooner
*Regina Pease—James A. Harkins
*Mary Reiners—Louis E. Fernandez
*Della Scarola—Edward Stevens
*Elizabeth Shepard—G. William Getzoff

Weddings

*Rosemary Kennedy—Daniel J. Lane
Florence Kessler—*Herbert E. Earl
*Rene Levesque—Robert Hudkins
*Helen Ozard—Frederick W. Kamps
Charlotte White—*William A. Schuler

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

AT THE ARCHER AVENUE PLANT, L. J. COBB, R. C. MINER, R. E. POLK and H. W. BRYANT witnessed the start of manufacture of the handset for the 500 type telephone set; G. F. SCHMIDT and I. H. BAKER observed the performance of the handset type coin collector equipped with two units for picking up coin signals; J. R. WEEKS attended conferences regarding the examination of the first lots of metallized paper condenser units; and G. F. SCHMIDT and R. C. MINER reviewed data of special inspection of telephone instruments and discussed miscellaneous receiver and transmitter problems.

H. H. ABBOTT and R. D. de KAY with K. A. Ganssle of A T & T visited the Stromberg-Carlson Company at Rochester.

S. D. ROBERTSON spent a week in April at Ohio State University on personnel recruitment.

H. T. FRIIS went to Washington on April 27 for a meeting of the Committee on Electronics, Research and Development Board.

F. J. GIVEN attended the RMA-IRE Spring Meeting of TR-9 Committee on Transmitter Components in Philadelphia on April 25.

E. E. ALDRICH and A. B. HAINES visited Haverhill in connection with various problems associated with the manufacture of power transformers and coils.

Reprints Available

A limited number of reprints of *Television I-F Coil Design* and *A Scientific Look at Weight Control,* published in the May issue of the RECORD, are available from the Library, Extension 565, at West Street.