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Flow Properties of Cellulose Esters

By C. J. FROSCH
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SHORTAGE of phenol fiber, a laminated insulation used extensively in sheet form in telephone apparatus, has necessitated investigation of substitutes. With specific reference to the telephone art, an essential property is small cold flow; an incidental one, ability to withstand nearby soldering without softening. Moisture absorption usually has a plasticizing effect which modifies the flow characteristic of sheet insulations and the swelling and shrinking incidental to absorption and emission of moisture are added causes of dimensional changes. These changes are of particular importance if they result in mal-functioning or breakdown of equipment in which it is used.

Some of the cellulose esters meet the requirements of low-moisture absorption together with a high degree of resistance to flow under reasonable pressures. At the same time they are well adapted to modification, so that a balance between the flow, toughness and water absorption properties may be secured for a particular application. This modification can be obtained by varying the nature and concentration of the acyl groups in the ester and by the use of plasticizers. Theoretically, pure cellulose triacetate would be a desirable insulating material from the standpoint of resistance to flow and water absorption. The interchain forces are so high in this substance, however, that its fabrication into sheets and the conversion of these into parts by punching has not yet been accomplished. The use of plasticizers to reduce the interchain attractions also has not been successful. When partially acetylated products are employed, greater compatibility with plasticizers is possible and suitable adjustments of the amount and type of plasticizer result in compositions having more useful properties. Plasticized cellulose acetates show dimensional changes, however, which cause permanent shrinkage when they are subjected to cyclic changes in moisture content.

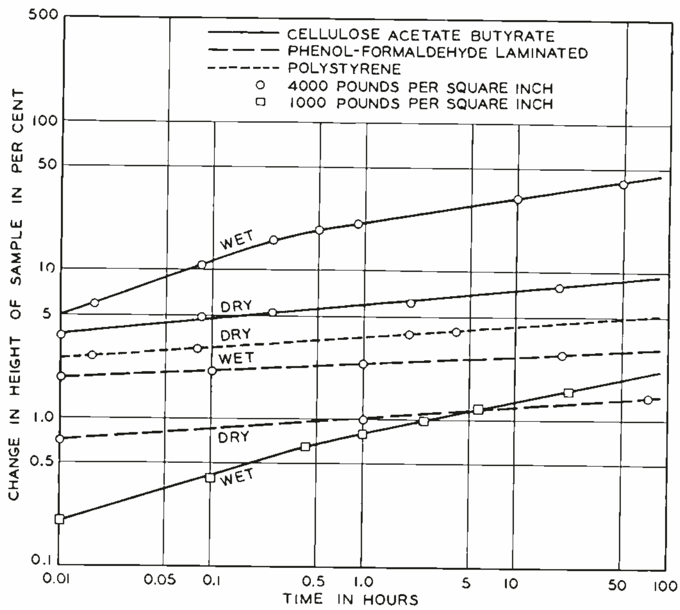

Fig. 1—Flow of cellulose ester sheet material at 50 degrees C. and under pressures of 4,000 lbs. per sq. in. and 1,000 lbs. per sq. in. compared with that of polystyrene and phenol fiber. These esters offer possibilities as substitute insulating materials where not subjected to excessive pressures

Higher acyl and mixed esters of cellulose such as cellulose acetate butyrate are much more satisfactory with regard to moisture effects than cellulose acetate. Although the softening points of the higher acyl esters are somewhat lower than those for the corresponding grades of cellulose acetate, the flow characteristics of the lower mixed types such as acetate-propionate and acetate-butyrate are more desirable. The commercially available cellulose acetate butyrates, for example, have lower water absorption and greater resistance to flow. The lower water absorption is due partly to the higher degree of esterification, which is possible without loss of plasticizer compatibility or molding qualities, and partly to the hydrocarbon nature of the butyryl group. In addition, the internal plasticizing action of the higher acyl groups greatly reduces the concentration of external plasticizers necessary for proper molding. For example, a commercial cellulose acetate-butyrate molding compound requires approximately one-quarter as much external plasticizer as a corresponding grade of the cellulose acetate. The lower concentrations and higher boiling points of the plasticizers employed in mixed esters also make these materials suitable in applications where leaching or evaporation of the plasticizer with its consequent change in dimensions is likely to occur.

The flow properties reported here were determined on a parallel plate plastometer using cylindrical pellets 0.372 inch in diameter and approximately 0.350 inch long which were cut from compression molded discs. Before measurements were made the pellets were conditioned for ninety-six hours either over calcium chloride or at ninety-one per cent relative humidity. The flow or change in height with time of the conditioned pellets was determined then for pressures of 1,000 and 4,000 pounds per square inch at 50 degrees C. Typical flow curves are shown in Figure 1.

Rockwell penetration values, which offer a more rapid but less accurate means of comparing the potential flow characteristics of plastic materials under pressure, also were determined on specimens 1 inch square and $\frac{5}{16}$ inch thick, conditioned in the same manner as for the flow tests. A $\frac{3}{16}$-inch steel ball served as the penetrating medium and a ten-kilogram minor load was followed by a major load of forty kilograms. Penetration readings were made during the first sixty seconds after the major load was applied and recovery values were taken for thirty seconds after its removal and are plotted in Figure 2.

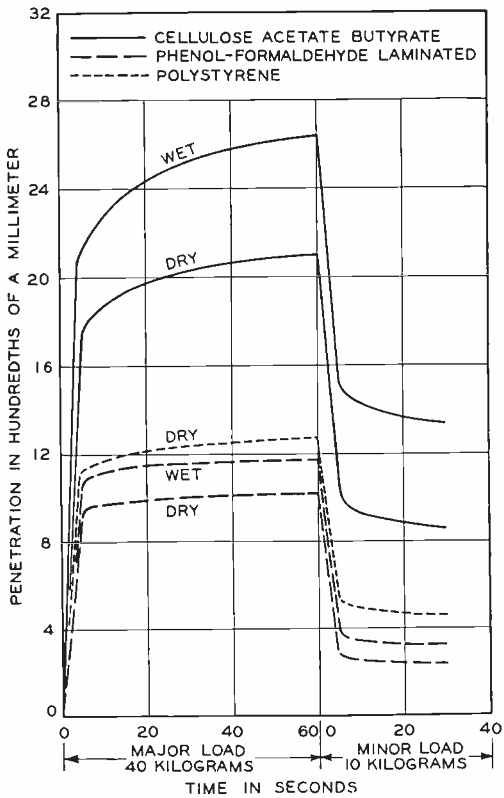

Fig. 2—The relative penetrations of a steel ball under pressure in cellulose esters, polystyrene and in phenol fiber indicate the flow characteristics of these materials

Both the Rockwell penetration and flow data place the materials tested in the same relative order with regard to the plasticizing effects of water and the inherent flow properties of the materials themselves. Because of its simplicity the Rockwell test offers a very practical means of comparing materials from the flow standpoint, especially when a large number of substitute materials are being investigated. The short test-times required also avoid appreciable moisture changes which obviously must occur during the much longer flow test.

In considering the use of laminar insulations for specific applications, however, allowance should be made for the clamping pressures encountered in the apparatus. Although high-test pressures probably select the most suitable material for the purpose, some of these may be rejected when they would be

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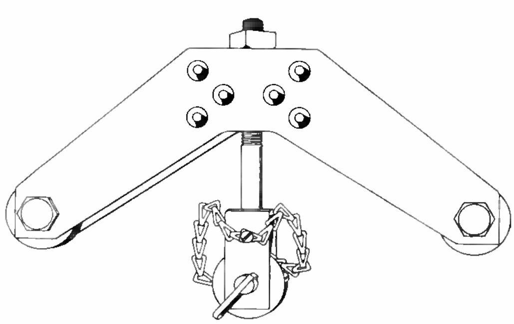
THE AUTHOR: C. J. FROSCH graduated from Union College in 1929 and immediately joined the Laboratories. He attended a summer course at M.I.T. in 1934. From 1929 to 1934 Mr. Frosch worked on wood preservation problems. Then he began studies of high molecular weight organic polymers. Since 1940 he has been engaged in the fabrication and development of plastics for telephone use. Mr. Frosch also shared in the development of Paracon, the new rubber substitute recently announced by the Laboratories.

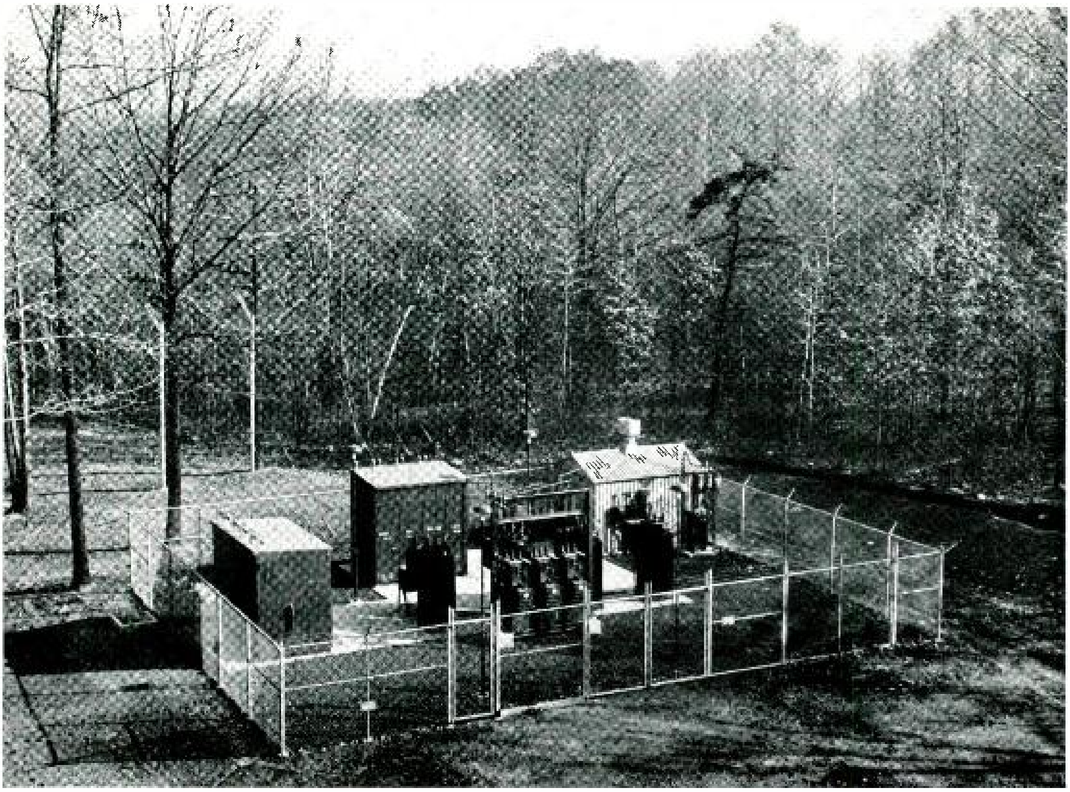
satisfactory in applications where the pressures are much lower. In fact, some of the available cellulose esters are now used in applications where the clamping pressures are relatively low. In addition, the advent of a punchable polystyrene sheet makes this material of possible use as a laminar insulation in telephone equipment. Polystyrene has excellent cold flow properties and it is also one of the best plastic insulations. These tests indicate that cellulose mixed esters may be satisfactory in some applications as separators in place of phenol fiber.

Cable Slack-Puller

A LARGE part of the aerial cable installed during the past few years has been supported by lashing it closely to the suspension strand. When the cable is to be spliced, as for instance to connect a terminal, working space for the splicer's fingers must be supplied between the cable and the strand. So, a tool has been developed by Outside Plant which not only pulls the strand aside but draws it tighter so as to leave the cable slack. As the illustrations show, the slack-puller has a V-shaped steel frame which supports a grooved roller at each end; another grooved roller in the center. The lifting roller is supported on a pin bearing in a bracket on the other end of which there is a screw with a nut to raise and lower it. A chain secures the pin and roller to the bracket.

When lashed cable is repaired the lashing wire has to be removed near the work. The pin and center roller of the slack puller are then taken out and the nut is run out to the end of the lifting screw. With the puller in position and the two outer rollers against the strand, the center roller is replaced and its pin inserted. Play in the screw is removed by tightening the nut with the fingers; then the strand is deflected by applying a lineman's wrench to the screw. Tests indicate that a two-inch deflection of the strand provides sufficient working space. C. W. Rolph is shown in the photograph.





Power Distribution for Murray Hill Buildings

By C. T. SIEBS

Plant Engineer, Western Electric Company, Kearny Works, formerly Assistant Construction Engineer, Bell Telephone Laboratories, Murray Hill Project

NEITHER the course of research nor its final product can be forecast in great detail, and for that reason the Murray Hill buildings of Bell Telephone Laboratories were planned for flexibility in room size and in facilities. Safety to the personnel was also dominant in the plans for power supply and other services.

In addition to flexibility and safety, refinements also had to be incorporated in the power system to meet the peculiar operating requirements of research without seriously affecting the economics of the ultimate project. Since ability to change is essential to a research organization, provisions were made permitting easy and economical rearrangement of power services.

A survey indicated that for the initial buildings a 1,500-kva transformer bank would be sufficient, and that 7,000 kva might be required to service the ultimate development. The substation, shown above, was designed with four 500-kva single-phase transformers, one serving as a spare that can be quickly cut into service in the event of a breakdown. This transformer bank, connected Δ-Y, transforms the incoming three-phase 13.2-kv unregulated supply to 4-kv three-phase regulated power for transmission by underground cables. Spare conduit in the concrete mat permits of future extensions. Between the secondaries and the cable potheads are voltage regulators that provide a total of 10 per cent regulation in steps of five-eighths of one per cent. For repair or maintenance, these regulators may be cut out and by-passed by suitable switchgear.

The primary power comes from the Jersey Central Power and Light Company over two independent 13.2-kv overhead feeders from its Chatham substation. Figure 1 shows in single line the circuit diagram with oil switches and disconnecting potheads; its dotted lines indicate a first step in any expansion.

To supply power to the main laboratory buildings there are two 4-kv underground feeders with provision for a third. From one of these feeders a cable is tapped to feed a 50-kva 4150/120/208-volt transformer in the main substation enclosure for supplying power and light to the boiler house auxiliaries through two 208-volt, three-phase feeders, and a similar feeder supplies the substation auxiliary building that houses the storage battery for the high-tension switchgear. To supply power and light to the sewage pumping station, an additional 4-kv underground cable, tapped from the second main 4-kv supply feeder, is used to energize a 37.5-kva 4150/120/208-volt transformer located at the pumping station.

The layout of the buildings is shown in Figure 2. Buildings 11, 20, 21, and 22 are three stories with attic and basement. Altogether there is nearly a quarter of a million square feet of floor space. The lighting load, on the basis of something less than 4 watts per square foot, averages about 800 kva. The power requirements are in general those of small units except for the metallurgical laboratory and the building services such as elevators and pumps. Since power-using apparatus in laboratories is subject to frequent change in location, the branch distribution system has

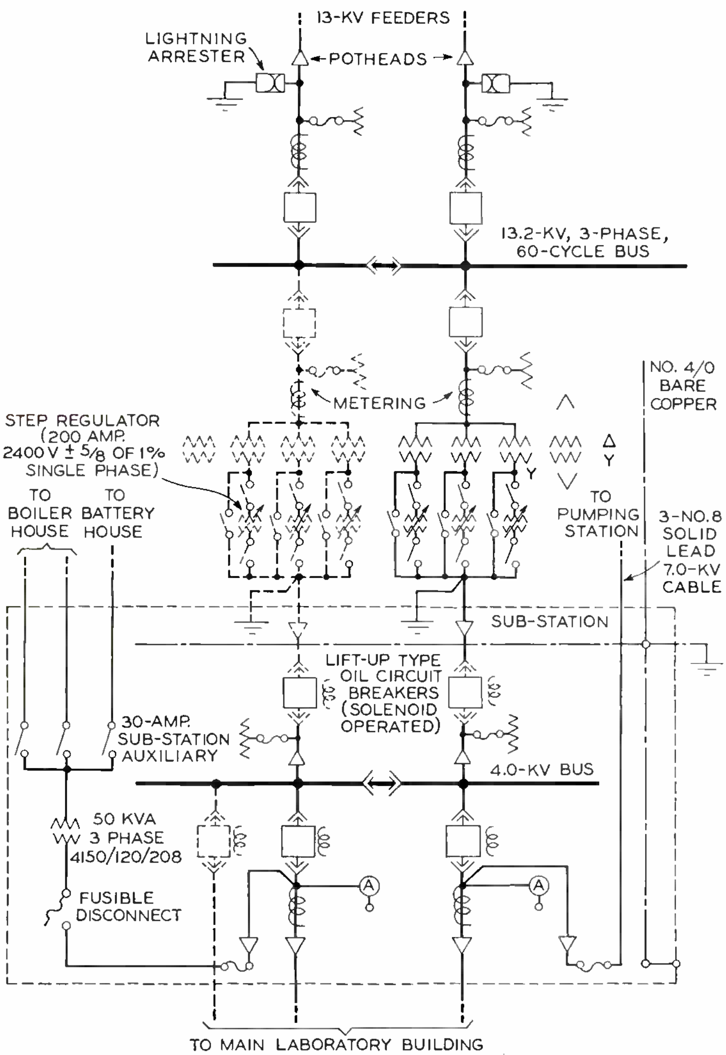


Fig. 1—Single-line schematic of the outdoor substation

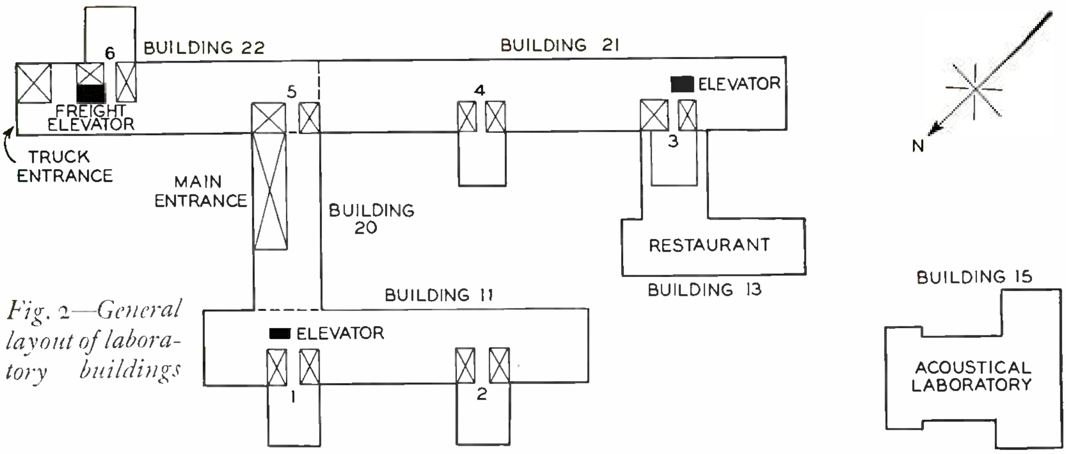


Fig. 2—General layout of laboratory buildings

been designed with inherent flexibility.

The general adaptability of three-phase four-wire 120/208-volt distribution to Murray Hill requirements, coupled with the fact that equipment to be transferred from West Street in general operated off similar supply voltages, were the main reasons for the decision to use this form of secondary distribution. For the secondary distribution, various systems were studied — radial, semi-radial network and combinations — but none of them was entirely suitable, mainly because of the strict operating requirements, such as absence of stray magnetic fields, good wave shape, close voltage regulation and operating simplicity. The method finally adopted, which has proven extremely economical, employs limiter-protected ring mains that are located in the basement floors, each fed from three 200-kva three-phase transformers and a spare. The transformers are specially designed and interlocked with slidable iron-clad high-tension connections so that no transformer can be removed when power is on; and the spare can be substituted

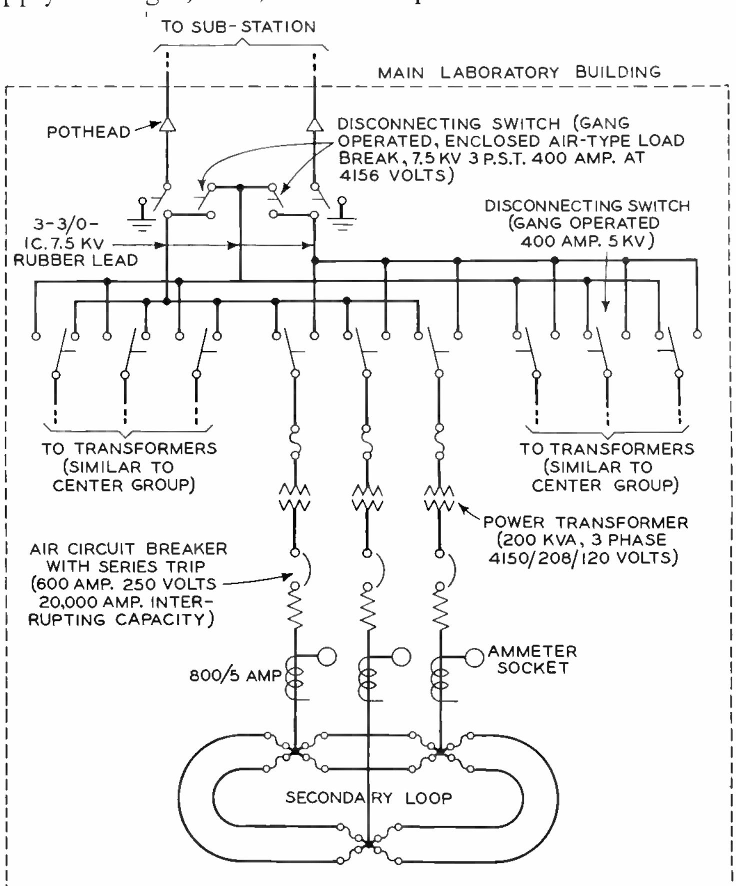
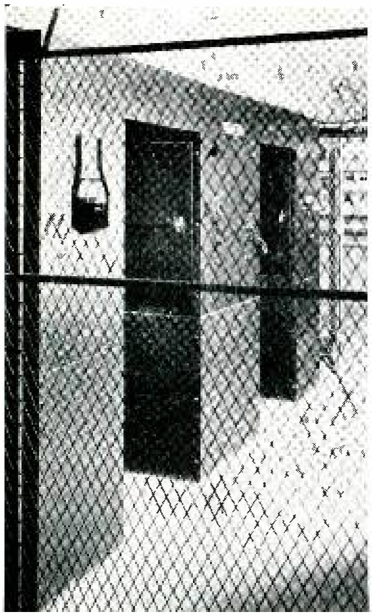


Fig. 3—Single-line schematic of distribution system in laboratory buildings



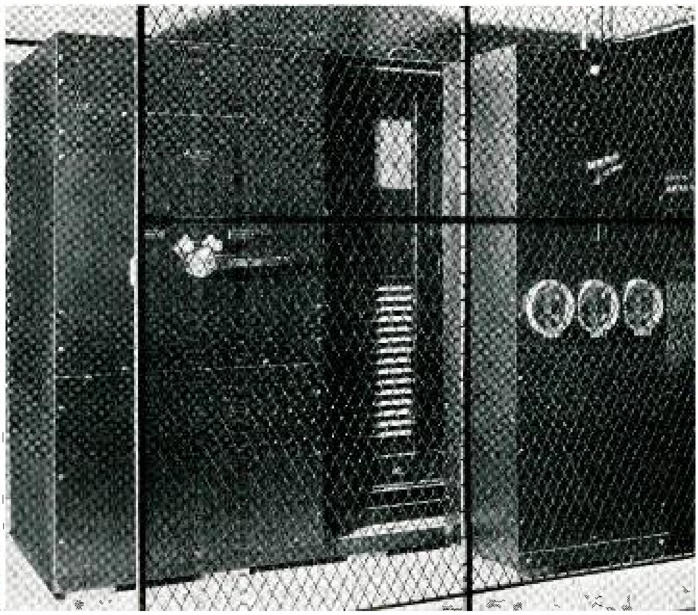


Fig. 4 (*left*)—4,150-*volt switching center. Fig.* 5 (*right*)—200-*kva transformer feeding loop*

without having to touch the high-tension circuit.

The general arrangement is shown in the single-line schematic of Figure 3. At the switching center shown in Figure 4 the three 4-kv feeders supplying the secondary transformers may be connected to either or both of the two feeders from the substation. The switches are of the enclosed air type and may be opened under load.

Each of the three 200-kva transformers supplying power to individual basement loops is installed symmetrically with respect to the length of the loop. On the 4-kv side is a three-position enclosed disconnecting switch, and on the 208-volt side, an enclosed circuit breaker. One of these substations is shown in Figure 5. The 4-kv cables run in conduit in the basement floor to terminating switchgear at each transformer location, where the three-

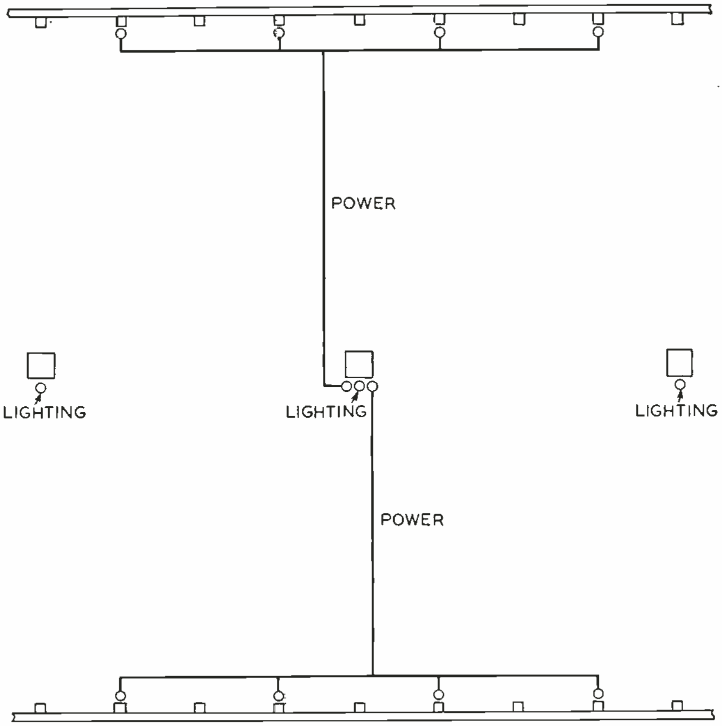


Fig. 6—*Typical distribution of light and power* position switch permits energizing the transformer from either cable or providing an open point. The switches for the transformers feeding the same loop are electrically interlocked so that connection cannot be made to both feeders at the same time. This avoids the possibility of power backfeed from the 120/208-volt loop to a 4-kv feeder that has been disconnected at the switching center and so would normally be considered dead. The disconnecting switches are mechanically interlocked by the Cory system with the 208-volt circuit breakers so that they cannot be opened when the transformer is loaded.

The transformer secondaries are Y-connected, providing a three-phase, four-wire insulated grounded-neutral system with 208 volts between phases and 120 volts between phase and neutral. Each transformer feeds its loop through a 600-ampere circuit breaker designed for 20,000-ampere interrupting capacity.

The loops consist of paralleled cables, each cable being individually protected against short circuit by limiters designed to isolate any affected section without injury to the cable insulation.

The loops are carried in two metallic conduits side-by-side in the basement floor along one side of the building's central row of columns. The two conduits are magnetically interrupted by concrete pull boxes at every column. The columns are 24 feet apart, and at each is a main distribution cabinet. Every other cabinet supplies, in addition to the lighting, laboratory power for a 48-foot length of building, as shown in Figure 6. A power feeder is run to each outside wall of the building. From these, risers 12 feet apart run to the attic, concealed by metal wainscot in the spaces between the windows. Taps are provided at each floor in hinged-covered boxes. Circuit breakers are inserted in these boxes as required to supply power to individual laboratories.

Lighting feeders, each supplying a building length of 24 feet, are taken from the basement distribution panels, Figure 7, located at each basement column, and run up each central building column, energizing lighting panels on every floor as shown in Figure 8.

Twelve different laboratory outlets have been adopted for use wherever wire trough or F.S. outlet box assemblies are installed. The ratings of the outlets are: 15-, 20- and 30-ampere, 120-volt single-phase; 20- and 30-ampere, 208-volt single-phase, three-phase; and 20- and 30-ampere, 120-volt DC. Some are single and some duplex, and others are available with or without the neutral connection brought out. Each of these

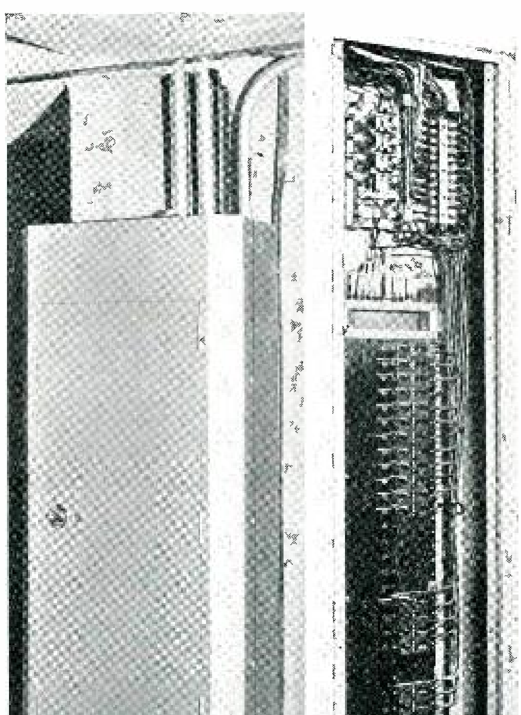


Fig. 7 (left)—Main distribution cabinet. Fig. 8 (right)—Center column lighting panel

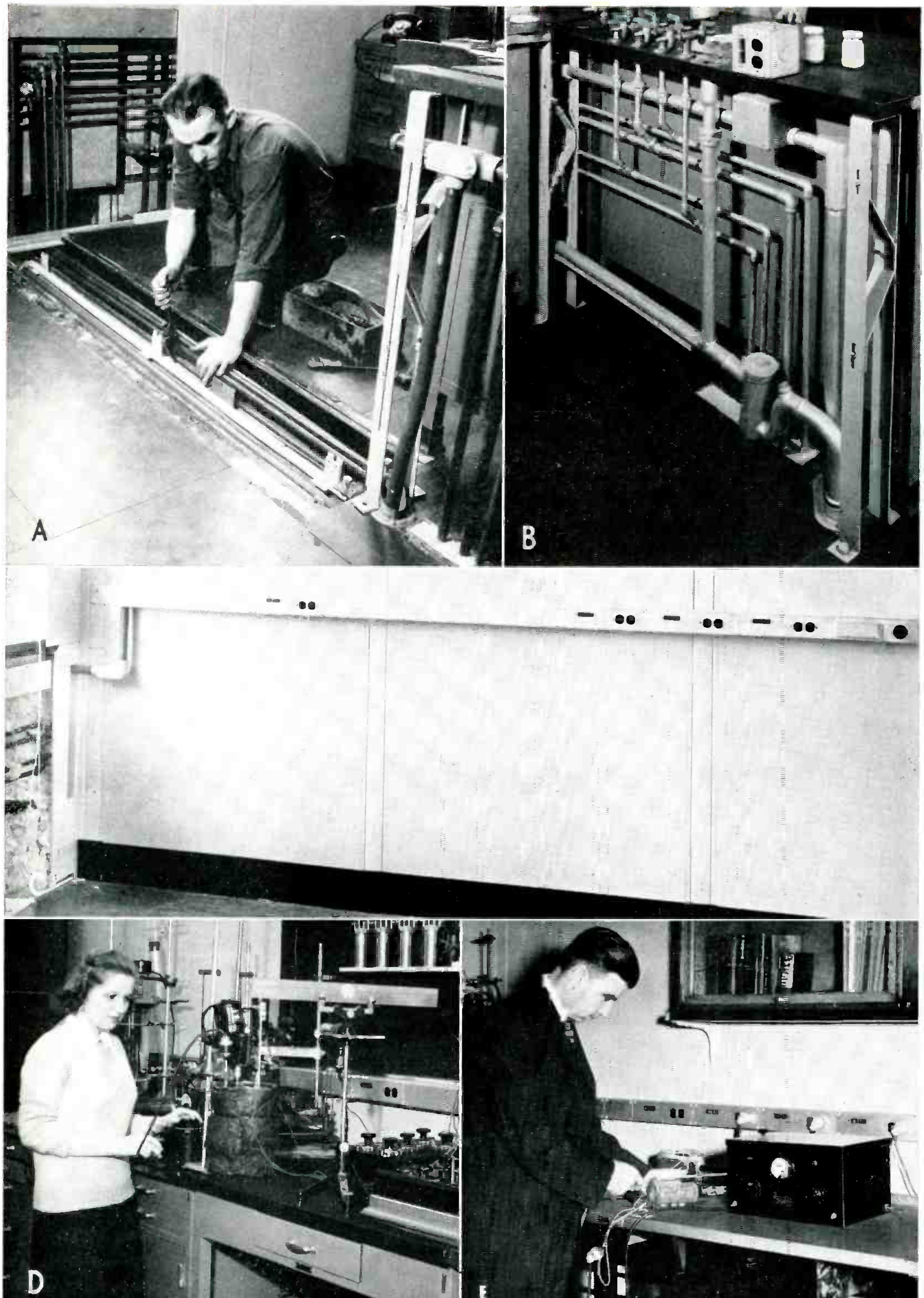


Fig. 9—A—For island benches, power and other facilities are obtained from a trench in the floor. B—A typical island bench. C, D and E—Arrangements for making power available at benches

Fig. 10—Lighting is the same throughout the main building, but its control may be varied to suit local conditions and room sizes

outlets is individually protected by circuit breakers or fusetrons, and all are interchangeably capable of substitution in all wire-trough and F.S. installations when four cover screws are removed. At each outlet ground terminals are provided.

In general a six-foot corridor runs along the middle of each building on one side of the central row of columns. On one side, rooms are 27 feet deep, and on the other, 19 feet. Corridor and subdividing partitions are standard interchangeable steel panels. All windows in the main areas are on six-foot centers. An arrangement is made for attaching partition panels at right angles to the piers separating windows. Thus rooms may have a width of any multiple of six feet. With power risers on twelve-foot centers, each room will have at least one 50-ampere circuit breaker. From this breaker, circuits may be run in an exposed wire trough, supported by the partition, or to special F.S. outlet box assemblies. Under special conditions wire may be run in concealed spaces at the top and bottom or between partition panels. In most of the laboratories under-floor ducts permit distribution to island locations, and a covered trench may be provided if necessary. This construction, used principally in the chemical laboratories, is shown in Figures 9A and B.

Each outlet has its own protection against overload and short circuit. The individual breakers are rated to protect single-phase utility outlets of 15-, 20- or 30-ampere capacity. Special fittings permit either single-phase, three-phase or DC outlets to be interchangeably located on wireways around the partitions or on island benches.

Typical of power distribution along partitions are Figures 9C, D and E. These photographs show a wire-way with a variety of outlets run horizontally along one of the steel partitions. At the extreme right of C is an outlet for three-phase 208-volt with three fusetrons under the adjacent cover. D and E show such an arrangement in use. The standard-unit benches usually have re-

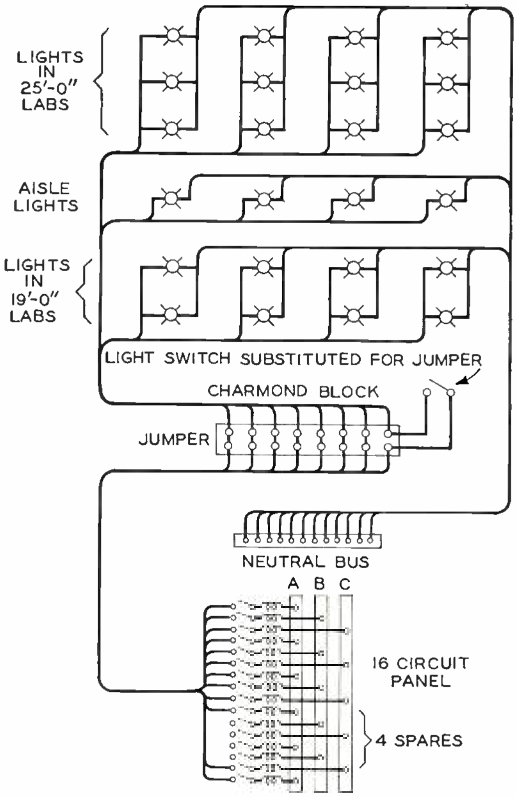


Fig. 11—Single-line diagram of a lighting cabinet

ceptacles installed in the top of their legs, as shown in E, to be supplied through a plug connection to the partition wireway.

There are three separate grounding systems provided; an equipment ground, a system ground and a quiet ground. These three grounds are carried independently and ultimately connect to a copper bus running the length of the building as may be seen in Figure 7 just above a main power cabinet. This ground bus is connected directly to the water mains, the building steel and general distribution service piping. The equipment ground connects from this ground through the metallic conduit to all outlets and is available for grounding frames of power using apparatus. To retain this safety feature automatically, all single-phase outlets are provided with three-wire receptacles and all three-phase outlets with four-wire receptacles. The system ground is the neutral wire normally found in a four-wire, 120/208-volt distribution system. The quiet ground is a separate low resistance lead carried from the ground bus to the individual laboratories as required.

Lighting cabinets, Figure 8, on the laboratory floors are installed flush with the central columns on the corridor side, each cabinet controlling the lighting for twelve feet each way. Lighting fixtures are hung between the floor beams on six-foot centers lengthwise, and approximately nine-foot centers crosswise of the building, as shown in Figure 10. This means a central light in the corridor, two in the short laboratory rooms and three in the large. They are supplied respectively by three separate circuits. Partition changes therefore require no relocation of fixtures.

In each main lighting cabinet is a Charmond terminal block through which each circuit passes to its individual switch. A single-line diagram for one cabinet is shown in Figure 11. This arrangement permits the control point to be rearranged without cutting wires or changing circuits. For example, to control the three lights in one room from a switch on its doorpost, it is necessary only to remove the jumper from the terminal block, and run a pair of wires from the terminals provided through the wireways of the partition to the switch at the door. The switches in the lighting cabinets are trip-free overload circuit breakers, and their handles may be locked open or closed. The switches are locked closed when the control is transferred to the door. This arrangement permits the corridor lights to be grouped as desired. It also allows several circuits to be grouped for remote control from a single point.

To provide emergency power to important boiler house auxiliaries in the event of a failure, a turbine-driven generator is installed in the boiler house.

This generator, with its circuit arrangement shown in Figure 12, is three-phase four-wire 120/208-volt and rated 50-kva. The turbine is kept hot with exhaust steam, and the main steam valve will operate automatically on a power failure. Only a few seconds are required to bring the turbine up to speed. The generator is also permanently connected to a 208/460-volt three-phase transformer which supplies a number of 440/32-volt transformers that are installed at various points to supply emergency lighting circuits for stair wells and exits.

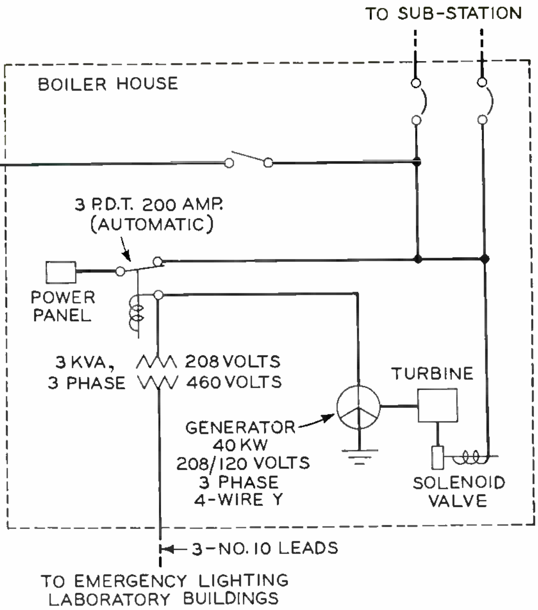


Fig. 12—Diagram of emergency boiler-house supply

Since the emergency lighting distribution system in the main building is limited to the use of 15-watt 32-volt lamps to insure correct re-lamping, left-hand threaded bases and lamp sockets are used.

The power distribution arrangements described have proved satisfactory during the time that the Murray Hill buildings have been in laboratory service. Many visitors interested in erecting research laboratories have been so favorably impressed as to adopt for their own structures some of the features in the Murray Hill laboratory.

THE AUTHOR: C. T. SIEBS was educated in Europe, graduating with highest honors from the City of Guilds of London Institute (Finsbury College), England, in Electrical Engineering in 1903. Following graduation, he spent 16 years with the British Thomson-Houston Company, where he became Engineer to the Supply Department at Rugby, England. During World War I Mr. Siebs took an active part in the design and construction of devices to permit shooting through airplane propeller blades, in naval shell construction, in sonic signaling, and in anti-Zeppelin defense apparatus. Coming to this country in 1919, he at first practiced as Consultant in New York City, and then joined the Western Electric Company at Hawthorne in 1923, where he was in charge of electric heating development and the electrical laboratory. In 1930 he transferred to the headquarters organization of the Engineer of Plant as Service Systems Engineer. As a result of this work, he has 24 electrical and mechanical patents to his credit. In 1939 he came to the Laboratories as Assistant Construction Engineer of the Murray Hill project. He returned to the Western Electric Company as Plant Engineer at their Kearny works in 1941.

Crystals of Quartz

By W. P. MASON
Crystal Research

DURING World War I quartz crystals were employed only experimentally in commercial communication circuits, but by June, 1943, the fourth year of World War II, the Western Electric Company alone had supplied 8,000,000 crystals for electrical circuits employed in defeating the Axis. This outstanding growth in the use of crystals, which have not only become of great importance in communication but have opened up entirely new fields for the application of electrical devices, is due in no small degree to research and development carried on in Bell Telephone Laboratories. One reason for the great utility of quartz crystals is their ability—deriving from the piezoelectric effect—to maintain oscillations when they are associated with suitable electrical circuits.

The piezoelectric property which quartz, as well as many other crystals, possesses was discovered by Pierre Curie in 1880. Curie applied his discovery in an electrometer for measuring small charges. With few exceptions, however, the piezoelectric property of crystals remained little more than a scientific curiosity until World War I when A. M. Nicolson of these Laboratories and Professor Langevin of France carried on independent studies of piezoelectric crystals. This led on Nicolson's part to development of piezoelectric microphones, loud-speakers and phonograph pick-ups. Nicolson also devised the first form of piezoelectric oscillator circuit. Although Nicolson worked both with quartz and Rochelle salt, in these developments he used Rochelle salt for the most part because of its large piezoelectric effect. Langevin developed a marine sounding apparatus which was exploited commercially after World War I was over.

Among other contributors to the early piezoelectric art were Professor W. G. Cady of Wesleyan University, who applied crystals to selective circuits and to the control of oscillators; Professor G. W. Pierce, who also worked with piezoelectric controlled oscillator circuits; and Lloyd Espenschied of these Laboratories, who devised a band filter utilizing piezoelectric crystals. Quartz

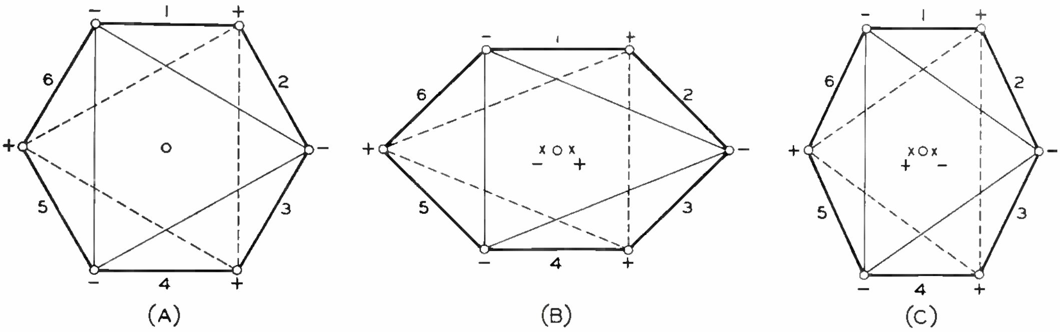


Fig. 1—Diagrammatic representation of the molecules of a quartz crystal: normal at A, and stressed in B and C

crystals were also adapted by W. A. Marrison of these Laboratories to the control of precise standards of time and frequency. Application of crystals in wide-band lattice filters such as are employed in our broad-band carrier systems is due to the writer.

A very important epic in the piezoelectric field began with systematic determination of orientations of crystal plates to secure freedom from changes in temperature and to minimize the effects of undesired modes of motion in operation of crystals in oscillators and filters. To a very considerable extent this was the work that has been done by Lack, Willard, Fair, Sykes and the writer, all of these Laboratories.

The material of quartz is silicon dioxide, SiO_2, which in crystallizing from the solution forms six-sided prisms often with pyramidal terminations. With a melting point of 1750 degrees C., about that of platinum, and a density of 2.65, about that of aluminum, quartz is harder than all metals save the hardest types of steel, and in its commonly used form is clear and transparent. A single-crystal molecule may be represented, approximately, as shown in Figure 1A, which gives a section of the crystal perpendicular to the axis of the prism. The small circles marked with a "+" represent silicon atoms, and those marked with a "−" represent double oxygen atoms—the plus and minus signs representing equal positive and negative charges. The three positive and negative charges are at the vertices of interlacing equilateral triangles as indicated by light dashed and solid lines. The combined effect of the three positive charges is the same as though all three were at the center of the equilateral triangle, which falls on the axis of the hexagonal prism. This is also true of the three negative charges, and since these two net effects are equal and at the same point, their combined effect is zero, and the crystal is neutral electrically.

Suppose, however, that pressure were exerted across faces 1 and 4 of the crystal. Greatly exaggerated as indicated at B, the crystal would be flattened as a result. The center of effect of the three positive charges would move

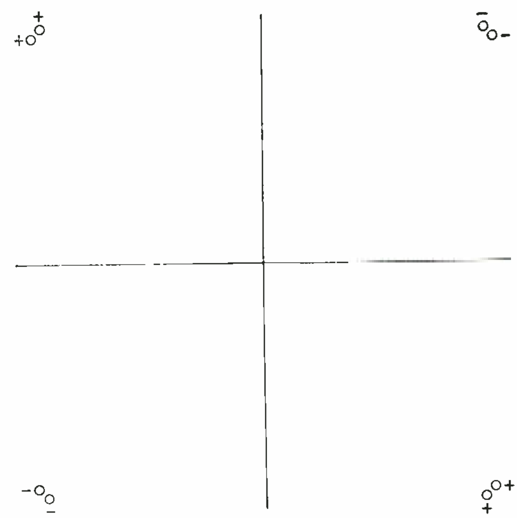


Fig. 2—With a crystal arrangement as indicated above, deformation does not cause the appearance of electrical charges

to the right, and that of the three negative charges would move to the left. With this shift in positions of the two effective charges, the crystals would no longer be neutral—its right edge would show a positive charge and its left edge a negative charge. Had tension been exerted on faces 1 and 4, or had compression been exerted horizontally as indicated at C, again in greatly exaggerated magnitude, the shift in the positions of the effective charges would have been in the opposite direction—the left edge would have become positive and the right negative. It is because the crystal molecules in quartz are so arranged that mechanical pressure changes the positions of the centers of positive and negative charges that quartz is piezoelectric. This is not true of all crystals, however. If the atoms of the crystals are arranged as in Figure 2, for example, no symmetrical application of force could separate the centers of positive and negative charges, and hence such crystals are not piezoelectric. Based on the symmetry arrangements of their atoms, crystals can be grouped into

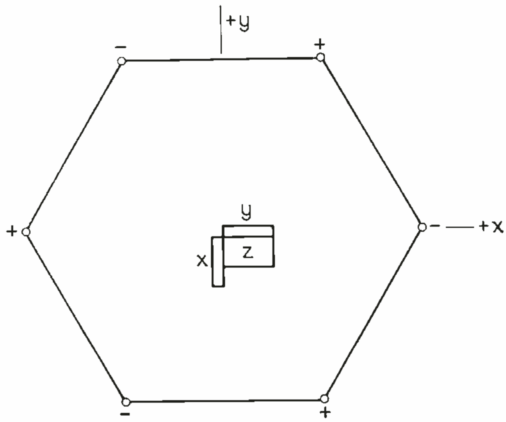


Fig. 3—Orientations of X, Y *and* Z *cuts with respect to the* X, Y *and* Z *axes of the original crystal*

32 classes, and 20 of these are piezoelectric, and 12 are not.

Returning again to Figure 1, is it obvious from the symmetrical arrangements of the atoms that the piezoelectric effect could have been demonstrated by forces exerted across any pair of opposite faces, and that for any of these directions of pressure there is a direction at right angles to it in which the electrical forces would have been along the line of force instead of at right angles to it. Moreover, if forces are exerted in any direction other than that perpendicular to opposite pairs of faces or edges, there will in general be a shift in the center of forces that will result in the appearance of a charge which may be separated into two components: one along the line of force and one at right angles to it. The great usefulness of quartz crystal in electrical circuits lies in the converse effect. When a voltage is applied across two faces, the crystal will deform in one manner or another, and if the voltage is alternately positive and negative, the deformation follows a similar cycle. Any crystal, or any elastic substances for that matter, has a number of frequencies at which its vibrations may be maintained with very little energy. These are called its natural frequencies. The substance, in other words, acts like a pendulum. It can be forced to vibrate at any frequency by the application of sufficiently great force, but at certain particular frequencies its vibration can be maintained with very little energy if the force is applied in step with the vibration.

What the natural frequencies of a particular plate of quartz are depends largely on its dimensions and on how the particular plate is cut with respect to the faces and angles of the original crystal. Because of the complicated structure of quartz, however, any particular piece of it may vibrate in many ways; it may simply expand and contract along one or more axes, or there may be a complicated motion resulting in flexure or shear. Besides depending on the dimensions of the plate and its orientation with respect to the crystal faces, the natural frequencies of vibration will depend also on temperature. In developing crystals for use in oscillators, therefore, it early became evident that their behavior would depend greatly on how the plate was cut from the original crystal, and extensive studies were undertaken to determine how these various factors were affected by the way the crystal was cut.

To provide a convenient method of specifying the manner of cut, three rectangular coördinates were used as reference directions. These three axes, following ordinary algebraic terminology, are marked X, Y and Z, but they are also given names that indicate certain characteristics of the crystal along them. The Z axis, which is also called the optical axis, runs vertically up the center of the hexagonal prism that the crystal assumes. In Figure 3, for example, which is the same as A of Figure 1 but on a larger scale, the optical or z axis is perpendicular at the center of the hexagon. The Y, or mechanical, axis is taken perpendicular to one or another of the three pairs of opposite faces, and is shown running vertically in Figure 3. The X, or electrical, axis runs horizontally through opposite edges of the crystal. These latter two axes get their names because, with the earliest types of crystal used, the vibration was along the mechanical axis and the changes in charge along the electrical axis. The positive direction along the z axis was taken as out from the plane of the paper, and if the positive direction along Y is taken as upward, the positive direction of X would be to the right so as to form a right-hand coördinate system.

The first crystals to be used were known as X cut and Y cut. Both have their width parallel to the z axis but the X cut has its face perpendicular to the X axis and its length parallel to the Y axis, while the Y cut has its face perpendicular to the Y axis, and its length parallel to the X axis. Their orientation relative to the crystal is shown in Figure 3. For the X-cut crystal the voltage is applied along the XX or electrical axis, and the vibration—a simple expansion and contraction—occurs lengthwise or parallel to the mechanical axis, and the frequency is a function chiefly of the length of the crystal. For the Y-cut crystal, the voltage is applied along the mechanical axis, or across the faces of the crystal. Voltages will appear along this axis when the applied pressure is at an angle of 45 degrees to the mechanical and electrical axes, and thus the vibration of the Y-cut crystal when voltage is applied along the Y axis is one of shear—the two faces moving back and forth in opposite phase.

The factors that make it desirable to seek other forms of cuts may be illustrated with the X-cut crystal. As described above, the voltage is applied along the electrical axis, and the vibration is along the mechanical axis. As already pointed out, however, motion

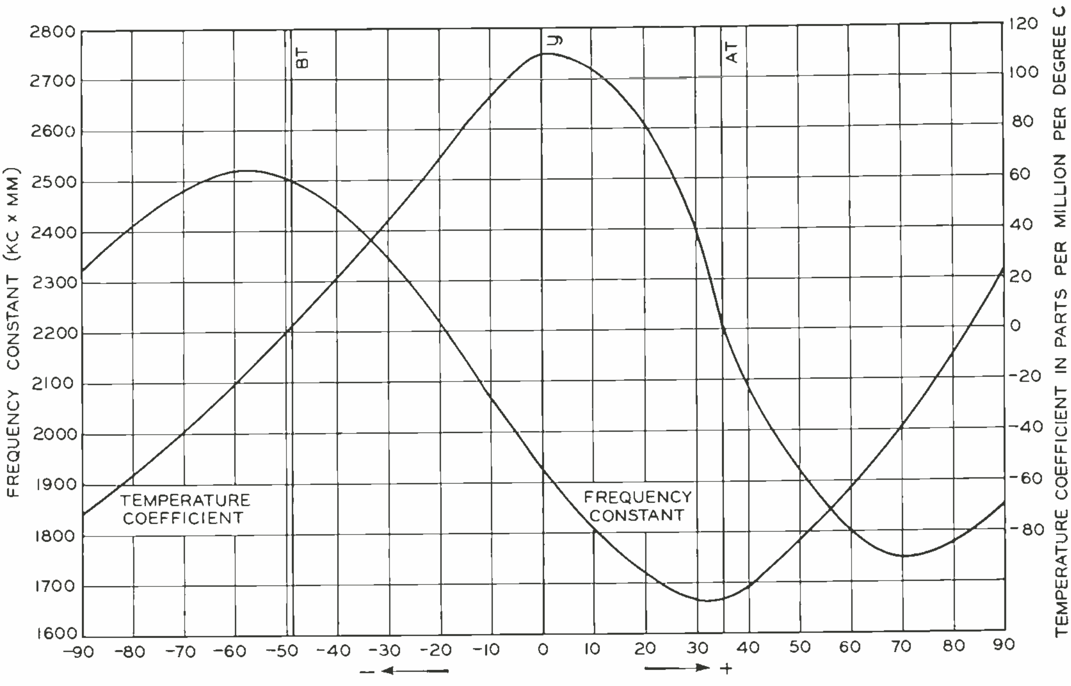


Fig. 4—Frequency constants of quartz plates for various rotations around the X axis

along the electrical axis will also give a displacement of charge along the electrical axis, and thus the x-cut crystal could vibrate in either direction, but the frequency of vibration, which will be chiefly determined by the dimension of the crystal in the direction of its vibration, will be much lower when the vibration is along the Y axis than when it is along the X axis. As used, a voltage frequency was applied that corresponded to the length vibration, and thus was comparatively low. If an effort were made to use the crystal for a high frequency, utilizing vibration along the X axis, difficulties occur because harmonics of the Y-axis frequency might be very close to the X-axis frequency, and slight changes in condition might cause the controlling vibration to shift from that of the X frequency to a harmonic of a Y frequency. The most common of such changes of condition is the temperature, since the frequency of the X-cut crystal, and also of the Y cut, is very sensitive to temperature changes.

It was in an effort to reduce this effect of temperature, and to secure crystals that did not have frequency components of several modes of vibration lying close together, that the investigations were undertaken in these Laboratories. One cut tried early—due to W. A. Marrison—was an annulus with the Y axis through the center of the hole. By properly proportioning the dimensions of such a "doughnut," the temperature coefficient, which measures the change in frequency relative to a small change in temperature, can be made essentially zero. Crystals of this type were used in the early forms of crystal clocks and frequency standards.

One of the earliest studies revealed the effects of rotating a Y-cut crystal around the X axis. Some very interesting factors were brought out, and are shown in Figure 4 by two curves plotted against angle or rotation around X. One gives the frequency constant, which is

Table I—The Angular Description of Some of the Important Crystal Cuts

Name	ϕ	θ	Ψ
Z	0	0	0
X	0	+90	+90
−18° Filter	0	+90	+108
+ 5° Filter	0	+90	+85
Y	+90	+90	+90
AT	−90	+54¾	+90
BT	−90	−41	+90
CT	−90	+52	+90
GT	−90	+38° 52′	±45

the product of frequency in kilocycles and thickness in millimeters, and the other gives the temperature coefficient, or the variation in frequency in parts in a million per degree centigrade. It will be noticed that both the AT and BT have zero temperature coefficient—the former combined with a low-frequency constant, and the latter with a high. Both of these have proven very useful in communication work.

Other investigations were made of more complex rotations with respect to the three axes. To specify any particular orientation of the crystal, three angles of rotation are required. The method of specifying them used here is in conformance with the designating system recommended by the Institute of Radio Engineers. The initial, or zero-angle, position of the crystal is with its face perpendicular to the Z axis, its length parallel to the X axis, and its width parallel to the Y axis. The first rotation angle, ϕ, turns the crystal around the Z axis; the second angle, θ, rotates the crystal around an axis parallel to its width; and the third angle, Ψ, rotates it around an axis parallel to its thickness. The three angles for some of the important cuts are given in Table I.

The effects of these various rotations can best be seen from Figure 5. "A" represents the initial position of the crystal, with angles ϕ, θ, and Ψ all zero.

This is called a z cut, because the face of the crystal is perpendicular to the z axis. The position for any other type of cut can be determined by specifying three angles, each from 0 to 90 degrees either positive or negative, through which such a z-cut crystal would have to be turned successively to reach the orientation desired for the crystal. To keep track of the signs of the various angles, it will be convenient to designate the corner of the crystal at the origin by O and three of the corners of the upper surface along the three axes as X, Y and Z, respectively. With these designations the positive direction of rotation is counter-

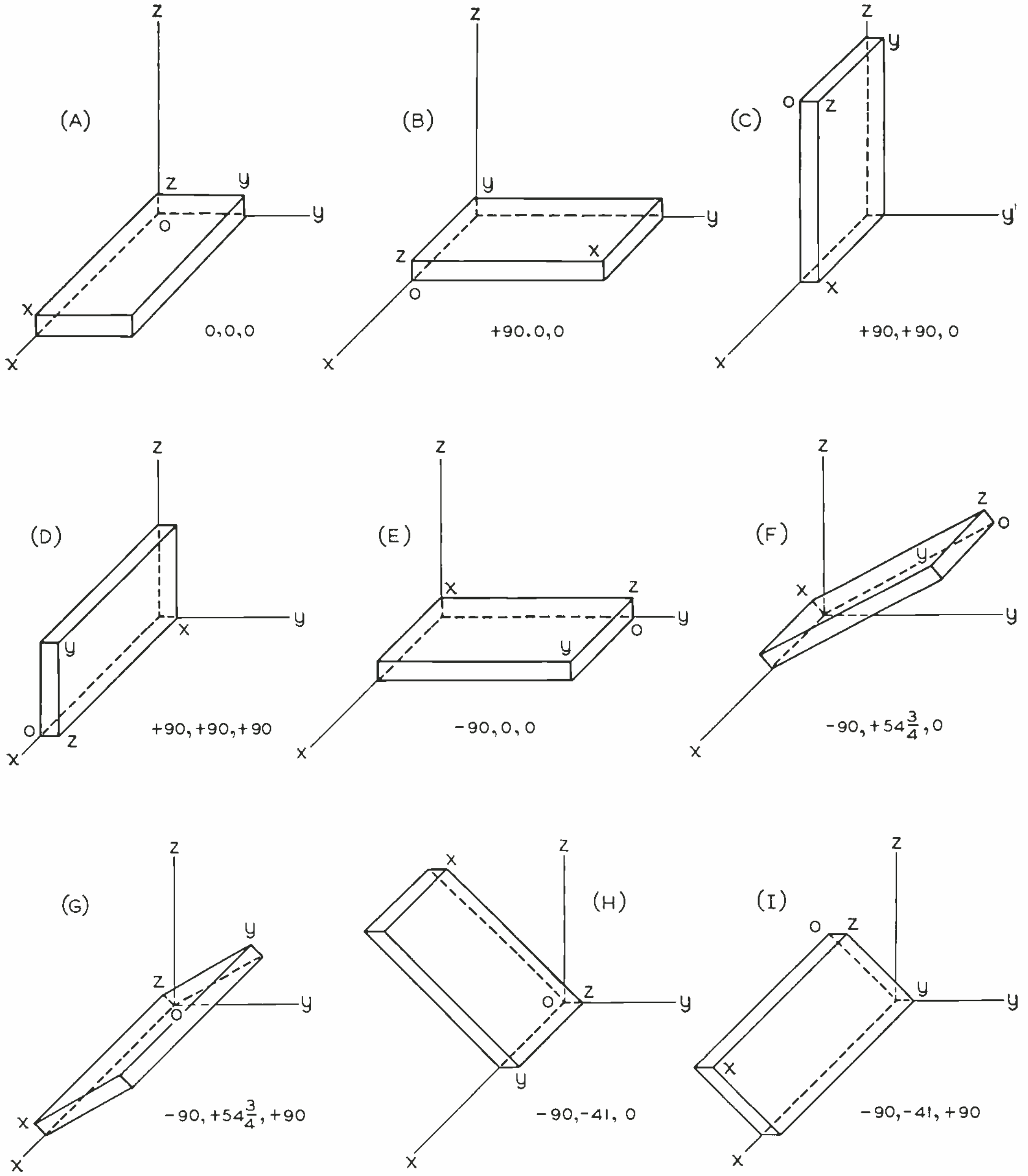


Fig. 5—Perspective representation of the various rotations used in specifying the orientation of quartz plates

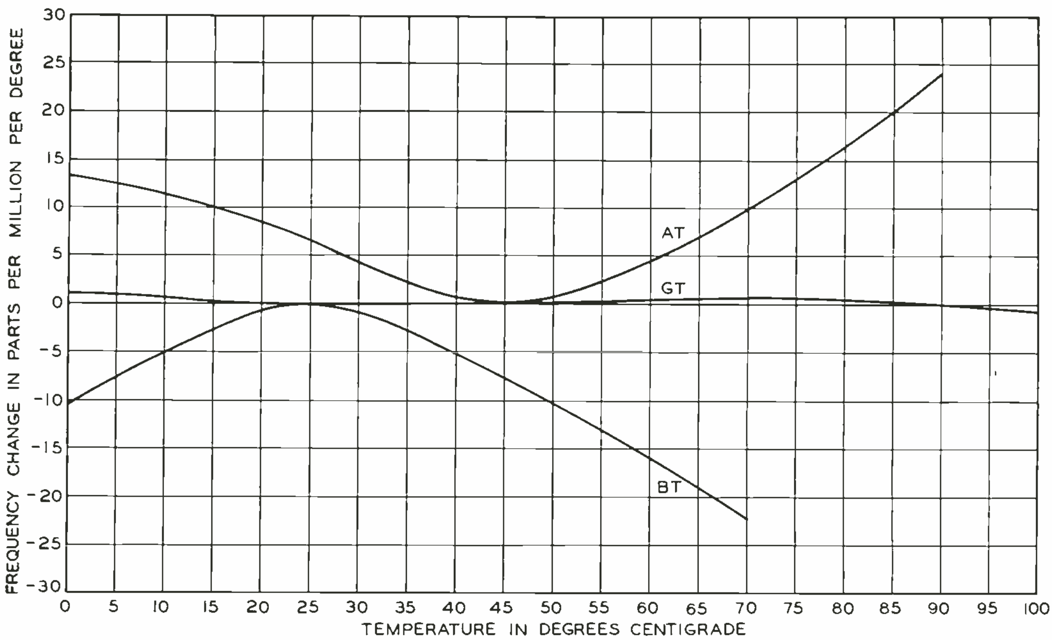


Fig. 6—Relationships between temperature and change in frequency of the crystal for AT, BT *and* GT *cuts*

clockwise looking in the direction ZO or YZ. While the first angle, ϕ, is turned around the Z axis, the second, θ, around YZ, and the last, Ψ, around ZO, it should be noticed that these last two rotations are not around the Z and Y axes unless the preceding rotation was O. For a Y-cut crystal the angles are +90, +90, +90, and the positions of the crystal after each angle is turned are shown at B, C and D. For the AT cut the angles are −90, +54¾, +90, and the successive turns are shown at E, F and G. For the BT cut, angles −90, −41, +90, the turns are shown at E, H and I.

A zero temperature coefficient, as obtained with the AT and BT crystals, does not mean that the behavior of the crystal is independent of the temperature, but that at some particular temperature the curve giving the relationship between temperature and rate of change in frequency with temperature is horizontal. This is shown in Figure 6. The curve for the BT crystal becomes horizontal at about 25 degrees C., and if the crystal is operated at this temperature small deviations from 25 degrees will result in only extremely small changes in frequency. At higher temperatures the temperature coefficient is negative, that is, an increase in temperature results in a decrease in frequency which becomes larger the greater the departure from 25 degrees, while at lower temperatures the coefficient is positive. The AT crystal, on the other hand, has a positive coefficient which becomes zero at about 45 degrees, and is opposite to those of the BT crystal at high and low temperatures.

With a crystal of zero temperature coefficient, the frequency can be held to almost negligible variations by maintaining the crystal at the proper temperature. Accurate temperature control apparatus, however, is necessary when high constancy of frequency is desired. It would be very desirable if a crystal cut were available that had a zero temperature coefficient over a wide range of temperature, since this would make temperature control unnecessary over this range. Search for such a cut resulted in the GT crystal, which, as shown in Figure 6, has a temperature coefficient that is essentially zero from 0 degree to 100 degrees C. The orientation of the plane of this cut is similar to that of the AT except that it is tipped up 38 degrees 52 minutes instead of 54 degrees 54 minutes. In this plane, however, the crystal is rotated 45 degrees. Its rotation would be the same as that of the AT cut, sketch E of Figure 5, but the next two rotations would be as shown at A and B of Figure 7.

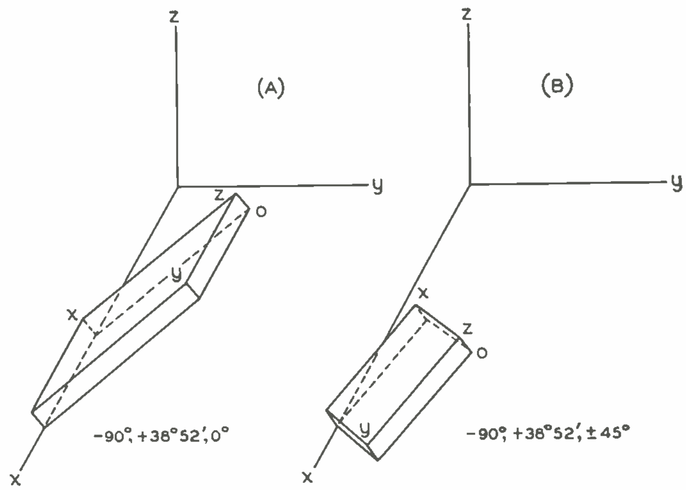


Fig. 7—Final rotations in the orientation of the GT *crystal*

These various cuts, besides giving the temperature characteristics desired, are also selected, and the dimensions of the crystal chosen, so there will be only one mode of vibration that has a fundamental or harmonic frequency in the neighborhood of the frequency at which the crystal is to be operated. It was largely the pioneering work of Bell Laboratories in studying behavior of quartz at various orientations of cut that has made possible the wide usefulness of quartz crystals to electrical communication in general and to specific applications to war purposes. Along with these fundamental studies have gone extensive investigations of methods of cutting and grinding quartz plates to the orientation and dimensions desired. The grinding tolerances are very small, and the ability to produce high-precision crystals in large quantities has become possible primarily because of these studies.

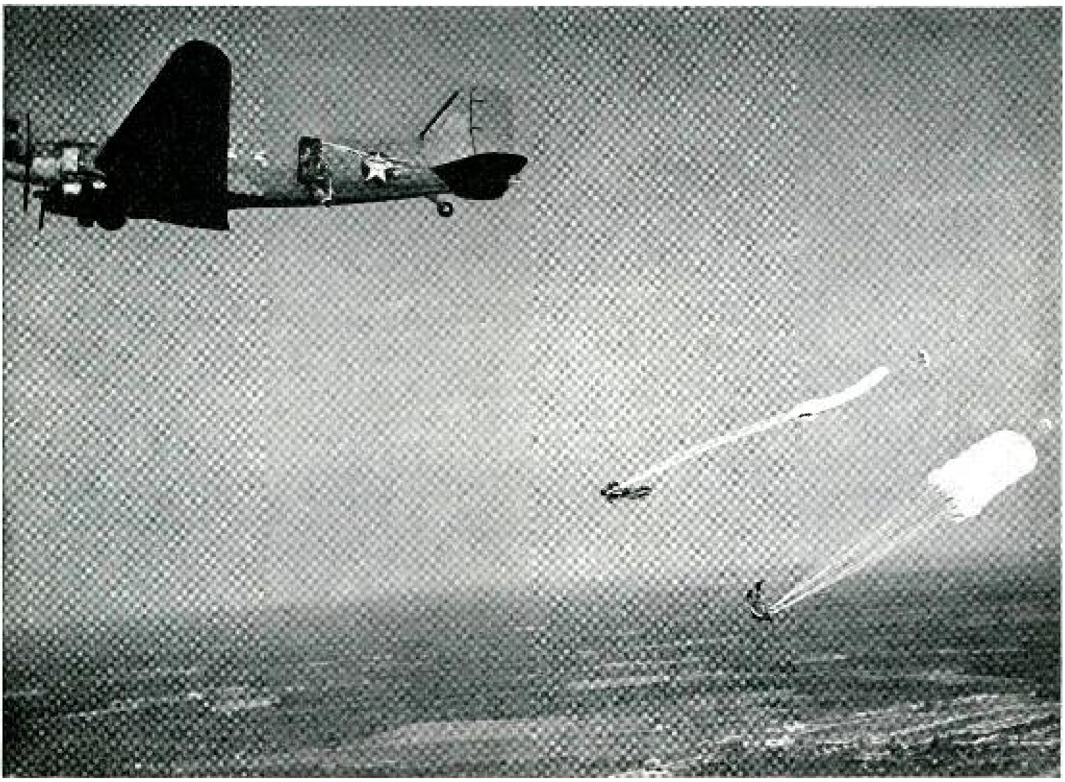
THE AUTHOR: W. P. MASON received a B.S. in E.E. degree from the University of Kansas in 1921 and immediately joined the Laboratories. While here he took post-graduate work at Columbia University and received an M.A. degree in 1924 and a Ph.D. degree in 1927. The first four years of his work with the Company were spent in investigations of carrier transmission systems. Since then he has been occupied in the development of wave transmission networks, both electrical and mechanical, and in research on piezoelectric crystals.

Laboratories Engineers Make Parachute Jumps

I—Hitting the Silk
By Paul V. Koos
Equipment Development

FOR some years past I have been engaged in Bell Telephone Laboratories in designing the arrangements for telephone offices which we call "equipment." The mechanical design of equipment has recently taken on new importance, for many of our military developments need ruggedness and compactness never required for telephony. So, for the past two years or more, I have been one of a group working on new devices. Many of these are installed on airplanes so that I have been at airfields a great deal and have made many flights. One who rubs shoulders day after day with airmen picks up a good deal of their lore—a circumstance for which I was to be profoundly thankful.

Late in November, 1943, I was directed to proceed to X Field where a device in which I was concerned was to have a flight test. There I found another Laboratories man, John Morrison, was to fly in the same plane as I. We drew our parachutes from the airport stockroom—a familiar procedure from previous flights—and took our places in the ship. The take-off, at 10:30 A.M., was without incident; we climbed to cruising altitude and flew above the 2,500-foot ceiling while making our measurements. Manning the plane were the pilot, co-pilot, navigator and crew chief—the latter a man who was responsible for the ground maintenance of the ship. About noon we were ready to



U. S. Navy Photo

These Para-marines in training illustrate the experience of Messrs. Koos and Morrison land and as the pilot began to lose altitude, he operated the controls to lower the wheels. Nothing happened. After a few minutes, the crew chief came back to the rear compartment, where Morrison and I were, and tried to lower the wheels with the emergency gear. The small wheel in the nose came down, but when the main wheels were halfway, they stuck fast. In the struggle, the equipment broke. At Morrison's suggestion we made further efforts with a piece of rope and a spar but to no avail. Nor could the nose wheel be drawn up, so that a "belly landing"—skidding on the underside of the plane—would have been suicidal.

J. F. Morrison

P. V. Koos

Meanwhile, as I learned later, there had been a great deal going on on the ground. The pilot was in constant communication by radio. Several expedients—all fruitless—were suggested; telephone calls were made to Wright Field, central engineering laboratory of the Air Force. The supply of gas on the plane was now running low, and the decision was made that all should "bail out." The escape hatch in the rear compartment was opened; we checked our chute harnesses and stood by. The ship came out of the cloud ceiling over the airport. Morrison was the first to jump; then, "Koos out" was the pilot's order. I poised myself over the small opening, facing the tail, clasped my arms over my chest, ducked my head, drew up my knees and dropped through. Instantly I was hit from behind by a blast of wind with the force of a blow. The air speed, added to the back wash from the propellers, must have been well over 200 miles an hour. I knew, of course, the formula "Count five, then pull." But I didn't use it; I waited till my drag had slowed down my forward motion so that the wind was not so strong, then pulled the rip cord. Standard advice to chutists is "Keep your fingers off the ring until you are clear of the ship" lest a bump on the hatch-way make one pull the ring too soon. However, my finger tips were pressing against the ring; I was taking no chances on being able to find it when the moment came to pull. As the ring and its cable came clear, the pilot chute shot out and the main chute trailed after it. Before I could even wonder if it would open, I felt the jerk of the harness and immediately my motion seemed to stop. I was drifting slowly off the cleared area of the field over the sandy plain with its scrubby trees. Below me I could see a jeep and an ambulance following my course. Not far away was Morrison, swinging wildly under his parachute and evidently having a time of it.

Gradually the ground came up to meet me—very slowly at first, but in the last fifty feet at an alarming rate. I flexed my knees, ducked my head again, and then with a shock I was down in the sand, trying to keep my feet going to keep up with the drag of the chute. In a few yards it stopped, and I slipped the catches of the harness. To my relief, I was uninjured, save for a cut in my lower lip.

Having due regard for the scarcity of nylon, I bundled the chute together, got it up on my shoulder and started back for the field. Within fifty yards I came to a drainage canal, with the jeep and the ambulance on the other side of it; we decided that they should start for a bridge about a quarter mile away, while I followed along. An unfolded parachute is a mean load and I was glad to see the jeep come bumping along to meet me. Back at the hangar, someone brushed me off, the doctors looked me over and pronounced me fit as a fiddle after my lips had been dressed.

Morrison did not fare so well, but I shall let him tell his own story. The rest of the crew came down safely; the pilot after putting the controls over to the automatic pilot pointed the ship in a safe direction and bailed out.

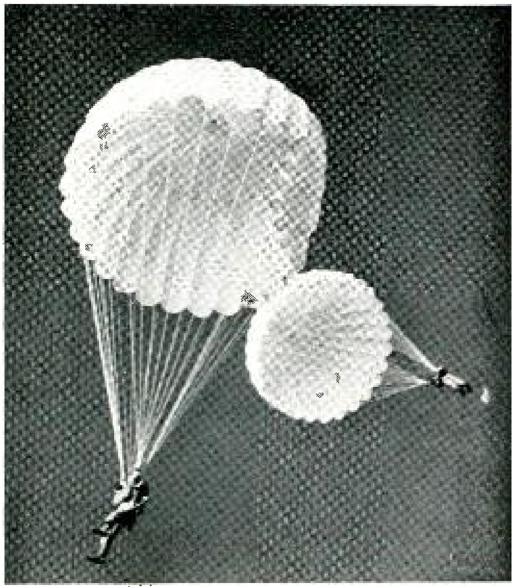
People have asked me if I was frightened. My feelings tell me I was not even nervous; parachutes were a commonplace to everyone and I had been well instructed in their use. But Morrison says my face was covered with perspiration as I stood by the hatchway, so I will just let it go at that.

II—We Join the Caterpillar Club

By J. F. Morrison

Radio Development

WHEN word came that we all had to don parachutes and jump, I was designated the first to go. The hatch in the bottom of the plane was opened; the roar of the wind through the gaping void was deafening. I straddled it with one foot on each side and held on by one arm from a handle above. I was suddenly tapped on the back by one of the Army men as a signal to drop. I brought my feet together, let go of the handle and plummeted into the blue with my hand on the rip cord. The pressure of the wind and a blow on my chin from one of the buckles on the chute nearly knocked me out but I recovered in time to yank the cord. Expecting it to bring up against a stop, you can imagine my feelings when it came entirely out of the pack; during the seeming eternity before anything happened, I was terrorized with the thought that something was wrong. The chute opened, I felt a sudden pull across my chest and my precipitous fall to earth stopped. The mental relief was tremendous. The deafening noise had ceased and the chute floated gently down with soothing relief.



U. S. Marine Photo

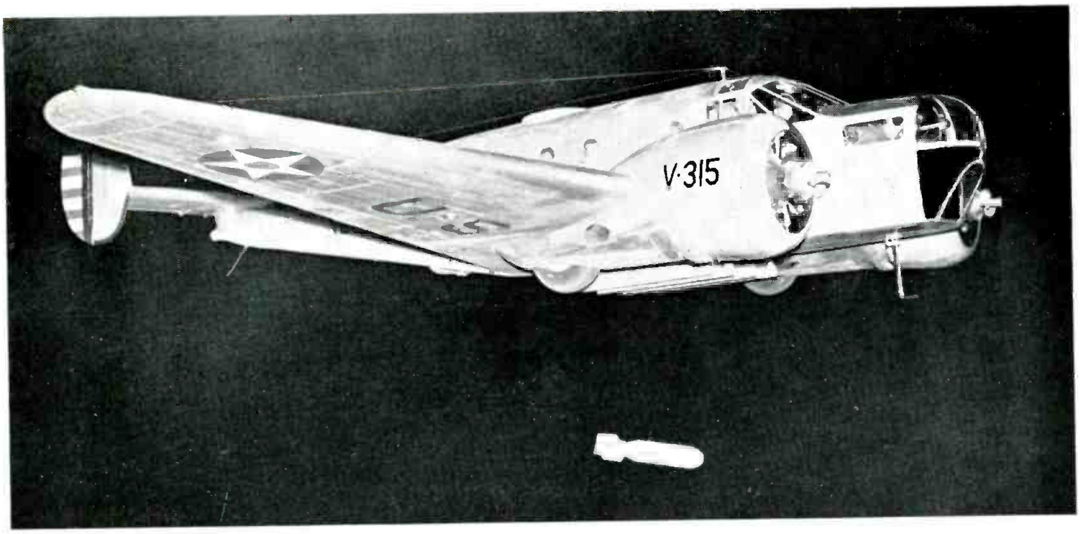
"Not far away was Morrison, swinging wildly and evidently having a time of it"

But my troubles were not over. Perhaps because I passed through a cloud, perhaps because the wind was strong and gusty, I began to swing like a pendulum, farther and farther on each upward swing. That was really frightening; and the motion, which continued all the way down, was decidedly hard on the stomach.

Meantime the flying field below got nearer and nearer. I saw a jeep racing toward me and had to think quickly how I should attempt to land. With my feet together I struck at the edge of a concrete runway, my legs collapsed, and I sat down with a shuddering jolt. The jeep had caught up with me. A soldier grabbed my parachute and an Army surgeon was at my side.

They rushed me in an ambulance to the hospital, X-rayed me and put me to bed. The emergency over, I now became aware of considerable discomfort from my abrupt contact with the runway, but in spite of this a profound feeling of calmness and exhilaration pervaded my whole being and made me so happy at the fortunate outcome of my experience that I wanted to hug everyone, male and female, who came near my bed.

After four days I was up again and on the job. They tell me I am now eligible for membership in that unique organization the Caterpillars, limited to those who have made an emergency parachute landing, but I am not recommending the initiation ceremony to my friends.



Dr. O. E. Buckley, President, Bell Telephone Laboratories:

Directly as a result of the outstanding contribution made by your organization in the development of special electronic equipment and in the making of pre-production models thereof it has been possible for the Army Air Forces to take the offensive with telling effect against Japanese shipping in the South and Southwest Pacific areas at a much earlier date than would otherwise have been possible and under conditions which normally would have made such operations impossible.

It is my great pleasure in behalf of the Army Air Forces to express our appreciation for this contribution and to congratulate you and your people on their achievement.

Arnold.

[*Copy of a telegram received on January 14 by Dr. Buckley from General Henry H. Arnold, Commanding General, Army Air Forces.*]

Both Photos, Army Air Forces from Acme

Don't Quit Now!

By Vivian Kilpatrick
Research Staff

SOME people making their familiar rounds in this comparatively peaceful part of the world are saying unthinkingly to themselves, "I've done all I can. I can't do any more. There is a limit to all things. One can't keep on subscribing forever, one has to quit some time and I'm quitting now. I've done my share."

I wonder if people who are talking to themselves this way have thought what the results to themselves and others would be if our boys on the far-flung battle fronts of the world started saying: "We're quitting. We're tired almost to the point of exhaustion. We've had our fill of bloodshed and bullets, of mud and insects, of heat and fever, of sleepless nights filled with the sound of screeching bombs. We've had enough of the terror of death and of destruction that lies in wait for us every moment of our lives. We long for the familiar sights and sounds of home. We long to see again the faces of those we love, to know again the comfort and security of peaceful roofs over our heads and of solid ground under our feet. We don't ask for much—just the simple things we used to take for granted. Don't get us wrong. We want to do our part. We'll take any kind of job that furthers the war effort. We won't mind the long hours, the high taxes. We'll gladly sacrifice the usual conveniences and luxuries to buy our share of war bonds. We would do all this and much more just to get back home."

How many people would willingly change places with one of these boys! Some day take a paper and pencil and jot down on one half the sacrifices you are making and on the

In December, executives of the Third Naval District visited the School for War Training. As pictured above, while William Keister demonstrated testing equipment, they were: Commander H. C. Garrison, Ass't Director of Training; Captain S. C. Loomis, Director of Training; Lieut. Commander L. W. Nuesse, Inspection Training, Patrol Forces; Captain H. M. Jensen, Assistant Commandant; Captain W. C. I. Stiles, War Plans Officer; Captain L. E. Lindsay, Commander, Patrol Forces; Captain S. B. McKinney, Chief of Staff. Behind Mr. Keister are R. K. Honaman, Director of the School, and E. J. Thielen, Assistant Director. After hearing a report of the visit these executives made, Commodore F. G. Reinicke, Port Director, and members of his staff also visited the school

When the Big Drive Starts on Germany

Are You Going to Fight?

On the Second Front your friends and relatives will be in those landing parties or on their escorting ships and protecting planes. Many people from the Laboratories will be in those positions of danger.

Let's get right down to grenades and cartridges. Will you save just one week's standard pay during the next twelve weeks? Will you do this in addition to keeping on with your present pay allotment for War Bonds?

Laboratories Bond Committee

Buy Extra Bonds **Buy Extra Bonds**

other those that the soldier or sailor is making. Then dig down deep in your pocket and try to balance the ledger. You can't ever do it, of course, but you can help by lending some money to Uncle Sam who will give it back to you after a period of ten years with interest to boot.

The extra bond you buy will serve many purposes. It may save a life. If enough people buy enough bonds the end of the war will be hastened. If the end is hastened by as little as one day as a result of the purchase of bonds by the people on the home front, thousands of boys who might not otherwise have done so will return to their homes and families. When that great day arrives we won't feel that our contributions have been made at great personal sacrifice but our hearts will swell with pride to think that we had some part in bringing them safely back.

Don't quit now! Let's all keep pace with the boys in Africa, in Italy and in the Pacific by supporting the Fourth War Loan to the limit of our ability to do so.

Third "E" Pin Award

For the third time, the Laboratories has won the Army-Navy Production Award for high achievement in the development and design of military equipment. In notifying the Laboratories, Robert P. Patterson, Under Secretary of War, said: "In maintaining the fine record which first brought you distinction, you have set an inspiring example for your fellow Americans on the production front. This second renewal adds a second White Star to your Army-Navy Production Award flag, and stands as a

OFFICIAL TELEGRAM

N. Y., DEC. 31, 1943

O. E. BUCKLEY, PRESIDENT

BELL TELEPHONE LABORATORIES

ALL OF US HERE SEND BEST WISHES TO YOU AND YOUR ASSOCIATES FOR A VICTORIOUS NEW YEAR. I PERSONALLY WANT TO THANK YOU FOR YOUR CO-OPERATION AND HELP IN THE YEAR JUST ENDING. BELL SYSTEM TEAMWORK WAS NEVER BETTER WITH THE RESULT THAT WE FINISH THE MOST DIFFICULT YEAR WE EVER HAD, READY TO MEET SUCCESSFULLY WHATEVER PROBLEMS THE NEW YEAR MAY BRING.

WALTER S. GIFFORD.

symbol of your great and continuing contribution to the cause of freedom."

With this award, new lapel pins became available for all those who were connected with the Laboratories on December 31, 1943, and who had not received a pin for the previous award, which was "as of" June 19, 1943.

High School Graduates Being Recruited

Mrs. L. C. Hinrichs has been going out to high schools in the metropolitan area recruiting girl graduates of the January classes. The Personnel Department has under consideration a rather extensive program for the training and promotion of the girls selected and will welcome any help from members of the Laboratories in the way of referring candidates for clerical and messenger jobs to Mrs. Hinrichs in Women's Employment.

A. M. Baum has also been recruiting young men, graduates of the January classes in metropolitan high schools, for positions in the Laboratories. If you know any young men, just graduated from high school and possible candidates for work at the Laboratories, please refer them to Mr. Baum in Men's Employment.

News Notes

Among the exhibits on view at the conference of Vice-Presidents of Bell System operating companies at the Waldorf-Astoria in January were a number of war developments of the Laboratories. These included various military instruments such as the throat and lip microphones and airborne radio command set equipment installed in a bomber. The Laboratories' exhibits were erected under the supervision of Henry J. Kostkos and Ray Erickson.

Frank B. Jewett visited the Aberdeen Proving Ground, Maryland, on December

"The Telephone Hour"

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

FEBRUARY 7, 1944

Hungarian Fantasy José Iturbi and Orchestra	*Liszt*
On the Trail from "Grand Canyon Suite" Orchestra	*Grofé*
Waltz in A Flat José Iturbi	*Chopin*
Zapateado and Paso Doble from "Fantasy" José Iturbi and Orchestra	*Iturbi*

FEBRUARY 14, 1944

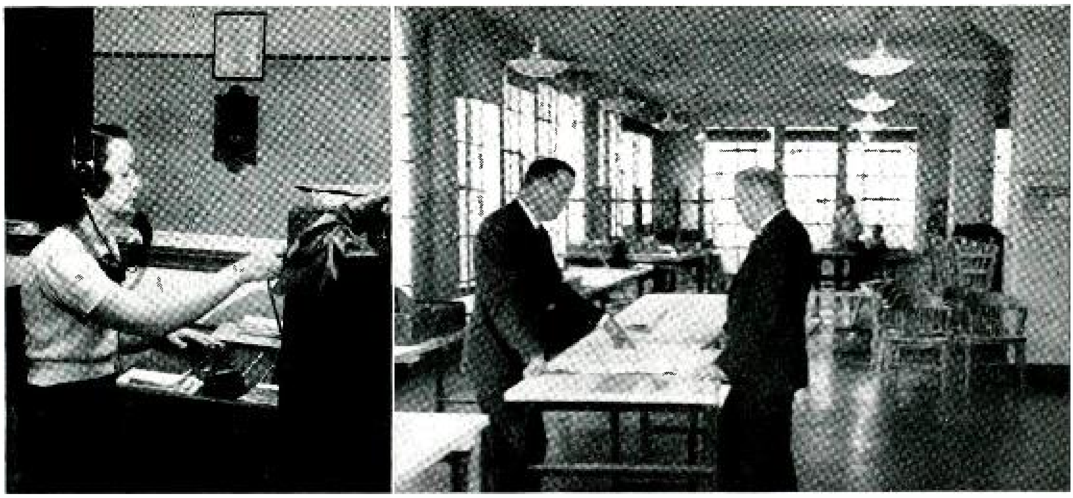
Because James Melton	*D'Hardelot*
Surrey with the Fringe on Top from "Oklahoma" James Melton and Chorus	*Rodgers*
People Will Say from "Oklahoma" Orchestra	*Rodgers*
From Fervent Lips the Song of Love Arises from "Falstaff" James Melton	*Verdi*
Violin Concerto in E Minor—Finale Orchestra	*Mendelssohn*
Johnny the One James Melton and Chorus	*Sacco*

FEBRUARY 21, 1944

Yankee Doodle Orchestra	*Traditional*
By the Bend of the River	*Edwards*
Morning Helen Traubel	*Speaks*
Falling in Love with Love from "Boys from Syracuse" Orchestra	*Rodgers*
Voi Lo Sapete from "Cavalleria Rusticana" Helen Traubel	*Mascagni*
Coronation Scene from "Boris Godounoff" Chorus and Orchestra	*Moussorgsky*
America the Beautiful Helen Traubel and Chorus	*Ward*

FEBRUARY 28, 1944

Spanish Serenade from "Suite of Serenades"	*Herbert*
Cuban Serenade from "Suite of Serenades" Orchestra	*Herbert*
Miller's Dance from "Three-Cornered Hat"	*DeFalla*
Liebesleid	*Kreisler-Rachmaninoff*
Golliwog's Cake Walk from "Children's Corner Suite"	*Debussy*
March from "Love for Three Oranges" Oscar Levant	*Prokofieff*
Rhapsody in Blue Oscar Levant and Orchestra	*Gershwin*



To provide additional shop and associated office space, the Laboratories has rented four floors in the industrial building at 157 Chambers Street. L. P. Bartheld is responsible for setting up of this shop and E. L. Nelson (right) for engineering of the products to be made. Miss May Craig, a PBX operator from West Street, will operate the switchboard at "Chambers Street," which has direct tie lines to the West Street switchboard. While a nucleus of people will be transferred from other locations, most of the personnel will be recruited, and trained as need be

8, in his capacity as Consultant to the Ordnance Department, to witness a demonstration staged for the National Inventors Council. Dr. Jewett also participated in the Second War Congress of Industry, held by the National Association of Manufacturers from December 8 to 10 at the Waldorf-Astoria Hotel, in which he took part in the panel discussion *Whither Research.*

EFFECTIVE January 15, W. FONDILLER took direct charge of the Development Shop activities at all locations. H. C. ATKINSON, as Development Shops Manager, now reports to Mr. Fondiller. Reporting to Mr. Atkinson are the following:

- New York Shops—
  - West Street and Graybar-Varick—A. H. SASS.
  - Chambers Street— L. P. BARTHELD, in addition to his duties as Building Layout Manager.
- New Jersey Shops—
  - All locations—G. DOBSON.
- Outside Shop Work—A. F. GILSON.
- Office Service—A. I. HEITZMAN.
- Administrative Assistant—W. W. SCHORMANN.

T. C. FRY now reports direct to M. J. KELLY, Director of Research. He will continue his activities with the NDRC and, as time permits, will make a study of the Research Department switching program.

H. W. BODE has been appointed Research Mathematician, reporting to H. FLETCHER, Director of Physical Research, and is in direct charge of the mathematical research group. This group moved to the Murray Hill laboratory on January 12.

PHILLIP H. SMITH's article, *An Improved Transmission Line Calculator*, appears in the January issue of *Electronics*.

Men and Women Urgently Needed

Skilled all-round mechanics and trainees are needed to man the new Laboratories location at Chambers Street, shown above. They will work on the pre-production models of the special equipment referred to by General Arnold on page 293 of this issue of the RECORD.

Trainees will receive full pay while learning to do this vital work. Essential workers will need a statement of release.

Christmas at the Laboratories

H. W. HERMANCE visited Buffalo, Cleveland and Pittsburgh to study contact noise problems.

G. N. VACCA and J. B. HOWARD were at Point Breeze in December on synthetic rubber problems.

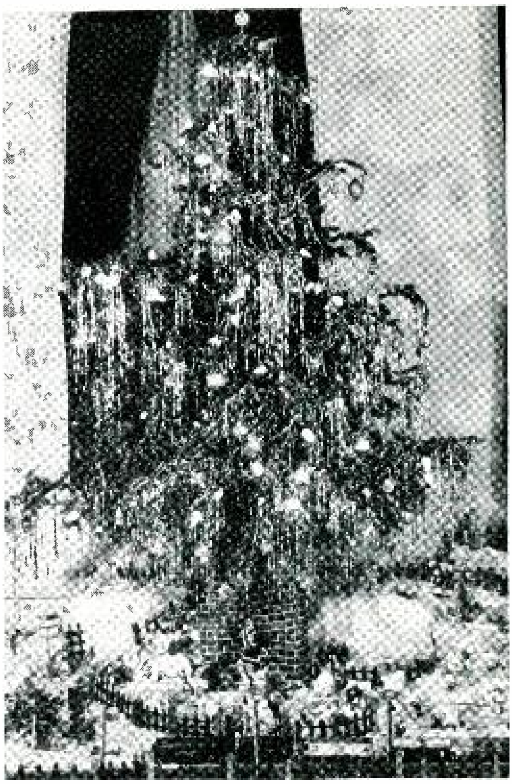
DURING THE MONTHS of November and December the United States Patent Office issued patents on application previously filed by the following members of the Laboratories:

L. H. Allen	D. H. King
W. O. Baker	J. A. Mahoney
H. W. Bode	W. P. Mason
N. Botsford	C. W. McWilliams
M. S. Burgess (2)	A. H. Miller
A. J. Busch	D. Mitchell
L. Espenschied	N. R. Pape
E. W. Gent	K. W. Pfleger
W. S. Gorton	W. T. Rea
C. R. Gray	G. C. Reier
C. A. Hallam	B. E. Stevens
F. H. Hibbard	A. L. Stillwell
W. H. T. Holden	G. K. Teal
H. Hovland	J. G. Walsh

R. E. Wirsching

CHORAL SINGING, led by a mixed choir and instruments, shown during rehearsal in the bottom photograph on the opposite page, featured exercises held by the staff at Murray Hill in the Arnold Auditorium the day before Christmas. M. B. LONG extended the Season's Greetings after introduction by F. D. LEAMER. As part of the program, G. W. LEES, JR., narrated, through the public address system, excerpts from the biblical story of the nativity. Carols played from phonograph records preceded and followed the program which was also heard through loud-speakers in the restaurant, the lounge and the lobby.

D. A. MCLEAN and J. D. CUMMINGS, accompanied J. P. Greener of the Western Electric Company, observed paper making processes and discussed condenser problems at Crocker Burbank and Company, Fitchburg; Stevens Paper Mills, Inc., Westfield, and Smith Paper Company, Lee, all in Massachusetts



This is the tree and miniature village which Edward A. Fern, wounded Laboratories Marine, asked to have set up this past Christmas. Edward started the village as a hobby seven years ago and gradually added to the display until, when he joined the Armed Forces, it included seventy houses illuminated by electricity, two sets of trains operating on sixty-five feet of track and a concealed recording machine to play Christmas music

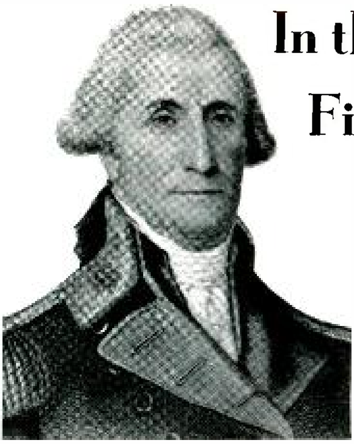
Engagements

James F. Kelly, U. S. Navy—*Elaine Arlotta
*Walter A. Getchell, Jr.—Polly Higgins
*William R. Grant, U. S. Army—Alice Hofmann
*Edward B. Gempler, U. S. Navy—Katherine Holden
John Kelleher, U. S. Army—*Mary Parsons
*F. Gordon Merrill—Lola Schmidt
*William J. Szmeikal—Katherine Shumacher
Ernest Redfield, U. S. N. R.—*Eleanor Soneson
*Chester S. Cook—Marilyn West
*John H. McConnell, U. S. Navy—*Marion Whitney
*Howard L. Bond—Ruth W. Wilkins

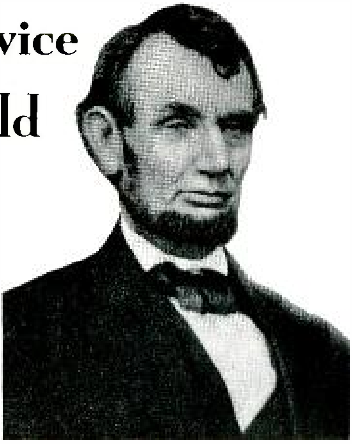
Weddings

Lt. John Watson, U. S. Army—*Irene Bier, U. S. Navy
Harry F. Clifton—*Elsie Grauling
George L. Nichil—*Helen Liter
William Marks, U.S.M.S.—*Vita Padlog
*George B. Thomas, Jr.—Jean Russell

*Members of the Laboratories. Notices of engagements and weddings should be sent to Mrs. Helen McLoughlin, Women's Editor, Room 1103.



In the Nation's Service Fighting to Uphold the Ideals of These Great Men



Edward A. Fern

Word has been received that EDWARD A. FERN has been wounded. Edward, formerly a draftsman in the Systems Development Department, was in the South Pacific theater of war. He joined the Marines in November, 1942, and within six months was shipped to a tropical island. A buddy of his wrote that Edward fought at Bougainville.

Major Arthur D. Soper

"When I returned to the Army I was assigned to the Office of the Chief Signal Officer where I have been based ever since. However, my work on ground electronics has taken me across the continent several times, to Texas, Florida and Maine, and has included short tours of duty in Panama, Iceland and the Aleutians, so there has been enough variety to keep things interesting. That phase of my work is about finished and I may perhaps stay closer to Washington for a while."

Lieut. Col. John Hayward

The cover of this issue of the RECORD carries the picture of LIEUT. COL. JOHN HAYWARD of the Switching Apparatus Development Department. This picture, taken by James N. Keen, and the following quoted excerpt appeared in the "Interesting People" section of *The American Magazine* under the caption *He Flies Our Messerschmitts:*

"The cockpit is that of a Messerschmitt 109-F, one of Germany's most deadly fighters, captured and rebuilt by Uncle Sam. And the man fingering its control stick is Lieut. Col. John Hayward, of Wright Field, Ohio. He's the U. S. Army's expert on enemy aircraft. A few minutes after the picture was snapped, Colonel Hayward, a World War I ace, took this Nazi plane high into the Ohio sky, put it through dives, loops, and rolls to compare it with crack U. S. fighters. After that each part of the plane was tested and smashed to bits to discover the materials used in construction. Hayward has sleuths on all our fighting fronts watching for Zeros, Stukas, and other enemy planes and parts of planes to send him."

Louis A. Kramer

"I am now with a malaria survey unit on an island in the South Pacific. While you must be on the receiving end of a biting February wind, I am enjoying the soft breezes coming in from the blue Pacific. The swimming is of the best and we have movies every night. Yet with all the pleasures to be had here, I'd like to be walking down Bethune Street this minute."

Robert E. Henneberg

ROBERT E. HENNEBERG, whose Army assignment is guarding prisoners of war, had some interesting sidelights to offer on the Germans. Robert collects prisoners in New York and helps to take them to various camps all over the country. He is at present guarding Nazis at Ruston, Louisiana.

Thomas J. Slattery

"I am in England now. Will you please give my regards to the boys in my (7521) department? I'm fine and I hope all the bunch are the same."

Lieut. Frederick W. Whiteside

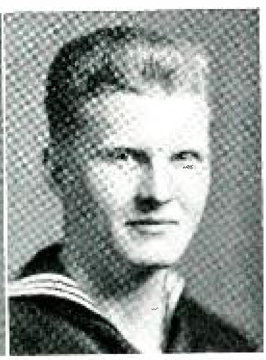
"At the present time I am stationed at the Victorville Army Air Field in California. My duties are that of rail transportation, procurement and property accounting officer. This field is an advanced training school and when the cadets graduate from here they receive their commissions as second lieutenants and their wings as bombardiers.

"I find the work very interesting and at the same time am receiving valuable experience. This has been my second assignment, the first being Luke Field."

Richard C. Bogstahl, Jr.

RICHARD C. BOGSTAHL, JR., returned recently from active duty aboard a destroyer escort in the Mediterranean where he saw "plenty of action." Richard, an electrician's

R. E. HENNEBERG



RICHARD BOGSTAHL

mate 3/c, was formerly a power maintenance hand in the Plant Department. While on leave he had time to call on his friends at West Street to tell them interesting highlights of his visit to Casablanca. He has since left this country for sea duty on which he hopes to raise his rating to 2/c.

Lieut. S. Milton Ray

"I am with a Naval Supply Unit at Babson Institute. The campus grounds are very beautiful. The buildings are of Colonial architecture with brick walls, white trim, and dormer windows on all third stories. Ours is a full schedule, and on our 'free' time we frequently see movies (compulsory attendance) on military subjects pertaining to our work here." (*As this issue goes to press, word has been received that Lieut. Ray has been transferred to Ogden, Utah.*)

Ensign P. H. Thayer

"Though the Navy life does not leave much spare time for writing letters and keeping in touch with former friends at West Street and Varick Street, I often find myself thinking of them and wondering how things are going. The work here at Bowdoin College, Maine, is most interesting, and the instruction is uniformly excellent. It is pleasing to find that the Laboratories' reputation is topnotch with the Navy people who work on this equipment. I have yet to hear a derogatory comment on Laboratories or Western apparatus, except when the boys are trying to get a rise out of me. Once or twice, however, the Laboratories' good reputation has put me on the spot, as it is sometimes assumed that being from the Labs, you must know it all. The four-hour Saturday morning exams rather quickly dispel that illusion.

"Please give my regards to JIM ST. CLAIR, FRANK DANIELS, and to all the others."

Edwin E. Birger

EDWIN E. BIRGER really enjoys Grove City College where the girls outnumber the Armed Forces. "All you have to do for a date is to go to a dormitory and ring a bell. If the girl already has a date she will fix you up with one of her friends. What a life!"

Lieut. Colonel K. O. Thorp

"Some of my friends who do not already know it may be interested to hear of my promotion to Lieutenant Colonel. I am still Resident Representative of the Army Air Forces at the Nashville Division of Consolidated Vultee Aircraft Corporation. We are in the process of retooling to build new

E. E. BIRGER

LIEUT. S. M. RAY

Captain Irving C. Osten-Sacken

airplanes. My work is most interesting and it is very educational as well."

John G. Phillips

"To my fellow Labs members and friends, especially those at Whippany: Since I left you in January, 1943, for the AAF Cadets I have spent six weeks at Atlantic City for basic training; then to Syracuse University for five months of college training. Next I went to Nashville reclassification center where I hit a snag and had to be operated on. I was six weeks in the hospital, had a ten-day furlough on which I visited Whippany Labs, and was sorry I couldn't see you all. Now I am at pre-flight and primary flight training at Santa Ana. The place is nice and the weather is wonderful."

Robert W. Blaschke

"When I first came overseas I was stationed in Northern Ireland, but since July I have been on detached duty traveling around England and have seen a good deal. The part of the country I am in was beautiful but the war made a big change and spoiled the beauty. I was particularly fond of one lovely little town where I made many friends—more than I've ever made since. My duties were many; I took care of the mail for the men in my unit; I had to buy their food; and I also ran a small boat. At other times I would act as an escort for visiting officers. In doing these things I came

There Were 717 Members of the Laboratories on Military Leaves of Absence as of December 31, 1943

Army 456 Waves 27 Wacs 9 Marine Corps Women's Reserve 4

Navy, Marines and Coast Guard 221

LEAVES OF ABSENCE SINCE LAST ISSUE

United States Army

Philbrick M. Crouch	Edward W. Karpen	Harry A. Malone, Jr.	Peter H. Shearer
Milton Dudeck	Catherine Lennon	Joseph R. May	Harry J. Stewart
Arthur Henricks	John P. Mahoney	Robert W. McMurrough	William L. Vedera
Guerdon B. Herblin	Frank J. Majorossy	Joseph T. Murphy	

United States Navy

John J. Carroll	Raymond W. Eckerson	Carmen C. Marsicovete	Joseph E. O'Keefe
Catherine M. Covert	William J. Gallagher	Lt. Jane B. McIlwraith	Arnold Wander
William J. Douglas	Robert H. Light	Thomas Musca	Peter Yurica

United States Marines—Robert G. Kemple to know the townspeople. They had a drive to collect funds for their prisoners of war. They asked us to parade with a jeep. We did and collected eight £ for them."

Captain I. C. Osten-Sacken

Capt. I. C. Osten-Sacken called at the Laboratories while on a short leave. He had attended the Flight Commanders' Meeting in Washington and was glad of the opportunity to visit West Street. Captain Osten-Sacken is the Commanding Officer of a Photo Squadron. The detachment consists of ten planes, twelve pilots and their crews of one hundred and twenty men, among them the most outstanding aerial commercial photographers in the United States. Men trained in this detachment are now serving in every theater of war. Captain Osten-Sacken, a former member of Switching Engineering, has been on military leave since 1942.

John A. Lasco

"I am still in the Ordnance Department but temporarily assigned to a gun battalion for maintenance and instruction purposes on some equipment that I once had the pleasure of working on at the Laboratories.

"The weather and atmosphere here in the tropics of the South Pacific are certainly a new experience. Let us all hope that soon we may all return once more to a normal life in a normal world."

John H. Devereaux (left) and James B. Kennedy are two members of the Systems Drafting Department who have been lucky enough not to have been separated since joining the Army together. They have just completed a course of study in New York City

Howard B. Creuziger will be remembered by many as their former paymaster. He is shown talking to Ann Weeber while he was on furlough from Camp Thomas A. Scott, Indiana

Lieut. Joseph A. Lehans

"Since October first I have been stationed with the fleet in the Pacific. I am in charge of all * * * on board and it is a real undertaking, especially since there are no Laboratories consultants in the next room. Please send my regards through the Record to all my friends at the Laboratories."

Military News

"Have arrived at Final Squadron in Pensacola, the last stop before commissioning," Lawrence A. Vabulas writes. "February is the earliest date I can possibly get my wings because this weather is not good for flying."

Alexander F. Lawson's assignment is still with the

Signal Corps at Amherest (Mass.) College.

THE STAFF of the RECORD wishes to thank all the members of the Armed Forces who sent greetings at Christmas and New Year's.

R. T. DUFFEY   LT. GEORGE BUKUR

SIGMUND FRONCZAK returned from eleven months of land-base duty in England and Northern Ireland, part of which time he spent on a station with ROBERT W. BLASCHKE. Mr. Fronczak is now assigned to a destroyer and is much happier "because he can occasionally visit the United States."

JOSEPH C. BERKA is stationed at the Frankford Arsenal in Philadelphia. His work has been on the M9 and 10 directors since he volunteered for that assignment.

EUGENE A. STEPPUHN is a cook, third class, and is now in an active theater of war.

ENSIGN GEORGE E. ORAM called at West Street to visit friends after he had completed his indoctrination course at Princeton. He is studying communications at Harvard.

THOMAS F. JEW visited the storerooms in the Laboratories when on furlough in December. A radio operator and gunner in the Air Corps, he is at Salt Lake City training with the crew in which he will see action.

ENSIGN M. K. ASDAL is at the Naval Mine Depot at Yorktown, Virginia.

LIEUT. GEORGE BUKUR is completing his course in languages at Yale University.

ENS. M. K. ASDAL   SIGMUND FRONCZAK

Merchant Marine and National Defense Leaves of Absence

AS OF DECEMBER 31, 1943, there were 717 members of the Laboratories on military leaves of absence of which approximately 125 were overseas. In addition there were 14 on Merchant Marine leaves of absence and 27 on personal leaves with the National Defense Research Committee or various government departments.

MERCHANT MARINE LEAVES OF ABSENCE

Edward J. Chance	Frank W. Lindberg	James Onderwater	Bertrand H. Sommer
Joseph V. Davis, Jr.	Clifford J. Lundquist	William J. Rosoff	Ensign Austin R. Suneson
Frank J. Fleischer	James O. McDermott	Frank Sardinha	John T. Travers
Graham R. Freer			Russell L. Valentine

PERSONAL LEAVES ON WORK CONNECTED WITH THE WAR EFFORT

Hamilton Baillard	Erhard Hartmann	Mary E. Quinn	Walter L. Tierney
Michael J. Burger	Joseph W. Hoek	Max S. Richardson	Richard J. Tillman
Eginhard Dietze	Joseph F. Keithley	William Shockley	John E. Tweeddale
Paul V. Dimock	Joseph P. Maxfield	William B. Snow	Robert G. Watling
Louis J. Dorff	James H. Moore	George R. Stibitz	Raymond L. Wegel
Calvin S. Fuller	Charles A. Parker	Albert L. Thuras	Genevieve D. Weldon
Frank H. Graham	Charles H. Prescott		Julian M. West

RECENT PROMOTIONS of members of the Laboratories include: WALTER F. SMITH, JR., to Lieut. Colonel; WALTER W. MAAS to Captain; WALTER A. FARNHAM to Sergeant.

CAPT. ERNEST C. GRAUNAS says: "A recent issue of the RECORD had notices of the promotions of MAJOR H. W. HOLMLIN and CAPTAIN S. C. TALLMAN. I would like to offer my congratulations to them. Their work must be representative of the fine work that I'm sure other members of the Laboratories are putting out both at home and on all fronts. Was surprised and happy to meet the Laboratories' MAJOR SMITH here in Australia. Please extend 'Holiday Greetings' to my former associates at the Labs."

ETHEL MCALEVY, formerly of the Davis Building, is at a Wac overseas station in London. "Just a card to give my new address so the good old RECORD can keep up with me. Like it very much here."

T. E. JEW E. A. STEPPUHN

ROBERT T. DUFFEY is with the Air Corps in Charleston, South Carolina.

"ON NOVEMBER 16 I was graduated from the Naval Reserve Midshipmen's School at Northampton. I am now stationed at the Naval Air Supply Deport in Philadelphia." ENSIGN ELOISE YOUNG.

"WE ARE located 'somewhere in England' and find it very pleasant. The work is interesting, but, naturally, I can say nothing of that. I do enjoy receiving the Overseas Edition." From CAPT. LAMBERT W. STAMMERJOHN's most recent letter.

JAMES S. DEVANNEY sent his regards to all in Building T on a card to the RECORD just before he sailed from Virginia.

WILLIAM R. CAROLAN's assignment in the A.S.T.U. is at the University of Utah where he is in an engineering group.

Michael V. Sullivan, one of the Laboratories' most popular sailors, visited the Chemical Department with his wife after completing his boot training at Sampson

P. W. FOY's newest assignment is the Pilot School at Bainbridge, Georgia.

"TELL MY FRIENDS that with the Bell Telephone Laboratories' Scotch Major in the South Pacific, the situation will be well in hand." From a card sent by MAJOR ROBERT W. HARPER with the Signal Corps.

EDWARD W. O'HARA is attached to an anti-aircraft unit at Nahant, Mass.

FROM HAMMER Field, California, where he is with a bomber squadron, G. V. SMITH sends regards to his friends at the Labs.

ARTHUR M. DOYLE, a member of the M.P., now has a New York assignment.

MAJOR JOHN H. DEWITT has been transferred to New Jersey where he is officer in charge of the Technical Liaison Section at Camp Evans Signal Laboratory.

WM. HENRY OLPP, assigned to the University of Cincinnati, is training in the field of civil engineering.

Addresses Wanted

MEMBERS OF THE LABORATORIES on military leaves of absence whose military and home addresses are missing: Lt. Paul Flickinger, Lt. Charles M. Redding, William J. Meehan, Leon M. Goldfeder.

Retirements

Thomas H. Roberts of the Switching Development Department, with over forty-four years of service in the Bell System, retired with a Class A pension under the Retirement Age Rule on December 31. Before the turn of the century he joined The Bell Telephone Company of Pennsylvania. Late in 1899 he transferred to the Western Electric Company where he had a very active career in the Installation Department. He was division foreman in Illinois, Ohio, the Northwest and New York in charge of manual office installation. He also made special trips to Rio de Janeiro and Port of Spain, Trinidad, to supervise the installation of No. 1 switchboards in these places.

T. H. Roberts

Mr. Roberts came to West Street in 1920. As a member of the circuit design group of the Systems Development Department, he worked on the original panel tandem system development and then was engaged in the development of the sender, decoder connector, decoder and call-announcer circuits of the panel suburban tandem system installed in several of the large panel areas. Later he specialized in the design and development of sender circuits for both the local panel and crossbar switching systems.

* * * * *

Clifton O. Cross of the Transmission Engineering Department retired on February 1 at his own request with a Class A pension following a year of absence due to sickness. Mr. Cross joined the Long Lines Plant Department of the A T & T in 1902 and with the exception of two years was engaged until 1910 in open-wire construction work in the East, South and Middle West. He then left to become superintendent of the T. D. Just Graphite Mining Company at Uwchland, Pennsylvania, where he remained for eight years. Again joining the Long Lines Plant Department, he worked for four months as a clerk on an installation between Washington and Lynchburg and then as a construction foreman on a new line from Culpepper, Virginia, to Washington and

C. O. Cross

January Service Anniversaries of Members of the Laboratories

10 Years

Eugene Bohan
Winifred Danwitz
Joseph Kay
Joseph Lodato
Susie Terracciano

15 Years

Viola Cavalier
F. W. Clayden
W. G. Dauernheim
Catherine Dauner
C. D. Dixon
Birney Dysart
A. E. Emerson
W. G. Finigan
F. G. Fossetta
H. A. Hesch
J. J. Jacobs
F. H. King
J. P. Laico
G. H. Lovell
E. J. Mandable
C. T. McCarthy
John McEvilly
Winifred Meszaros
H. W. Nelson
J. W. Nordstrom
Joseph Novotny
N. C. Olmstead
John Schaefer
F. W. Stubner
John Stuparich

20 Years

Frank Hardy
Alvin Hecker
B. P. Herbort
Karel Lutomirski
M. W. Redmond

25 Years

Le Roy Armitage
H. A. Burgess
R. W. Burns
F. J. Canavan
W. T. Haines
Edward Jacobitti
Harriet Kaiser
Mary Kane
Raphael Marino
Alfredo Quaranta
P. W. Spence
A. W. Tucker
S. B. Wright

35 Years

H. C. Pauly

40 Years

C. A. Walters

on the rebuilding of the Dallastown-Lancaster line from Redwell to McCall's Ferry in Pennsylvania.

In 1919 the Newtown Square-Temple toll line was abandoned by the A T & T but an eight-mile section at Phoenixville was retained by the D & R for testing purposes. For many years this line was used in connection with the design of transpositions for open-wire circuits, particularly of the carrier-frequency type.

Mr. Cross was transferred to Phoenixville for the line construction work required for these tests. Because of "Whitey's" mechanical and constructional abilities, he was of great assistance in this program. In addition to handling the installation of new transposition arrangements from time to time, construction of special lines for test, etc., he assisted in electrical measurements.

Upon completion of the Phoenixville tests, Mr. Cross was transferred to the group handling interference prevention problems on voice and carrier-frequency cable systems. His work since then, which was mostly concerned with the field testing program, took him to many widely scattered points.

* * * * *

Niccola R. Zucconi of the Development Shop retired on December 31 at his own request with a Class A pension upon the completion of twenty-six years of service. He joined what is now the Development Shop as an instrument maker in the days when the Shop was on the eighth floor. During World War I he made tools and dies for the manufacture of vacuum tubes for the Army and Navy. Following the war he worked on the general run of material going through the Development Shop. Later he worked on the two-way television apparatus demonstrated between the Laboratories and 195 Broadway in 1930. More recently he had been concerned with the making of elements for vacuum-tube assembly.

N. R. Zucconi

Your Money and His Life

Sergeant: The signal for the attack will be two shots from my revolver. As soon as you hear them, everybody up and at them.

Private: Sorry, sir. I can't go.

Sergeant: Why not?

Private: Well, you see, I was in an attack last month, and one attack is enough for any soldier in one war.

If you think this is ridiculous, how do you think that private feels about *this* conversation?

Bond Committee: How much can we sign you up for the Fourth War Loan?

Civilian: Oh, I bought my bond when you were around a few months ago.

Surely, if we ask our soldiers to risk their lives more than once, it isn't too much to ask ourselves to dig down more than once. Bear in mind—it isn't a gift, but a loan . . . a loan at a profit.

H. H. Glenn reviewed cords and cables with engineers at Point Breeze.

H. H. Staebner also visited Point Breeze on cord development problems.

The manufacture of new channel filters was E. S. Willis' special problem in Chicago.

D. R. Brobst made studies of special networks in Chicago.

J. H. Bower discussed batteries at the Bureau of Ships during a recent trip to Washington.

During the weeks of December 6 and December 20 M. Whitehead discussed electrolytic condenser matters on visits to the Sprague Specialties Company at North Adams, Massachusetts.

D. S. Myers, R. J. Miller and R. G. Koontz were at Point Breeze to confer on equipment for the Armed Forces.

H. J. Wallis discussed communications projects at Hawthorne.

H. M. Spicer visited the Western Electric Company at Hawthorne, the Allen Bradley and Cutler Hammer Companies in Minneapolis, and the Guardian Electric Company in Chicago in connection with control problems on power systems.

H. J. Berka conferred on power problems at the Allen Bradley Company, Minneapolis, and at the Western Electric Company, Hawthorne.

On Monday following Christmas sixty-five members of the high-frequency transmission group of the Transmission Development Department gathered at the Gramercy Park Hotel for dinner and dancing.

F. J. Samerdyke appeared before the board of appeals at the Patent Office in Washington on an application for a patent.

H. W. Gillette was recently elected Vice-Chairman of the New York Personnel Management Association. Mr. Gillette was also reëlected Chairman of the Program Committee of that organization.

Telephone Talk

During 1943 the Bell System placed special emphasis on the job of providing the facilities through which the men and women of the armed services can talk to the folks back home. The number of attended telephone centers at or near military establishments was more than doubled in 1943, and the number was expected to pass 400 by the end of the year. At the end of October there were, in addition, 285 Company-operated Army and Navy PBX switchboards.

The basic shortage of materials, which barred the building of enough long distance lines to meet the Nation's demands, also brought sharp limitations on local service in many areas. The number of main service applications on file, awaiting facilities, was expected to reach 600,000 by the end of the year. This accumulation of held orders for exchange service posed a problem which called for careful attention. Customers were given complete explanations of the reasons involved, to insure their full understanding of the problem.

Telephone Pioneers Enrolled from June 1, 1943, to Dec. 31, 1943

W. J. Abbenseth	Elizabeth Culbert	P. P. Harvey	A. F. Leyden	P. C. Ryder
W. J. Adams, Jr.	F. W. Cunningham	F. W. Hecht	H. C. Lloyd	H. W. Salch
A. J. Akehurst	M. G. Currier	R. A. Hecht	Dorothy Mahon	Veronica Salis
Dorothy Allyn	A. J. Daly	G. E. Heiland	O. H. Maurer	Ernest Sanchez
C. H. Amadon	F. J. Daniels	I. H. Henry	Jacob Mayer	W. G. Sawyer
H. B. Arnold	K. K. Darrow	W. J. Hill	V. J. Mayer	J. P. Schafer
H. C. Atkinson	G. C. DeCoutouly	Helen Hoar	D. R. McLennan	F. J. G. Schebler
D. P. Barry	E. D. Deery	Gilbert Howard	Margaret McNally	William Schwarz
John Baumfalk	R. A. Deller	F. A. Hubbard	Lillian McNeill	Joseph Shea
P. H. Betts	Claude Deyo	R. N. Hunter	B. A. Merrick	F. J. Singer
J. H. Bigelow*	Mary Dolan	Eleanor Iasillo	R. A. Miller	R. F. Squires
Harold Bott	H. A. Doll	L. M. Ilgenfritz	Mary Mulhern	Jack Stark
D. R. Brobst	P. J. Doorly	A. G. Jensen	A. H. Muller	J. A. St. Clair
Marjorie Broderick	G. M. Eberhardt	A. T. Jensen	Alfred Muller	J. C. Steinberg
Mildred Brosnan	J. S. Elliott, Jr.	A. L. Johnsrud	P. B. Murphy	C. W. Stevens
May Brown	L. A. Elmer	F. C. Kahnt	Joseph Nedelka	G. R. Stilwell
F. W. Brunnengraber	H. J. Elwood	Alice Kavanagh	E. L. Norton	Adelaide Sweeney
J. H. Bullwinkel	H. W. Ericsson	B. J. Keating*	R. J. Nossaman	Cornelius Tanis
W. K. Burke	W. A. Evans	Helen Keiningham	Kathryn O'Connor	R. V. Terry
R. O. Burns, Jr.	Howard Fagan	E. J. Keiper	R. S. Ohl	Laura Tinelli
L. H. Campbell	W. J. Farmer	Vivian Kilpatrick	G. O. Pedersen	Michael Tompa
W. E. Cantwell	W. L. Filer	E. F. Kingsbury	C. E. Pierce*	C. C. Towne
J. S. Clark	Helen Fitzgerald	O. L. Kip	W. J. Pinckney	Louise Van Bergen
W. H. Clarkson	Mary Fitzsimmons	Rose Kirk	Isabel Polantino	Henry Walther
Walter Clarner	C. E. Flaig	H. T. Kohlhaas*	F. J. Prachnaik	M. L. Weber
Louise Coker	A. P. Goetze	H. J. Kostkos*	Molly Radtke	D. O. H. Weston
J. B. Connolly	Raymond Guenther	R. A. Leconte	J. R. Riker	John Whytock
E. G. Conover	Marion Haggerty	Wilfred Leemon	T. H. Roberts	V. C. Williams
Ada Corcoran	F. F. Harlin	V. E. Legg	C. F. P. Rose	M. L. Wilson
J. C. Crowley	H. C. Harrison	H. K. Leicht	W. J. Rutter	H. H. Young*
J. E. Crowley				L. G. Young

*Transferred from other chapters.

By devoting extraordinary effort and attention to calls associated with the war effort, Long Lines was able to put through important long distance messages with reasonable speed. But on a great volume of toll and long distance traffic, delays were not uncommon. Average speed of service on toll board calls during nine months of the year was 3.7 minutes, as compared with 2.3 minutes in 1942 and 1.6 minutes in 1941. The percentage of calls completed or on which definite reports were made while the calling party remained on the line was 81.8, as against 87.2 in 1942 and 91.6 in 1941.

E. C. Wegman
1885-1943

B. C. Bellows
1884-1943

Obituaries

Brian C. Bellows, Director of Toll Facilities, died on December 21. Mr. Bellows received his M.E. degree from Cornell in 1906; he immediately joined the A T & T where for six months he was in the student course and for a year and a half in a group engaged in service and force requirements. He later went to St. Louis for six months as division supervisor of the Long Lines, and then returned to continue his former duties. In 1909 he became Toll Line Engineer.

Three years later he joined the Western Union Telegraph Company as Toll Line Engineer and later became Traffic Engineer. In November, 1919, he returned to the Long Lines as Service Engineer. While in this position he assisted in the development of the dispatch-operating method designed to get the greatest number of telephone calls over congested facilities. He supervised the operation of this method in San Francisco during the Democratic National Convention in 1920. In October, 1920, he became Division Traffic Superintendent of the Long Lines in Chicago and three years later transferred to the Illinois Bell Telephone Company as General Supervisor of Toll Traffic.

Mr. Bellows, upon joining the Department of Development and Research of the A T & T in 1926 as Toll Systems Facilities Engineer, brought into the Department a wealth of practical traffic operating experience with all types of toll switching equipment. This knowledge and experience of the operating conditions prevailing in areas extending from small communities to large congested districts has been of exceptional value in the proper guidance and coordination of the development of toll facilities for the Bell System. When the D & R was merged with the Laboratories in 1934, Mr. Bellows became Toll Facilities Engineer in the Systems Development Department and, in 1935, Director of Toll Facilities. In this capacity he conducted fundamental studies relating to toll switching and signaling systems, and was responsible for formulation of requirements to guide the development work to which the studies led.

* * * * *

Ernest C. Wegman, a member of the Laboratories' Outside Plant Development organization at Point Breeze, died on December 25. Upon graduating from Cornell University with the degree of M.E., specializing in Electrical Engineering, Mr. Wegman joined the Bell System in 1910 at the Hawthorne Works of the Western Electric Company. He was first assigned to the student course where he remained for about six months, part of this time being spent in installation work in Chicago and Columbus. In January, 1911, he was transferred to the Engineering Department of the Western Electric Company at Hawthorne where, for several years, he was engaged in the development of phantom-type cable circuits suitable for loading.

Later, in what is now the Outside Plant Development Department, he was concerned with cable development problems, one of the most important of which was that of pulp insulation. In 1938 he transferred to the Laboratories' group at Point Breeze where he had since been engaged in the development of various types of carrier cables, including the coaxial cable.

Women of the Laboratories

SYLVIA LOEZERE is one of the few members of the Laboratories who have had first-hand experience with bombings. In 1937 when she was living with her family in the Balearic Islands, bombs were dropped like clockwork four times a day. Fortunately they were not the block busters of today.

Although Miss Loezere was born in Buffalo, she lived abroad for eleven years and was graduated from the University of Paris in 1936. During that summer she took a walking trip through France and Italy into Jugoslavia and Albania and came home to Paris by way of Hungary, Czechoslovakia and Germany. In the fall she moved to Spain with her family and was attending the University of Barcelona studying Spanish when the revolution broke out there.

The Dispatcher in the Graybar-Varick Messenger Service is Irene Runge, a June, 1943, Cathedral High School graduate. Besides receiving incoming telephone calls for messenger service and sending boys and girls to answer these requests, Irene also accepts mail for departmental delivery and does general clerical work. Her special recreation is dancing with a ballet group

Upon her return to this country she became representative for the French National Museums and for two years traveled across the United States, opening salons to which reproductions of the art and sculpture of France were brought. With the approach of war in America, Miss Loezere decided to do essential work and was employed in the

SYLVIA E. LOEZERE

calibrations department of an electrical concern before becoming a member of the Laboratories. Her work here as a T A has been to test crystal filters for broadband carrier systems and to assemble and test high-frequency networks for use in special radio equipment for the Armed Forces. Other duties have included calibrating and plotting impedance and transmission loss characteristics of networks.

Miss Loezere has been a Nurses' Aide at

Blanche R. Dooley

St. Vincent's Hospital for nearly two years. Her hobbies are sculpture and caring for her three fox terriers. She lives in a Village apartment with her sister.

* * * * *

Miss Dooley came to the Laboratories on a temporary job twenty-four years ago. Her talent for precise workmanship on delicate construction jobs soon involved her in the making of small thermocouples, and successively of switchboard lamps, ballast lamps, flashlight lamps, resistance lamps, neon lamps, and large incandescent lamps up to 1,000 watts in size. Having more than normal curiosity, she could not make models without testing them. As a result her work finally covered everything from formulating test procedure to summarizing the final results, and from making the samples to destroying them. Her special accomplishment is the measurement of light intensity by means of a photometer, a temperamental instrument which requires not only nice color and brightness discrimination, but the sagacity of Solomon and fortitude of Job. She even admits that she likes to do it and looks down her nose at amateurs who think the photometer is an instrument of indigestion.

Since the war started she has devoted her knowledge of test procedure to more urgent work on wire insulation and similar problems for the Armed Forces.

She and her husband, an engineer, live in the Chelsea section within walking distance of the Laboratories. At present there is only time for the milder kind of activities, so that golf and bowling have been pushed aside.

* * * * *

Growing up on a farm in West Virginia gave Mary Wisniewski a knowledge of machinery and tools that helped her to become a member of the Laboratories. When she applied at the Personnel Department there was an opening as a tool crib attendant, for a girl to whom the drills, clamps, cutters and vises in the Development Shop tool room would not be entirely unfamiliar. Now Mary helps to run the tool room; she fills requisitions for tools and for equipment for lathes, milling and other machines; she keeps records and dispenses small tools to the Shop members; she also takes a monthly inventory and sends out follow-ups on overdue parts which have been borrowed.

Mary Wisniewski

Mary, who is a graduate of Shinnston High School in West Virginia, lives in Astoria. Reading, roller-skating and visiting her married sisters in the metropolitan area are the things she enjoys doing after hours. She hopes to be able to return to see her parents this year and to spend her vacation doing essential chores on their farm.

ALVINA MAND

Alvina Mand Retires

"It has been a great experience to have been in the Department of Development and Research and then at the Bell Telephone Laboratories," according to ALVINA MAND who was retired from the Laboratories on January 31. "I have seen many student engineers from whom I took dictation progress to prominent positions in these Laboratories and in subsidiary companies of the American Telephone and Telegraph Company," she added.

Miss Mand became the eighth member of the Stenographic Force to join the old Engineering Department of the A T & T. That was on December 10, 1910, when that company had been down from Boston only three years. The stenographers were quartered in the penthouse of the Havemeyer Building, then at Church, Dey and Cortlandt Streets and a bridge connected their quarters to the former home of the New York Telephone Company on Dey Street where the A T & T executives were located. Theodore N. Vail was the president at that time.

"The earlier days found 'us girls' working on the transcontinental line. Every memorandum we wrote about it—and we worked nights and all day Saturdays and Sundays when that great project was under way—we felt that we were building that line!" Four girls worked on the Sunday of the rehearsal for that official transcontinental opening and the reward, plus food money, was a talk to San Francisco that very day. "Believe me that was a thrill! We had talked across the continent before the line was officially opened. We girls had a part in the construction of the teletypewriter, radio telephony, ship-to-shore telephone, television and in all the great projects of the Bell System.

"In the earlier days of my career there was very helpful experience in substituting in the executive offices of the A T & T Company, and especially for General Carty, in whose office I was later officially located. During World War I, for a period of six

Murray Hill doll display with Frances Galbavy (left) and Joan Greiner

NANCY F. O'KEEFFE

months, I was assigned as secretary to A. F. Adams, representing the Postmaster General in the management of the Postal Telegraph-Cable Company in New York. Mr. Adams was also executive head of the independent telephone companies operating in Missouri, Kansas, Illinois and Texas.

"July, 1934, brought me to the Laboratories—a fitting 'cap' for the closing years of my sojourn with the Bell System. Again to Transcription and to all secretaries I would say: 'When one's work seems mechanical, check up on yourself. Realize that you are a part of the construction of many great inventions.'"

Murray Hill Doll Committee

More than two hundred boys and girls in Summit, New Jersey, and vicinity received at Christmas a doll or a toy provided for them by the Doll Committee at Murray Hill. Under the chairmanship of MARIE WRIGHT, the young women there dressed one hundred and twenty-five dolls and purchased ninety toys with contributions made by the staff. The other members of the committee were: MARJORIE BACHELER, LOIS BURFORD, RUTH BOWERMAN, FRANCES GALBAVY, JOAN GREINER, ALICE HEITHMAR, BETTE HYDE, MARY ELIZABETH KING, SUE LUBY, RUTH MANDELL, JANE MELROY, ERNA MERSEBURGER, JANE OTTO, CARMEL RILLO, CHARLOTTE SCHANDOLPH and DOROTHY STORM.

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AFTER graduating from Plainfield High School, NANCY O'KEEFFE attended Drake Business College for a year and then joined the Laboratories in 1940. Last March she transferred to Murray Hill to follow the distribution of confidential specifications. The Book of the Month Club occupies most of Nancy's literary interest. Skating and dancing are her outstanding recreations.

Nancy has the unusual distinction of having triplet sisters, thirteen years old. One is blonde and two are brunette; and there is a tomboy, a manager, and a prima donna among them. Nancy also has a brother with the Marines and an older sister.

* * * * *

VIRGINIA ERDWURM is happier doing essential work in the Graybar-Varick building by day, and doing canteen work evenings,

C. Virginia Erdwurm takes an engineer's instructions

VIVIAN HOPPE

than she was as a photographer's model. A general service assistant, she helps to handle the many calls for local service made on her group during the day; she places and follows through on blueprint and photographic orders for the engineers from the twelfth through the fourteenth floors in Graybar; she sees that materials they need are shipped and received; and she also arranges for porter and telephone service for them. Occasionally she places orders with outside suppliers.

Jinny lives in West Hempstead and is a graduate of St. Joseph's Academy, Brentwood. Her free time is spent at one of the many canteens on Long Island, cheering up the soldiers, mending their clothes, writing letters for them, or dancing with them. For relaxation she plays selections from her collection of recordings—she is partial to Gershwin—and she corresponds with the lieutenant whose silver bar she wears.

* * * * *

VIVIAN HOPPE, the tiniest miss in the Development Shop, finds no difficulty in running a bench lathe at which her picture was taken. She is proud of her ability to do vital war work and has completed a fifteen-week course during business hours to help her to understand the assignments which she is given. Miss Hoppe's training in art at Washington Irving High School and at Pratt Institute have given to her hands skill and dexterity that are essential in the work which she does.

After hours her hobby is her Village apartment which she thoroughly enjoys. She also likes art work and the ballet. More recently she has been learning to play bridge.

News Notes

M. D. RIGTERINK and L. EGERTON visited Lenox Inc. in Trenton regarding the production of special ceramics.

M. D. RIGTERINK and G. GOODMAN were in Hawthorne to check on vitreous enamel resistor developments.

C. J. CHRISTOPHER, A. N. HOLDEN and A. C. WALKER conferred on crystal problems at Hawthorne.

W. G. STRAITIFF and W. MCMAHON visited the New Jersey Zinc Company plant in Palmerton, Pennsylvania. Mr. McMahon also attended a meeting of the Preservatives Committee of the American Wood Preservers Association and the award dinner tendered the Synthetic Rubber Industry.

R. M. BURNS gave a talk on *Mechanism of Corrosion Processes* before the Detroit district meeting of the American Society for Testing Materials.

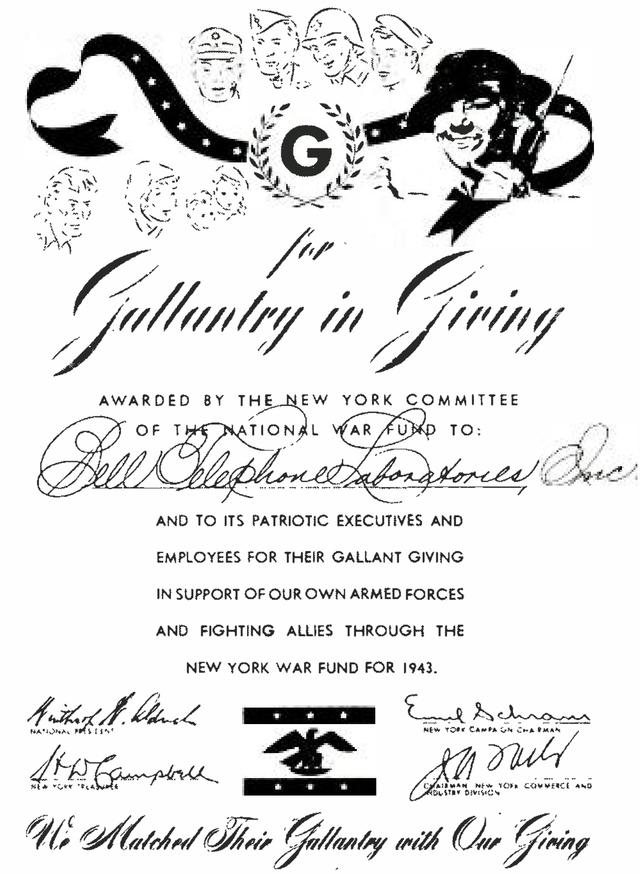
K. G. COMPTON, C. C. HIPKINS and C. H. SAMPLE visited the General Electric Company in Schenectady where they reviewed the subject of finishes and hydrogen ab-

Each General Service group sent cards similar to this to its members in the Armed Forces sorption by metals. Mr. Compton and Mr. Sample also visited the Naval Research Laboratory in Washington, at the invitation of Commander J. L. Reinartz, to discuss moisture and fungus proofing and the prevention of corrosion on Naval radio equipment. Returning home, they stopped at the Signal Corps Repair Depot in Philadelphia to examine Western Electric vehicular radio sets for finishes and corrosion protection.

G. N. VACCA and V. T. WALLDER attended a meeting of the WPB Technical Advisory Committee for wire and cable at the Hotel New Yorker.

J. H. HEISS, J. W. MULLEN and W. O. BAKER participated in a research conference on Government synthetic rubber at Akron, Ohio. Mr. Heiss and Mr. Mullen also visited the Naugatuck plant of the U. S. Rubber Company to confer on research developments carried out for the Office of the Rubber Director.

G. E. MOORE and H. W. ALLISON presented a paper, *Thermionic Effects of Thin Films of Alkaline Earth Oxides on Metals*, at the New York Meeting of the American Physical Society which was held at Columbia University.



"You and everyone in your company who participated in the National War Fund have thus earned the gratitude of those who will benefit from the contributions. In their behalf and for myself as Chairman of the Communication Division, let me express sincere thanks."—R. H. Hughes, Vice-President, New York Telephone Company

A. C. PETERSON has been made a member of Panel No. 1 on Spectrum Utilization, one of thirteen panels of the Radio Technical Planning Board. This board has been charged with important work for the furtherance of the radio industry and the advancement of the electronic art.

P. S. DARNELL spent two weeks at Hawthorne in connection with resistors.

Mr. Darnell is a member of the Task Group of the ASA War Committee on Radio which prepared the American War Standard for fixed composition resistors.

C. T. WYMAN was also at Hawthorne for three weeks testing special networks.

H. T. WILHELM studied problems on the manufacturing testing of carbon deposited resistors during his visit to Hawthorne.

W. J. THOMPSON conferred on transformers with Western Electric engineers at Hawthorne.

R. R. MACGREGOR made power transformer studies at the Magnetic Windings Company of Easton, Pennsylvania, from November 30 to December 3 and at the Line Material Company, Zanesville, Ohio, from December 5 to 10.

W. L. CASPER, N. INSLEY, A. W. ZIEGLER and R. M. C. GREENIDGE visited Schenectady to confer on crystals.

Scientific Research—an editorial by John Mills

RESEARCH, according to Webster's dictionary, means "critical and exhaustive investigation or experimentation, having for its aim the discovery of new facts and their correct interpretation."

Compare with this the concept of H. D. Arnold, who before his untimely death was a brilliant director of research. "Research," he said, "is not constructing and manipulating; it is not observing and accumulating data; it is not merely investigating or experimenting; it is not 'getting the facts'; although each of these activities may have an indispensable part to play in it. Research is the effort of the mind to comprehend relationships which no one has previously known. And in its finest exemplifications it is practical as well as theoretical; trending always toward worthwhile relationships; demanding common sense as well as uncommon ability."

To Arnold, investigating and experimenting, although indispensable, were not research. To him it was a mental attitude and a mental effort. Some of its finest examples have involved little investigating or experimenting – as, for example, Planck's work which led to his famous constant, and Einstein's illuminating conclusions as to photoelectric emission.

It is because research is misconceived as fact-finding experimentation that the term is so often misused. Two men side by side in a laboratory may be performing similar experiments, but one may be doing research while the other is engaged in engineering. Not all work which is called "research" is really research; on the other hand, sometimes work called "engineering" or "development" is research.

Although the true research worker is keenly aware of practical applications, his goal differs from that of engineer or inventor; and he resists premature diversion from his search for unknown relationships. "But rather seek ye," says the Gospel according to Luke, "the kingdom of God; and all these things shall be added unto you." The research man seeks first the extension of scientific knowledge, knowing well that unto it will be added invention, development and socially valuable applications.