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In Murray Hill's PBX, L. H. Wood of New Jersey Bell tests the first permanent installation of lead-calcium batteries in the Bell System.

An improved telephone battery

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During 1950 Bell System Operating Companies will be receiving storage batteries with an expected life at least 40 per cent longer than those now being used. In addition, the new batteries will bring about further savings, through simplified maintenance procedures. This improvement results from the use of calcium in place of antimony as a hardening agent for the lead alloy in the grids and other metallic parts.

The grids function as supporting structures for a battery's active materials: the sponge lead of the negative plate and the lead peroxide of the positive plate. Under the conditions encountered in telephone use it is now known that the eventual failure of a storage battery is usually caused by the corrosion of the positive grid. As shown in Figure 1, this corrosion results in an expansion or "growth" of the grid structure which ultimately cracks the grid frame and thus destroys the support for the positive active material. The calcium alloy shows less corrosion and growth, under comparable conditions than the antimony alloy which has been standard for many years. The story that is behind this development is an interesting example of the progress of a research program the first step of which was the identification of a trace of an unexpected gas in the atmosphere of a battery room. It started in 1930, when a program of electrochemical research on the lead-acid storage battery was initiated under the direction of H. E. Haring. The purpose was to determine whether the existing battery type could be improved from the standpoint of the telephone system's special requirements. Although there was little complaint against the lead-antimony storage battery, it had not undergone any radical change in fifty years. Inasmuch as recognition of fault is prerequisite to improvement, the initial object of the investigation was to discover in what ways the operation of the telephone battery was less than ideal. It was believed that this procedure would provide a clue which would open up a profitable program of research. Results obtained from subsequent tests supported this belief but the clue came from an apparently unrelated source.

Sometime previously a series of analyses of the atmosphere in central offices had been made in studies of relay contact tarnish. Close re-examination of the results revealed that the concentration of reducing gases, such as sulfur dioxide and hydrogen sulfide, was always slightly higher in the atmosphere of a battery room when the battery was being overcharged.

This mysterious excess of reducing gas was traced to the batteries. Caught in a liquid-air trap, it was positively identified as stibine (SbH_3) a gaseous compound of hydrogen and antimony.*

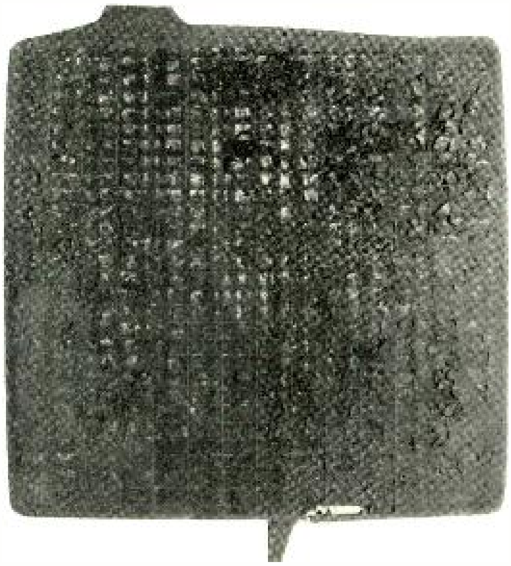

Fig. 1—Positive lead-antimony plate after nine years' operation.

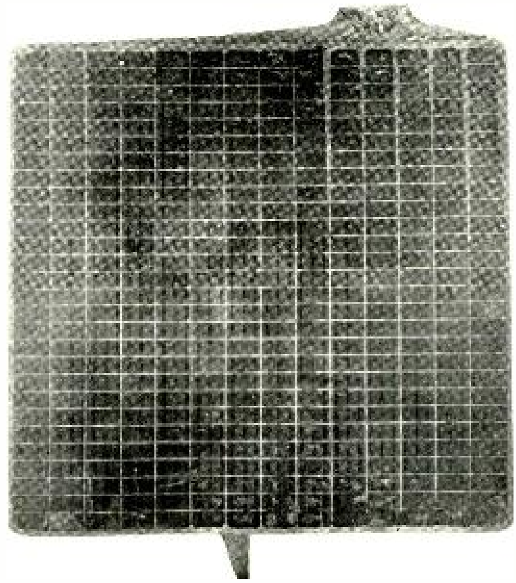

Fig. 2—Positive lead-calcium plate after nine years' operation.

Identification of this gaseous compound of antimony suggested the hypothesis, later confirmed, that in the course of normal battery operation, antimony slowly dissolves from the positive grid, passes through the electrolyte, and plates out upon the sponge lead of the negative. During the overcharge period, the hydrogen formed at this electrode combines with the antimony to form the gas, SbH_3. The migration of antimony from the positive to the negative electrode has two results: the positive grid structure is weakened, and the negative plate is contaminated with antimony. Being electropositive to the sponge lead which constitutes the active material of the negative electrode, the antimony causes local action and hence self-discharge. Thus, antimony is objectionable in telephone batteries because it accelerates self-discharge, and reduces their life by hastening the destruction of the positive plates.

Theory showed that the grid-hardening material should be electronegative to lead. It should also be present in minute amounts and well-dispersed to minimize leaching out. A lead-calcium alloy then being developed for cable sheath approximately met the requirements. In 1933 experimental cells using a lead-calcium alloy containing less than 0.1 per cent calcium were made in the laboratory and compared with similar cells using the 12 per cent antimony alloy then being used in commercial telephone batteries. As predicted, self-discharge was markedly slowed down in the calcium cells. They required only one-fifth as much current as the antimony cells to maintain them in a state of full charge. Moreover, the new alloy was less susceptible to corrosion.

Next, arrangements were made with a manufacturer to produce a number of full-size lead-calcium cells for field trial. Proper

*Record, *September,* 1937, page 12.

control of the very small amount of calcium required presented a major difficulty. Some of the calcium originally added to the melt was lost by oxidation during melting and casting; determination of the calcium content was laborious and slow. Consequently, the composition of the final castings was variable, with results, however, that later proved to be highly significant.

In November, 1936, a battery of twenty-four cells with a rated capacity of 684 ampere-hours was made and installed in a teletypewriter power plant of the Long Lines Department at 32 Avenue of the Americas, New York. On an adjacent rack a comparable battery using the standard antimony alloy was installed and operated under identical conditions. After four years of operation, some of the positive grid frames in the lead-calcium batteries began to develop cracks. Since this is usually a precursor of failure, all the lead-calcium batteries were replaced and sent to the Laboratories for study.

The cracked grids, it was found, had not affected the electrical performance of the batteries, which still delivered 120 per cent of their rated capacity. Moreover, chemical analysis showed that cracking was limited to grids having more than the specified 0.1 per cent calcium. On the basis of this information, it was then decided to order cells for additional tests, with more careful control of calcium content.

In 1945, after nine years of service, the lead-antimony battery at 32 Avenue of the Americas had reached the end of its useful life. A discharge test showed that some of its cells could deliver less than 70 per cent of their rated capacity, well under the 75 per cent minimum required for a telephone battery. In contrast the remaining lead-calcium cells in simulated service at the Laboratories, still delivered nearly 120 per cent of their rated capacity, despite the bad physical condition of many of the positive grids. More recent tests show no significant decrease in capacity of the lead-calcium cells after thirteen years of life—40 per cent longer than the useful life of standard batteries. Their total life still remains to be determined. (See Figure 3).

At random, three cells from the original

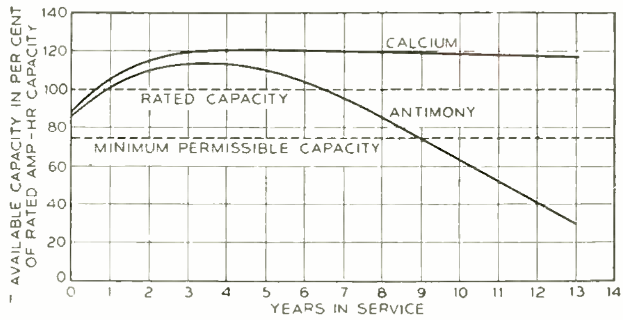

Fig. 3—Life performance.

batch were disassembled at the end of the nine-year period for inspection and comparison with some of the antimony cells removed from 32 Avenue of the Americas. The earlier findings were confirmed: grids with the specified calcium content remained in excellent condition; they had no cracks and showed relatively little growth, (Figure 2). Similar results were obtained after thirteen years. The grids with more than 0.1 per cent calcium expanded and, in many cases, deteriorated badly. As shown by the curve in Figure 4, the degree of growth is closely correlated with the excess calcium. The antimony grids from the cells which had failed in service had grown three to five times as much as lead-calcium grids containing 0.07 to 0.08 per cent calcium.

The grid-cracking in the first commercial lead-calcium batteries vividly demonstrated the need for close control of the alloy in the manufacture of these batteries for the Bell System. For the analysis of calcium in lead, there was developed a completely new and very simple method which virtually elimi-

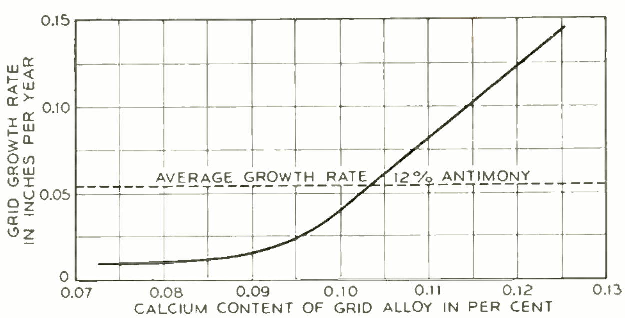

Fig. 4—Growth rate of 11-inch positive plates for various concentrations of hardening agent.

nates the difficulties of calcium control in manufacture. Sensitive to 0.001 per cent calcium, the new method takes less than half an hour, instead of the forty-eight hours previously required. The first group of batteries made using the new test method demonstrated that the desired calcium concentration can now be maintained with little difficulty.

The first post-war calcium cells were delivered in 1947. After a period of laboratory tests, twenty-four of these commercial cells were installed in the PBX at the Murray Hill Laboratories and have been a regular part of the power plant since January, 1948. This installation is shown on the first page.

All three of the Bell System's regular battery suppliers have now made lead-calcium batteries which have operated satisfactorily in a broad program of field trials: in large 48-volt batteries in the Beechmont central office in Cincinnati, the Plantation central office in Pittsburgh, and in the central offices at Maple Heights and Bedford, Ohio, and Tonawanda, N. Y. Most of the 12-volt filament batteries for the TD-2 radio relay route from New York to Chicago will be of the lead-calcium type. Present plans call for the conversion of future production of nearly all cells of 180-1680 ampere-hour capacity to the lead-calcium type. Later, other sizes will be available.

Calcium cells will not require the equalizing charges now necessary to counteract the change produced by aging in lead-antimony cells. Their low self-discharge rate means a reduction of 80 per cent in the power consumed in maintaining a state of full charge. More important, the water additions required to maintain the electrolyte level will be reduced by 80 per cent. This represents an important saving in maintenance cost in unattended remote locations. Reduced maintenance and a longer period between battery replacements are expected to result in savings which greatly exceed the slightly higher initial cost.

A word of caution is directed to those who may expect to buy long-life lead-calcium batteries for other uses. The new battery was developed for the specific requirements of the Bell System where the majority of telephone batteries are maintained on a closely regulated floating routine with batteries held at a voltage just sufficient to maintain a full state of charge. Discharge occurs only during the infrequent failures of commercial power. With continual charge and discharge, lead-calcium may be less satisfactory than lead-antimony.

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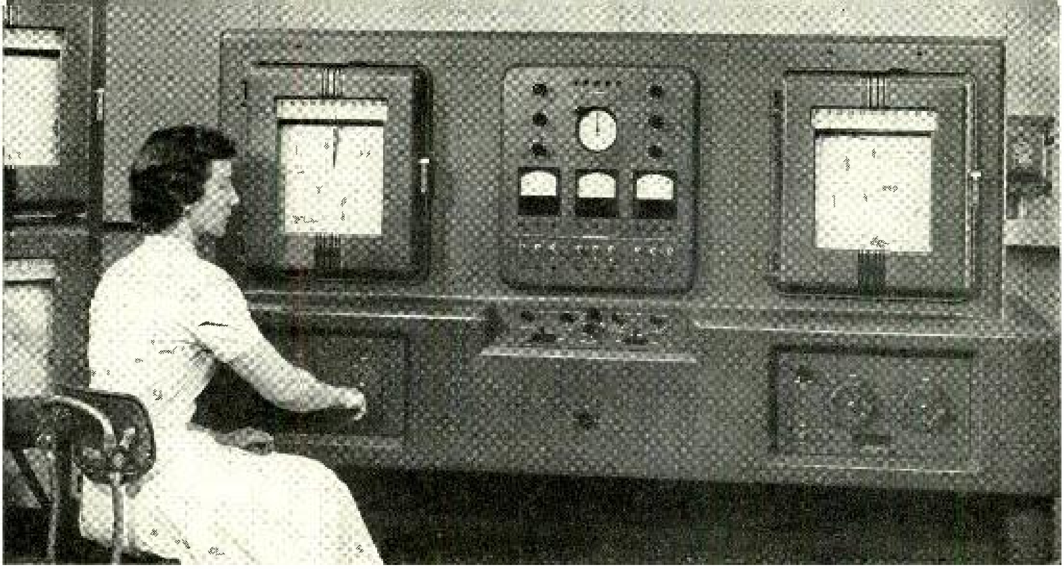

Seated at the consol of the computer, Miss R. A. Weiss operates the controls.

The general purpose analog computer

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One of the trends in science and technology is that the problems requiring solution are getting ever more complex. In developing communication systems, extensive research and engineering effort is required to design a system which will be practicable, reliable, and economical. The successful culmination of this effort depends, to a large extent, on the success with which complex systems of mathematical equations are solved. Many of them may be solved in the conventional manner—by use of pencil, paper, slide rule, and possibly a desk calculating machine. Others are very difficult to solve in this manner, and some are not susceptible to hand solution at all. It is necessary, therefore, to place more and more reliance on one or another of a variety of computing machines which have been evolved over the past decade or so. Such computers are of two general classes: digital and analog. Typical of the former is the relay computer[1] developed in these laboratories a few years ago. To date the only analog computers developed by the Laboratories have been for specific applications,[2] such as the control of anti-aircraft and seacoast artillery fire. Recently, however, a general purpose computer of the analog type has been constructed to assist in the work of the Laboratories.

In this computer, electronic circuits are used to perform the various mathematical operations of addition, subtraction, multiplication, division, integration, and differentiation. Some of the circuits employed for these purposes have already been described in the RECORD,[3] and to a large extent the new general purpose analog computer is based on these earlier circuits. Its basic computing unit is a three-stage negative feedback amplifier, shown in simplified form in Figure 1. A number of inputs are provided, all feeding through input resistors of the same value to the signal grid of the first stage. The amplifier output is normally connected through another resistor of the same value to the signal grid for feedback. When a voltage is applied to one or more of the inputs, a voltage e appears on the grid on the first

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[1] RECORD, *February* 1947, *page* 49. [2] RECORD, *May* 1946, *page* 177; *March* 1947, *page* 114. [3] RECORD, *March* 1947, *page* 114.

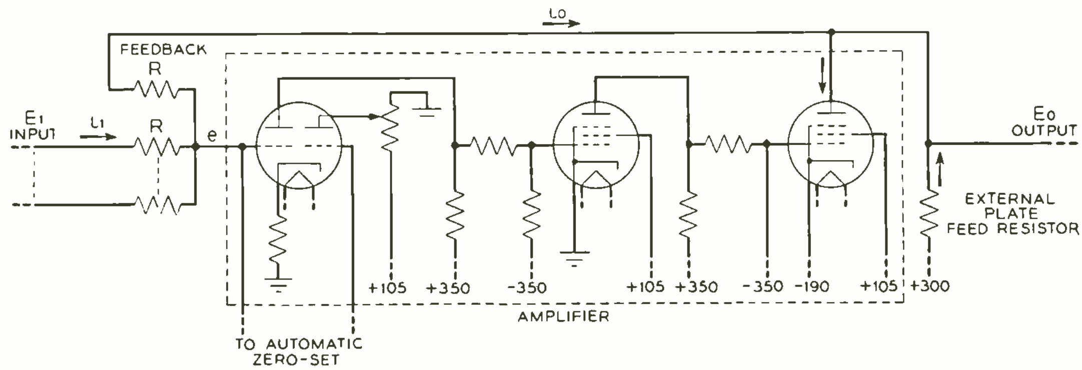


Fig. 1 — Simplified schematic of the basic feedback amplifier of the analog computer.

tube, and a voltage $E_0 = -\mu e$ at the output of the final stage. The currents through all but the feedback resistor are of the form $(E_n - e)/R$, with the direction of flow being as indicated. Since the grid of the tube draws essentially no current, and the connection to the automatic zero set circuit is open except during the momentary check periods, the only path for the current flowing in the input resistors is through the feedback resistor. Current in this latter resistor, in the direction indicated, is thus $(e - E_0)/R$. Since this current is the sum of the other currents, the basic equation for the amplifier is:

$$(1)\quad \frac{e - E_0}{R} = \frac{E_1 - e}{R} + \frac{E_2 - e}{R} + \ldots + \frac{E_n - e}{R}$$

Multiplying both sides of this equation by R and rearranging, the equation becomes:

$$(1a)\quad E_1 + E_2 + \ldots + E_n = -E_0 + (n+1)e$$

Since $E_0 = -\mu e$ as noted above, $-E_0/\mu$ may be substituted for e in equation (1a). This results in the equation:

$$(2)\quad E_1 + E_2 + \ldots + E_n = -E_0 - (n+1)\frac{E_0}{\mu} = -E_0\left[1 + \frac{(n+1)}{\mu}\right]$$

For the amplifier of the computer, μ is made very large, 30,000 or greater, and n is never more than 6. Substituting these values in equation (2) gives:

$(3)\quad E_1 + E_2 + \ldots + E_n = -E_0\,(1 + 0.00023)$ or, to within an accuracy of at least 23 parts in 100,000 (0.023 per cent):

$$(4)\quad E_1 + E_2 + \ldots + E_n = -E_0$$

It is this characteristic—that to within very close limits the output voltage is equal to the negative of the sum of the input voltages—that makes this type of amplifier so useful in the computer. It is, of course, necessary to match the input and feedback resistors closely and use care in the design of auxiliary circuits associated with the amplifier to realize accuracies of this order.

With only slight changes in some of its ancillary circuits, this same basic amplifier is used for most of the functions performed by the computer. That it serves as an adder is evident from equation 4.

It becomes a differentiator with respect to time if the resistor for the input voltage is replaced by a capacitor, as shown in Figure 2. With this circuit, $i_0 = (e - E_0)/R$ as before, but i_1 becomes $C\frac{d}{dt}(E_1 - e)$.

Equating i_1 and i_0, and neglecting the effect of e as before, gives:

$$(5)\quad E_0 = -RC\frac{dE_1}{dt}$$

In other words E_0 is now proportional to the derivative of E_1 with respect to time.

To convert the amplifier into an integrator, the resistor and capacitor of Figure 2 are interchanged, giving the arrangement shown in Figure 3. By equating the currents as before, this circuit gives the expression:

$$(6) \quad E_0 = -\frac{1}{RC}\int_0^t E_1 dt$$

where E_0 is now proportional to the integral of E_1 with respect to time.

For multiplying and dividing, potentiometers are associated with the amplifier. Figure 4, for example, indicates the circuit used for multiplying by K, where K is less than 1. Here, because of the potentiometer, the effective amplifier input voltage is KE_1, and thus the equation for this circuit is:

$$(7) \quad E_0 = -KE_1$$

The potentiometer is shaped to compensate for the load imposed by the input resistor of the amplifier. The purpose of the amplifier in this and similar circuits is to prevent any variable load of succeeding elements of the circuit from affecting the voltage KE_1.

For dividing by a constant less than 1, the potentiometer is put in the feedback path as indicated in Figure 5. As may readily be calculated, the equation for this circuit is:

$$(8) \quad E_0 = -\frac{1}{K} E_1$$

Since multiplying by a constant greater than 1 is the equivalent of dividing by the reciprocal of this constant, multiplication by a constant, L, greater than 1 may be accomplished by making the K of equation (8) equal to the reciprocal of L. Similarly to divide by a constant greater than 1, equation (7) will serve if K is made equal to the reciprocal of the constant.

The above two equations will take care of situations where a variable is to be multiplied by a constant. Very often, however, it is necessary to multiply two variables together, such as XY, or to multiply one variable by a function of another variable, such as Y cos X. For such purposes, and for a number of others that sometimes arise, an amplifier is used as the control element of a servo that drives two or more potentiometers; the potentiometers may be wound uniformly (i.e., linearly) or shaped to match any one of several common functions such as the sine, cosine, etc. The circuit employed under these conditions is illustrated in Figure 6.

In this circuit the amplifier is essentially the same as in the other schematics except for the RC circuit connected to the midpoint of the feedback resistor. This is inserted to avoid oscillation or "singing" of the servo; insofar as the basic circuit equations are concerned, it may be ignored. Any output voltage, E_0, from the dc amplifier interacts with one phase of a two-phase alternating voltage supplied to the modulator amplifier by a 200-cycle oscillator. The modulated two-phase voltage is amplified and applied to the two-phase servo motor. The motor will thus rotate clockwise or

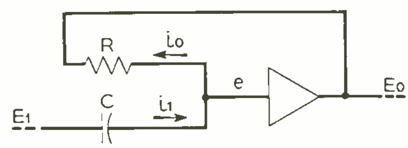


Fig. 2 — Block diagram of the basic amplifier arranged for differentiation.

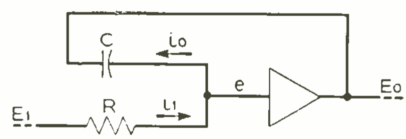


Fig. 3 — Block diagram of the basic amplifier arranged for integration.

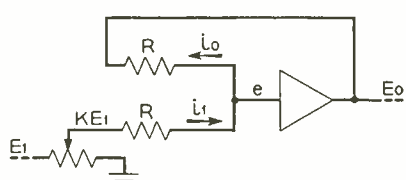


Fig. 4 — Block diagram of the basic amplifier used for multiplication by a constant.

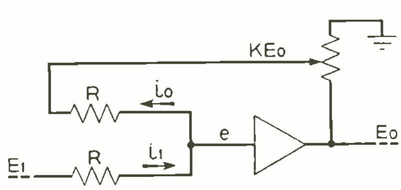


Fig. 5 — Block diagram of the basic amplifier used for division by a constant.

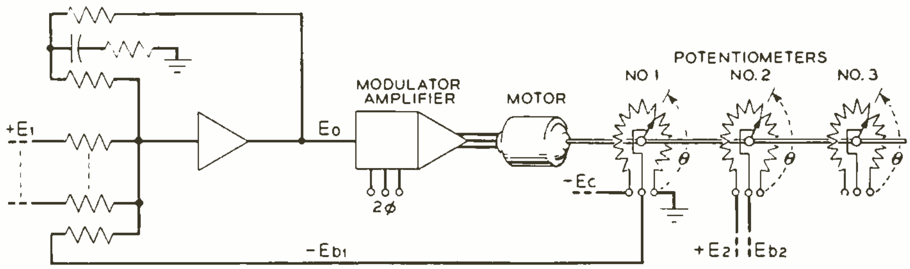


Fig. 6 — Block diagram of the servo circuit of the computer.

counterclockwise at a rate dependent on the polarity and magnitude of E_0; it will stop when $E_0 = 0$.

In Figure 6 it will be noticed that two inputs are connected to the dc amplifier—a voltage E_1 representing some variable in the computing system, and a voltage E_{b1} from the brush of one potentiometer of the servo. This particular potentiometer is connected to the negative computing voltage source, $-E_c$. The servo is so connected that when $E_1 + E_{b1}$ does not equal 0, the resultant control voltage, E_0, will drive the motor to a position where $E_1 + E_{b1} = 0$. At this balancing point, the angular brush position will be the same fraction of the maximum angular span, Θ_m, of the potentiometer as E_1 is of the computing voltage, E_c, or

$$\frac{E_1}{E_c} = \frac{-E_{b1}}{-E_c} = \frac{\Theta}{\Theta_m}$$

Now consider a voltage, E_2, representing another variable, applied to another potentiometer of the servo. The relative brush position on this potentiometer will also be Θ/Θ_m, and its brush voltage will be

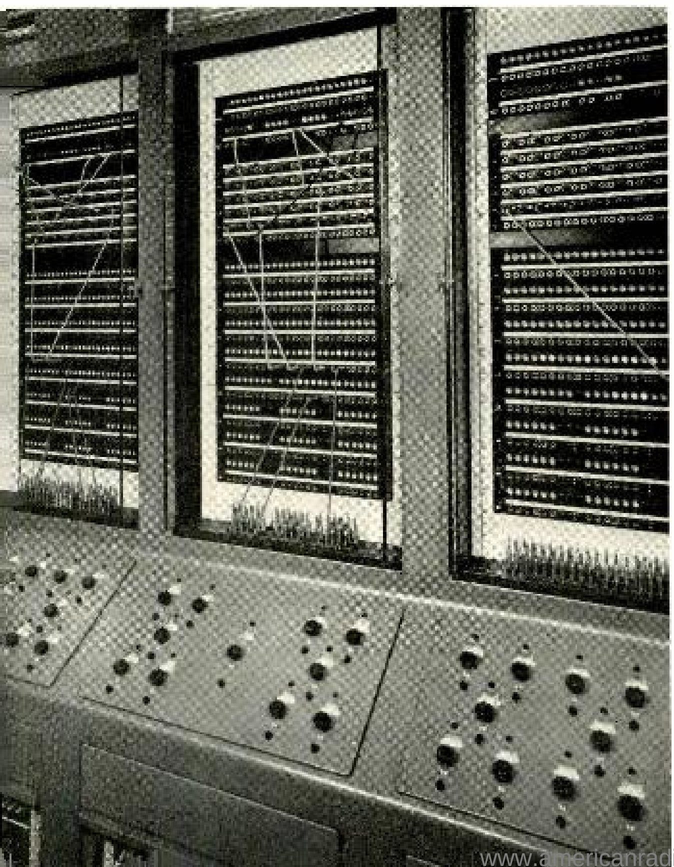
$$E_{b2} = E_2(\Theta/\Theta_m)$$

The above two equations indicate how the servo operates, i.e., it requires a voltage input, E_1, and the end product is a voltage, E_{b2}, appearing on the brush of a potentiometer. These quantities may be interpreted mathematically by dividing both sides of the second of the above equations by E_c; it then becomes

$$\frac{E_{b2}}{E_c} = \frac{E_2}{E_c}\left(\frac{\Theta}{\Theta_m}\right) = \frac{E_2}{E_c} \times \frac{E_1}{E_c}.$$

Mathematically, then, the voltages involved in the operation of the servo may be represented as decimal fractions of the computing voltage, and these ratios related to the various quantities of the mathematical equations. This same notation is used throughout the computing system in translating mathematical quantities to operating voltages. Using this notation, the ratios appearing in the above equation may thus be replaced by single letters, as: $r_{b2} = r_2 \times r_1$. An example will indicate the proce-

Fig. 7 — Upper part of the patching bays of the computer.



dure described above. Assume that two quantities, m and n, are to be multiplied to give a third quantity, p, and that m = 200 and n = 250. Obviously

$$m \times n = p$$

$$200 \times 250 = 50000$$

Since each of the variables must be reduced to a decimal fraction, assume that each side of the equation is divided by 90000:

$$\frac{200 \times 250}{90000} = \frac{50000}{90000}$$

$$\frac{200}{300} \times \frac{250}{300} = \frac{50000}{90000}$$

$$0.667 \times 0.833 = 0.555$$

The number 90000 is selected arbitrarily so that all quantities in the equation will be 1.0 or less. The ratio 0.667 which represents m is now to be associated with E_1, and if the computing voltage, E_c, is 100 volts, E_1 will equal $0.667 \times 100 = 66.7$ volts, or

$$m/300 = E_1/E_c = 0.667$$

The ratio 0.833, which represents n, will be similarly associated with E_2, and thus E_2 will be 83.3 volts. The servo will balance at a value of $\Theta/\Theta_m = 0.667$, since $E_1/E_c = 0.667$, and the brush voltage E_{b2} will be $E_{b2} = E_3(\Theta/\Theta_m) = 83.3 \times 0.667 = 55.5$ volts. But 55.5 volts is $0.555 \times E_c$:

$$E_{b2}/E_c = 55.5/100 = 0.555.$$

The output is thus seen to be 0.555 in the notation which has been adopted, which agrees with the mathematical equation in decimal fraction notation. Obviously, by retranslating this equation, the actual value of p is readily obtained: $p/90000 = 0.555$, or $p = 0.555 \times 90000 = 50000$.

Instead of being wound linearly, the potentiometers may be wound to conform to any of a number of transcendental and exponential functions, as already described in the Record.* With a potentiometer wound to conform to a cosine function, for example, the voltage at the brush is $E_2\cos(\Theta/\Theta_m)$.

Besides these various uses of the basic amplifier, it is also used to obtain the basic ±100 or ±50 measuring voltages referred to above, to isolate two successive potentiometers in a circuit, and also to multiply by −1.

How these units are associated to solve various problems is described on page 109 of this issue. The complete computer includes 30 adders, 1 differentiator, 12 integrators, and 9 servos, for which 45 linear potentiometers and 15 assorted function potentiometers are available. In addition there are 41 potentiometers which may be set by hand to supply the constant voltages called for by various equations. To permit these units to be selected as required in setting up a problem, their inputs and outputs appear in one form or another on a three-panel patch board shown in Figure 7.

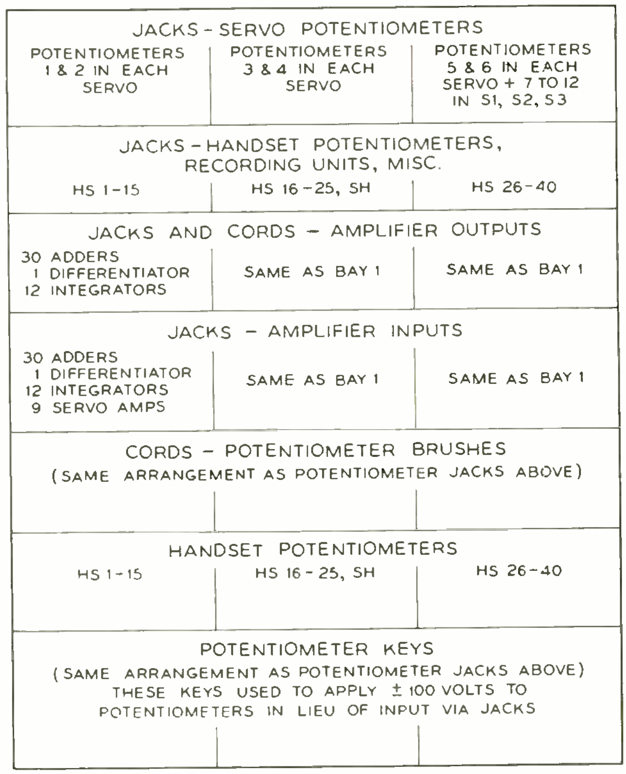


Fig. 8 — General arrangement of apparatus on the patching bays.

On this board, the appropriate terminals of all of the adders, integrators, differ-

*Record, *March* 1947, *page* 114.

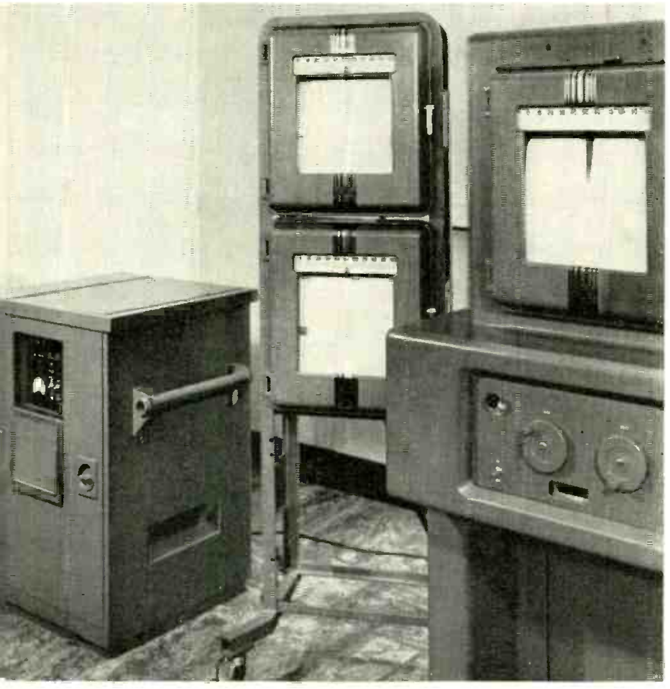


Fig. 9 — A power supply unit at left, a stand carrying two of the single-motion recorders, middle, and left end of the control console at the right.

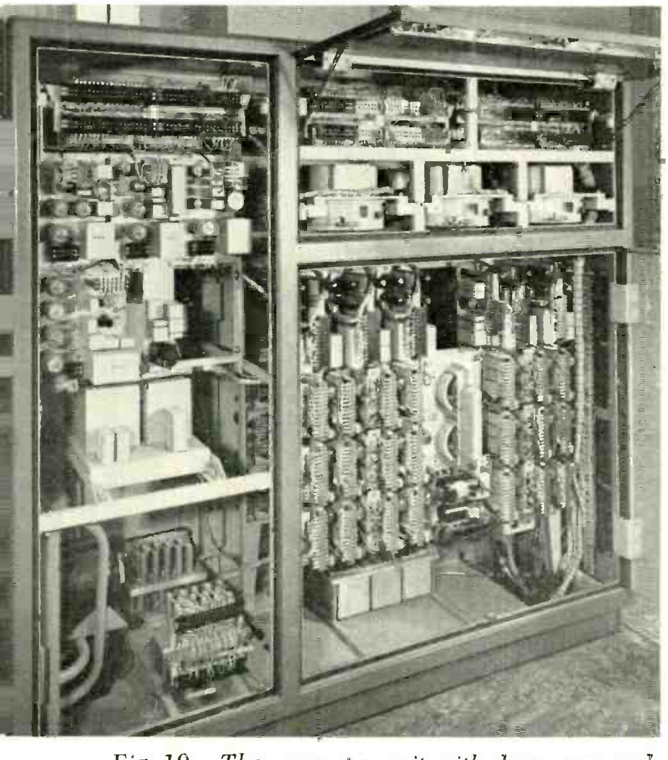


Fig. 10 — The computer unit with doors removed.

entiator, servo amplifiers, potentiometers, and recording units, are brought to conventional telephone type jacks and plugs. In a complex problem, 100 or more connections may be required, and thus it is necessary to distribute the apparatus terminals judiciously to avoid an undue concentration of cords on the board. All amplifier terminals appear on each bay, with the input terminals connected to jacks and the output terminals to jacks and cord plugs. All potentiometer terminals are brought to jacks, while potentiometer brushes are connected to cord plugs. These elements each appear once; they are distributed over all three bays. The general arrangement is shown in Figure 8. By distributing the terminals in this way, all bay-to-bay patching is avoided, and the patching for a given problem is distributed generally over the board as a whole. Most connections are made by cords integral to the board; additional connections may be made as required by separate patch cords. Lamps on the patch board are associated with each potentiometer or amplifier input jack for monitoring purposes. A lighted lamp informs the operator either that a connection has been made to an input jack on another bay, or that the computing voltage has been applied to a potentiometer by operation of the key on the bottom panel. No apparatus failure will occur if the operator disobeys these warnings, but the resulting circuit will no longer be analogous to the system under study.

For recording the solution of problems, four Leeds and Northrup single-motion type-G Speedomax recorders and two Leeds and Northrup two-motion type-G Speedomax recorders are employed. In addition all servos are equipped with drum dials by means of which brush positions may be read to 0.001 for problems where only the end product of the computation is significant. The Leeds and Northrup single-motion units contain a synchronous motor for the paper drive, and a servo-driven pen. Any voltage applied to the pen servo will cause the pen to assume a proportionate position between 0 and 1 (0 to 10 inches of pen travel) to scales of 1, 2, 5, 10, 20, 50 or 100 volts per 10 inches as desired. A dependent variable may therefore be graphed automatically as a function of time.

The two-motion recorders are similar to the single-motion units except that the paper as well as the pen carriage is servo controlled. These units may, therefore, be used to plot any two variables regardless of how each of them varies with time. These two-motion recorders have been modified to enable them also to introduce empirical data into the computing circuits, and are thus referred to as function units. A curve representing the desired data is plotted on the chart of one of these recorders, and then when the pen is made to follow the plotted curve, either by manual or by automatic means, a voltage proportional to the value of the function is supplied to the computing circuits.

The four single-motion recorders are mounted on two movable stands, one of which is shown in the middle of Figure 9. The two double-motion recorders, which are the ones used as function units, are mounted on the control console, shown in the photograph at the head of this article. In all, the computer includes 6 units: the patching panel, the control console, the two recorder stands, a power supply unit (shown at the left of Figure 9), and the computing unit, which is shown with its covers removed in Figure 10. This latter unit houses the power supply regulators at the left, and the various computer circuits at the right. Near the top of this latter unit may be seen three of the servos, and in the row of apparatus immediately below them are some of the servo modulators and the 200-cycle oscillator. Beneath these, about in the middle of the cabinet, is the automatic zero-set circuit, and on the left of this are 12 feedback amplifiers and on its right are 9 amplifiers.

Control of operation of the system for most problems is effected by operation of

TABLE I — ACCURACIES OBTAINABLE IN THE VARIOUS COMPONENTS OF THE COMPUTER

Line Amplifiers (adders)	± 150 volt swing ± 0.005 volts max. bias due to zero setting error
Integrators	± 150 volt swing ± 0.002 volts max. bias due to zero setting error on RESET ± 0.0005 volts per second max. drift on INTEGRATE
Servos	Settable to nearest turn of wire on control potentiometer. Potentiometer card ratios accurate to at least one part in 1000.
Handset Potentiometers	Ratios accurate to at least 1 part in 1000.

THE AUTHOR: After graduating from the University of Pittsburgh with a B.S. degree in Electrical Engineering in 1933, A. A. CURRIE spent some seven years with the Westinghouse Electric Corporation engaged chiefly in synchronous motor design. In January, 1941, he was ordered to active duty as a First Lieutenant in the Coast Artillery Corps, and during the next five years served as an Instructor, Officers Division, Coast Artillery School, Fort Monroe, Virginia, Instructor-in-charge, Fire Control Section, in the Enlisted Division of the Antiaircraft Artillery School. Camp Davis, N. C., and as a Member of the Antiaircraft Artillery Board, becoming a Lieutenant Colonel before leaving the Army. In February, 1946, he joined the technical staff of these Laboratories and since then with the Military Electronics Department, he has been associated with a wide variety of military projects.

a single switch on the control console. In the initial, or RESET, position of the switch, the inputs to the integrators are opened, the integrator feedback condensers are short-circuited, and the timer is stopped. In the second, or INTEGRATE, position, the inputs are closed, the feedback condensers released, and the timer started. The third position, MEASURE, may be used where it is desired to measure quantities throughout the system at particular values of the independent variable. In this position of the switch, the integrator inputs are opened and the timer stopped. Since there is no current flow on the grid side of the amplifier, except the very small signal grid current and the intermittent automatic zero-set grid current, there is no appreciable change of voltage across the feedback condensers of the integrators, and their output voltages remain fixed. This situation is analogous to "stopping" time for a brief interval.

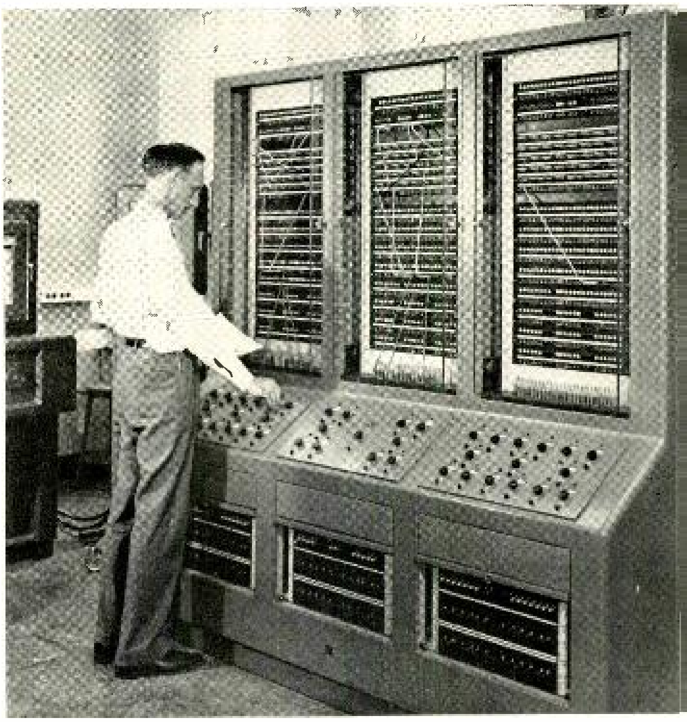
In an analog system of this type, where the circuit configuration is variable from problem to problem, individual component accuracies must be as high as practicable to avoid unduly large over-all errors. In addition, of course, the machine must be used judiciously to avoid unfavorable scale factors. In general, the component characteristics shown in Table I indicate the accuracies which are obtainable. The accuracy of the computer has been checked on a limited number of problems and has been found to lie generally within the range 0.1 per cent to 1 per cent. On a recent problem, for instance, which utilized about 70 per cent of the capacity of the machine, it was found that the solutions agreed with those produced by a digital machine to well within 1 per cent on the average. On other problems, spot checks made by hand computation have indicated computer accuracies of the order of 0.1 per cent.

The operation of the computer is relatively simple but demands a broad knowledge of the capabilities of the components in order to select scale factors and circuit configurations which are optimum. Maintenance, likewise, is not difficult, technically, but may be cumbersome due to the large number of components involved. The components themselves are identical with those developed in World War II for use in fire control systems, and are reliable under severe operating conditions. The assignment of a small portion of the available operating time to routine maintenance by skilled engineering personnel serves to maintain the instrument at peak operating efficiency.

The general design of the computer was conceived by E. Lakatos of the Mathematics Research Department, and its detailed design and construction was undertaken by the Military Electronics Department under the direction of O. H. Danielson. J. Maas and E. Habit of this group, under the direction of J. C. Bain, carried out the mechanical design, and the author, the electrical design.

Problem solving with the analog computer

E. LAKATOS
Physical Research



H. C. Rorden adjusting the hand-set potentiometers on the patch board.

In the general purpose analog computer, circuits are available to perform a number of the basic mathematical operations, such as addition, subtraction, multiplication, division, integration, and differentiation. In solving a problem, certain of these circuits, each corresponding to one of the operations required in solving a problem, are connected together in the proper sequence. As the first step toward a solution, therefore, the problem is analyzed to determine which computer components should be employed and how they should be interconnected. An over-all circuit is then drawn up to indicate the connections required. To simplify the sketching of this over-all circuit, symbols have been devised to represent the various elements of the computer. These are shown in Figure 1, where their correspondence to the actual circuits described in a companion article* will be evident. All of the circuits shown employ the three-stage amplifier, but the amplifier symbol is not shown specifically in the servo symbol.

How a problem, or a part of a problem, might be drawn to guide in setting it up on the computer is shown in Figure 2. Here the dependent variable v is expressed as a polynomial with time as the independent variable. The first integrator, at the upper left, receives a dc voltage of unit amplitude. The output voltage of this integrator is therefore proportional to time. This voltage is used as the input for the next integrator in the chain, whose output is thus proportional to the square of time. In this manner the successive powers of time may be generated. The individual terms are taken off the output terminals of the integrators, and then by use of potentiometers are multiplied by fixed constants so as to yield the individual terms of the polynomial. These terms, including the constant term, which is derived from a unit negative voltage, are then summed by an adder. The resulting output v represents the polynomial.

Suppose instead that the polynomial is in a variable y that is not proportional to time. The first step is to convert the input voltage y to a shaft motion in a servo. As

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* See page 101.

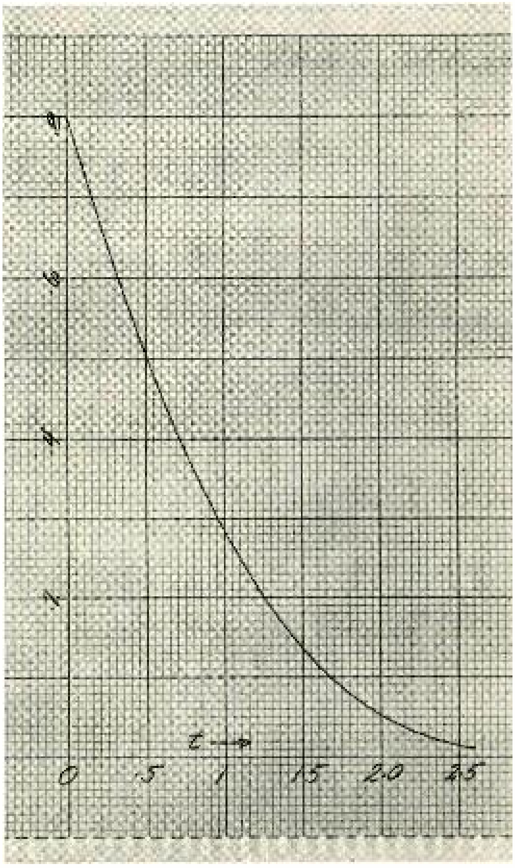


Fig. 7 — Curve drawn by the recorder while the computer is solving Equation 6.

where y_0, the constant of integration, is the value of y when t equals 0.

To solve this equation, the circuit set up on the computer is as shown in Figure 6. As before, the solving amplifier A_1 has three inputs: one supplied from a hand-set potentiometer giving the value $-y_0$, another the term y fed back from the output of A_1, and the third from a circuit arranged to give $\int_0^t (t + y)ydt$. The output of A_1 will thus always be equal to y, and is connected both to the recorder and to the auxiliary circuit that derives the above integral. This auxiliary circuit is more involved than that used for the previous problem since it must add t and y, multiply the sum by y, and then integrate.

To secure a voltage equal to t, integrator I_1 is employed, which has minus unity voltage applied to its input. Its output is thus $-\int_0^t -1dt = t$. This voltage, together with that for y obtained from the output of the solving amplifier, is applied to the point of an adder A_2 whose output is thus $-(t + y)$.

To permit the multiplication of $(t + y)$ by y, the output of the solving amplifier is also connected to a servo, which thus maintains the brushes of the potentiometers connected to it at position y. One of these potentiometers P_0, is used to control the operation on the servo, but to the winding of the other, P_1 the output of A_2 is connected. The voltage on the brush of P_1 is thus always $-y(t + y)$, which is the negative of the quantity under the integral sign of equation (6). This voltage is connected to the integrator I_2, which thus gives the

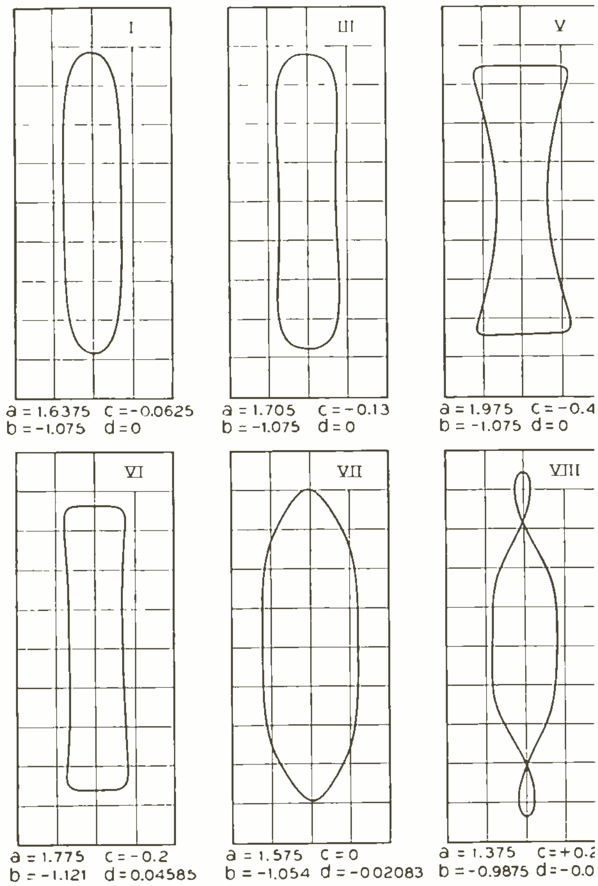


Fig. 8 — Group of graphs made by a recorder while the computer was solving an equation for various values of four parameters.

$$\left(C_L + \frac{du}{dt}\right)\frac{d^3u}{dt^3} + \left(1 + u + 2\frac{du}{dt}\right)\frac{d^2u}{dt^2} - \frac{1}{K}\left(2\frac{du}{dt} + u + 1\right) = 0$$

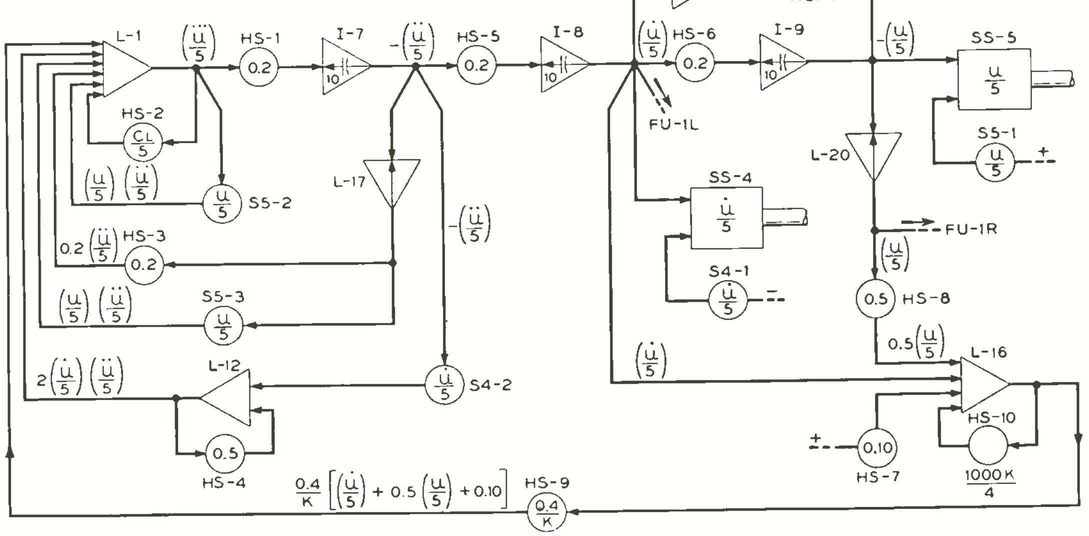


Fig. 9—A non-linear differential equation, above, and the circuit set up on the computer to solve it.

voltage $\int_0^t (t + y)ydt$ required as the other input for the solving amplifier. This equation is of the Ricatti type, and its solution as actually drawn by the recorder is shown in Figure 7.

The ready solution of ordinary differential equations, either linear or non-linear, is one of the outstanding advantages of the general purpose analog computer. Once the set-up has been made, solutions can be turned out at the rate of about one every two minutes. The highest order that can be solved directly is limited by the number of integrators available, namely 12. This does not mean that all 12th order equations can be solved, for bottlenecks may develop from other components. On the other hand, one case of a 15th order equation, occurring in a PCM problem, was handled by the expedient of breaking the problem into two parts; recording the solution for the first part, and using this as the input for the second part.

While ordinary differential equations frequently occur in the work of the Laboratories, they necessarily comprise only a modest portion of the various mathematical problems requiring solutions. However, in many of these problems, inspection shows that the most powerful technique is to deliberately convert their equations into differential form! This is a rather astonishing conclusion to one used to thinking in terms of the conventional hierarchy of mathematical operations. Most of us have been conditioned to think that integration is a higher-level process than the algebraic operations, and the solution of differential equations is at a higher level than integration. Consequently, there is a feeling that in some sense it is wasteful to replace algebraic operations or integrations by methods which require solutions of differential equation. This, of course, is a reflection of the experience that few differential equations can be solved by pencil and paper methods. Nevertheless, it has been our experience that the differential equation technique is generally the simplest and most powerful when backed up by a computer of this type.

One of the virtues of the General Purpose Analog Computer is that it permits a rapid and thorough exploration of a complicated situation. An instance of this arose in connection with the design of delay equalizers for the L-3 carrier system. The design engineer wished to determine that combination of values of four constants A, B, C, and D in the equation

$$P = AZ + \frac{B}{Z} + \frac{C}{Z^3} + \frac{D}{Z^5}$$

which would result in optimum performance. He wished the variable P to trace in the complex plane a figure of given shape as the independent variable Z traversed a unit circle centered on the origin. The problem was run with an assumed set of values of the four constants. The design engineer examined the shape of the resulting figure, made a few slide rule computations, chose a new set of values, and the problem was then re-run, and so on. A group of these trial runs are shown in Figure 8. The individual runs took about two minutes. The total elapsed time from proposal of the problem to the time the design engineer had his solution was two and a half hours. To get the same result by any other means available to the Laboratories would probably have taken some days.

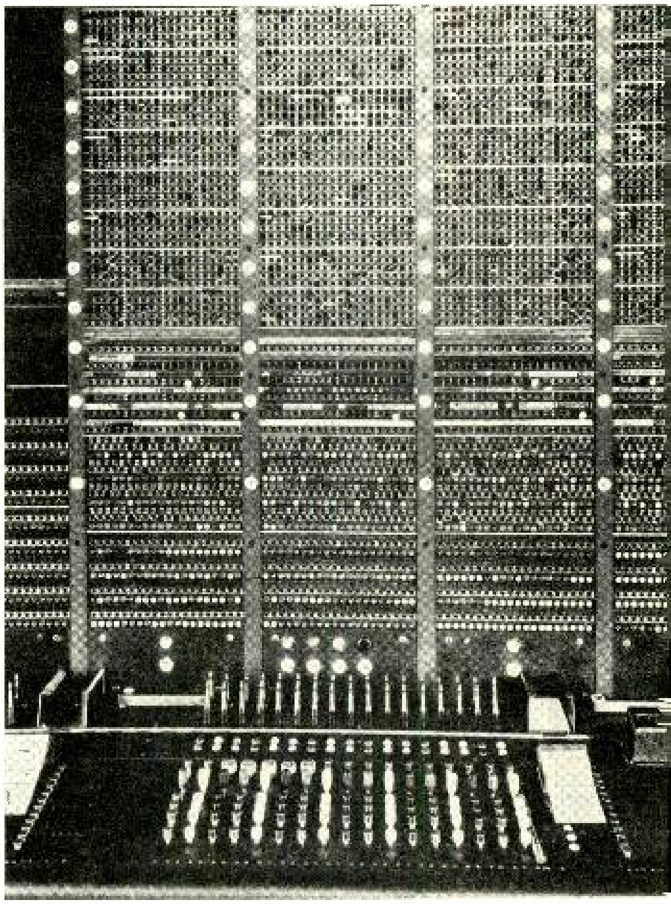
Another instance of such an exploration occurred with a problem in telephone relay design. By analysis, the engineer had reduced the problem to the non-linear differential equation shown in Figure 9, and he wanted the solution of this equation for two values of C_L and for a wide range of values of K. The actual circuit employed is also shown in Figure 9.

This particular problem was complicated by the wide range of values of K, which necessitated two changes in the machine set up. Nevertheless, the elapsed time from receipt of the problem to completion of the runs was only two days. The need for a complete survey of this particular problem has been felt since about 1938. At any time prior to the advent of the general purpose analog computer, however, the means available for a direct attack on this very complicated problem were so prohibitively laborious that the engineer concerned was forced to rely on somewhat unsatisfactory approximations.

Many other problems have been solved by the techniques described above. They include the equations of motion of a telephone relay for the operate case, an electron trajectory problem, the effect of band limiting on PCM pulse shapes, the roots of a transcendental equation encountered in a study of piezo-electric crystals, harmonic analysis of speech data, and a non-linear partial differential equation arising from the study of eddy current transients in a magnetic core. While the machine has only recently been put into use, it has already demonstrated its versatility and reliability.

THE AUTHOR: Graduating with an M.E. degree from Stevens Institute in 1926, EMORY LAKATOS spent a year with the New York and Queens Electric Company, and then joined the technical staff of the Bell Telephone Laboratories. With the Apparatus Development Department he first engaged in the design of telephone transformers, but a few years later transferred to the Acoustical Research Department. From 1938 to 1941 he was associated with the switching analysis group developing switching equipment. During the war years he worked on fire-control projects with the Physical Research Department. During this period he also acted as consultant to Section H, Division A, of the N.D.R.C. Since the end of the war he has been with the Mathematical Research Department.

W-R-J-M



On March 6, 1911, the Engineering Department of A T & T issued a circular (T.C. 30) to the Bell operating companies pointing out the desirability, from the point of view of the general public, of a uniform plan of designating jack-per-line party-line stations. At this time some companies were using letters only, and some a combination of letters and numerals. There was also a considerable difference in the letters chosen by the various companies. In four-party service, for instance, such combinations were being used in the different large cities as L.X.J.Y., Y.R.X.L., A.Y.M.Z., X.Y.J.M., X.Y.Z.K., and J.L.M.R.

With the thought that there must be some combination of letters which would involve fewer misunderstandings than any other when calls were passed by subscribers to operators, extensive tests had been made, the results of which were given in the circular. It had been found that the letters which gave the fewest misunderstandings were W, R, J, and M, and the circular requested comments by the operating companies regarding the standardization of those letters.

The replies received in answer to this circular indicated a general agreement with the recommendations, and the letters W, R, J, and M were accordingly standardized for four-party service in a circular issued on October 28, 1912 (T.C. 52). For two-party service, the letters W and J were chosen, it having been determined that they occasioned fewer misunderstandings than M and R.

One form of a subscriber's position at a No. 1 manual switchboard is shown in the accompanying illustration. The front four horizontal rows of push buttons are, from back to front, the W, R, J, and M ringing keys. Behind them are the operator's talking keys, and then the message register keys, the supervisory lamps, and the switchboard cords.

At the time these letters were adopted, manual service was predominant, and the easy distinguishability of the four letters adopted was the important factor. With the rapid expansion of dial switching, and the adoption of lettered dials an additional advantage became evident, since the four letters selected were sufficiently separated in the alphabet to bring each letter opposite a different finger hole. The same letters could thus readily be used with the dial system since each corresponded to a distinct digit: W = 9, R = 7, J = 5, and M = 6.

This becomes important only when a subscriber in a dial exchange calls a party-line subscriber in a manual exchange with jack-per-line party-lines, since under these conditions the party-line letter must be dialed after the four-digit station number. When a dial subscriber calls another dial subscriber, however, no party-line letter is used, since all party-line subscribers in a dial office are given separate numbers in the directory, without party-line letters.

R. B. Hill

A microwave noise source

W. W. MUMFORD
Radio Research

Did you ever hear the sound caused by one molecule colliding with another molecule? Of course not, for the energy involved in a single collision is so small that the human ear does not respond to it. It would take many simultaneous collisions to build up the total energy to an audible level, and that is just what happens when steam escapes through a small orifice. The characteristic hissing noise of escaping steam is the result of many many molecular collisions; as the agitated molecules are being forced through the small orifice, they collide, and the vibrations caused by these impacts add up to an energy level sufficient to actuate the mechanism in our ears that imparts to us the perception of sound. It can be likened to the noise of many random collisions of billiard balls, although it occurs at a much lower sound level.

E. L. Chinnock holds a fluorescent lamp noise generator in his left hand preparatory to a measurement of noise figure of an experimental amplifier.

Electrons, too, release energy when they collide, but it is a different kind of energy and our ears do not hear it. It is electromagnetic energy, such as is light, to which our eyes respond, or X-rays, to which photographic emulsions are sensitive, or radio waves which bring television and radio programs into our homes. As in the case of molecular collisions, single electronic collisions involve minute amounts of energy but when many many collisions are occurring at random, the total effect may be strong enough to be detected by our eyes. This happens when electricity is applied to an incandescent lamp. The flow of current heats the filament, and the free electrons within the metal filament are agitated, colliding as they jostle about. As the electric current increases through the lamp, the filament gets hotter, the jostling becomes more vehement, and the resulting radiated energy increases until the level is high enough to stimulate the eye.

The eye is not sensitive to all of this energy, however. Some of it lies in the visible region of the spectrum to be sure, but much of it lies in other frequency ranges, to which the eye is insensitive. Some lies above and some below the visible range, and the relative distribution of the energy depends upon how hot the filament becomes. If it becomes very hot, the relative energy in the high-frequency or ultra-voilet range is enhanced. If it is cooled off, the relative energy in the low-frequency range or red region is enhanced. The total energy available in all frequency ranges also depends upon the temperature, among other things; the higher the temperature the more the radiated energy.

When a hot metal filament—as in an incandescent lamp—is operating in a circuit, only that part of the collision energy at frequencies that will pass through the associated circuits will appear in the output. In audio frequency circuits, only the audio frequency portion of the collision energy will appear in the output. If its amplitude is great enough, it will be heard as a hissing sound like that of escaping steam and is thus called noise. In high-frequency circuits the portion of the collision energy passed by the associated circuits will be far above the audio frequencies, but since in telephone and radio broadcasting circuits it is always reduced to audio frequencies ultimately, the collision energy is called noise even when at its point of origin it is at frequencies very much above the audio range.

How great the noise will be, however, depends on several factors. First it depends on the intensity of the collisions, that is, on the number of collisions per second and on the velocity of the electrons at the time of the collisions, and both of these depend in turn on the temperature of the filament. This relationship is linear; the noise power is directly proportional to the absolute temperature of the filament.

Even with the highest temperatures at which a metal filament is operated, however, the noise is not great enough to activate a loudspeaker. Before the noise can be heard, there must be amplifiers between the source and the loudspeaker, and thus a second factor in the loudness of the noise is the amount of amplification. Amplification in turn brings in a third factor because the amplifier is an electronic device, and thus introduces noise of its own. This applies equally to all different types of repeating amplifiers, whether they be operating in the audio frequency range or the microwave range. Indeed it even applies to our home broadcast and television receivers. The hissing noise that one hears in the background when the receiver is tuned to a distant station is caused partly by the accelerated electrons colliding with each other within the vacuum tubes. The familiar "snow storm" that one sees on a television set when it is tuned to a weak station is also caused by electron collision energy. This type of interference has been known as noise, even though no sound may be involved at all. It is called "thermal noise" if it originates in a hot body, or "shot noise" if it originates from the interaction of electrons with electrodes within a vacuum tube. All known substances, devices, and amplifiers possess a noise level due to electron collisions which will mask weak signals.

In any communication system, the output noise is a disturbing influence. There is usually a definite level of noise, relative to the speech or signal level, which will not impair the quality of the transmission. If this relative level is exceeded by the noise, the transmission of intelligence is degraded. Conversely, if the level of the noise is too far below the tolerable value, the transmission system will be operating uneconomically. As a result, the noise level is an essential consideration in the design of practically all telephone apparatus; its proper control is vital in seeking the Bell System's objective of "the best possible service at the lowest cost."

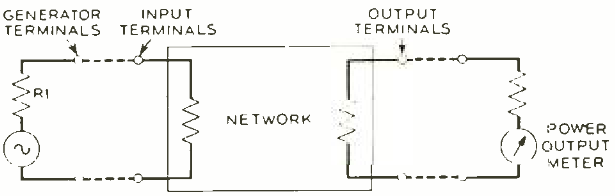


Fig. 1—A circuit of the type used for measuring noise figure.

One important component of a telephone transmission system is the vacuum tube amplifier, and a first step in attempting to control its noise level is to evaluate the performance of the amplifier in terms of the electronic noise it generates. This evaluation is based upon the ratio of the actual output noise power of a receiver to the output noise power which would exist if the receiver contributed no noise of its own. This ratio is called the "Noise Figure" of an amplifier or receiver. A receiver with a poor noise figure, i.e., a high noise figure, will generate most of the output noise within itself; only a small fraction of the noise output will be generated in the circuit attached to the input terminals of the receiver. On the other hand, a receiver with a good noise figure, i.e., a low noise figure, will contribute very little noise power to the total output power; most of the output noise power will originate in the circuit attached to the input terminals of the receiver. From these considerations it is evident that a receiver with a good noise figure will have a better signal-to-noise ratio in its output circuit than a receiver with a poor noise figure.

To measure the noise figure of a receiver, or circuit of any type, a circuit like that of Figure 1 is commonly used. The internal resistance of the generator is designated R_1, and since the noise caused by a resistance varies as its absolute temperature, it is possible to change the noise produced by the generator over a wide range. By making output readings for two different values of noise in the generator without changing the conditions of the circuit under test, it is possible to determine the noise figure of the receiver.

If the noise produced in the output with the generator resistance at a temperature of 290 degrees absolute is represented by Ng_1 and the noise output caused by the receiver is some constant, C, times Ng_1, then the total noise output is $Ng_1 + CNg_1$. Since the noise figure is defined as the ratio of $Ng_1 + CNg_1$ to the noise output that would have been found had there been no noise produced in the receiver, that is had C been zero, the noise figure, F, is thus:

$$(1) \qquad F = \frac{Ng_1 + CNg_1}{Ng_1} = 1 + C$$

Suppose now that a measurement is made of output noise when the generator source is at 290 degrees absolute and thus contributes noise of value Ng_1, and then that the noise of the generator is increased by increasing the temperature of the resistance until the output noise is some constant Y times what it was before. Under these particular conditions:

$$(2) \qquad Y = \frac{Ng_2 + CNg_1}{Ng_1 + CNg_1}$$

or, dividing by Ng_1

$$(2a) \qquad Y = \frac{Ng_2/Ng_1 + C}{1 + C}$$

Since the noise is proportional to the absolute temperature, this expression may be written:

$$(3) \qquad Y = \frac{T_2/290 + C}{1 + C}$$

When solved for $1 + C$, the noise figure, F, this equation becomes:

$$(3a) \qquad F = \frac{T_2/290 - 1}{Y - 1}$$

Such a measurement of noise figure is commonly made by increasing the effective temperature of the noise generator until the noise output is double what it was before. Under these conditions $Y = 2$. Thus:

$$(4) \qquad F = T_2/290 - 1$$

Since T_2 may be determined, this gives a method of measuring the noise figure.

Noise generators for measuring the noise figure of receivers have been devised, and have been used throughout most of the useful radio frequency spectrum. At low frequencies, a vacuum tube diode is commonly used as a source of noise, and the effective temperature of this noise generator is readily calculable when the filament is saturated. The noise diode is convenient in that it furnishes a source of noise that can be readily adjusted by changing the filament temperature, so that a convenient increment in output noise power can be obtained. The noise diodes that are commercially available are not suitable for use in the microwave region, however, because of their large dimensions relative to the wavelength, and satisfactory measurements of noise figures at microwave frequencies become difficult to make. It has been discovered, however, that ordinary fluorescent tubes produce a suitable level* of noise, and methods have been devised in these Laboratories for using them to obtain noise figures at microwave frequencies.

For this purpose the fluorescent tube is mounted in a wave guide structure as shown in Figure 2. Within the guide the lamp is exposed, but the two ends are encased in a metal shield. These shields are too small in diameter to permit the propagation of 4000 mc energy, and hence noise produced at the cathode and anode does not enter the guide; the only noise that does is that originating in the positive column, where the electrons are moving rapidly with random velocities in a stable manner.

*Practically, this level is too low to interfere with ordinary radio reception.

These random collisions of electrons give rise to microwave noise power equivalent to that of a resistance at a temperature of about 11,400 degrees absolute. This temperature appears to be characteristic of the fluorescent lamp under normal conditions. Of 32 different lamps, including ten different types of fluorescent coatings such as used in the pink, red, gold, soft white, daylight, green, white, 4500-degree white, black light, and blue, 31* were all within ± 0.25 db of each other in excess noise, as was also a germicidal lamp with no fluorescent coating. The microwave noise power from a fluorescent lamp is substantially independent of the d-c current from 40 ma to 140 ma, but changes slightly with ambient temperature. This coefficient is only –.055 db per degree centigrade, however, and can be ignored for some applications. The noise power also appears to be independent of frequency, having been checked at several different frequencies, 65 mc, 3000 mc, 4000 mc and 9000 mc.

One thing that the fluorescent lamp lacks as a noise source is variability. When it is used to determine the noise figure, therefore, a slightly different test procedure has to be followed. Substituting 11,400 degrees for T_2 in equation 3a reduces it to:

$$(5) \qquad F = \frac{38.3}{Y - 1}$$

and the noise figure is readily found by inserting the observed value for Y. If this ratio were 1.05, for example, the noise figure would be, from Equation 5, $F = 38.3/(1.05 - 1) = 766$, or 29 db. For poorer receivers, the accuracy falls off rapidly, but we are usually interested in accurate measurements only on the good receivers. The best receivers at 4,000 mc have noise figures around 8 db. This corresponds to an increase in output noise power of about seven times when the fluorescent lamp noise source is connected to the input of the receiver. A power ratio of seven times can be measured readily with fair accuracy on a thermocouple type of power meter. Greater accuracy can be achieved, however, by using a carefully calibrated attenuator in the output of the receiver, in order to take advantage of the accuracy obtained when reading full scale deflection on the power meter. This expedient may, however, lead to overloading of the receiver on the peaks of the noise if the power handling capacity of the output stage of the receiver is comparable with the power required to actuate the output power meter. In this event, it is better to attenuate the noise elsewhere in the setup, where the noise level is low enough not to cause overloading in the succeeding stages, yet high enough so that the noise originating in succeeding stages is insignificant. If this is not convenient, as for example in an amplifier contained all in one long strip, the calibrated attenuator can be inserted in the output of the noise source, thus reducing the excess noise to give any convenient value of Y desired. Equation 5 no longer applies, since the effective temperature of the combination of the fluorescent lamp plus the attenuator pad is no longer 11,400 degrees.

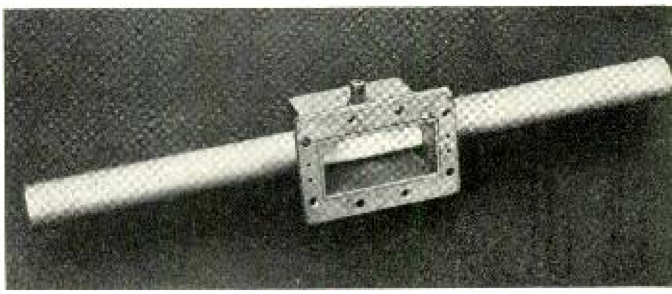


Fig. 2—A fluorescent tube mounted in a wave-guide fitting is used as the noise source.

To compute the actual effective temperature of the combination, one considers the contributions of the two resistances in series, and adds the resulting noise powers together. One of these resistances, that due to the hot noise generator, is at a temperature of 11,400 degrees and constitutes a fraction α of the total resistance, R. The other resistance, that due to the attenuator pad, is at a room temperature, 290 degrees, and constitutes a fraction $1-\alpha$ of R. The mean square noise voltage in a resistance R is given by the relation:

$$(6) \qquad E_N^2 = 4kTRB$$

* One of the 32 lamps flickered erratically. At times its excess noise was ½ db higher than average.

where k is Boltzman's constant, T the absolute temperature, and B the effective bandwidth of the system.

From the lamp, the noise voltage is thus $E_N^2 = 4k(11{,}400)\ \alpha RB$, and from the pad it is $E_N^2 = 4k(290)\ (1\text{-}\alpha)RB$. Adding these, gives for the total mean square noise voltage:

$$E_N^2 = 4k\,[11{,}400\alpha + 290(1-\alpha)]\ RB$$

The term in the bracket is the effective temperature of the combination, and substituting this for T_2 in Equation 3a gives:

$$(7) \qquad F = \frac{\left(\frac{11{,}400}{290} - 1\right)\alpha}{Y-1}$$

$$(7a) \qquad F = \frac{38.3\alpha}{Y-1}$$

By adjusting the attenuation α until $Y = 2$, Equation 7a reduces to

$$(7b) \qquad F = 38.3\alpha$$

Thus it is seen by adding a variable attenuator to the constant noise source, measurements of noise figure can be made just as accurately as they can be made with a variable noise source.

During the course of the experimental work which involved the measurement of the microwave noise level of the fluorescent lamp, an interesting tie-up between microwave noise and black body radiation developed. Since the level of the microwave noise energy from a fluorescent lamp is so constant with respect to time, reproducible from tube to tube, practically independent of the current, and only slightly affected by the ambient temperature, it might be expected that it is being controlled or limited by some invariant physical property of the atoms and ions within the gaseous discharge. Suppose we ask ourselves, "If we should terminate our wave guide in a resistance at 11,400 degrees, what color would the resistance be?" According to Wien's displacement law, the wavelength of maximum radiation from such a "black body" is given by the relation:

$$(8) \qquad \lambda_m T = 0.289 \text{ cm deg.}$$

Substituting $T = 11{,}400$ degrees

$$(8a) \qquad \lambda_m = 2535\ (10)^{-8} \text{ cm}$$

This is indeed an interesting result, since the mercury vapor discharge in the fluorescent lamp radiates most of its energy in the ultravoilet line spectrum at $\lambda = 2537\ (10)^{-8}$ cm. The design of the lamp was guided by an effort to accentuate the radiation at this wavelength, and the manufacturers state that this has been achieved so successfully that no other spectral line is excited to radiate more than two per cent of the input power.

The striking similarity between the black body and the mercury vapor discharge at $2537\ (10)^{-8}$ cm, suggests the following hypothesis:

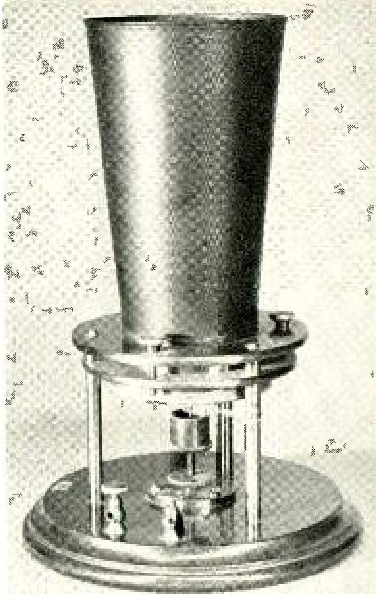
"In a gaseous discharge which is radiating light energy substantially monochromatically at a particular wavelength, λ_m, the microwave noise energy is the same as that available from a black body which radiates its maximum energy at that wavelength, λ_m."

This hypothesis remains to be proven. It is a controversial matter, but in the meantime we now have a microwave noise source that we have long been waiting for.

THE AUTHOR: W. W. Mumford majored in mathematics and physics at Willamette University, and after graduating with an A.B. degree in 1930, at once joined the Technical Staff of the Laboratories. With the Radio Research Department at Holmdel, he has worked on ultra-short-wave propagation and microwave components for radio relay systems. During the war he engaged in developments for radar. Mr. Mumford's contributions in the microwave field include the directional coupler, wide-band coaxial to waveguide transducers, helix to waveguide transitions as used in the traveling wave tube, and the gas-discharge noise generator.

THE TELEPHONE 75 YEARS AGO

By James T. Lowe
Curator, Bell System Historical Museum



Liquid transmitter

THE GREAT EVENT took place in the evening of March 10, 1876. Alexander Graham Bell and his assistant Thomas A. Watson were working on Bell's experiments as they had been for months in the attic of the boarding house at 5 Exeter Place, Boston, where Bell had rented two rooms for the purpose. Bell in the front room was at the transmitter of the one-way line and Watson in the rear room had his ear to the receiver with the connecting wire strung out through the hall between them when Bell accidentally spilled battery solution on his trousers. This was serious because Bell, then twenty-nine years old; had a small wardrobe and little money.

"Mr. Watson," he shouted into the transmitter "come here, I want you."

To Watson, Bell's voice seemed to leap from the receiver. He had heard sounds heretofore (in June of the previous year Mr. Bell had succeeded in devising and Watson in making a telephone which transmitted voice sounds but not words). This time he heard a complete sentence. He dropped the instrument and ran down the hall to Bell's door. "Mr. Bell," he exclaimed, "I heard every word you said—distinctly."

Forgetting all about his acid-spattered clothes Bell dashed into Watson's room to listen while Watson talked. This was the triumphant moment for which he had been pondering and laboring for years. Night after night he and Watson had labored until the small hours of the morning hoping to achieve this.

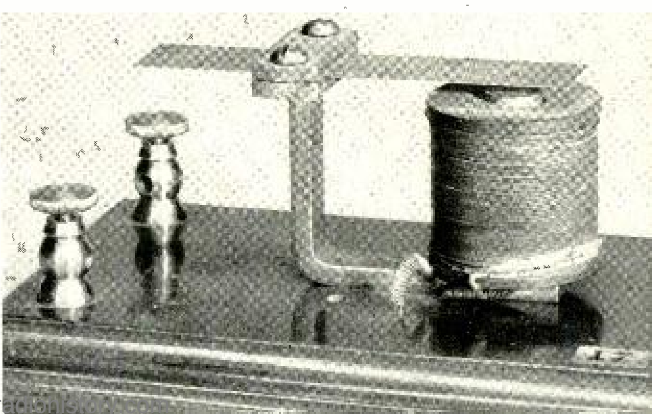
Man's desire to extend the sound of his voice is no doubt older than history. Nobody knows who first discovered that if he cupped his hands about his mouth and shouted, his voice would travel farther than if the sound were allowed to be dissipated in all directions. Later the megaphone, the speaking tube, and the string telephone or "lover's telegraph" were devised. In the thousands of years that man had been talking, he had developed no better facilities for transmitting voice sounds than these until that historic night seventy-five years ago when Bell proved that it was possible to generate and use a current of electricity that would "undulate" as he put it, or vary in intensity as sound waves, shrill or deep, loud or soft, vary as they disturb the air. He had come to understand that to transmit sound electrically, he had to have a current that could be "shaped" by sound.

In Bell's newly devised variable resistance transmitter on this night of March 10, 1876, a wire attached to a voice-operated diaphragm dipped into a cup of acidulated water, the cup with its conducting liquid and the movable wire forming part of the electrical circuit containing also a battery and a receiving telephone. As the diaphragm vibrated, the wire would rise and fall in the liquid causing the resistance of the circuit to change and the current to vary in conformity to the sound waves set up by the voice directed upon the diaphragm.

In today's transmitter, carbon granules in a tiny chamber rest against the diaphragm. As the vibrations of the diaphragm alternately press the granules closer together and allow them to relax, the varying pressure on the granules causes a varying resistance to the talking current just as in the liquid transmitter. In later receivers, the simple reed became a diphragm, which has undergone continued development right up to the present time.

Replicas of the liquid transmitter and tuned reed receiver used on this memorable evening are in the collection of the Bell System Historical Museum at the Bell Telephone Laboratories. A length of the original wire connecting the two rooms has been preserved.

Tuned reed receiver



Excerpts *from the* Annual Report *of the* AT&T

In the 75th year of the telephone the Bell System served more people and handled two and a half billion more conversations than in any previous year. The national emergency brought a new tide of telephone demand. Service high in quality was well maintained. The men and women of the System did a superb job.

Today more than ever, our country has the most and the best telephone service in the world. This is a bulwark of defense. The telephone speeds production. It is vital to the Armed Services. It spreads warning against attack. As the nation gathers its strength, the urgent calls of the hour are on the telephone lines.

The Bell System is alert to its essential task and is preparing further. The System will do its full part in helping to keep America secure. That is our Number One job today.

Rates and Earnings Must Be Adequate

Operating revenues of the System in 1950 were $3,261,528,000, an increase of $368,255,000 or about 13 per cent over 1949. Operating expenses of $2,334,362,000 compared with $2,248,833,000 in 1949. Net operating income in 1950 was less than 4.5 per cent on telephone plant and the return would be even lower if the plant were valued at present costs. The rate of earnings on capital was 6.1 per cent, compared with 4.9 per cent in 1949 and 7 per cent in 1940, ten years ago.

Wage, tax and material costs have continued to mount. Telephone rates and earnings must be sufficient to meet these increases, to attract and protect equity capital, and to assure a sound financial structure. With rates adequate to maintain the necessary earnings, most of the Company's convertible debentures would be converted into stock and the debt would be reduced.

Demand for Service Continued to Increase

Though the gain in telephones in 1950 was a little less than in 1949, the gain in the second half of the year was higher. Toll and long distance messages increased throughout the year and most sharply in the second half. Demand went up as the nation acted to meet the defense emergency. The importance of good telephone service was never more clear.

Six million telephones were installed to meet new requests for service. The net increase of 1,955,000 brought the total number in service to over 35,300,000. Toll and long distance calls were put through at an average speed of 1.6 minutes and 94 per cent of them were handled while the calling party held the line.

The Telephone Works for Defense

The whole expansion and improvement of the telephone system since World War II have made it more sturdy, more useful, more convenient, and a greater asset to the nation. The long distance network has grown from 16 to 26 million miles. Dial service has been greatly expanded for both toll and local calling. Rural areas served by the Bell Companies have more than twice as many telephones as in 1945. Service to automobiles, trucks, boats, trains and other vehicles is available in nearly 150 areas and more than 9,000 vehicles are being served —a 20 per cent increase last year.

Radio relay systems were extended more than 2,000 miles in 1950 and construction to provide transcontinental telephone service by radio relay is now under way. These systems, like coaxial cables, provide wide communications highways that can carry hundreds of telephone conversations, or television programs. Facilities for carrying television programs more than doubled during the year and networks now serve 82 television stations in 44 cities, or 19 more cities than at the end of 1949. These stations broadcast over areas containing half the country's population.

Research Is Increasingly Productive

Bell System research has resulted in a greater output of new things in the last five years than in any similar period before. It has produced a new telephone set for the customer's use; new kinds of wires and cables to carry his messages; new ways of using the wires and cables more efficiently; new devices and systems for carrying intelligence by microwave, without wires; new dial systems to connect telephones together; and new ways of automatically recording information for the customer's bill.

These things will contribute greatly to the nation's defense, both in providing essential communication services and in reducing the

A supply of copies of the Annual Report is available in the Libraries at West Street and at Murray Hill.

need for scarce materials. For example, a new system is now being manufactured that permits twelve conversations to be carried over each four wires in short telephone cables, from 20 to 200 miles in length. This can be applied to cables already in place and hence will be of particular value in saving copper. Carrier systems, of which this is one, have been employed for years and Bell Laboratories has led the world in their development. Previous systems, however, have been economical only over long distances. The new "N Carrier," combining new ideas and miniature apparatus, opens up a whole new field to the carrier art.

Bell Laboratories scientists are diligently seeking substitutes for various scarce materials used in telephone equipment. Research on materials has long been a major Laboratories activity, and the experience gained will help greatly in obtaining utmost economy in critical materials, with a minimum of compromise in the quality of equipment.

Bell System research facilities are also an invaluable national resource in the development of military equipment. Bell Laboratories contributions in World War II, especially in radar, submarine detection, and gunfire and bombing control systems, as well as in military communications by wire and radio, played a major role on land and sea and in the air. Since the war a substantial amount of research has been continued for the Armed Services on projects requiring the Laboratories' skills and facilities.

Western Electric Sales Were $758,000,000

Western Electric Company had another busy year meeting the heavy needs of the Bell Telephone Companies. Production was again far above the level of pre-war years although not as large as in 1949. Sales amounted to $758,064,000. Eighty-seven per cent of the sales were to Bell Telephone Companies and most of the remainder to the United States Government. Earnings for the year were $38,647,000 or 5.1 per cent of sales.

The Company's ability to produce telephone equipment and cable for the Bell Telephone Companies has already been affected by shortages of strategic materials such as copper, zinc, nickel, rubber and aluminum. Continuing difficulties in obtaining materials and parts may curtail deliveries to the Bell System in 1951. Western Electric and Bell Laboratories are taking advantage of all practical substitutions and adaptations but these can meet the problem only in part.

Since the end of World War II the Company has continued to produce much special equipment for the Government defense departments. Deliveries to the Government in 1950 exceeded $53,000,000. In recent months work has started on large additional orders for military equipment, chiefly electronic in character.

Through its subsidiary, the Sandia Corporation, Western Electric with the cooperation and assistance of Bell Telephone Laboratories continues to operate the Sandia Laboratory at Albuquerque, New Mexico, for the Atomic Energy Commission. Sandia is concerned with military applications of atomic energy.

Freedom to Serve in Freedom's Defense

For three quarters of a century the Bell System has rendered service of more and more value to the American people. The telephone began in this country. Here it has been most widely developed and used. Our service has always been the best in the world, and its greatest increase in usefulness has come in the last five years. This is a great asset in helping to defend the freedom of the United States.

Our telephone service is also a product of freedom. In the building of the Bell System, countless discoveries and inventions have had to be achieved by the inquiring spirit of free men. Opportunity has been open to all. Competition has flourished throughout the organization. Worthwhile incentives and reasonable rewards have fostered the will and capacity for leadership. In the rendering of service day by day, the responsibility to get the message through is accepted as a public trust: that too is the exercise of freedom.

All that has been achieved flows from the nation we serve. Under public regulation, the Bell System has generally been allowed the freedom it needs to perform its service well. It is essential that this freedom to serve be undiminished; that research and invention go vigorously forward; that new leaders be encouraged and prepared to lead; and that earnings be fully adequate to continue to pay good wages to employees, and a return to investors sufficient to attract and protect the billions of dollars of savings that make the service possible.

Through the years private enterprise and public policy in telephone communication have returned to the nation a value beyond price. We are confident they will do no less in the years to come. We are determined to meet the responsibilties entrusted to us, and we pledge our utmost efforts, always, in devotion to the public service and to the lasting security and advantage of the people of the United States.

O. B. Blackwell (left) receiving the Edison Medal from T. G. LeClair, President of the American Institute of Electrical Engineers. H. S. Osborne, Chief Engineer, A T & T, is looking on

O. B. Blackwell Awarded Edison Medal

On January 24, O. B. Blackwell, former Vice President of the Laboratories, who, before his retirement in 1947, was Assistant Vice President of A T & T, received the Edison Medal for "his pioneer contributions to the art of telephone transmission." Presentation was made at a General Session during the Winter General Meeting of the American Institute of Electrical Engineers at the Hotel Statler, New York City.

H. S. Osborne, Chief Engineer of A T & T, delivered the career citation for Mr. Blackwell. Tracing the career of the medalist from the time he graduated from M.I.T. in 1906, Mr. Osborne described the state of the telephone art in those early days, when the quality of transmission was poor, judged by present standards. Long distance intercity service had been developed to some degree by the use of large gauge bare conductors on pole lines; most important lines were built around the big cities because going through the cities would mean going through sections of cable, and that would spoil the transmission. At that time, the Bell System served approximately two million telephones.

Mr. Blackwell was one of the outstanding contributors to the developments in the telephone transmission art that brought about the vast extension and growth of long distance telephony. Early contributions were new testing routines and splicing methods which made practicable the application of the phantom principle to cables. He also invented and designed the first transmission measuring set and inaugurated a system of transmission maintenance measurements that has been of untold value in maintaining transmission quality of the telephone plant throughout the country.

"I can testify" said Mr. Osborne, "to the inspiration of working with Mr. Blackwell.

Honorable Dan A. Kimball, Under Secretary of the Navy, and Rear Admiral C. M. Bolster, assistant chief for Research and Development of the Bureau of Aeronautics, visited the Murray Hill Laboratory on Monday, January 29, to review the Laboratories' progress on research programs for the Navy. Left to right: R. K. Potter, J. B. Fisk, Mr. Kimball, Admiral Bolster and M. J. Kelly.

His creative imagination and penetrating power of analysis made him a real leader. His intellectual honesty was infectious. His keen sense of humor and dry wit, and his unfailing consideration for all, made it a great personal pleasure to work under his supervision or to collaborate with him. He was not only our leader, but was and is our cherished friend."

In his response, Mr. Blackwell expressed his appreciation to those who had placed his name on the roster of medalists. "A medalist," said Mr. Blackwell, "is allowed a short time during which he is expected to say something important, or failing that, at least something interesting. The most important matters I know today are the appalling problems of human relations which confront us. A man who has had the experience of seeing and feeling the power of large scale, properly staffed and organized scientific investigation, naturally wonders what a similar approach would do to the problems involved in human relations.

"We develop a great deal intellectually as we become adults, but our emotional progress is not very marked—and emotions are the driving forces in our lives. The pleasantest use of the intellect is in rationalizing the actions our emotions bid us do. It is men who have not grown up emotionally and do not know it, and cannot be told, who are dangerous. Just now the world's 'emotional children' are playing with fire.

"Surely, everyone should welcome whatever the intellect of man can find to help his emotional childishness. 'The proper study of mankind is man' is more completely true today than when it was written; a study with every technique and tool that man can devise, and in coverage and intensity commensurate with its importance."

Telephone People Aid in Rail Disaster

Emergency crewmen of the New Jersey Bell Telephone Company doubled as rescuers and installers at the scene of the Pennsylvania train wreck at Woodbridge, New Jersey. Eighty-four commuters died in the accident and over 500 were injured. Among the casualties were four New Jersey Bell people killed and 24 injured. No members of the Laboratories were involved.

Within an hour of the fatal crash, 32 telephones had been installed within a hundred yards of the wreck for use by police, Red Cross and the press. Emergency lighting equipment, cutting tools, blankets, bandages and other medical supplies were rushed to the scene by the Telephone Company.

Three repairmen and one installer, who were working on regular assignments in the vicinity of the crash, immediately left for the scene and began first aid treatment for those trapped in the telescoped rail cars that teetered on the edge of a 20-foot embankment.

Arrangements were made to clear all lines in the vicinity for emergency use. Party-line telephones in four homes nearest the wreck were converted into individual lines and with the

During this month the American Red Cross is making its annual appeal to all of us for funds to support its work at home and with our Armed Forces. With so many of our men and women already in service, the cause of the Red Cross is more than ever our cause.

Further information about the campaign will be sent to all members of the Laboratories calling attention to the opportunity to make contributions to the Red Cross and giving information as to where contributions may be sent.

permission of these subscribers, 11 new lines were strung to their homes. Twenty-five equipment and construction volunteers were on the job within half an hour after the wreck. With the cooperation of commercial and public relations representatives, who acted as liaison for the police, press and Red Cross, 19 additional telephone lines and two radio circuits were established as the demand for communication service increased.

A traffic supervisor who was a passenger on the train but was uninjured left for the Woodbridge central office after assisting in first aid relief and there coordinated traffic operations. Within the first six hours after the crash, a total of 150,000 calls above average were handled by exchanges within a 25-mile radius. Despite the heavy calling, the record traffic was handled with dispatch by operators, many of whom reported to their posts as soon as word of the disaster reached them.

Dr. Widdowson Organizes Disaster Plan for Pennsylvania

Dr. W. D. Widdowson was on leave for a month to organize an emergency medical disaster plan for the Military and Civil Defense Commission for Pennsylvania at Harrisburg.

In a letter to Dr. Buckley, Richard K. Mellon, Commanding Officer of the Commission, wrote: "Your cooperation in making Dr. W. W. Widdowson's services available to this Commission during the recent critical planning period is one of the most valuable contributions so far made to civil defense in Pennsylvania.

"It goes without saying that to draft a State emergency plan for maximum use of medical resources, both of manpower and material, would be an enormous task under any circumstances. To do so within a month's time, without prior study either of the general problem or of local conditions, is an assignment that would have discouraged all but the most stouthearted. Dr. Widdowson not only met the challenge, but brought to it such enthusiasm and good nature that all who worked with him were sorry when his leave of absence came to an end.

"In thanking you for this invaluable aid, I am speaking not only for myself personally, but for everyone concerned with civil defense in the Commonwealth, which means more than ten million men, women, and children."

There's no anachronism here; the beards are just as real and even newer than the A.M.A. equipment which the wearers are watching. The group are businessmen of Media, Pa., who engaged in a beard growing contest as a feature of the town's centennial celebration. The telephone in Media has a long history; it was introduced in 1881.—The Telephone News.

Frank B. Jewett Fellowships

A seventh group of promising young scientists have been named as recipients of the 1951-52 Frank B. Jewett post-doctoral fellowships. The awards, designed to stimulate and further the work of researchers in the physical sciences, grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research.

Recipients, with the subject of their researches and the institution where they will work are:

Murray Gerstenhaber, higher mathematics, particularly mapping problems; Harvard or Chicago.

Donald Roy Francis Cochran, light nuclei and their energy levels; specifically, the reactions of tritium with helium and beryllium; Johns Hopkins.

Ilse Lisl Novak, relation algebras; Institute for Advanced Study, Princeton.

Stephen Prager, polymer-small molecule systems; University of Utah.

Donald Robert Yennie, theory of elementary particles; Institute for Advanced Study.

Awards were made on recommendation of a committee consisting of Ralph Bown, chairman; M. B. Long secretary; C. S. Fuller, L. A. Wooten, Harry Nyquist, T. C. Fry, J. B. Fisk, and William Shockley. Primary criteria were the demonstrated research ability of the applicant, the fundamental importance of the problem proposed and the likelihood of growth as a scientist.

Conference on Measurements

A number of Laboratories People participated in the second A.I.E.E.-I.R.E.-N.B.S. Conference on High Frequency Measurements held in Washington, January 10 to 12, 1951. The meeting was organized by the Joint A.I.E.E.-I.R.E. Committee on High Frequency Measurements of which E. I. Green is I.R.E. Group Chairman, and E. P. Felch and E. W. Houghton are members.

Among the twenty-five papers in the four technical sessions were the following by Laboratories authors: *Measuring Techniques for Broad Band Long Distance Radio Relays* by W. J. Albersheim; *A Precise Sweep Frequency Method of Vector Impedance Measurement* by D. A. Alsberg; *Wide Band Swept Frequency Measurements Applicable to Traveling Wave Tubes* by F. E. Radcliffe; *Measurement of Characteristics of Crystal Units* by L. F. Koerner; and *High Frequency Crystal Units for Primary Frequency Standards* by A. W. Warner.

E. P. Felch arranged and presided at the session on *Measurement of Transmission and Reception* and E. W. Houghton, that on *Measurement of Power and Attenuation.*

E. I. Green presided at the evening demonstration session which was also the Annual Joint Meeting of the Washington Sections of A.I.E.E. and I.R.E. W. E. Kock, assisted by F. K. Harvey, presented a demonstration of the parallel behavior of microwaves and centimeter wavelength sound waves to accompany his paper, *Measurement of Microwave Field Patterns Using Photographic Techniques.*

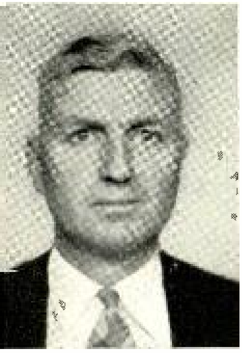
Also attending the conference were A. W. Clement, J. R. Flegal, A. A. Roetken, B. S. Woodmansee, G. R. Frantz, A. G. Fox, W. M. Goodall, F. F. Merriam, F. A. Polkinghorn, O. E. DeLange, E. D. Reed, L. H. Von Ohlsen, R. C. Pomeroy, V. W. Wall, L. E. Cisne, C. A. Bieling and D. M. Black.

Introductory Survey

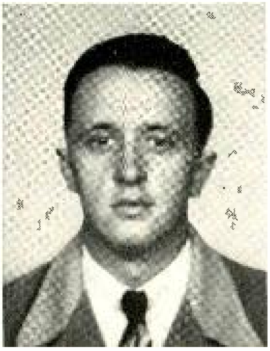
As a means of acquainting the new members of the technical staff with the several areas of technical effort and staff activities embraced by the Laboratories, and to introduce them to their associates—particularly those in management positions—a series of meetings was held during December and January. These meetings, along with visits to A T & T Long Lines, the New York Telephone Company, and Western Electric at Kearny, gave the new people an opportunity to become better acquainted with what is going on in the Laboratories and in other Bell System Companies.

Talks by representatives of management included descriptions of the functions of the Laboratories in the Bell System and discussions of the broad policies in those functions. Technical aspects were described, such as Switching Development, Transmission Development and Engineering, Systems Engineering, Electronic Apparatus, and Research. Visits to the several Departmental Laboratories gave the new members a coordinated view of the many Laboratories activities. Inspection trips to the other Bell System locations were preceded with suitable talks.

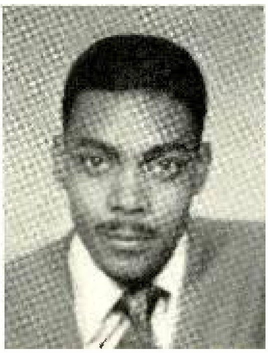
Some of the participants of the Introductory Survey posed for their picture at Murray Hill.



W. J. BENJAMIN

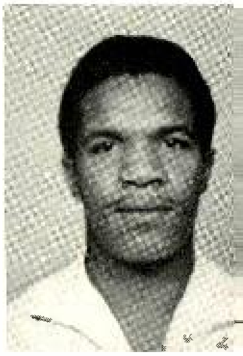


T. W. KEARKUFF



C. L. RANSOME

F. J. SKINNER



J. E. TROGDON

Called to Active Duty

During January, five more Laboratories people were granted leaves of absence to enter military service.

William J. Benjamin, who came to the Laboratories in October last year, has enlisted in the Navy and is now a Chief Hospital Corpsman at the U. S. Naval Hospital in St. Albans, Long Island.

Thomas W. Kearkuff, an assembler of electron tubes, who also came here last October, has enlisted in the Air Force and is now in training in Texas.

Clarence L. Ransome, a Helper in the restaurant, has been employed by the Laboratories since May, 1950. He has been called for military service in the Army, and is now at Fort Dix, N. J.

Frederick J. Skinner, member of the Technical Staff, came to the Laboratories in August, 1938. During World War II he served for 3½ years, returning to the Laboratories in December 1945. As a reservist, he returns to duty as a Major in the Signal Corps, and is now at the Coles Signal Laboratory at Fort Monmouth, N. J.

James E. Trogdon, Restaurant Helper, enlisted in the Army and is now at Fort Dix. He came to the Laboratories in October, 1950.

Laboratories' Activities at the A.I.E.E. Winter Meeting

Bell Laboratories' engineers were honored by the American Institute of Electrical Engineers during the Winter General Meeting at the Hotel Statler, New York, January 22 to 26. John Meszar of Switching Systems Development received the first prize in the Communication Division for his paper *Fundamentals of the Automatic Telephone Message Accounting System.* Second prize in this division was awarded to B. Ostendorf, Jr., of Telegraph Transmission Engineering for his paper *A New Electronic Telegraph Regenerative Repeater.*

The Laboratories took a very active part in the program of the Meeting. Technical papers and talks were given at sessions held throughout the week. At a meeting on *Magnetic Materials at High Frequencies,* January 23, with R. M. Bozorth presiding, K. K. Darrow gave a talk, *Electronic and Nuclear Magnetic Resonance.* On the same day, L. H. Germer spoke on *Electrical Breakdown of Very Short Gaps* at a session on *Electrical Breakdown in Gases.* On January 24, at a session on *New Techniques of Network Synthesis,* R. B. Blackman spoke on *Transducer Design Based on Statistical Properties of the Signal.* In the afternoon, at a session on *Advances in the Communication Switching Art, Telephone and Telegraph,* with R. C. Davis presiding, W. M. Bacon and G. A. Locke presented a paper entitled *A Full Automatic Private Line Teletypewriter Switching System;* at the same session, N. A. Newell and A. Weaver presented a paper entitled *Single Frequency Signaling System for Supervision and Dialing Over Long Distance Telephone Trunks.*

On January 25, at a meeting on *A New Carrier System for Medium Haul Telephone Circuits,* with P. G. Edwards presiding, R. S. Caruthers gave a paper entitled *The Type N-1 Carrier Telephone System — Objectives and Transmission Features.* This was followed by the paper *N-1 Carrier Telephone System — Ap-*

paratus and Equipment by W. E. Kahl and L. E. Pedersen.

L. Espenschied spoke on *The Genesis of Submarine Cables* at a meeting in the afternoon on *Electronic Paths Under the Sea* to mark the centennial of cable laying. At this session, J. J. Gilbert presented his paper *A Submarine Telephone Cable with Submerged Repeaters.*

On January 26, at a session on *Point-to-Point and Mobile Radio Communication,* L. A. Dorf gave a paper, *Operational Study of a Highway Mobile Telephone System.* In the session on *Feedback Control Systems,* J. C. Lozier presented a paper entitled *Carrier Controlled Relay Servos.*

Committee meetings were attended by a number of Laboratories representatives. R. K. Honaman was present at a meeting of the Publications Committee; at the Forum of Technical Committee Chairmen, R. C. Davis, L. G. Abraham and J. D. Tebo represented their committees. D. E. Trucksess attended meetings of the Electronic Power Converter Committee, Hot Cathode Power Converter Subcommittee, and Metallic Rectifiers Committee. W. H. Tidd, vice-chairman of the Electronic Instruments Sub-Committee, attended a meeting of that committee. L. G. Abraham and R. C. Davis were at the Communication Division Advisory Committee meeting. Mr. Abraham is chairman of the Wire Communication System Committee and P. G. Edwards is secretary; they both attended a meeting of this committee. H. A. Affel was also present. R. C. Davis, chairman, and John Meszar, secretary, attended a meeting of the Communication Switching Systems Committee.

W. H. MacWilliams, vice-chairman of Computing Devices, attended a meeting of his committee. R. L. Dietzold was present at the Electric Circuit Theory Subcommittee and Basic Science Committee meetings. J. G. Ferguson attended a luncheon meeting of the Committee on Instruments and Measurements; E. F. Watson and R. B. Shanck were at the Telegraph Systems meeting. E. I. Green, chairman of the Science and Electronics Division Advisory Committee, called a meeting at which J. D. Tebo, member-at-large, was present. Mr. Green also attended a luncheon meeting of the Technical Advisory Committee. J. D. Tebo was present at meetings of Section Delegates, the Nominating Committee, and the Committee on Basic Sciences. Mr. Tebo also attended the luncheons that were given for medalists K. G. Compton and O. B. Blackwell.

Patents Issued from September, 1950, to January, 1951

. O. Adam
. L. Alford
. E. Anderson
. C. Avery (2)
. Bardeen (2)
. L. Barney
. F. Barry (2)
J. S. Berger
. A. Bieling
A. E. Bowen (2)
. H. Bower
. J. Bowne
W. H. Brattain (5)
. B. Brehm
M. D. Brill
. W. Bryant
M. J. Burger
T. C. Campbell
R. L. Carbrey
B. H. Carmer
F. Caroselli
L. E. Cheesman (2)
F. W. Clayden
G. F. Clement
A. M. Clogston
R. E. Coleman
J. E. Corbin
C. J. Craft
J. R. Davey
J. B. DeCoste
O. E. DeLange
F. R. Dickinson
S. Doba
G. H. Duhnkrack
B. Dysart
W. B. Ellwood (3)
E. L. Erwin
L. Espenschied
C. E. Fay (2)
E. B. Ferrell
A. G. Fox (4)
M. Fritts (2)
R. R. Galbreath
A. S. Gano
R. B. Gibney (2)
J. J. Gilbert
G. W. Gilman
M. S. Glass
M. C. Goddard
W. M. Goodall
J. W. Gooderham
R. S. Gormley
R. E. Graham
E. I. Green
L. Gross
H. D. Hagstrum
A. E. Hague
D. A. S. Hale (2)
H. Hansen (2)
C. D. Hanscom
J. B. Harley
H. C. Harrison
R. V. L. Hartley
G. Hecht
R. A. Heising
R. E. Hersey
H. C. Hey
A. N. Holden
H. F. Hopkins
R. T. Jenkins
A. E. Joel
J. B. Johnson
K. S. Johnson
W. F. Kannenberg (2)
A. C. Keller
S. B. Kent
L. A. Kille
K. L. King (2)
J. P. Kinzer
R. J. Kircher
W. A. Klute
W. A. Knoop
W. E. Kock (4)
F. W. Koller
J. G. Kreer (2)
E. Lakatos
F. R. Lamberty
B. F. Lewis
W. D. Lewis (2)
E. Ley
G. A. Locke
J. J. Lukacs
C. Maggs
W. A. Marrison
A. S. Martins
W. P. Mason (4)
C. F. Mattke (2)
J. H. McConnell
L. A. Meacham (2)
H. E. Mendenhall (3)
C. G. Miller
K. W. Miller
H. A. Miloche
R. C. Miner
D. Mitchell (3)
L. F. Moose
W. W. Mumford (2)
W. A. Munson
R. C. Newhouse
J. G. Nordahl
A. T. Nordsieck
H. G. Och
R. S. Ohl
B. M. Oliver (3)
E. Peterson (3)
L. C. Peterson
K. W. Pfleger (2)
J. R. Pierce (4)
R. K. Potter (3)
R. E. Prescott
R. W. Prince
A. J. Rack
O. E. Rasmussen
W. T. Rea (3)
J. B. Retallack
C. D. Richard (2)
R. R. Riesz
D. H. Ring (2)
S. D. Robertson
V. L. Ronci
W. L. Roth
A. L. Samuel (2)
A. K. Schenck
C. W. Schramm
R. W. Sears
W. L. Shafer
R. B. Shanck
W. G. Shepherd (2)
F. J. Singer
P. H. Smith
J. M. Snyder
G. C. Southworth
L. J. Stacy
J. C. Steinberg
R. R. Stevens (2)
W. B. Strickler
W. G. Turnbull
P. W. Wadsworth
R. L. Wallace
H. M. Watts
E. J. Walsh (3)
J. R. Weeks
J. W. West
W. E. Whidden
W. T. Wichman
S. B. Williams (3)
O. H. Williford
A. Wilson
I. G. Wilson
D. E. Wooldridge
L. A. Wooten
G. R. Yenzer
W. R. Young
A. W. Ziegler

A Look Toward the Future

BY LLOYD BUNTING, *Insurance Counselor*

Everybody pays for life insurance. *You* pay for it if you purchase the insurance needed; otherwise *your family* pays for it by doing without things they should have. All of us can set up a program of insurance which, supplemented by Social Security and the Employees Benefit Plan, will take care of most needs after we are gone.

Saving money is always hard work. It requires resolve and sacrifice and determination. But these are the qualities necessary to carry any plan to completion. Without them we get nowhere. Since buying life insurance is saving money, it can be done with confidence.

There are certain expenses which will be with us always; such as food, rent or its equivalent, clothing, medical expenses, recreation, general running expenses, insurance premiums, etc. Since this is the case it is only common sense to understand and make proper provision for them. This usually means to budget for them. There are many books dealing with budgets so that we can know when we are setting aside a proper amount for most of these items.

The usual needs for money when the head of a family dies, are:

Cash, to meet immediate expenses of last illness and funeral, to pay up debts and current obligations, to meet administration expenses (lawyers and other fees, etc.), to pay the current income tax, to provide running expenses for the family until the estate can be settled. For many there will also be cash required to pay Federal Estate and State Inheritance Taxes.

Funds to provide permanent housing for the family. If there is a house it is then a question of whether it is best to liquidate the mortgage, to sell and to rent elsewhere or to continue the mortgage. No matter what is decided, funds are required to meet the situation.

An income is required to enable the wife to keep the home together and to meet the current living expenses. This can be done on a short time basis to give her a period of adjustment to the new circumstances and time to find a means of earning the required income herself. Or it can be done on a basis which will enable her to keep the home together and manage it herself until the children have acquired their secondary or college educations and are able to then support themselves and to help their mother. Or it can be arranged so that the wife will have an income for her lifetime thereafter and be independent of assistance from the children.

Educational expenses. This is a need which attracts all parents today and is one which is most often provided, to the exclusion of other needs. Many times the wife will unselfishly impoverish herself in order to set aside funds for this purpose. But it is only one of the needs which a father must provide for. It should be considered as a part of the whole picture in setting up a program.

Retirement income. After all we either die too soon or live too long. Both situations require financial planning. Fortunately however, if we plan wisely for the former, and have luck, those same funds will also take care of the latter.

A well organized and designed financial program is not completed overnight. It is built to meet the requirements discussed above. It should be changed or revised as these evolve. First we examine what each now has. There is the Bell Laboratories Benefit and Pension Plan. There are the death and retirement benefits from Social Security. Then, there is the life insurance already owned as well as cash in the bank, investments and equity in any property owned.

These assets must be examined to determine how closely they meet the requirements. If they do not, then more life insurance is needed. This is the only way the needed money or income can be provided quickly. It would take many years otherwise to provide the needed funds through straight savings or investment. For one seriously desiring to provide for his family, judgment requires the device of the insured method instead of taking the chance of living long enough to provide otherwise.

← A brief welcoming address was delivered by H. J. Delchamps, Vice President of the Chapter, at the start of the Pioneer party.

H. G. Geetlein, at → the piano and Evelyn Dee (Mrs. Geetlein) entertain an audience that responded with demands for encores.

TELEPHONE PIONEERS

On Wednesday evening, January 17, the New Jersey Council held another regional get-together in the East Orange Hotel Suburban. Col. Loren B. Thompson of the New Jersey Bell Telephone Company gave a first-hand factual presentation on Korea and the Far East, with a prolonged and interesting question and discussion period following.

A short musical program was given by Harry Geetlein, Evelyn Dee (Mrs. Harry Geetlein), and John Dry. A pleasant evening was topped off by drawing for door prizes which were won by D. G. Blattner, Mrs. R. T. Jenkins, and E. G. Conover, and a social hour around the buffet table where both active and life members with their guests enjoyed the Pioneer fellowship. More than 180 reservations were received for the party.

Col. Thompson's discourse on Korea and the Far East was closely followed. His listeners subsequently were loath to break for the refreshments as witnessed by the prolonged questioning to which the Colonel and his wife (Major Martinelli) were subjected by smaller groups.

The Winnahs! A. J. Akehurst, left, is handing E. G. Conover a prize drawn by Mrs. Geetlein who also gives another that she drew to D. G. Blattner. K. P. Hansen, rear, glows because his wheel-of-fortune gadget has spun a pleasing interlude. A third prize went to Mrs. R. T. Jenkins.

John Dry gave choice evidence of his "push box" mastery.

R. P. Wells operating the Civilian Defense Radio Control Station at Livingston, N. J.

Laboratories Radio Amateurs Aid Civil Defense Effort

Increasingly nowadays, the Record learns about Laboratories people who are accepting one or several responsibilities within the enlarging civilian defense effort. In the amateur radio communications field, for example, functional organization is now geared for faster tempo, and activity of New Jersey radio club members, many of them from the Laboratories, grows accordingly. The following news relating to the counties of Morris and Essex has come to light recently and similar items will be welcomed by the Record.

In Morristown, efficient amateur radio communications emergency service for the Red Cross, community and area civil defense personnel, as well as for municipal authorities, is a major objective of the Morris Radio Club. As the name implies, this club is made up of radio amateurs who are organizing the club's local facilities in cooperation with the American Radio Relay League, the parent organization of radio amateurs. Radio telephone and telegraph networks, partially with independent power supply, have already been established within the amateur bands. These networks permit fixed or portable stations and mobile units owned by individual amateurs to communicate with one another under a versatile centralized control. This control, at the Morristown headquarters of the Red Cross, will tie in with state, inter-county, and national networks to be alerted as necessary to relay messages to and from National Headquarters of the Red Cross or other relief authorities.

The club's apparatus and procedures are being perfected and periodic drills are held to familiarize members with emergency operation and maintenance. Among the more active members who are also Laboratories employees are T. W. Winternitz, president of the Morristown Radio Club, T. A. McCann, G. H. Day, L. R. Schreiner, B. McWhan, A. H. Lince, F. A. Shorkley, B. F. Orchard, J. W. Schrage, V. Wall, W. P. Slichter, and F. B. Walters.

In Essex County 22 communities are lining up to link amateur, police and civil defense communications to headquarters located at the West Orange armory.

Livingston is a typical community enlarging its own communications through cooperation with the Livingston Radio Club, Inc., and the Civil Defense Council. The township police radio system at present serves the communities of Roseland, Essex Fells and West Caldwell and an enlarged linkage is being established. A radio trunk line already exists between Livingston and Morris County headquarters. R. P. Wells of the Laboratories is president of the Livingston Radio Club as well as Civil Defense Communications Director, American Radio League Emergency Coordinator and Secretary of the Council of Essex County Emergency Coordinators.

Civil defense activities of the Bloomfield Radio Club members include R. L. Tambling who is American Radio League Emergency Coordinator for Glen Ridge, Radio Communications (amateur) Chairman of the Glen Ridge Civil Defense Council and Chief Operator of the Bloomfield Radio Club; W. R. Neisser, a member of the Emergency Communications Board of the Bloomfield Radio Club; E. J. Aridas, a member of the American Radio

T. W. Winternitz at the control station of the Morris Radio Club.

Relay League Emergency Corps for Newark; and J. I. Stockwell, Jr., who is American Radio League Emergency Coordinator for Montclair, Radio Communications Chairman of the Montclair Civil Defense Council, and of the American Red Cross Chapter, and member of the Emergency Communications Board of the Bloomfield Radio Club.

The Bloomfield Radio Club's emergency communication plan was put into operation at the request of the Montclair Red Cross at the time of the explosion at Perth Amboy. Radio communications were established between Perth Amboy and Montclair using three mobile radio units and a fixed station. This network handled vital messages necessary for proper operations of the Montclair Red Cross Chapter at Perth Amboy. Recently the club has put on tests for the Sheriff of Essex County, the Newark Police, and several Civil Defense Councils in Essex County.

All radio amateurs in Morris and Essex Counties and environs are invited to participate in this emergency communications program either by operating their own or available stations in the established networks.

H. A. Affel
35 years

C. F. Seibel
40 years

J. M. Wilson
35 years

T. C. Fry
35 years

March Service Anniversaries of Members of the Laboratories

40 years
C. F. Seibel

35 years
H. A. Affel
T. C. Fry
O. C. Hall
Veronica Monahan
J. H. Sailliard
J. M. Watson
W. A. Weikert
J. M. Wilson

30 years
L. P. Bartheld
F. S. Entz
G. S. Mueller
A. J. Pascarella

25 years
M. Conlon
Anna Dowd
F. J. Grattan
J. B. Harley
M. M. Jones
Helen Matej
D. O'Neill
E. J. Reilly
S. J. Stockfleth
Ruth Thompson

20 years
L. Szeglowski

15 years
Elizabeth Chambers
A. G. Fox
W. E. Lichte
M. J. O'Brien
J. P. Schweitzer
L. J. Steinbach
E. C. Weiss

10 years
Mary Anderson
J. A. Brankner
G. A. Carlson
Mildred Datkowsky
R. T. Duffey
Leda Girouard
W. T. Hansen
J. R. Harris
P. J. Kreider
Patricia Malone
C. W. Muehling
E. F. O'Neill
H. U. Pearce
K. H. Schreyer

J. H. Sailliard
35 years

O. C. Hall
35 years

W. A. Weikert
35 years

J. M. Watson
35 years

RETIREMENTS

Among those retiring from the Laboratories are May Reilly and S. H. Anderson, each with 34 years of service; and W. A. Bischoff and A. I. Crawford, 31 years.

May G. Reilly

When May Reilly graduated from high school, she got a position in Wanamakers book department. The work was congenial, and she built up a clientele which eventually included some of Western Electric's patent executives. Because she could find books with but a slight clue to the title, she was offered a position in the Patent Files and joined Western Electric in 1917.


May Reilly S. H. Anderson

There is a rumor that when Miss Reilly is asked to verify something that happened long ago, she puts on a special pair of gloves with eyes in their finger tips. Be that as it may, she is remarkably successful in her quests. A good memory helps, but her meticulous supervision of her force over the last quarter-century and her genius for good housekeeping are principally responsible.

Living alone in upper Manhattan, Miss Reilly looks forward to her leisure years as time to be filled with service to others, perhaps as a hospital volunteer, and as time to catch up with her reading.

Squire H. Anderson

Soon after joining Western Electric in 1916 Mr. Anderson came to the Systems Development group at West Street, where until 1927 he was engaged in the development of central office systems, particularly power plant equipment. He was especially active in the early development of large gas engines for standby emergency power generation in central offices. He then transferred to what is now the Quality Assurance Department and continued to devote his time to power apparatus and equipment. For many years he has been in charge of a group handling quality surveys, investigation of complaints and related activities in this field.

The Andersons are home-owners in Hollis. Their immediate plan is to return to their native town, Brookfield, Missouri, where many of their kin still live. If they like it, they may stay; if not, they will come back to Hollis. Mr. Anderson is a graduate of University of Missouri (B.S. in Eng. 1916), and a member of Eta Kappa Nu, Tau Beta Pi, and A.I.E.E.

William A. Bischoff

After several years' experience elsewhere, Bill Bischoff joined us as a draftsman early in 1920. His first work was on the printing telegraph, at that time built by Western Electric. In 1924 he was given charge of apparatus information files, the Apparatus Card Catalogue and some of the departmental staff services. Three years later, placed in charge of apparatus drafting, he reorganized the procedures of the group and became actively interested in standardization work. One of his first activities in this connection involved the establishment of a new series of Laboratories drawings from which Western Electric manufacturing drawings are produced photographically and without substantial alteration. This change has effected very large savings in over-all drafting effort.

During World War II Mr. Bischoff entered the standardization problem on a national scale. As chairman of an A.S.A. war committee on drafting, he and his associates in Army, Navy and industry brought together representatives of many important industries and secured agreement with the Armed Forces as to uniform sizes of drawings, presentation of information on them, and to a considerable extent the standardization of details. Work of this group is now being carried on by the Armed Services


W. A. Bischoff A. I. Crawford

THE FIRST TRANS-ATLANTIC TELEPHONE CALL

Heard on the Telephone Hour February 5. Austin Bailey (left) A T & T, and Arthur Oswald (right), Bell Laboratories, re-enact the first call with Tom Shirley, the announcer.

Announcer: Let's turn back the calendar twenty-five years—to the night of February 6, 1926. In a quiet room in New York City a man with earphones on his head listens intently. The hands of a clock move to eleven minutes past eleven. The man hears a crackling and humming and then a voice!

First Voice: Hello! Hello, New York!

Second Voice: Hello! Hello!

First Voice: This is Oswald talking from Rugby, England. Who is that?

Second Voice: This is Bailey talking in New York!

Announcer: The voices you have just heard are those of Austin Bailey and Arthur Oswald, speaking once again the words they used in the first telephone conversation ever to span the Atlantic. That was twenty-five years ago, and Bailey and Oswald were members of the Bell System team that for many months had been working to make two-way Trans-Atlantic telephone service a reality.

And today they are still working on research to extend the range of the human voice—Austin Bailey at the headquarters of American Telephone and Telegraph Company, and Arthur Oswald at Bell Telephone Laboratories. Their work today has the same objective as it had on that night twenty-five years ago—to help make your telephone service ever better, whether you call across town or the ocean.

Before that historic night, it was impossible for you to talk with anyone beyond this continent. Today, you can talk from your own telephone to almost every other telephone in the world. A businessman picks up his telephone and orders supplies from Australia or South Africa. The far corners of the world are in instant touch with America by telephone.

And today, across this land the telephone gives the orders, receives the orders, and helps move into high gear the productive power of the most productive nation on earth.

And yet it's only twenty-five years since that first telephone conversation across an ocean. What another 25 years will bring no man can tell. But this we do know. Improvement in your telephone service will continue, and each step will come from the teamwork of telephone people like Austin Bailey and Arthur Oswald, the two men who were the first to talk together across an ocean's span.

Thank you Mr. Bailey and Mr. Oswald for re-enacting that night twenty-five years ago.

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themselves; the effort put forth during the war is now bearing fruit.

In 1948 Mr. Bischoff moved to Murray Hill where he has most recently been in charge of all drafting and technical file records relating to transmission, station and outside plant work engineered at that location. In recent years he has been chairman of the Laboratories' design standards committee which specifies standards for drawings, parts and processes.

Mr. and Mrs. Bischoff will shortly move to Florida where in the vicinity of St. Petersburg they are building a house. Bill expects to play golf, go fishing, and make a garden, to catch up with some of the leisure he has long wanted. The Bischoffs have one son, a master technical sergeant in the Air Force.

Allen I. Crawford

During Allen Crawford's Bell System career he has seen electronics unfold from a few "vacuum tubes" to the extensive line of today.

Entering Western Electric here at West Street in 1920, he had had engineering training at Purdue and elsewhere, and with his drafting experience he first went into that work. Soon he transferred to mechanical design; his subsequent work on tube bases and sockets indicated a transfer in 1928 to electronics development. For many years he headed up a group which was responsible for the preparation, issuance and distribution of manufacturing drawings, specifications and technical information on vacuum tubes. He also had under his charge the development of packaging for vacuum tubes and the coordination of the technical investigations of field complaints and the quality assurance matters within the Vacuum Tube Development Department. For several years Mr. Crawford was a member of standardization committees under the Joint Electron Tube Engineering Council. Thus he took part in the coordination of many manufacturers who during World War II made identical tubes for various government agencies.

When it was decided to station a group of Laboratories engineers at the Western Electric plant in Allentown, Mr. Crawford laid out their physical facilities and supervised the installation. At that time the specification work was moved to Allentown, so he gave up that job, and worked on the layout of the department's facilities at Murray Hill, supervising that move also. Recently he has been working on laboratory layouts for various developments, and doing a number of special jobs.

Mr. and Mrs. Crawford have leased their home in Manhattan and have completed a house at 500 Rafael Boulevard, Shell Isle, St. Petersburg, Florida, where they expect to spend the major part of each year, returning North for short visits. Mr. Crawford has been interested in numerous real estate activities in the past and expects to devote considerable time to this activity in the future. This, along with other hobbies such as golf, fishing, etc., will undoubtedly keep him busy. He has one son in business in Dover, Delaware, and three boys still in preparatory school.

News Notes

A BUST of ALEXANDER GRAHAM BELL for installation in the Hall of Fame on New York University's campus will be executed by Miss Ethel P. Hood. Among other portrait busts from her hands are those of Helen Hayes and Beatrice Lillie. Selection of Miss Hood was made by a committee of distinguished sculptors. Dr. Bell was accorded recognition in the Hall of Fame last year, along with Woodrow Wilson, General Gorgas, Susan B. Anthony, Theodore Roosevelt and Josiah Willard Gibbs.

PROFESSOR M. H. L. PRYCE of the University of Oxford visited Murray Hill on January 10 and at a conference there spoke on recent developments in paramagnetic resonance. This consists in the appearance, at certain characteristic frequencies, of enhanced magnetic properties in certain metals and inorganic compounds. The study of this phenomenon increases our knowledge of the properties and structure of solids in general and of magnetic substances in particular. It serves as a tool in the continuing effort to improve the materials needed by the Bell System.

THIS IS THE HOUR FOR GREATNESS

From an advertisement of N. W. Ayer & Son, Inc.

There are times that require greatness in men. This is such a time.

Greatness, in this hour, is not beyond the reach of any man, nor is it reserved for those who make the headlines in world affairs. Its fuller measure is the willingness and capacity to rise to the urgency of the times, whatever the job may be.

Men with these elements of greatness are shaping this country's destiny today. Many wear the proud uniforms of our country. Many are in the hundreds of thousands of factories, mines and offices throughout the land. They are launching, once again, the most powerful weapon that history has ever known — the might of American production.

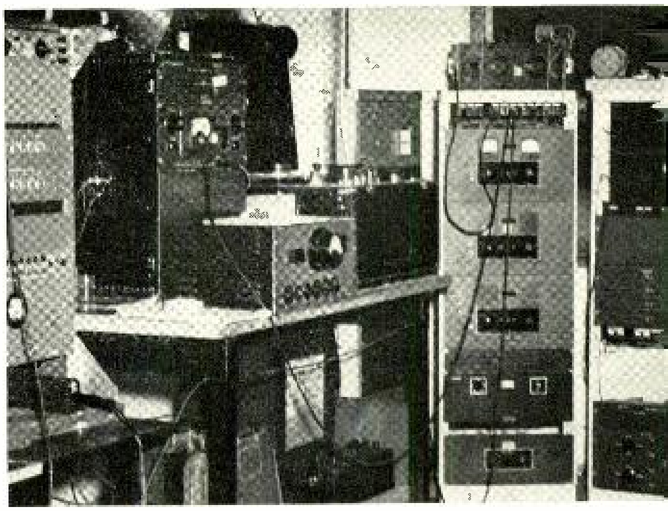
Guiding this effort are the men of management. They have spent their lives planning for the future, inventing or developing new machines, building new resources. These are the men who, in the last five years, have lifted the industrial capacity of this country to a level never dreamed of before.

It is America's production that is the foundation of her strength and security.

J. W. Gorgas of the Switching Systems Development Department has devised a radically different and very much simpler form for circuit schematics that would replace both the SD and OS forms now used. He has explained the construction and uses of the new schematic to A T & T and Western Electric engineers at Kearny, and recently—with D. H. Wetherell and R. E. Collis—went to Chicago to discuss the new schematics with Hawthorne engineers. More information regarding this new type of circuit schematic will appear in a later issue of the Record.

Type-N Carrier is a new twelve-channel system intended for shorter distances than have been thought economical for type-K carrier. A number of pre-production systems have been built at Kearny and installed in various parts of the country. A. J. Aikens has visited one of these, at Harrisburg, to investigate noise difficulties. He has also visited Eastern Maryland to study the probable effect on a proposed type-N system of nearby radio stations that use the same part of the spectrum. He also made tests on a newly-installed type-N system between Boston and Gardner.

Miss Gertrude Schleifer, who has recently become one of the three supervisors who share supervision of the West Street Restaurant. She is a graduate of Pratt Institute (1947) in dietetics and institutional management. Her initial assignment is to the kitchen; after this tour is completed, in April, she will become better known to restaurant patrons.



Thunder Hunters

When men go out deliberately looking for trouble, that's news: news that attracts attention and arouses interests. Those responsible for preparing script for the Telephone Hour felt this way about the story of the Laboratories static studies in the September Record (page 409), and briefly described the work for the Telephone Hour program of January 29 under the above title. Most of the equipment used for these studies is shown in the accompanying interior view of one end of the Hamokahodo Test Station in Madison, Florida. The tape recorders on which the static was recorded are on the large table near the left center.

Murray Hill Glee Club

A top notch noon hour program of folk songs, old favorites and close harmonies was presented by the Murray Hill Glee Club in the Arnold Auditorium January 25 with U. A. Matson as accompanist. Staging coordinator was A. J. Akehurst. The Glee Club, a newcomer to the entertainment field at Murray Hill, is the outgrowth of informal gatherings of a singing group previously at Graybar Varick. Organized by R. H. Klie, with A. R. Rienstra as coach and conductor, the Glee Club includes the Barber Shoppers, a twelve-man close harmony combination directed by G. B. Thomas, Jr.

Those on stage for the first presentation were: B. H. Carmer, Jr., T. R. D. Collins, R. D. Ehrbar, M. O. Fichter, G. T. Ford, C. T. Goddard, D. W. Grant, N. J. Herbert, J. J. Jansen, R. H. Klie, S. Korba, H. P. Lynch, A. R. Rienstra, E. F. Sartori, G. B. Thomas, Jr., R. L. Trent, D. C. Weller, N. C. Wittwer, W. H. Yocom.

Breakfast with Mrs. Murphy includes a tidbit for one of his two dogs.

L. J. MURPHY— PIPE FITTER, ARTIST

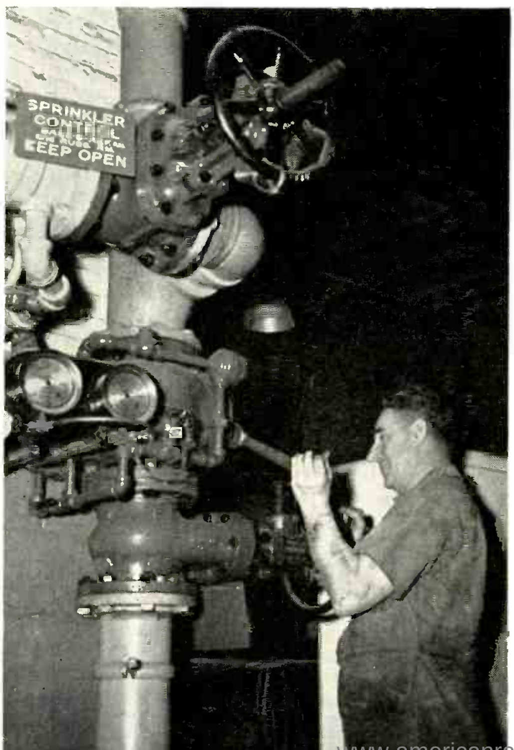
Like so many Laboratories people, it is hard to guess what Luke Murphy of the West Street Building Shop does in his spare time when you see him working with a four-inch pipe. Who would think that he could handle a tiny artist's brush with the same facility? And yet Luke is an accomplished artist, having studied in his native city of Liverpool, England and in Wexford, Eire. He is a member of the Irish Academy in New York. In fact, during the Irish Art Exhibit at the De Motte Galleries in New York January 1948, Mr. Murphy's "Seascape" was exhibited along with paintings and sculpture by such masters as Sir William Orpen, Sir John Lavery and Andrew O'Connor.

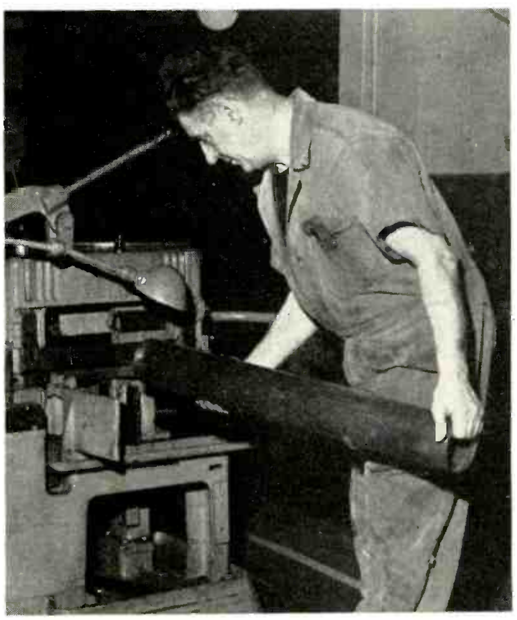
Mr. Murphy came to America in 1921 as a passenger, but shortly afterward he was back at sea, working for several different shipping concerns. Within two years, he had visited many places on both the East and West Coasts of North America, Central America and South America. Between 1923 and 1927, employed by the United States Lines, he made eighty crossings of the Atlantic. The next fourteen years he spent with the American Sugar Refining Company in Brooklyn, coming to the Laboratories as a steam fitter in 1941.

The Murphys live on Long Island in Kew Gardens with their two dogs and a parrot. They have no children. While out walking with his dogs on the evening of November 22, 1950, he was startled by the crash on the Long Island Railroad. For the next six hours, Mr. Murphy aided in rescue work—a job, he says, that he hopes he will never again have to do.

Shown below is one of Mr. Murphy's regular jobs—maintaining the sprinkler system.

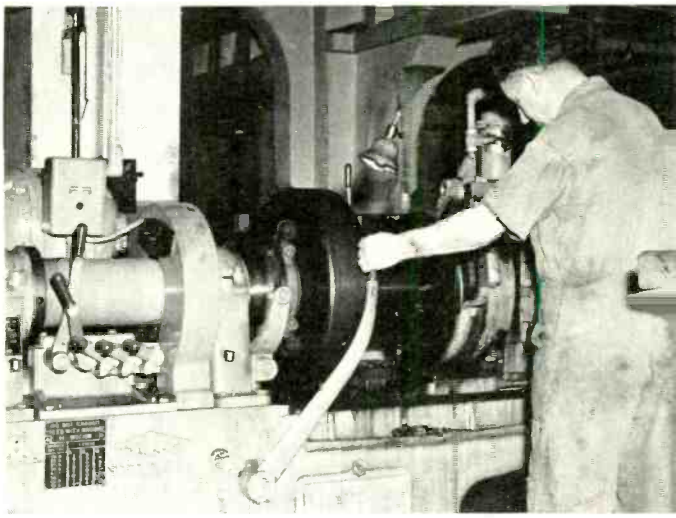
At the right, Mr. Murphy is shown cutting a 3-inch pipe with a power saw.





During lunch hour, cards provide recreation. In the photograph, left to right, are E. H. Johnson, James Marshall, Thomas Walsh (back to camera), Mr. Murphy, Harold Shaw (partly concealed), and H. A. Rosenbohm.

Mr. Murphy obtains chain tongs from Hugh Gill in the Tool Room.

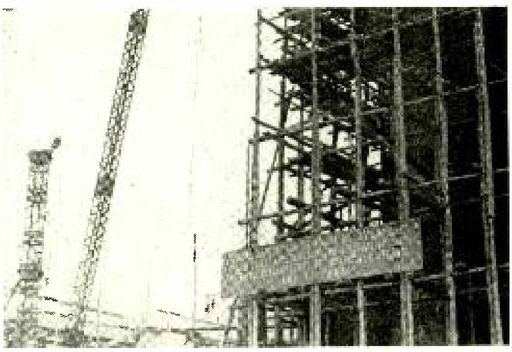


The photograph, right center, shows Mr. Murphy threading a large pipe with the thread-cutting machine.

Mr. Murphy at his hobby of oil painting. Marine scenes are his favorite subject.

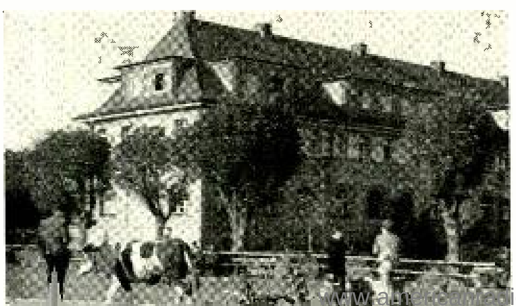
Mr. Siegmund (center) with Dr. Six (left) and Professor Bähler. Dr. Six is with the N. V. Philips Company in Eindhoven, Holland. Professor Bähler of Delft University is a consultant of the Philips Company.

Typical of the destruction in Berlin are the remains of the Aden Hotel.



Contrasting construction methods in Berlin. On one side of the street, in the Eastern Sector, wooden poles are lashed together to form the scaffold. At the extreme left, in the Western Sector, a modern steel derrick and a concrete pouring tower can be seen.

In the village of Bad Orb, a milch cow pulls a wagon that uses a skid to replace rear wheels.



H. O. Siegmund Visits Europe

H. O. Siegmund, Switching Apparatus Engineer, who visited Europe recently to study telephone switching developments there, had an opportunity to compare East and West Berlin during his travels. "From the standpoint of personal reaction," says Mr. Siegmund, "my visit to Berlin was the high spot of the trip. In the Soviet Zone, I saw the complete destruction of the buildings formerly occupied by the Reich Chancellery, the Luftwaffe and the Propaganda Ministry. All were in complete ruins and, for the most part, remain so, including the palace of former Kaiser Wilhelm, the National Museum, National Library, the Cathedral and other public buildings. There is extensive effort to rebuild in the Eastern Sector, particularly buildings for use by the People's Government. At the boundary between the East and West Sectors, the most casual observer cannot fail to recognize the striking differences in the conditions under which life is carried on and work is being done in the two zones. In the Western Sector, reconstruction is accomplished by means of modern power equipment, tools, trucks, materials, and facilities comparable to what we are accustomed to in America. Across the street, in the Eastern Sector, the methods are different. Here one finds little power equipment, hand labor largely from women, derricks operated by hand-cranked winches, scaffolding of tree trunks mortised together and lashed in place with rope.

"The spirit in West Berlin was high and the energy with which these people are striving to recover is great. In all my visits, it was here that the American way of life and our philosophy appeared to be held in the highest regard. This can be ascribed to the performance of the air lift in the hour of their trial when, without such help, West Berlin would not have been able to carry on.

"In the rural sections of occupied Germany, the scars of war are much less in evidence and life there is quaint and unchanged. The needs of the people are small and their work is primitive. In these places, age and antiquity are all around."

Commuters to Hear Labs Chorus

The West Street mixed chorus, directed by R. P. Yeaton, will appear in concert on March 20 at Grand Central terminal. The 40 voices, accompanied at the piano and organ by Grace Wagner and Betty Garrow, will be heard in a group of hymns and spirituals at 5:30 p.m.

Annual Meeting of the American Physical Society

Several members of the Laboratories attended the 1951 annual meeting of the American Physical Society held at Columbia University in New York City, February 1 to 3. G. E. Moore, secretary of the Division of Electronic Physics, took an active part in arranging the meeting; preceding the annual meeting his Division, along with the Panel on Electron Tubes of the Research and Development Board held a conference at the City College of New York on January 30-31. At this conference, J. A. BECKER gave a paper on *Migration of W Atoms on the Surface of a W Single Crystal As a Function of Temperature and Electric Field Strength.* H. D. HAGSTRUM spoke on *Ejection of Electrons by Positive Ion Impact: He^{+} and He^{++} on Mo;* H. W. ALLISON and G. E. MOORE gave a paper on *The Adsorption of Sr Metal on Tungsten,* and C. KITTEL discussed *Theory of Antiferroelectric Crystals.*

During the annual meeting, at a symposium of the Division of Electron Physics held February 1, J. A. Hornbeck spoke on *Distinguishing Atomic from Molecular Ions: A Review of Positive-ion Mobilities In the Noble Gases.* On the morning of February 3 at a session on Semi-conductors; Photoconductivity; Lattice Defects, with W. Shockley presiding, K. G. McKAY presented a paper on *Efficiency of Alpha-Bombardment Conductivity in Germanium;* E. J. RYDER spoke on *Mobility of Electrons in High Electric Fields;* and Dr. Shockley gave a talk on *Mobility of Electrons in High Electric Fields: Theory.* In the afternoon of February 3, J. BARDEEN spoke on *Supraconductivity and Lattice Vibrations.* At the same time, in another session, MATILDA GOERTZ gave a paper entitled *Heat Treatment of Iron-Silicon Alloys in a Magnetic Field.* Miss Goertz was introduced by R. M. BOZORTH. Also on February 3, P. W. ANDERSON spoke on *Theory of Paramagnetic Reasonance Line Breadths in Diluted Crystals.*

Polkinghorn Honored by Japan

"In recognition of his initiative and interest in furthering communication progress in Japan" during the two years that he served as Director of the Research & Development Division of the Civil Communications Section of General MacArthur's staff, Frank A. Polkinghorn of Military Electronics has been elected an Honorary Member of the Institute of Electrical Communication Engineers of Japan. Formal conferment will be made in the Spring.

P. E. Mills shown here with his bass viol, is one of the seven Laboratories people who are members of the Metropolitan Bell Symphony Orchestra. This orchestra, a full symphony organization, composed of Bell System people of all types of occupations, will offer its third Carnegie Hall concert Friday, March 30, at 8:30 p.m. Guest soloist will be the distinguished concert pianist, Amparo Iturbi. Tickets for the concert, priced from $1.00 to $2.50, can be obtained by filling out the application blanks that will be distributed to all members of the Laboratories.

Among the projects carried out under Mr. Polkinghorn's guidance was the organization of the Electrical Communications Laboratory, the research and development body of the Ministry of Telecommunications, which was initiated by King Gould, and carried forward by R. D. Parker. This laboratory is under the leadership of Dr. Goro Yoshida who visited the Laboratories last July. Another project was the organization of electrical engineering professors for the improvement of engineering education. This project was responsible for the sending of five professors to America to study. All of these men were visitors to the Laboratories in 1950. A third project was the supervision of courses in industrial management given for the benefit of the communications industry. One of the two leaders of this course was Charles W. Protzman of the Western Electric Company at Point Breeze.

The October issue of the *Journal of the Institute of Electrical Communication Engineers of*

Japan contains an article (in Japanese) on the Improvement of Telecommunications Engineering Education in Japan by Mr. Polkinghorn. This is a translation of a talk which he gave to professors and students at several universities in furtherance of a program for obtaining more effective engineers. The translation was made by Dr. I. Koga, professor of communication engineering at Tokyo University and Tokyo Institute of Technology, who was a visitor to the Laboratories last Spring and who is well known in the United States for his researches on quartz crystals.

The August, 1950, issue of the *Journal of the Institute of Electrical Engineers of Japan* also contained an article on engineering economics by Mr. Polkinghorn. The September, 1950, issue of *The Bridge of Eta Kappa Nu* published an article on "The Occupation in the Land of the Rising Sun" by Mr. Polkinghorn describing the purpose and policies of the Occupation as well as life in Japan since the end of the war.

Whippany Nurse

Since October 1, Ann Williams has been the registered nurse in attendance at Whippany. She is also trained as an X-ray Technician, and alternates with Gertrude Thomas of Murray Hill in providing that service there – an arrangement that assures X-ray coverage. Mrs. Williams is a graduate of the Robert Parker Hospital, home of the famed Guthrie Clinic, in Sayre, Pa. She lives in Upper Montclair, N. J., with her husband and four and a half year-old son. Mr. Williams is a supplier of medical equipment.

Ann Williams, registered nurse at the Whippany Laboratory.

Changes in Organization

C. W. Halligan has been appointed head of a new department which has been set up for the duration of a special project; he will report to W. H. Martin. Mr. Halligan will continue supervision over his previous group as station systems development engineer. K. E. Gould is transferred from Carrier Systems Engineering to the new department, reporting to Mr. Halligan.

Commercial and Staff Service formerly reporting to H. J. Wallis in a "junior" position has been assigned to W. C. Pitman, Jr., in addition to the project and local order service group and the plant and shop service groups which he is retaining. Mail, Central Correspondence and Catalog Files, formerly reporting to Mr. Pitman, have been assigned to General Service reporting to R. C. Carrigan.

Shirley Lawton, formerly in charge of Apparatus Files, has been made supervisor of Patent service at Murray Hill. Her place has been taken by Marguerite Johnston, supervisor of Apparatus Records; and Miss Johnston in turn has been replaced by Lillian Schou.

J. F. Neill has replaced the late Edward Alenius as supervisor of the Illustrations group.

Mary Regan, a clerk in Apparatus Records, has become a junior draftsman in the Apparatus Drafting Department.

Club Announces 6th Annual Arts and Crafts Exhibition

The Sixth Annual Exhibition sponsored by the Laboratories' Arts and Crafts club will open on May 22 in the Game Room (Section 1H) at West Street, to run for three successive days. Deadline for entries is May 18.

Every member of the Laboratories is invited to submit entries and to attend the exhibit. Work submitted must have been made by the entrant, and not have been entered in previous exhibitions at West Street or Murray Hill. Classes for entry are sculpture and ceramics, oil paintings, watercolors, pastels and monochromes; and handicrafts. The last group may include metal, leather, wood, stone, plastics, needlework and china painting. Each exhibitor may submit an unlimited number of works. Not eligible for showing are commercial art, technical illustrations, photographs, collections such as stamps or coins, and art, sculpture or

In a wagon drawn by "Babe"—a possible descendant of Paul Bunyan's famous blue ox—four Bell System men start for the woods to study pole production in the southern pine forests. Seated, F. F. Farnsworth and guide. Standing, F. R. George, Purchasing Division, and L. L. Bulter, Supplies Service Division, of Western Electric, and G. Q. Lumsden of the Laboratories.—Photo courtesy of Mr. Lumsden

ceramic ware which is a facsimile of an existing work. Full rules covering the exhibition, and a list of prizes to be awarded will be announced soon by the exhibition committee. Information can meanwhile be obtained by calling Alice Loe, Ext. 560, or Mrs. C. H. Hamilton, Ext. 1179.

New Officers for Murray Hill Popular Orchestra

The annual election of the Murray Hill Popular Orchestra held January 4 resulted in the following officers being elected: *Executive Chairman,* U. A. Matson; *Secretary-Treasurer,* F. L. Crutchfield; *Orchestra Director,* L. J. Speck; and *Librarian,* W. H. Kossman. Because of the increase in the activity of the orchestra, a new officer—*Talent Director*—was created whose duties include the recruiting of musical talent at Murray Hill and the rehearsing of such talent for performance with the organization. H. G. Geetlein was elected to this office.

News Notes

RESPONSIBILITY for Western Electric sales made directly to the United States Government of all wire communication products and of radio communication products of a type identical or similar to those sold to Bell Telephone Companies has been transferred from Western Electric's Radio Division to its Telephone Division. H. N. Willets, presently Commercial Relations Manager, Telephone Division, has been designated Manager, Government Communication Sales. The post of Commercial Relations Manager will be taken by S. Hubbard.

NEED of the Bell System and other pole users for the urban type joint-use poles—those that support both telephone and power wires or cable—has raised a question as to whether southern pine forests can continue indefinitely to supply sufficient quantities of these poles. The western species such as western larch, Douglas fir and western red cedar are being used to supplement the short supply of southern pine poles in those sizes under great demand. However, it takes at least 100 years for some of these western poles to grow, whereas the southern pine poles of these same sizes are full grown at 30 to 35 years. Because southern pines grow rapidly in those areas under strict forestry management, particularly where forest fires are controlled, the production of pole timbers is becoming an increasingly important activity. Results in certain areas, particularly in the longleaf-slash pine region of the deep South, indicate that much can be accomplished by intensive forest management. Recently F. F. FARNSWORTH and G. Q. LUMSDEN visited one such area, the Satilla Forest, belonging to the Georgia Forest Products Company at Woodbine, Georgia, to examine the results of the methods successfully used there. On the same trip they looked over treating plants in neighboring states.

AT A CONFERENCE to discuss the work of the Physical Electronics Research group held in the Arnold Auditorium at Murray Hill January 17, H. W. ALLISON gave a talk on *The Adsorption of Strontium on Tungsten* and G. E. MOORE spoke on *The Thermionic Emission of Barium-Strontium Oxide without Metallic Support.* A second conference held January 24 included a talk by H. D. HAGSTRUM on *The Ejection of Electrons by Positive Ion Impact—Singly and Doubly Charged Helium Ions on Molybdenum* and another by J. A. BECKER on *The Use of the Field Emission Electron Microscope to Study the Adsorption of Tungsten on Tungsten and Barium on Tungsten.*

MARY ENTRABARTOLO
1907-1951

K. U. KALSKE
1916-1951

Recent Deaths

MARY S. ENTRABARTOLO, January 29

Mrs. Entrabartolo, after attending business and secretarial schools, began her Bell System career in 1929 when, as Mary Studney, she was employed as a stenographer at Western Electric in Kearny. After a few months she accepted a position as a clerk at West Street. In October, 1949, she transferred to Murray Hill where from May of last year until the time of her death she worked as a secretary. Mrs. Entrabartolo devoted much of her spare time to charitable work. As one of her benevolent projects, she "adopted," through the Commission for Children's Relief, a small Polish boy who had been seriously wounded early in World War II. She sent money and numerous packages of clothing to help the lad, his brother and widowed mother in Warsaw.

KAIKU U. KALSKE, February 4

Kaiku Uljas Kalske, an assembler and wireman, joined the Laboratories in September, 1944. He was graduated from Theodore Roosevelt High School, New York City, in 1938, and worked as a carpenter for various companies, including Bethlehem Steel Company in Hoboken before he came to the Laboratories. At Murray Hill, he was on assignment to various engineering laboratories, and recently worked on the wiring of components of the L-3 carrier system.

News Notes

K. K. DARROW gave a talk on *Electricity in Metals and Semi-Conductors* before the Poughkeepsie (New York) Sections of the A.I.E.E. and I.R.E. on January 9. Dr. Darrow has been reelected Secretary of the American Physical Society, beginning his eleventh year in that office of the Society.

LAST MAY, A. G. JENSEN gave a lecture on color television before the Science Engineering Club at Kearny. Since that time, the popularity of this lecture has been attested by the number of times he has repeated it. Capacity audiences greeted him twice at West Street and at Murray Hill and once at Whippany during June, 1950. A number of Sections of the I.R.E. and A.I.E.E. have also heard the talk.

THE DECEMBER 9, 1950 ISSUE of the English publication *Nature* contains a review of W. P. MASON'S new book *Piezoelectric Crystals and Their Application to Ultrasonics.* Recognition is given to Dr. Mason's extensive contributions to the researches on piezoelectric crystals; the reviewer states that Dr. Mason has compiled a "lucidly written book."

W. L. MRAZ presented a paper on *Automatic Gain Control and Automatic Frequency Control as Feedback Problems* at the U. S. Naval Air Station, Willow Grove, Pa.

G. N. VACCA has been made a member of the Wire and Cable Technical Committee of the Industry Operations Bureau, National Production Authority. Among the committee's objectives is to recommend ways of allocating strategic rubber for wire and cable use. H. PETERS works on a similar committee for the hard rubber industry. Substitutes for scarce metals were discussed by E. E. SCHUMACHER, D. H. WENNY and J. H. SCAFF at Hawthorne.

DURING A RECENT VISIT to Hawthorne, E. L. FISHER, with the cooperation of the E of M and Quality Control engineers, established observational standards for use in inspecting the new cylindrical protector blocks used in the recently developed station protectors and protected distribution cable terminals. In today's heavily loaded plant, occasionally distribution cable terminals are over filled with drop wires. While in Chicago, Mr. Fisher discussed with representatives of the Illinois Bell Telephone Company the design features of a supplementary cover which might be used to provide more wiring space in these congested locations.

"Telephone Hour"

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

March 5	Nelson Eddy, *baritone*
March 12	Jussi Bjoerling, *tenor*
March 19	Clifford Curzon, *pianist*
March 26	Ezio Pinza, *basso*
April 2	Jascha Heifetz, *violinist*
April 9	Lily Pons, *coloratura-soprano*

AT THE JANUARY meeting of the Deal-Holmdel colloquium C. H. ELMENDORF described the new L-3 carrier system for coaxial cables and its transmission objectives. This system will enable the transmission of 1800 telephone channels or alternatively 600 telephone channels and one television channel. Mr. Elmendorf stressed the need of planning the system and designing its equipment for ready conversion of existing systems from L-1 to L-3 operation. At a February meeting A. M. SKELLETT, formerly of the Bell Laboratories, and now with the National Union Radio Corporation, spoke on *Recent Developments in Dark Trace Cathode Ray Tubes.*

AS DEMANDS for communication apparatus increase, particularly apparatus to be used in airborne equipment, space and weight limitations become more and more important. Efforts are constantly being made to "miniaturize" not only capacitors and resistors, but is extending to transformers and other power coils. Terminals for hermetically sealed power coils required visits during January to several plastics companies by L. W. KIRKWOOD together with H. R. Bosworth, C. J. Rix, R. A. Walker and W. Stolberg of the Western Electric Company. Mr. Kirkwood also visited the Westinghouse Electric Corporation at Sharon, Pa., to review production of 400-cycle power coils.

COMMON CAUSE of relay contact failure is a microscopic deposit of dust which mechanically prevents closure. Studies are underway to determine the types of dust which do the most damage and how best to keep them away. T. F. EGAN, H. J. KEEFER, H. W. HERMANCE and G. T. KOHMAN visited the Lehigh and Homestead Central offices in Pittsburgh where The Bell Telephone Company of Pennsylvania is cooperating in analyses of atmospheric dust in relation to contact performance.

HIGHER RESISTANCE subscriber loops in step-by-step areas will become possible in the near future as a result of Laboratories developments. By taking advantage of more precise control of the per cent break period of a new dial, and of the use of full selective ringing sets employing 313A vacuum tubes, it has been possible to readjust the step-by-step relays at the central offices to secure satisfactory operation on loops of more than 18 per cent higher resistance than has been possible before. A. S. KING and F. B. LAMBERTY of the step-by-step equipment and circuit groups, respectively, were recently in Hawthorne to discuss with the Western Electric Company the best ways of getting this improvement into the field promptly.

Seated on the spring board during a lull in the swimming club activities are (left to right) Doris Ketchow, Thelma Gradwell, Elizabeth Hull, Priscella Westphal, Mildred Read, and Marjorie Boyle.

Murray Hill Swimming Club

The Murray Hill swimmers do not let the weather interfere with their activities, as their program continues the year round. Having a large competent staff of Red Cross instructors, and with the objective of teaching greater safety in the water, the club provides training in all phases of Red Cross water safety. During the fall and winter season the program emphasizes beginner and intermediate swimming skills. In the spring, life saving training is added to the program. Early in the summer the indoor program moves from the Plainfield, N. J., Y.W.C.A. pool to the outdoor lake at the Schiff Scout Reservation near Mendham, N. J. An intensive training course in boat and canoe handling skills rounds out the over-all program. Occasionally, public demonstrations have been given of swimming, life saving skills and the handling of canoes.

Practicing lifesaving skills are, at the top, W. C. Westphal being towed by R. W. Hull; in the center, W. C. Buckland is being "rescued" by J. B. De Coste; in the foreground, H. Peters is towing Mildred Read.

Cathodes that don't wear out are a steady goal of Laboratories tube research. H. E. Kern and R. T. Lynch reported some new slants in their paper *Emission and Life of Planar Diodes as Related to the Reducing Agent Content of Cathode Nickel* before the Symposium on *Electron Emission*, City College, New York.

In order to reduce labor costs involved in underground conduit construction, the standard lengths of the more commonly used conduit sections have been increased by six inches. This will result in more duct footage per manufacturing operation and a comparable decrease in the number of joints required. A further change is the elimination of the glaze from the conduit.

Qualification Course for First Aid Instructors

There is a need for qualified American Red Cross First Aid Instructors to meet an anticipated demand for Out-Of-Hour instruction in First Aid in connection with Civil Defense.

Preparations are being made to conduct a combined First Aid Advanced and Instructor Reactivating Course at West Street and Murray Hill to qualify former instructors whose certificates have lapsed.

Currently qualified instructors interested in teaching First Aid, and former instructors interested in re-qualifying and teaching, may obtain information regarding registration from L. E. Coon, Extension 1713, at West Street.

These changes have introduced some new problems in manufacturing routines. J. H. Gray visited a supplier's plant in Indiana recently to consult with the manufacturer and to examine some of the conduit produced.

Subscribers' drop wires have long been made with a composite conductor embodying a steel core for strength and an outer copper sheath to provide conductance. Western Electric engineers have now developed a method of making this conductor in which the steel core wire is continuously plated with copper to provide the desired mechanical and electrical characteristics. After "electroforming" the conductor is insulated and jacketed in the usual manner. Recently, J. B. Dixon, W. K. Oser and I. V. Williams visited Point Breeze to observe the operation of the pilot plant which is making this conductor.

Growing interest in telephone switching has called a number of our switching engineers to the lecture platform in recent months. As has been mentioned in an earlier issue of the Record, A. E. Ritchie is giving a course on switching at M.I.T., and he has recently had two guest lecturers from the Laboratories. On January 9 E. G. Andrews talked on *Switching Techniques in Digital Computers*, and on January 15 and 16 W. Keister talked on *Automatic Telephone Switching Systems*. Mr. Keister also addressed an A.I.E.E. meeting held in Cincinnati on January 25 on *Fundamentals of Telephone Switching*.

Bell System Maintenance Practices are prepared by the Laboratories to guide the Operating Companies in the maintenance of their circuits and equipment. To make sure that the material and form of presentation is best suited to the needs of the local maintenance force, discussions are being scheduled with key men of the Operating Companies to secure comments and criticisms. Recently F. S. Entz, Switching Systems Development engineer, Charles Breen, Switching Maintenance engineer, and L. A. Leatherman of the Power Development group were in Indianapolis, together with a representative of A T & T, to get from the Plant and Engineering Department representatives of the Indiana Bell Telephone Company, their comments on the current type of Practices.

W. H. Bendernagel and N. V. Mansuetto were recently in West Haven, Conn., to discuss modifications in the fluorescent lighting system which is now being applied to step-by-step as well as to crossbar and panel offices.

A weather announcing system has been operating in Cleveland for the past year on more or less of a trial basis. E. Von Der Linden and R. O. L. Curry recently visited the installation to arrange for final modifications.

For the new 302A power plant, designed for the larger central offices, a greatly improved motor-operated switch for cutting in and out emergency cells is being manufactured by Albert & J. M. Anderson Company in Boston. H. T. Langabeer and H. M. Spicer, who suggested the design, were recently in Boston to go over the final drawings.

F. P. Wight of the trial installation group and R. W. Burns of the switching maintenance group were recently in Philadelphia to arrange with the Bell Telephone Company of Pennsylvania for a trial installation of a line insulation test frame in the Media No. 5 crossbar office. When set in operation by a maintenance force, this frame automatically runs through all the lines in the office and within a few minutes has obtained a measurement of the resistance to ground of each line.

DURING THE WEEK beginning January 19, J. W. McRAE gave several talks before I.R.E. and A.I.E.E. Sections in Detroit, Toronto, Cedar Rapids and Des Moines on the subject of *Microwave Super Highways for Television and Telephony.*

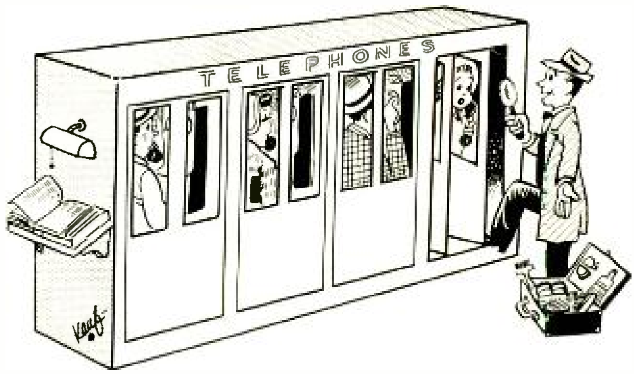
A FIFTEEN-WEEK Seminar and Public Lecture Series on *Prevention of Corrosion,* sponsored by the Graduate school of Stevens Institute of Technology began on February 7. This series of lectures is in co-operation with the National Association of Corrosion Engineers. One of these lectures, to be given May 16, 1951, will be by R. M. BURNS, on the subject of *Paints and Organic Coatings.*

H. S. BLACK was recently appointed to the Board of Editors of the I.R.E. and to the Administrative Committee of the Board of Editors. J. G. KREER, JR. was appointed chairman of the Task Group on Transducer Definitions.

J. R. TOWNSEND addressed the York, Pennsylvania Section of the American Society for Metals on *Plastics and Metals in Engineering,* and the Pittsburgh Section of the American Chemical Society on the *Role of the Technologist in the Utilization of Materials in the Modern World.*

IN KEEPING with the Bell System Program to conserve strategic metals, it is planned to substitute steel in place of aluminum for the greater part in future production of antennas for the TD-2 Microwave Radio Relay System.

"Okay if I bring a friend home for crackers and milk?"



R. R. ANDRES, in company with C. B. Cottrell of Western Electric, visited the Tennessee Aircraft Company in Nashville to discuss design and fabrication of these antennas.

A. H. LINCE visited the Western Electric Company at Winston-Salem to discuss tests on wave guide pressure windows for the TD-2 Radio Relay System. Mica, heretofore used for these windows, is becoming difficult to obtain and glass-resin laminates are being investigated as a substitute for mica.

WITH SOME of the materials used in permanent magnets becoming difficult to obtain, Laboratories people, in cooperation with Western Electric, are investigating the use of substitutes. P. P. CIOFFI visited Hawthorne recently to discuss these developments. He was also at the new Indianapolis plant to assist in solving production problems arising in the use of a new alloy for the ring armature telephone receiver.

LABORATORIES ENGINEERS are continually striving to hold down apparatus costs, but without impairing telephone service. In addition, there now is the problem of finding substitutes for strategic materials which are becoming more difficult to obtain. A. C. EKVALL visited Haverhill recently to discuss cost saving items and substitute materials on coils and transformers.

IN THE M1 CARRIER SYSTEM, a new unit has been developed by which several rural subscribers can be served by one carrier terminal. Voice-frequency lines are run to the subscriber and a conventional installation made at the subscriber's location. A. J. WIER and D. T. OSGOOD visited the Western Electric Plant at Winston-Salem in connection with the manufacture of these voice-frequency extension units.

THE JANUARY MEETING of the Movie Division of the Murray Hill Photographic Club featured a talk on movie planning and making by Mr. Sidney Moritz, a well-known amateur movie maker and a winner of awards by the Amateur

When the Coil Shop moved from West Street to Murray Hill this Fall, its potentiometer testing laboratory was removed to Whippany, accompanied by Marya Motowski, standing, who had worked on it during the war. She is shown with Lorraine Prothero checking tests on an electronic component.

Cinema League and Metropolitan Motion Picture Club. The Murray Hill Photographic Club meets every other Monday at 12:15 P.M. in the Arnold Auditorium.

To acquaint a group of large-scale users of Long Lines facilities with the background of Bell System Research and Development, members of the Communications Managers Association of New York spent January 10 at the Laboratories. This association is made up of representatives of large industrial users of communication facilities. They were accompanied by representatives of the Commercial Organization of the A T & T Long Lines Department. After an introductory talk by R. K. Honaman, visits were made to several locations within the West Street and Murray Hill buildings for brief discussions of a number of Laboratories' development projects.

A Seminar on *Prevention of Corrosion* sponsored by the Graduate School of Stevens Institute of Technology in cooperation with the National Association of Corrosion Engineers, began on February 7. This series of 15 lectures includes a talk by R. M. Burns entitled *Paints and Organic Coatings* scheduled for May 16.

On a recent trip to the Pacific Coast, John G. Ferguson visited the Hewlett-Packard Company and the Stanford Research Institute to discuss new developments on measuring apparatus. While on the West Coast, he gave short talks before transmission groups at the San Francisco and Los Angeles Headquarters of the Pacific Company.

The seventh annual national technical conference of the Society of Plastic Engineers was held at the Hotel Statler in New York January 18-20. C. J. Frosch was chairman of the Committee on Prize Papers.

Students from the Bell Telephone Company of Pennsylvania, who have been receiving training in telephone transmission, have visited the Murray Hill Laboratories to hear talks in this field. The third group of these students visited Murray Hill January 26, where they were given a series of talks on transmission subjects.

J. B. Fisk has been chosen as a member of the 1951 Nominating Committee of the American Physical Society.

R. G. Treuting conferred with a group in Cleveland, including Professor W. M. Baldwin of Case Institute of Technology, to arrange an educational symposium on residual stresses in metals for the 1951 Fall Meeting of the National Metals Congress. Mr. Treuting has been invited to give the introductory lecture. Residual stresses are important in apparatus parts as affecting dimensional stability and sometimes life of the parts.

In the facing advertisement S. R. King of Outside Plant Development demonstrates the technique of loading a 152-pair, 22-gauge Alpeth cable. Loading coils are spaced at intervals of 6000 feet.

Volume 28—Bound Copies and Index

Bound copies of Volume 28 (*January*, 1950 *to December*, 1950) *will be available shortly at* $2.75, *foreign postage* 25 *cents additional. Remittances should be addressed to Bell Laboratories Record,* 463 *West St., New York* 14, *N. Y. A separate index to Volume* 28 *of* Bell Laboratories Record *is available upon request.*