Electron Metallography

R. D. HEIDENREICH

Chemical Physics

Until about 1940 the industrial metallurgist seeking to examine the structure of a metal was limited to the optical microscope and X-ray diffraction. Since then, and particularly in the last five years, his vision into metals has been greatly extended by two new techniques both of which employ electron beams instead of light waves.

To examine structure by means of light, the metallurgist produces a magnified image with an optical microscope. To determine the atomic arrangement he shoots X-rays into the material. Deflected by the atoms, the X-rays combine in phase in one direction and out of phase in another so as to form a diffraction pattern of light and shade on a photographic plate. Such patterns reveal the nature, size and arrangement of the atoms.

Above—The specialized skill needed to construct Murray Hill's latest electron diffraction equipment was supplied by C. Geith who is seen tightening a vacuum gasket.

The magnified image of a metal, supplemented by its diffraction pattern, provides a comprehensive picture of its structure. By using electrons, instead of light and X-rays, exactly the same kind of information is obtained but in much finer detail.

In the electron microscope, electrons are shot through the test specimen or a replica and thence through electric or magnetic fields which act like lenses to produce a magnified image like that of a light micro-

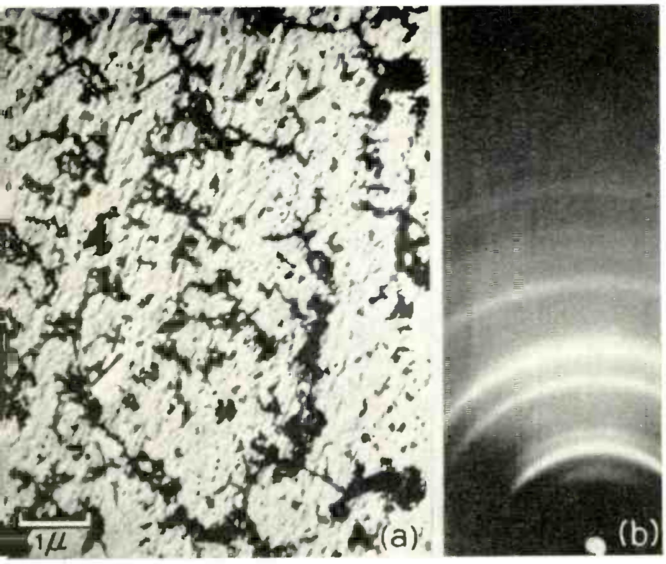
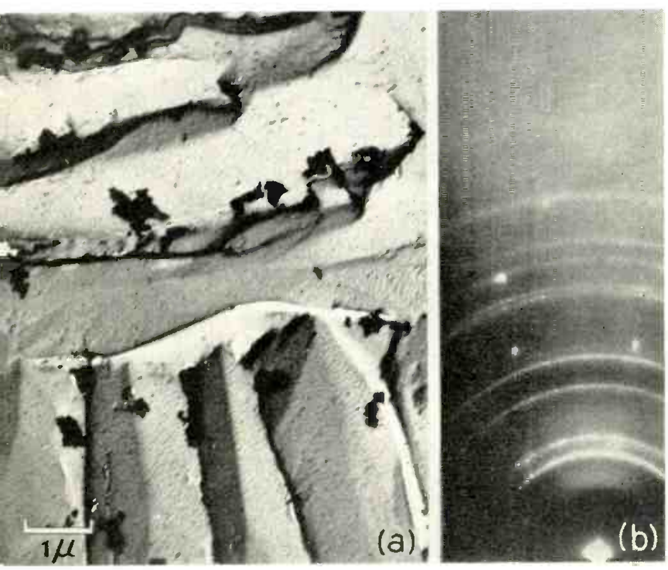


Fig. 1—(a) Electron micrograph of replica of lead-silver alloy quenched from 260 degrees C. Unusual feature is that silver particles, seen as black in micrograph, are actual silver grains which transferred from the specimen to the replica. Silica replica of lead appears behind. (b) Diffraction pattern shows small crystals characteristic of quench hardened lead-silver alloy.

Fig. 2—(a) Electron micrograph for slow-cooled alloy. (b) Diffraction pattern shows large particles characteristic of soft lead-silver alloy.



scope. In electron diffraction,* electrons are projected against the surface of the specimen at glancing angles. Scattered in a regular way the electrons form a multiplicity of beams to produce a diffraction pattern like its X-ray analogue.

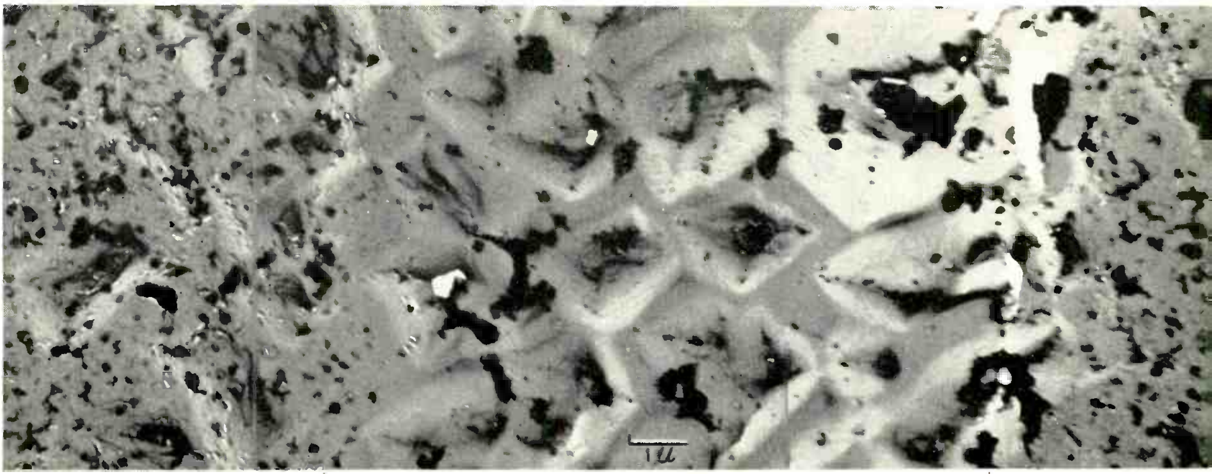
In both the microscope and diffraction techniques the minuteness of detail which can be detected depends on the resolving power; the shorter the wave length, the greater the resolving power. Behaving like waves of much shorter wave length than light, or even X-rays, electron radiation discloses fineness of detail well beyond the reach of the optical microscope or X-ray diffraction. Compared on the basis of routine laboratory instruments an electron microscope is 50 to 75 times more effective than its optical counterpart. It can separate two objects only 2×10^{-7} cm apart, a distance only ten times that between the atoms in silver. In other words, its *resolution* is said to be 20 angstroms; this unit is 10^{-8} cm and is abbreviated "A."

A further advantage which electron diffraction has over its X-ray counterpart is that the radiation does not penetrate as deeply into the material. Electrons projected at 50 kv penetrate only one-hundredth as deeply as X-rays of 2 to 3A, thus revealing minute amounts of matter and structural features which X-rays miss.

Electron metallography is used to observe those finely dispersed precipitates which certain alloys form on cooling and to which they owe such valuable properties as hardness. The minute slippage and fragmentation which occur in metal crystals during deformation may be detected, as well as the structural changes that follow plastic deformation and recovery in metals, and recrystallization upon heating.

The surfaces to be examined must be clean and free of tarnish as well as deformation due to mechanical polishing. The general scheme followed for metals and alloys consists in abrading the sample on No. O metallographic paper, electrolytically polishing and then etching in a reagent which is selective in its rate of attack. The desired end result is a surface in which precipitated

* Record, *March*, 1936, *page* 210.



GRAIN NO.1 | BOUNDARY REGION | GRAIN NO. 2

Fig. 3—Electron micrographs of lead-silver alloy that failed by intercrystalline fracture. Grains show hard structure of Fig. 1 while boundary region between them shows soft structure of Fig. 2.

phases are left standing in relief where they can scatter electrons incident at a glancing angle.

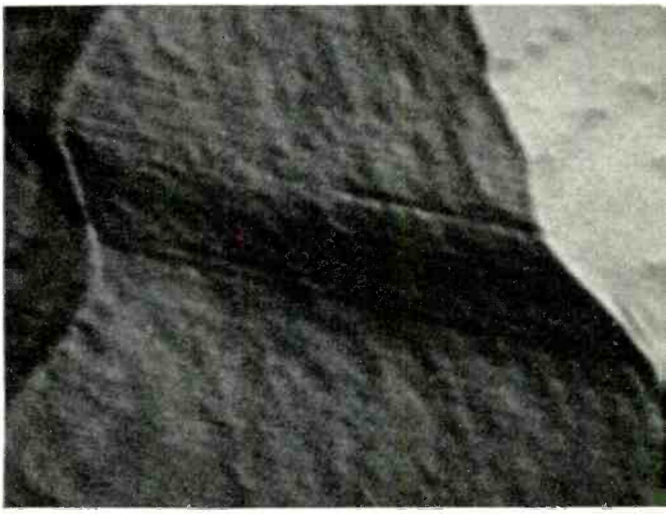
In this way a satisfactory diffraction pattern can be obtained for the precipitate alone. After this diffraction pattern has been obtained, a surface replica is prepared by one of a number of techniques; one is to deposit a thin film of silica on a polystyrene impression of the specimen, then dissolve the polystyrene in a solvent, leaving what amounts to a silica mold of the surface. The function of the replica is to reproduce the topography of the metal surface in a film thin enough to transmit electrons for electron microscopy.

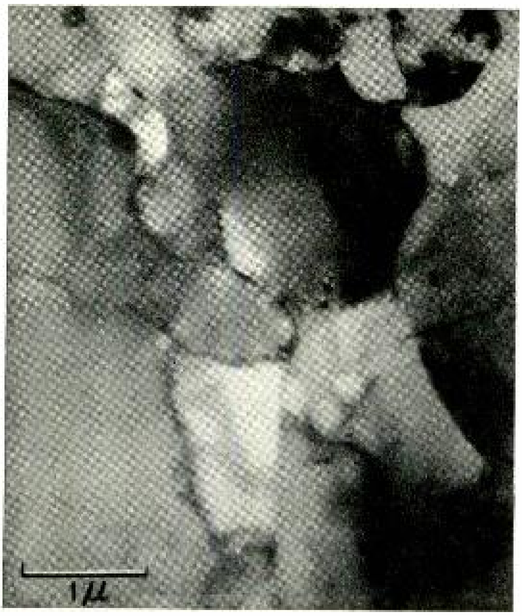
An example of how electron metallography yields results of practical interest is the dispersion of silver in a lead-silver alloy containing less than 0.02 per cent silver. Samples of quench-hardened alloy developed failure under strain. Optical microscopy revealed intercrystalline failure but did not disclose the cause of weakness in the boundary region which was thought to arise from variations in the dispersion of the silver.

The line of attack was a study of the particle size of the silver under different heat treatments. Alloy specimens were etched so as to dissolve the lead and leave the silver standing out in relief. The etched surface was then bombarded with electrons to obtain a diffraction pattern and a replica was made for viewing in an electron microscope.

Figures 1 and 2 show electron micrographs and diffraction patterns obtained for quenched and slow-cooled alloy specimens. The broad fuzzy lines of the pattern (Figure 1) for quenched alloy indicate the small polycrystalline aggregates of silver. In the micrograph the silver particles (which appear as black) are also small in size and gathered into groups. In contrast, the micrograph (Figure 2) for the slow-cooled specimen shows the background lead etched out

Fig. 4—Electron micrograph showing fine striations in a slip band crossing an etch pit in an aluminum crystal.





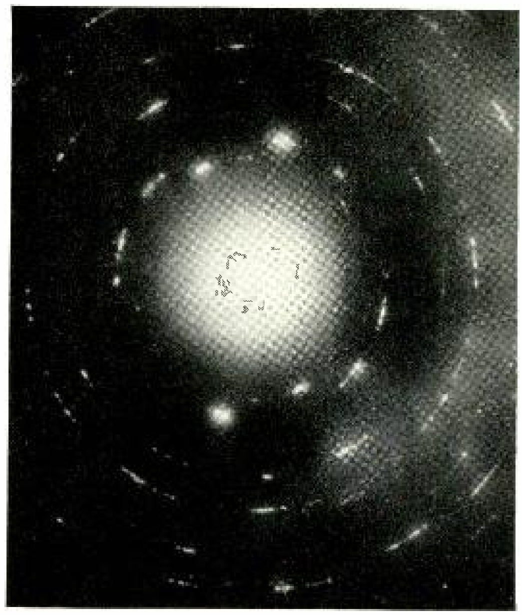


Fig. 5—Electron micrograph and diffraction pattern disclose break up of a crystal in cold worked pure aluminum. View covers about one-fiftieth of crystal which re-forms on heating.

in geometric form; the silver is in large and relatively widely spaced particles, a fact which is confirmed by the sharp, grainy lines of the diffraction pattern.

The results of Figures 1 and 2 now apply immediately to Figure 3 which shows an electron micrograph of a grain boundary in a lead-silver alloy subject to intercrystalline failure. Comparisons show that the grains themselves exhibit the hard-quenched structure of Figure 1, while the boundary region, seat of the failure, contains the slow-cooled, soft structure of Figure 2.

Metal crystals, it is known, deform by slipping along crystal planes. As near as can be told from light microscope images, a slip band is simply a step in the metal surface produced by a shift of adjacent portions of the crystal. Figure 4 illustrates the appearance of a slip band crossing an etch pit in an aluminum surface as an electron microscope sees it. The fine lines reveal that the band actually consists of a multiplicity of small bands. During deformation,

THE AUTHOR: R. D. HEIDENREICH, who hails from Cuyahoga Falls, Ohio, was graduated cum laude with a B.S. in chemical engineering at the Case School of Applied Science in 1938. Two years later he received an M.S. in physics and went to work at Dow Chemical, later applying the then novel electron microscope to metallurgical and chemical problems. Since joining the Laboratories in 1945, he has been engaged in electron diffraction and microscope research on the structure of metals and alloys and, more recently, on oxide cathodes. A member of the American Association for the Advancement of Science, a Fellow of the American Physical Society and author of nearly a score of papers in his field, Mr. Heidenreich is now president of the Electron Microscope Society of America.

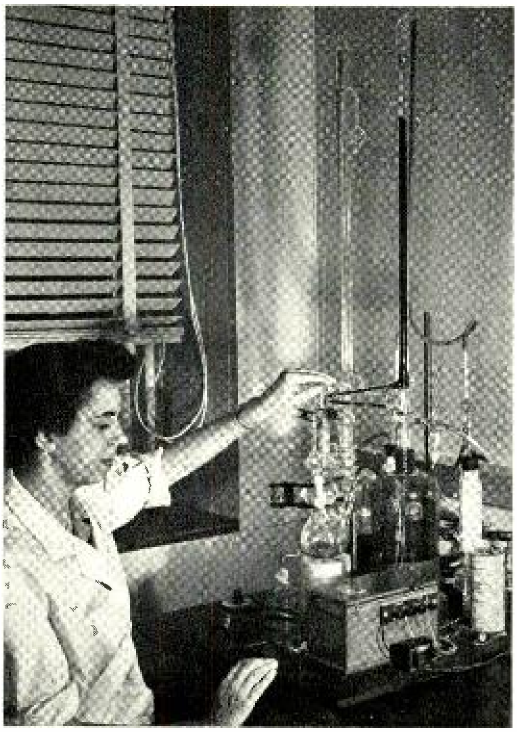
slippage occurs for about 2000 A on a given atomic plane then stops, to be repeated on another parallel plane about 200 A away and so on. Electron diffraction also shows that the slip lamina rotate as they shift, a feature as yet unexplained by theory.

When aluminum and certain other metals are deformed by cold working they harden, but partially recover to their original condition when released. The light microscope reveals no distinct structural changes during the process of recovery but X-ray diffraction discloses a sharpening of the lines indicative of structural change.

To explore these changes using electron metallography it was necessary first to work out a process for making sections of the metal thin enough for electron transmission. This was accomplished by an electrothinning method which did not introduce additional deformation.

The micrograph for a thinned section of cold worked aluminum is shown in Figure 5. Covering a small section (about 1/50) of the area of an aluminum crystal, it shows how the cold working broke up the original crystal into many small "recovery domains," each about two microns wide and disoriented with respect to each other. These observations are confirmed by the electron diffraction patterns which show discrete spots in the arced diffraction rings. If the recovered crystal is heated, a few of the recovery domains will grow absorbing their neighbors until recrystallization is complete.

Revealing in fine detail the effects of chemical composition, heat treatment and mechanical strain, electron metallography provides a powerful tool for the better understanding of metals, and their improvement for industrial uses.



Dry as a Bone?

Anything *merely* as dry as a bone could appear dripping wet to the new moisture tester Shirley Vincent is shown operating. For even a very dry bone contains several per cent moisture by weight, and this tester accurately measures as little as 10 parts in a million. W. E. Campbell developed it to test the efficiency of a new type of water barrier which is now used in the repeaters on the Key West-Havana telephone cable. It has also been used for determining the water content of transformer oils, piezoelectric crystals and molded nylon.

A "Packaged" Dial Office for Small Communities

L. A. O'BRIEN
Switching Systems Development

For many years the 355A step-by-step community dial office has been rendering effective telephone service. It was designed for communities having from 150 to 1500 lines, both limits being somewhat flexible, but the majority of the offices installed serve from 300 to 600 lines. There has been an increasing need, however, for greater extension of dial service to communities with fewer than 200 lines, and since in many of these smaller areas it is possible to employ simpler traffic and equipment features than those of the 355A, a new community dial office has been developed. Coded the 356A, it is of the "packaged" type, and has a normal range of from 60 to 200 lines but provides for expansion to 400 lines. Circuitwise it is essentially the same as the basic 355, but equipment arrangements have been developed which effectively decrease both its over-all cost and the time interval required between the request for new equipment and the start of telephone service.

Since the 355A office was designed for a wide range of subscriber services, many types of equipment units were necessary, and considerable time was required to select the proper ones for specific offices. Also, to fit the chosen features into an office, the equipment was standardized largely as shop-wired units, which are mounted on universal-type frames by the installer, who adds the wiring between units and the cabling between frames at the central office. For the larger offices, this procedure is economical, but in very small communities which are usually remote from a resident installing force, it is more desirable to reduce installation work and time to a minimum by making the equipment as near factory-assembled and wired as possible. With this in view, the 356A switching equipment for serving 100 lines shown in Figure 1, was mounted and wired on a single, double-sided frame. This "line" frame, together with a small distributing frame and a single-bay power plant, comprise all that is needed for the usual 100-line office. The installer's work is therefore greatly simplified and consists primarily of setting up the frame, mounting the cable racks, uncoiling the cables attached to the line frame, and running them to the distributing frame and power plant.

Standardized floor plans further facilitate engineering and permit the cabling to be cut to the proper dimension and attached at one end by the shop. Terminal strips are already connected to the line cable at the distributing-frame end, thus requiring only that the installer mount them and add the jumpers for the lines. This is followed by a routine test of the circuits preparatory for service.

Most of the subscribers served by these small offices are on party lines, and equipment is provided for 8-party semi-selective lines or 10-party lines with five codes on each side of the line. In the interest of economy, five initial packages (60, 100, 120, 160, and 200 lines) have been standardized for 8-party service and five for 10-party service. The same line frame is used for each of the above capacities, but different amounts of equipment are included. The 120-line office will consist of two frames equipped for 60 lines; the 160-line office will consist of one frame equipped for 100 lines and one for 60 lines; while the 200-line office will consist of two 100-line frames. When the growth of a community requires more than 200 lines, supplementary frames equipped for 60 or 100 lines are ordered as required. Since the initial 100-line bay includes certain apparatus such as common alarm relays and traffic registers which are sufficient for a maximum-size office, these items are omitted on all supplementary bays. For each size package, sufficient switches are included with the line frame to handle medium traffic loads.

The battery plant is the same for both types of service, but the ringing plant differs. Both the ringing and battery plants mount on a single-bay frame, but supplementary charging and battery bays are available for the larger offices.

The standardized floor plan covers all installations from 60 to 400 lines, as shown in Figure 2. A single-story building, approximately 12 feet wide by 14 feet long will take care of any installation up to 200 lines. As growth requires further expansion, the building may be lengthened to provide for a total of 400 lines. All frames are of a uniform height of 6 feet 10½ inches to permit them to be taken through standard 7′ doorways.

A front and rear view of the 100-line frame equipped for sixty 10-party lines is shown in Figures 1 and 3. On the front, the upper switch shelf is for the local selectors, and the lower switch shelf for the line finders. The two bays at the lower left are for line relays, while that at the lower right carries the alarm relays and the traffic registers. Above the switch shelves are the fuse and alarm panels. On the rear of the

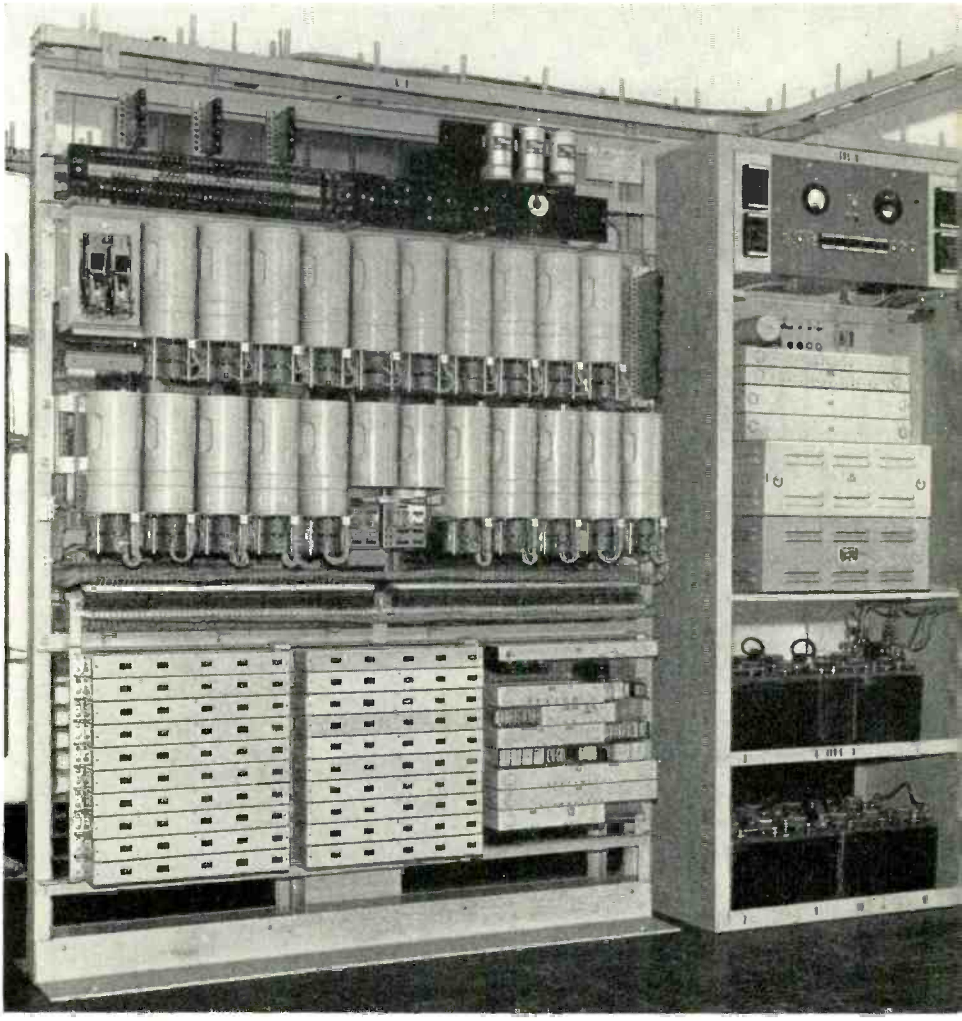


Fig. 1—Front view of the line frame for the 356A office.

frame, the local connectors occupy the top switch shelf, and the incoming selectors, together with certain test equipment, the lower shelf. Below these switch shelves are two gates for mounting relay units as required. The gates open to give access to the terminals of the gate equipments and to the line relays mounted on the front of the frame. On these gates, the factory mounts and connects enough coin-line and operator-office trunk units for medium traffic. The remaining space is available for other units, such as composite signaling sets, sometimes used with the operator-office trunks, or auxiliary long-line units. The relay rack bays indicated on the standard floor plan are required only for offices employing certain optional features, or for quantities of trunk units for which insufficient space is available on the gates.

To reduce the effort required in planning and ordering a small CDO, the Laboratories, in cooperation with the Western Electric Company, has devised a simplified "Order Blank" on a sectionalized basis. All the major equipment items required may be ordered from a single standard sheet, one of which is available for each initial size of office and type of ringing. These packages are adequate for medium traffic. For heavier traffic, the packaged quantities may be supplemented by additional switches and trunk units to be mounted by the installer. Ordering of these supplementary items, and other optional equipment, has also been simplified.

All local calls in a 356A office are completed by direct dialing without the aid of an operator. Calls to other offices, and toll calls, are placed by dialing O, which connects the calling subscriber to an operator in the "operator office"—a nearby attended office designated for the purpose. Operators in this office may complete calls directly to subscribers of the 356A office by dialing.

Should any of the CDO circuits fail to function, the alarm circuit operates and seizes one of the trunks to the operator office. When the operator "answers" and finds no one on the trunk, she recognizes

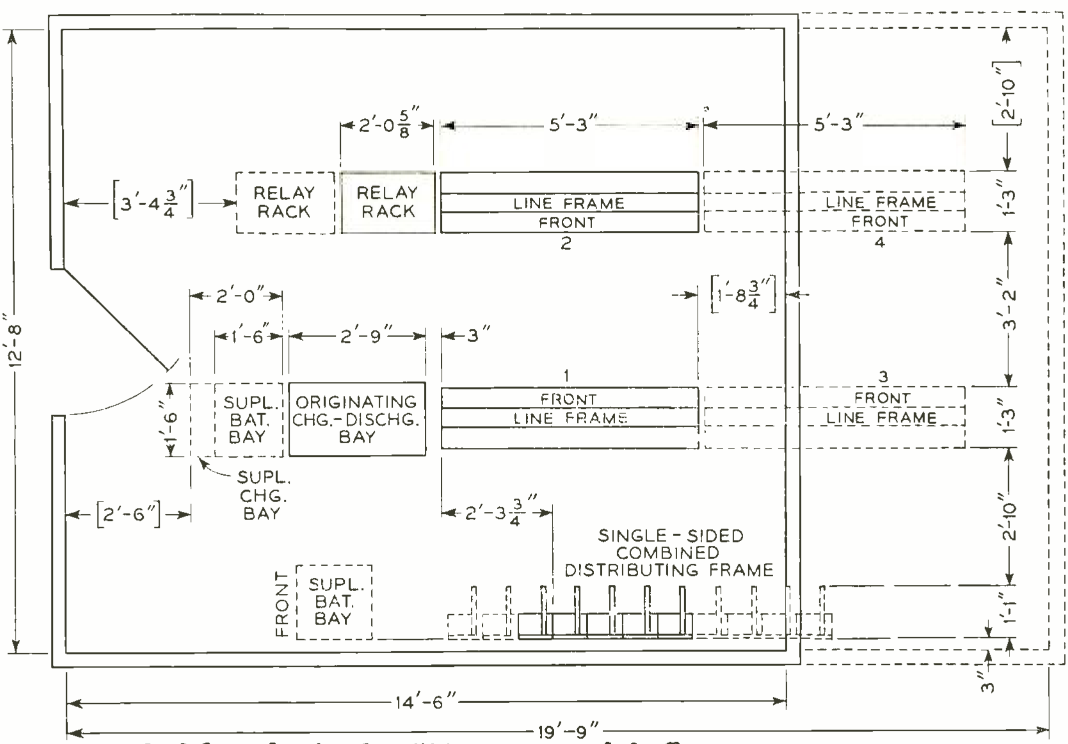
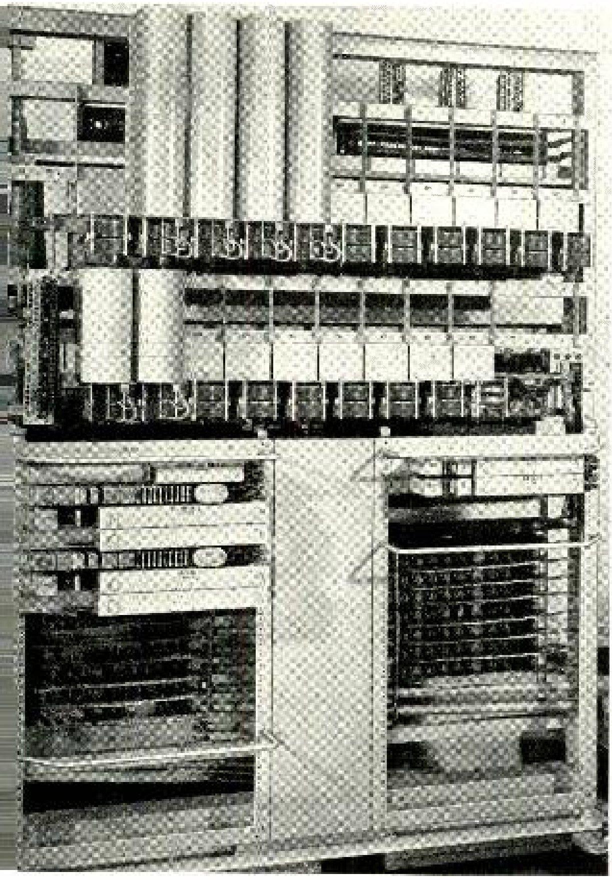


Fig. 2—Standard floor plan for the 356A community dial office.



this as an alarm. By dialing a line number at the CDO known as an "alarm checking terminal," she will hear signals which indicate the nature and importance of the trouble. This she reports to the maintenance man, who is normally located at the operator office and who visits the CDO either on a routine basis, or immediately when the need is urgent.

In addition to increased economy, the 356A CDO has achieved a new high in simplified engineering and "packaging" of a telephone office.

Fig. 3—Rear view of the line frame for the 356A office.

THE AUTHOR: L. A. O'Brien received the B.S. degree from Kansas State College in 1914, and then joined the Western Electric Company at Hawthorne. After taking the one-year student course at Hawthorne and New York, followed by three years of "job" engineering at Hawthorne, he spent five years with other companies, engaged principally in production engineering. During this period he received the E.E. degree from Kansas State. Returning to the Engineering Department of the Western Electric Company, now Bell Telephone Laboratories, he has since been engaged in equipment development work, except for five years devoted to war work starting in 1941. His assignments have included manual switchboards, telephone repeaters, telephoto equipments, telegraph carrier systems and repeaters, TWX switchboards and stations, and automatic switching tele-typewriter switching systems. His war developments included proximity fuzes and airborne radar. Since the war, he has been mostly engaged in the development of PBX, CDO and step-by-step central office equipments.

Screw Threads:

The Development of Standards

A. C. MILLARD
Switching Apparatus Development

Historically, the invention of the screw is ascribed to Archimedes. Very little of its early history is known; it appears that its ancient form was a crude affair made of wood and used principally in oil presses by the Mediterranean peoples.

Until the nineteenth century, the manufacture of screws was a crude process of forging and cutting by hand tools. Screws made by one firm did not match those cut by another; knowledge of the processes were trade secrets, and almost every establishment had its own standard set of tools. Each company seemed to have thought that its interest lay in the separation of practices in order to capture repairs, each of its own work. Interchangeability was unknown.

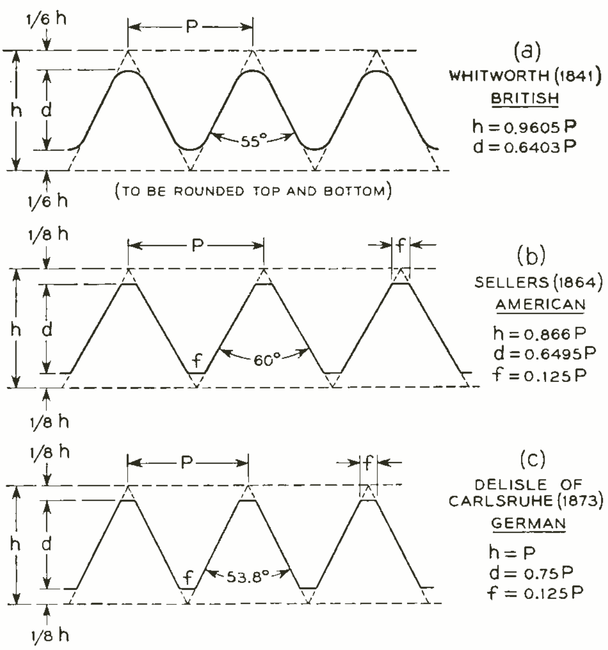


Fig. 1—Comparisons of the early standards for screw threads.

In 1836, as the result of the American invention of the cold heading process for screws of ¼-inch diameter and larger, hand tools gave way to machines. Instead of the blanks being forged by hand, the machine formed and cut the screw blank from wire. It was still necessary, however, to trim the heads and to cut the threads on the blanks. Small screws, except those used for clocks and watches, were still unheard of in the year 1836.

By 1846, automatic machines for the production of machine screws and wood screws came into use. Rolling threads onto the blanks was started, although widespread application of this method did not take place until after the turn of the century. But there was still no concrete pattern governing the production of screws. Some were made to metric dimensions; others to inch dimensions. In addition all of the sizes manufactured were made according to the individual ideas of the producer.

The first attempt at securing uniformity in the industry is recorded in a paper on screw thread standards by Sir Joseph Whitworth, presented before the Institution of Civil Engineers in 1841. He developed a system of diameter-pitch combinations that later became known as the Whitworth Thread. Over a period of about twenty years, the Whitworth System generally displaced the previous heterogeneous designs of threads that had made repairs both inconvenient and costly.

The Whitworth Thread, shown in Figure 1(a), has an angle of 55 degrees with rounded crests and roots. Although its adoption was a step in the right direction, the system was not complete, in that gaps appeared in the listing of diameters.

In the United States, William Sellers, in a paper presented at the Franklin Institute on April 21, 1864, laid the foundation for what was to become, in later years, the American Screw Thread System. This system uses a 60 degree angle thread and was fairly complete as to the diameter-pitch combinations. The Sellers Standard was recommended as standard for the United States Navy in 1868. Figure 1(b) illustrates the Sellers Thread.

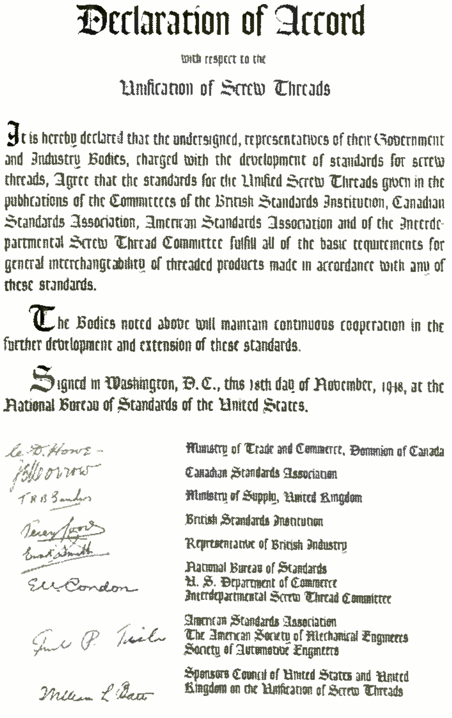
While America and Great Britain had made some progress toward standardization, both systems were based upon the inch as the unit of length. On the continent of Europe where the meter was the unit of length, the first steps toward standardization were taken by Delisle of Carlsruhe, Germany, who in 1873, proposed the system based upon a 53.8-degree thread angle as shown in Figure 1(c). This system became standard on the continent, and under the impetus of the Society of German Engineers, the International Screw Thread Congress was established.

As developments of mechanical devices and mechanisms gained momentum, demands arose for diameter-pitch combinations not included in the existing standards; this was especially true for sizes smaller than ¼-inch and for finer pitches. The American Society of Mechanical Engineers made some progress in this direction by setting up a committee to study the problem, and a report was issued in 1905. Similarly the Society of Automotive Engineers issued a report for the automotive industry in 1911.

Need for a means of determining whether the finished product met the specified dimensions led to the development of gaging procedures for threaded products. For example, during World War I, it was found that screws made in one part of the country would not mate with nuts or tapped holes made in another part of the country. Differences in threaded parts created difficulties in repairs made under battle conditions. These experiences during World War I led to the formation, by the United States Congress, of a National Screw Thread Commission in 1918. The work of this commission was reported in a series of standards beginning in 1921, with the latest edition being dated 1944.

In 1920 the American Engineering Standards Committee was formed to work on a screw thread standard. This committee was later succeeded by the American Standards Association, who formed a sectional committee on screw threads known as Sectional Committee B-1. This committee worked with the National Screw Thread Commission in developing a National Screw Thread

Fig. 2—Declaration of Accord with respect to the unification of screw threads.



Declaration of Accord

with respect to the

Unification of Screw Threads

It is hereby declared that the undersigned, representatives of their Government and Industry Bodies, charged with the development of standards for screw threads, Agree that the standards for the Unified Screw Threads given in the publications of the Committees of the British Standards Institution, Canadian Standards Association, American Standards Association and of the Interdepartmental Screw Thread Committee fulfill all of the basic requirements for general interchangeability of threaded products made in accordance with any of these standards.

The Bodies noted above will maintain continuous cooperation in the further development and extension of these standards.

Signed in Washington, D. C., this 18th day of November, 1948, at the National Bureau of Standards of the United States.

Ministry of Trade and Commerce, Dominion of Canada
Canadian Standards Association
Ministry of Supply, United Kingdom
British Standards Institution
Representative of British Industry
National Bureau of Standards
U. S. Department of Commerce
Interdepartmental Screw Thread Committee
American Standards Association
The American Society of Mechanical Engineers
Society of Automotive Engineers
Sponsors Council of United States and United Kingdom on the Unification of Screw Threads

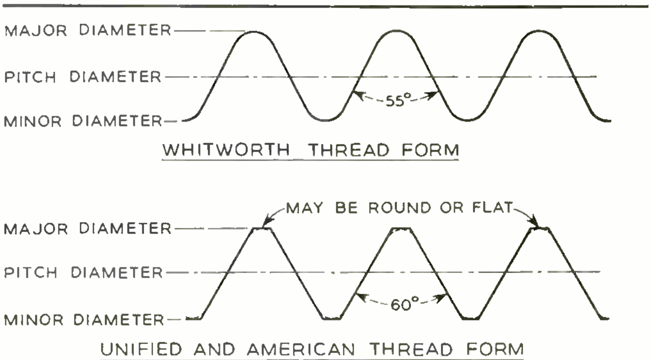


Fig. 3—Comparing the English Whitworth Thread and the Unified and American Thread form.

Standard—the one that the Bell Laboratories and the Western Electric Company adopted in the early 1930's.

The gradual development from the primitive to the machine made stage had, for a primary objective, standardization that would provide interchangeability of parts. Basic sizes and pitches became firmly established. Tolerances on pitch diameter and major diameter on the screw, and on pitch and minor diameters of the nut, or tapped hole, were uniformly accepted by American Industry and led to the term "class of fit" commonly heard during discussions of threaded products.

Four classes of fit were established by the Standard. Class 1 Fit is the loosest fit with no possibility of interference between the screw and tapped hole even with a screw made to maximum dimensions and a nut or tapped hole made to minimum dimensions. Class 2 Fit represents a medium or "free" fit, and is the one usually specified in Bell System apparatus. Dimensions in this case are such that a slight interference is possible under the worst conditions, i.e., maximum size screw and minimum nut. Class 3 Fit specifies closer tolerances on the mating parts, and may result in interference to the same extent as that of the Class 2 Fit. Maximum snugness is attained with the Class 4 Fit, but this requires selection of parts because of the likelihood of interference.

Thus, after many years, interchangeability had been achieved in this country. World War II, however, again emphasized the necessity of a common set of standards

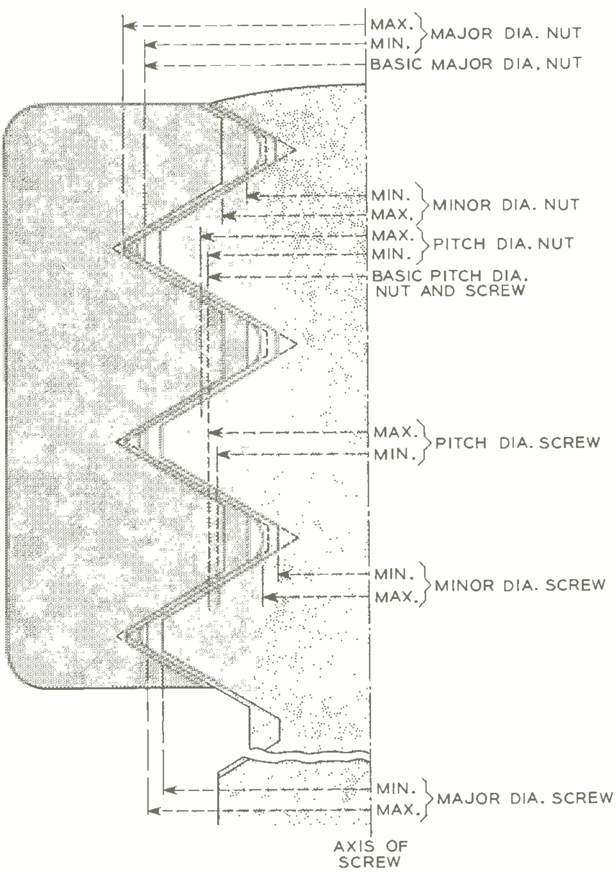


Fig. 4—Class 2 screw and Class 2 nut dimensions with tolerances.

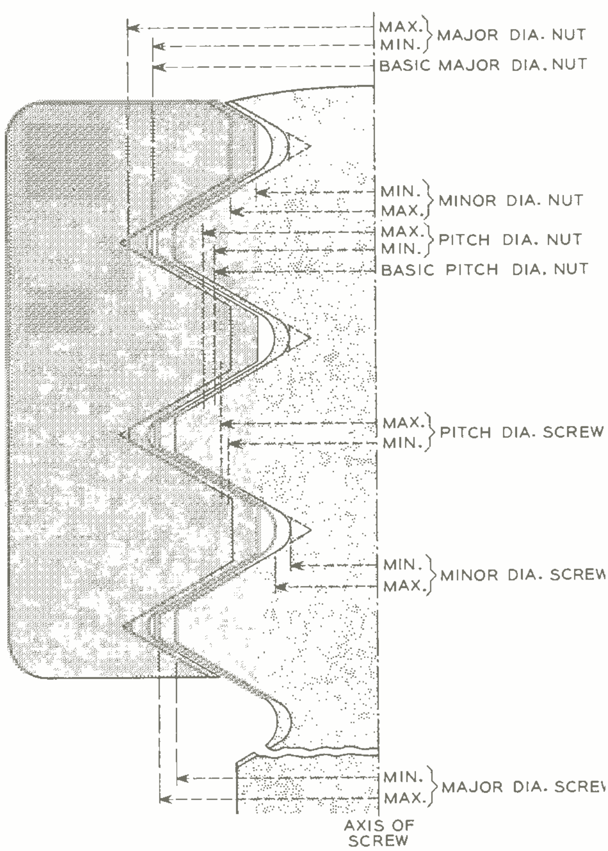


Fig. 5—Class 2A screw and class 2B nut dimensions with tolerances.

for screw threads among the English speaking countries. Under the impetus of the War Production Board, ASA Sectional Committee B-1 met on several occasions with representatives of the United States, Great Britain and Canada to try to work out a common standard. Success crowned their efforts, and the Declaration of Accord shown in Figure 2 was signed in November, 1948, setting up a new series of dimensions to be used by the three countries involved.

Figure 3 shows the comparison between older English Whitworth thread form of Figure 1 and the Unified and American Thread Form. In the unified thread form the American thread angle of 60 degrees is retained, but the crest and root of the thread may be either flat or rounded.

The new ASA standard B-1.1 1949 entitled *Unified and American Screw Threads*, contains a new series of fits. It had long been recognized that the possibility of interference between screw and tapped hole in the Class 2 fit made this fit not fully satisfactory where high speed assembly processes are used in mass production. Under the new standard, therefore, positive clearance is provided.

The new class of fit is known as 2A for the screw and 2B for the tapped hole or nut. The difference in dimensions between the old and new fits is so slight as to make no appreciable loss in the strength of fastening. The old Class 2 screw will work with a 2B tapped hole, and the 2A screw will work with a Class 1 or Class 2 tapped hole. Illustrations of these fits are shown in Figures 4 and 5.

When considering plated screws, those smaller than ¼ inch, frequently identified by numbers rather than by dimensions, an additional allowance, beyond those indicated in Figures 4 and 5, is needed for plating. The allowances indicated in the figures are provided for ease of assembly, but for larger screws, it also provides space for the plating; however, if the allowance provided by the 2A screw in the sizes above ¼ inch is absorbed by a plating deposit, the advantages obtained by the use of the 2A screw will be lost.

Although much attention has been given in the past to uniformity of thread sizes, very little thought was directed to the strength of the finished screw. Generally speaking, screws were made from a grade of iron that could be worked with the machines and techniques existing at the time and place of manufacture. Screws were also made from brass, and for special applications, copper or nonmagnetic alloys were used. Selection of the proper screw for a specified use was frequently pure guess work. It was usually taken for granted that a screw was made of a material that was strong enough for the purpose, and the margins of safety were so great that machine designs using screws seldom failed.

THE AUTHOR: A. C. MILLARD came to the Laboratories in 1917 where he was assigned to work on carbon transmitters and sound locating devices for use by the armed forces in World War I. Following this, he became concerned with the development of the first sound motion picture apparatus, and in 1926, transferred to the newly formed Vitaphone Corporation. When this company was absorbed by Electrical Research Products, Inc., in 1927, he engaged in installation work, and later became an area service supervisor. Returning to the Laboratories in 1936, he has since worked on mechanical fastening devices; during World War II, he acted in an advisory capacity on fastening devices of all types required on equipment for the armed forces. He has served on American Standards Association Committee B-1 on Screw Threads and on Committee B-18 on Bolts and Nuts; he is currently serving as assistant secretary of ASA Committee B-1. Mr. Millard is the author of several papers on strength of fastenings and self-tapping screws that have been published in *Mechanical Engineering*.

Present-day trends in design are in the direction of greater and greater economies in manufacture, together with smaller and more compact designs. Margins of safety begin to vanish to the point where the strength of the lowly screw becomes of considerable importance.

In the early stages of telephone development, certain sizes of screws were standardized for particular applications. It soon became apparent that, under some conditions of use, stronger screws were necessary. For example, the screws used for mounting springs and insulators to relay structures are subject to great tensile stresses during periods of high humidity, and if the screws stretch, loose spring pileups result when normal humidity returns. Western Electric high tensile screws, made from steel wire

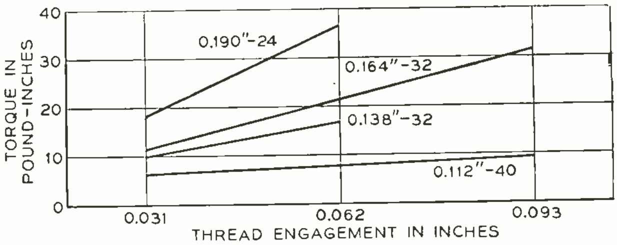


Fig. 6—Safe working torque for steel screws in steel.

that has been cold worked to bring its tensile strength up to a minimum of 100,000 pounds per square inch was an answer to this problem. However, wire with a tensile strength of 100,000 pounds per square inch is difficult to cold head, especially in the larger sizes. Careful inspection is required to avoid using screws that are weakened by cracks or folds occurring in the heads.

World War II provided an impetus for investigations of strength of screws under shock conditions. Much work was done to determine the strength of fastening of steel screws in various materials and of brass screws in brass. It was necessary to know how much load a screw of a given size would carry in shear, how many threads in a tapped hole were needed for a given load, and the effect of impact and shock on the screw.

These studies have been continued since World War II. One of the problems considered is the replacement of the present high tensile strength screw where the latter fails or is deemed inadequate. Development work resulted in a screw made from a medium carbon steel that, in its normal state, is equal to, or stronger than an ordinary steel screw, but when heat treated after fabrication, is about twice as strong as the present high tensile screw. Besides, medium carbon steel is easier to work mechanically and creates less wear on the heading and rolling dies.

All phases of the use of the new screw have been studied. Measurements of the strength of the new screw were made in torque, tensile, impact tensile, impact shear, and shear strengths.

Strength of a screw fastening, however, is not completely controlled by the tensile

(Continued on page 117)

Early Uses of Metal Screws

The chief use for metal in the earlier centuries of our era was to make weapons and armor, and it is in armor that we have preserved our oldest samples of pieces threaded to hold them together. Most of the pieces of plate mail were fastened to leather or riveted together; but to complete the assembly of some coats of mail after they were put on, an external and internal threaded piece was sometimes used at least as far back as the thirteenth century.

The production of some of these threaded parts must have been a slow and expensive hand operation as we have no definite record of any helpful mechanical equipment until 1564 when history states the first screw-cutting lathe was in use. It was as late as 1740 before we heard of a geared screw-cutting lathe and the slide rest did not come into use until 1800. It is practically certain that before 1800 most of the taps and dies used must have been made entirely without the aid of machinery. In the Museum of the Peaceful Arts, in New York City, is a set of taps and a jamb plate made in Wrentham, Mass., during Revolutionary days. These probably represent the average practice at that time.

From "Screw Threads, Taps, and Dies," by John E. Winter, Winter Brothers Company, Rochester, Michigan.

The Key West-Havana Cable: Transmission Aspects

O. B. JACOBS
Transmisson Development

In designing the new Key West-Havana submarine cable system, electrical as well as mechanical problems were greatly simplified by the use of separate cables for the two directions of transmission. This arrangement avoids severe restrictions on impedance balance and modulation performance at the inaccessible ocean-bottom repeaters; besides, development of the repeater circuit and design of the container were made less difficult by the smaller number of parts that were required by a one-way amplifier.

Conductors and insulation of the new cables, which are of the coaxial type, are the result of considerable experience in manufacturing processes, laboratory tests and deep-sea tests. Design of the cable structure was based on its suitability for systems of a broad range of cable lengths; the final product is about the smallest that can be laid satisfactorily at ocean depths. The diameter of the central conductor was made slightly larger than would result in minimum attenuation, in order to reduce the voltage drop in the direct-current supply to repeaters in a long system, but the slight increase in attenuation did not warrant a departure from a structure that had been thoroughly tested.

While the transmission circuit is the same throughout the submarine and land sections, the outer protecting layers of the cable differ* according to the depth of the water and also in the underground portions. For the latter, the outer conductor is enclosed in two overlapping steel tapes to provide additional shielding from extraneous interference, and a lead sheath replaces the armor wires. Over the sheath there are wrappings of impregnated paper and cloth to provide corrosion protection and to minimize stray currents in the sheath as a further means of reducing extraneous noise.

Figure 1 shows schematically the layout of the system. At 108 kc, which is the upper edge of the frequency band employed, the attenuation of the cables is about 213 db for No. 5 (transmitting from Key West to Havana) and 233 db for No. 6 (Havana to Key West), the difference being due to the greater length of the latter. Each of the three sea-bottom repeaters in each cable has a gain versus frequency characteristic closely matching the loss of nearly 36 nautical miles of cable, over the range from 12 kc to about 120 kc. However, feedback begins to decrease rapidly at about 108 kc (even though the gain continues to rise) thus limiting the number of high grade channels to the 12-kc to 108-kc range. Two additional channels below 12 kc and three above 108 kc could be derived, but greater interference due to modulation and thermal noise would make them less satisfactory.

Repeaters in these cables are three-stage, one-way amplifiers, having about 40-db feedback over the range from 12 to 108 kc, making it possible to transmit 24 wideband channels with adequate stability of gain and reduction of modulation products. For satisfactory modulation performance, the maximum operating level at 108 kc at the output of any repeater, should be at least 5 db lower than at the switchboard of the sending end of the circuit. For a system of this length having three low-level input points (i.e., at the inputs of the three repeaters), thermal noise limits the input level for any channel to a minimum of the order of —70 db. Accordingly, the repeater circuit was designed to provide a gain of about 65 db at 108 kc.

In contrast to the submarine repeaters, the amplifiers at the terminals do not need to use tubes having the very long life of those in the repeaters because these tubes can readily be checked and replaced. Designing the

* Record, *August*, 1951, *page* 366.

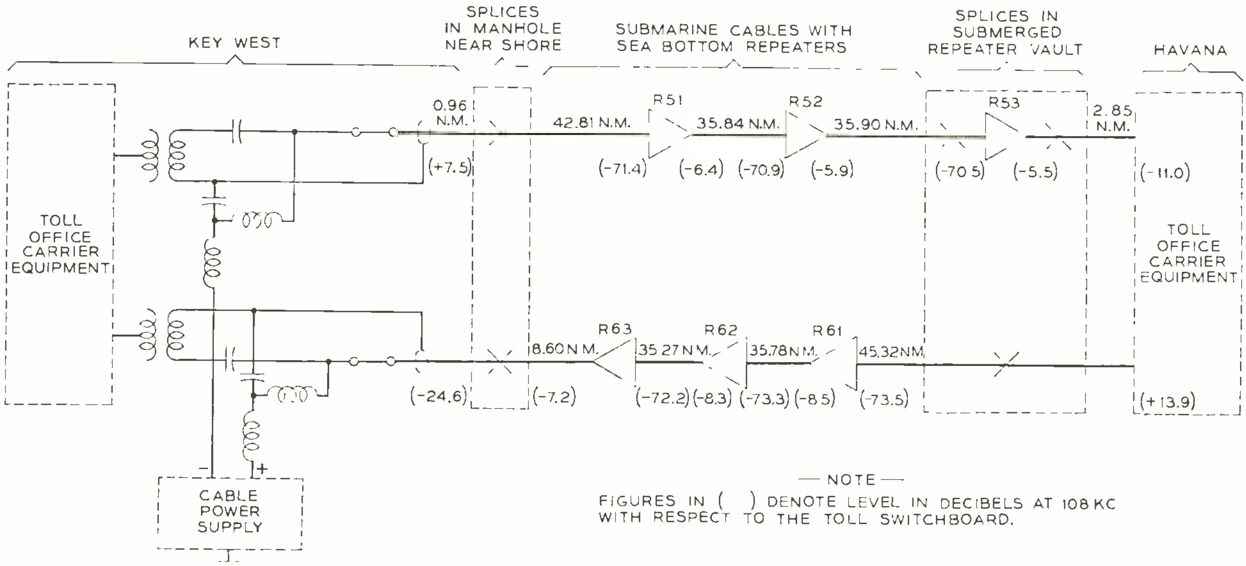


Fig. 1—Schematic of the new Key West-Havana cable system.

terminal transmitting amplifiers to provide a much higher output level permitted the first repeater to be placed much farther from the transmitting point than a normal repeater spacing. In turn, this made it possible to locate the last one so as to provide relatively high signal strengths in the shallow water and underground sections near the far terminals where static and other interference is relatively high. The last repeater transmitting toward Havana is located in a vault at the shore, since the shallow water section is short and a repeater location before reaching that area would be on a steep slope, with some hazard of storm damage.

For optimum system transmission performance, the signal level for each of the 24 channels should be the same at the grid of each submarine repeater output tube. To accomplish this, the substantially flat output of the transmitting amplifier is shaped by an equalizer before the signals enter the cable. The difference in lengths of the transmitting ends of the two cables requires that the shaping differ accordingly. Similarly, the different receiving end sections require different equalizers to compensate for the shaping in the output circuit of the submarine repeater and the attenuation characteristic of the length of cable concerned. In Figure 1, the levels at various points in the system are shown for the upper edge of the message circuit band. The transmitting amplifiers are operated at a level such that they will overload before the submarine repeaters and protect the latter from possible damage.

The repeaters are energized by a direct current of 230 milliamperes supplied over the central conductor of the cables from regulated supplies at Key West, one for each cable. Each electron tube consumes about 4 watts. Eventually the activity of the tubes is expected to decrease, with resulting increase in modulation, at which time satisfactory performance can be restored for a further period by increasing the energizing current to an allowable extent of about 10 per cent. Under that condition each tube would consume roughly 5 watts. With further deterioration, the transmitted signal levels may be adjusted to a lower value to reduce modulation at the expense of increased thermal noise. Half of the channels have an initial margin of about 10 db beyond the noise objective and therefore would continue to be entirely satisfactory. Others then would be equipped with compandors* when noise increased enough to warrant their use. It is expected

* Record, *December*, 1934, *page* 98.

that many years will elapse before the full extent of such changes will be needed.

As described in a previous article*, routine measurements at frequencies above the topmost channel enable the condition of each repeater to be determined periodically. Thus, if any repeater should give signs of becoming seriously impaired, arrangements probably could be made to replace it with minimum interruption of service and less expense than otherwise might be incurred if complete failure were the first indication of trouble.

At both terminal offices all of the 24 channels are brought to voice frequencies by means of standard carrier channel banks associated with specially designed group equipment. Channels for circuits terminated in the local toll switchboards employ four-wire terminating sets and signaling equipment, while others connect directly to circuits to distant points.

Transmission tests of the new system show that the design objectives were realized fully and that no appreciable deterioration has occurred during the first year of service. All 24 circuits are as satisfactory in every respect as those obtained from high-grade land line systems of equal length.

* RECORD, *January*, 1952, *page* 20.

THE AUTHOR: O. B. JACOBS graduated from Worcester Polytechnic Institute in 1910 with a B.S. in E.E. degree and at once joined the A T & T. In 1917 he entered the armed forces during World War I, and was a captain in the Signal Corps at the close of the war. Returning to A T & T Long Lines, he became Transmission Engineer of an area comprising the Northeastern States. Later, he transferred to the O & E where at various times he was in charge of groups working on toll transmission, toll cables, repeaters, loading, and electrolysis. In 1929 he joined the Technical Staff of the Laboratories and engaged in submarine cable development. During World War II he carried on liaison work between the Laboratories and the Signal Corps of the U. S. Army. Following the war, he returned to submarine cable work, where he had supervision of the manufacture, assembly and testing of the electrical features of the submarine repeaters for the Key West-Havana system, the design of the cables for underground use between the landing and terminal offices, and the establishment of requirements for regulation of the power supplied to the repeaters.

(Continued from page 114)

strength of the screw alone. To achieve the expected fastening strength, a screw and nut or tapped hole combination should be tightened to the proper torque, but not tightened too much, or the screw may twist off. This then, required additional study to determine the failure torques in various thicknesses of a material from a thin section up to sufficient thickness to twist off the screw. From many measurements, a table of safe tightening torques has been prepared and incorporated in Western Electric Standards. Figure 6 illustrates a typical chart of these safe tightening torques.

To insure the necessary strength in high tensile screws used in the Bell System, the drawings for these screws will call for the use of a medium carbon steel, heat treated after fabrication to give a definite tensile strength.

Ultimately it is hoped to have a master specification covering the strength of machine screws and associated tapped holes used in Bell System apparatus. After determining the strength required in his specific application, the designer can then more readily select the proper size screw and the number of threads.

Power Plants for the TD-2 Radio Relay System

R. R. GAY
Systems Engineering Department

For the experimental radio relay system, known as TDX*, put in service between New York and Boston in November, 1947, no batteries were used in the power supplies for the vacuum tubes. Regulated ac was used for the tube heaters, and each broadband channel had a set of rectifiers to supply the five plate voltages required. An engine-driven alternator was installed in each repeater station to carry the load during power outages, and a rotary converter operating from a 130-volt battery automatically took over the load for brief outages or while the engine-driven set was being started. With this arrangement, the only service interruption in case of power failure would be a duration of about two seconds while the converter was being brought up to speed.

Although these power plants have given satisfactory service, it was felt that for the main backbone routes for which the TD-2 system† was developed, the possibility of interruptions due to power failures should be further minimized. This could be made possible by floating batteries on all the power supplies. Subsequent to the design of the TDX system, simplified radio equipment was developed which required only two plate voltages of moderate value, thus making the use of floating batteries economically practicable. The two voltages employed are 130 and 250. A 63-cell battery is used with the 130-volt supply, and a 56-cell battery in series with the 63-cell battery is used for the 250-volt supply. These two plate supplies and a 12-volt supply for the heaters have been coded the 425-A power plant. As initially installed in an auxiliary repeater station, this power plant will handle 8 one-way channels, but when fully equipped will handle 12 one-way channels, which is the full capacity of the radio system. A small capacity 24-volt supply is also

* Record, *December*, 1947, *page* 437.

† Record, *October*, 1950, *page* 442.

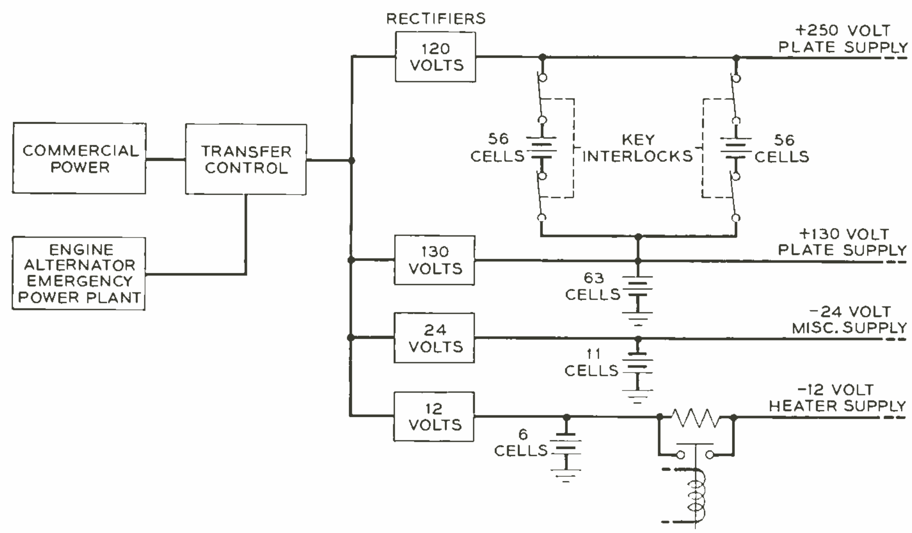


Fig. 1—Block schematic of the dc power supply for a TD-2 radio relay station.

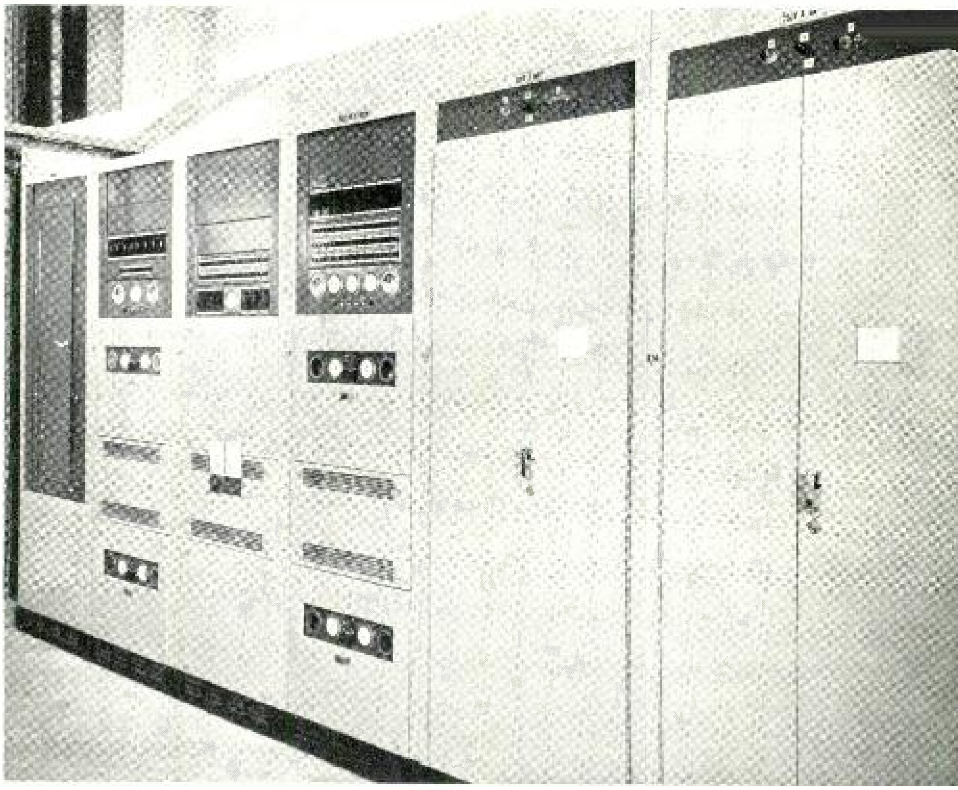


Fig. 2—Plate power supply for a TD-2 station. Left to right: ac distribution equipment; 130-volt rectifiers; 250-volt rectifiers; and 250-volt batteries.

furnished for power plant control and for alarm and order-wire equipment.

A block diagram for the d-c power supply, Figure 1, shows the inherent simplicity of the plant. An important characteristic is the absence of any direct switching in the load leads except for discharge lead resistances in the 12-volt filament leads, which are short-circuited during power failures. There is thus no interruption in the various supplies during power outages. The floated storage batteries simply carry the load during power failures until such time as the reserve engine alternator is started or until commercial power is restored. Upon restoration of the a-c, the rectifiers automatically operate under full load until the batteries have been brought back to normal voltage limits.

The sixty-three and fifty-six cell storage batteries for the plate supplies are each floated by full-wave rectifiers employing thyratron tubes with the output regulated by adjusting the phase relationship between the grid and plate voltages. Each rectifier is capable of supplying a continuous load of 8 amperes, and one more than the number of rectifiers needed to carry the load is always furnished so that a spare rectifier at each voltage will always be available.

All of the equipment for the plate supplies, except the 130-volt battery, is mounted in the line of cabinets shown in Figure 2. The large capacity 130-volt battery is mounted on a standard open type battery rack facing the cabinets, but is not shown in the photograph. The first cabinet at the left of Figure 2 contains the ac distribution equipment, while the next two cabinets are for the 130 volt rectifiers and the charge and discharge equipment. Two rectifiers are installed in the first of these cabinets with space available in the other cabinet for two additional rectifiers. In the fourth cabinet in the lineup are the two rectifiers and the charge and discharge equipment for the 250 volt supply. The two cabinets on the right house the two strings of 56 cell batteries for the 250 volt supply. Each of these latter cabinets is key interlocked to protect the maintenance personnel. Only one battery can be disconnected at a time.

Rectifiers for the 12-volt battery are of 200-ampere capacity and are of the selenium type. Output voltage is controlled by a saturable reactor and regulating transformer in series with the primary of the rectifier transformer; the secondary of this transformer supplies the selenium bridge. The output is automatically adjusted by the dc saturating current supplied to the reactors by the electronic control incorporated in the rectifiers. This plant employs 6-cell storage batteries floated at 13 volts. Since the normal limit at the point of load is 11 ± 0.1 volt, a resistor in each discharge lead is adjusted to drop the voltage to the desired value. Under power failure conditions, when the rectifiers are not operating, a contactor short-circuits the resistor to hold up the filament voltage.

The 12-volt supply is shown in Figure 3. The battery, which is of the lead-calcium type*, is mounted on an open type battery rack with space available in the upper tier for a second paralleled battery should an increase in load or reserve require it. The left hand cabinet in Figure 3 is for the 24-volt supply, and houses the battery as well as the rectifier. The second bay houses the charge and discharge and control circuits for the 12-volt supply, while the two cabinets at the right contain rectifiers—one in each cabinet.

Cabinets for all the supplies are 8 feet high and are designed to harmonize with the radio bays. The basic mounting structure for the equipment is a bulb-angle framework which can be completely divorced from the enclosing cabinet for shipment. With this arrangement a fully assembled and wired bay is shipped to the job less the cabinet, which is shipped as a separate item. The two units are assembled on the job merely by sliding the enclosing cabinet around the framework and then securing them together. All the cabinets are equipped with dead-front type fuse blocks to protect personnel and to avoid service interruptions. In addition all bus bars, terminals, and distribution leads associated with the discharge circuit have been com-

* Record, *March*, 1951, *page* 97.

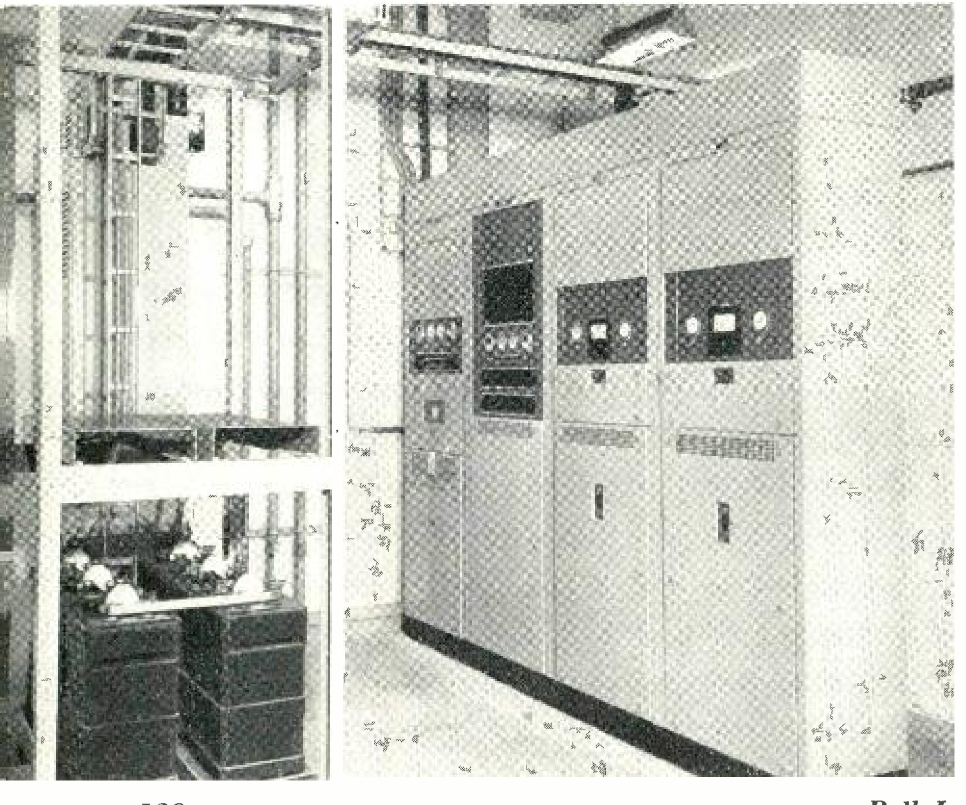


Fig. 3—12-volt supply for a TD-2 radio relay station.

pletely protected by insulated covers, insulated sleeving or taping. Protective plastic shields are used in the rectifiers to protect the maintenance personnel from high voltage points without blocking the use of test picks.

Emergency lights, operated from the 130-volt battery, are available in all installations, and are automatically controlled under power-failure conditions. Air navigation obstruction lighting arrangements, to be furnished as required to meet CAA specifications, have been developed for all types and heights of towers, and utilize steady or flashing lights.

The exposure of towers and antenna structures to lightning makes the grounding arrangements in TD-2 stations especially important. It is necessary that the waveguides, building steel, and equipment, be well bonded at all points and connected to a common ground to prevent hazardous potentials in the event of a lightning storm. A further use is made of this low-resistance ground path as a return for the 12-volt filament current in parallel with the positive conductors, so as to reduce the amount of copper required.

In general the batteries will have sufficient capacity to carry the load for at least eight hours in case of failure of the commercial supply, but an ac generator gasoline engine driven, Figure 4, is installed in each station and automatically takes over the load after a predetermined interval. After commercial service is restored, the load is automatically returned to it, and the engine is shut down. For the main route of the TD-2 system, engines of 20- or 30-kw capacity are normally employed, and are fully automatic in operation. They assume the load after a predetermined period of commercial service failure, return the load to the commercial service when it returns to normal, and are capable of long hours of operation under emergency conditions. Numerous alarms are available in the engine plant to indicate its status under all conditions. Diesel driven plants have recently been made available and are being used in the later installations.

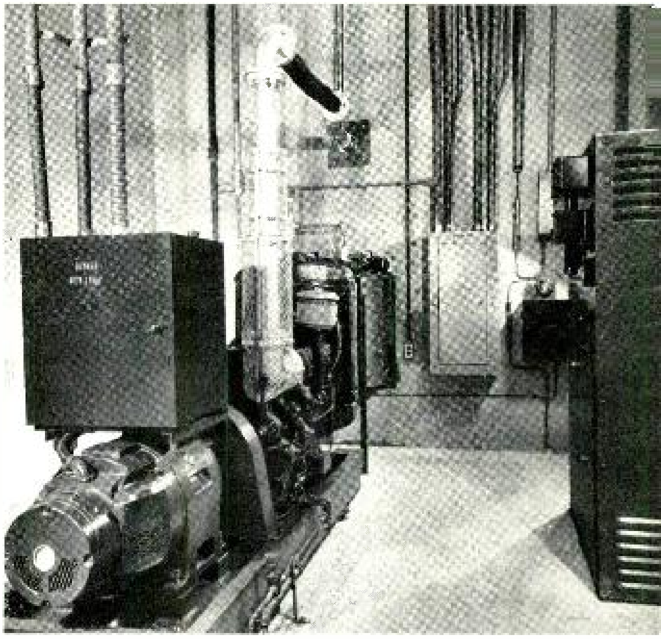
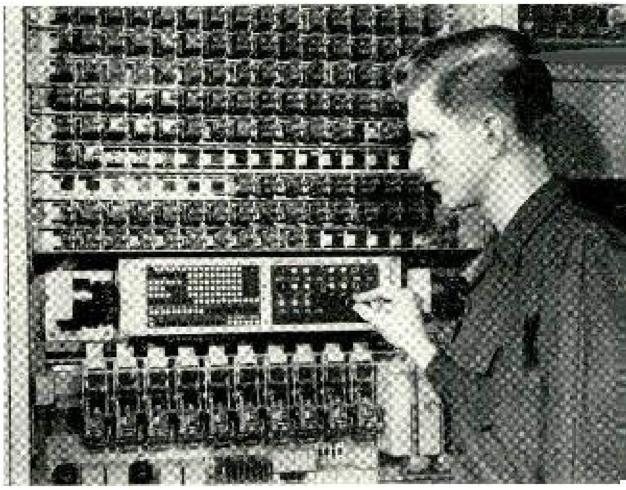


Fig. 4—An ac generator driven by a gasoline engine automatically takes over the load after a predetermined interval.

THE AUTHOR: R. R. GAY attended the University of Nebraska and Cornell University, and graduated from latter with an E.E. degree in 1937. He joined the Laboratories immediately afterward, and with the Special Equipment Department took part in the initial trial installations of L1 and J2 carrier systems. In 1939 he transferred to the current development group and was primarily interested in the conversion of outlying offices to function with the Philadelphia No. 4 toll system. In 1941 he transferred to the power development group where, except for special assignments during World War II, he has been engaged in the development of rectifiers and power plants primarily for application with carrier, radio, and television systems.

The AMA timer

W. C. JORDAN
Switching Systems Development



A maintenance man of The Bell Telephone Company of Pennsylvania operating the CKL *key to light the lamps that display the positions of the selectors.*

Automatic Message Accounting*, as its name implies, is a system that automatically records, sorts, computes, and summarizes the required information for subscriber dialed telephone messages to determine the service charges. The original information recorded includes the time of the beginning and end of each call, and thus a dependable source of time must be associated with the recording equipment. This is provided by the AMA timer, and two of them—called the "even" and "odd" timers—are furnished for each AMA office. Both maintain a continuous record of time and check each other every minute for synchronism, but only one of them is "in control" at a time. Only one of them at a time, in other words, is supplying time information to the recorders, but each has certain checking and testing functions to perform whether "in control" or not, and either may carry out all functions when the other is out of service.

Each timer has a small synchronous motor, driven from the commercial power supply, that serves as the basic source of time. This motor drives a cam shaft with two cam-operated switches. Every six seconds one of the switches is closed for a brief interval, thus sending a pulse to the control circuit. This sequence of six-second pulses operates a chain of 206-type rotary selectors on which the various time units

*RECORD, *September,* 1951, *page* 401; *October,* 1951, *page* 454; *November,* 1951, *page* 504; *February,* 1951, *page* 62; *and December,* 1951, *page* 565.

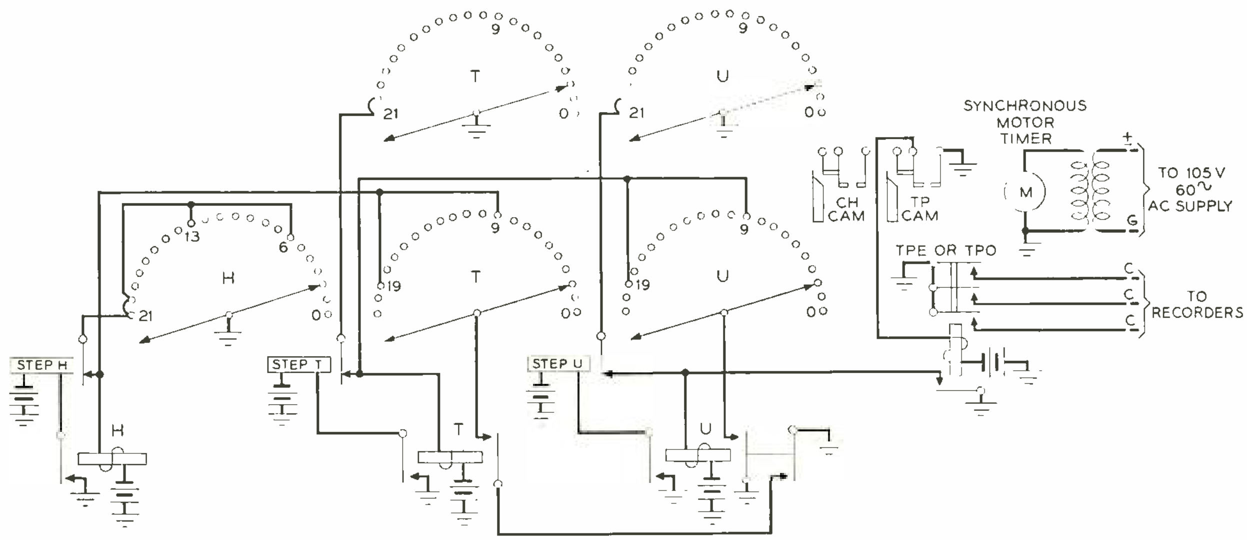


Fig. 1—Method of operating the U, T, *and* H, *selectors in the timers and recorders.*

are recorded. One of the selectors, designated U, records the six-second pulses themselves—each pulse moving the selector one step. The next, designated T, operates one step for each ten of the original pulses, and thus moves one step each minute. The third, designated H, operates one step for each ten steps of the T selector, and thus makes one step every ten minutes. Operated in a somewhat similar manner, there are also the HU, the HT, the DU, the DT, and the M selectors, operating one step for each hour, each ten hours, each day, each ten days, and each month, respectively.

To insure a continuous record of time even during failure of the commercial supply, means are provided for automatically transferring the timing motors to an emergency ac supply. This consists of a rotary converter, driven by the central-office battery, which is started automatically whenever the voltage on the commercial ac lines drops to 85 per cent of its normal value. When the voltage returns to 90 per cent, the motors are automatically transferred back to the commercial supply.

Besides operating the chain of selectors in the timer, the sequence of six-second pulses from the timer "in control" is also transmitted to each recorder in the office, and each recorder includes a U, a T, and an H selector, and thus has available within itself the information needed to control the perforation of the time of answer and disconnect on the tape. For the hour entry and the tape identification entry, however, the time comes from the master timer in control. The hour entry is made on each tape at the turn of each hour, and includes a tens and a units digit to identify the hour of the day. Six time digits are used for the tape identification entry: the month tens, month units, the day tens, the day units, the hour tens, and the hour units. The tape identification entry is made at 3 a.m. each morning. and at certain other occasions, such as at each splice, and each time a recorder is made busy or is returned to service.

The method of operating the time selectors is indicated by the simplified schematic diagram of Figure 1. Each pulse from the timing cam operates a relay that repeats the pulse over a number of branch leads—some going to the recorders and one to the associated timer circuit. Over this latter lead the stepping magnet of the U selector is operated, and on release, the selector moves ahead one step. A lead multipled to the 10th and 20th contacts of the U selector runs to the step magnet of the T selector. During each six-second pulse, ground is applied to the lower brush of the U selector, and every tenth pulse this ground, through a contact of the U selector, operates the T selector, and thus moves it one step. In a similar manner the H selector is operated every 10th contact on the T selector.

The 206-type selectors have six semicircular arcs each of 22 contacts, and since the brushes are double ended, the 23rd operation brings a brush again to the first contact. On the selectors such as the U selector just described, where a succeeding selector is operated every ten steps, the circuit is arranged—through connections on one of the other arcs of contacts—so that the selector moves automatically from the 20th to the first contact on the 21st pulse. Various other combinations of automatic stepping are used as required for some of the subsequent selectors. One, two, or even three of the arcs may be used to control the operation of subsequent selectors, while some or all of the remaining arcs are em-

DIGIT	PERFORATING POSITIONS 0	1	2	4	7
1	×	×	○	○	○
2	×	○	×	○	○
3	○	×	×	○	○
4	×	○	○	×	○
5	○	×	○	×	○
6	○	○	×	×	○
7	×	○	○	○	×
8	○	×	○	○	×
9	○	○	×	○	×
0	○	○	○	×	×

Fig. 2—Translation of the "2-out-of-5" code. Positions perforated are marked with a cross.

ployed for some of the other functions that the timer performs.

All digits carrying charging information are recorded on the tape in a "2-out-of-5" code: five perforating positions are available for each digit, and each of the ten possible digits from 0 to 9 is represented by a particular pair of perforations. The code is readily translated by assigning the five perforating positions the numbers 0, 1, 2, 4, and 7 from left to right. Then the digit perforated is equal to the sum of the numbers assigned to the two holes punched. The only exception is the digit 0, which is represented by positions No. 4 and No. 7. This translation is shown in Figure 2.

Two of the arcs of each selector are used to translate the digit represented by the position of a selector to the "2-out-of-5" code. There are five output leads from the pair of translation arcs of each selector, and for each position of the brushes of the selector, ground will appear on the proper two leads. How this is accomplished is indicated in Figure 3. A relay that is operated whenever a time digit is to be perforated on a tape supplies ground to the brushes of the two translator arcs of each selector. As a result ground will appear on two out of the five code leads from each selector to give the correct code corresponding to the position of the selector. These code leads are connected to the perforator by the recorder in the same general manner as other information, which has already been described*. In recording the time of answer or disconnect, the codes are taken from the selectors in the recorder, as already mentioned, but for the hour and the tape identification entries, the codes come from the selectors of the timer, since this information is not available in the recorders.

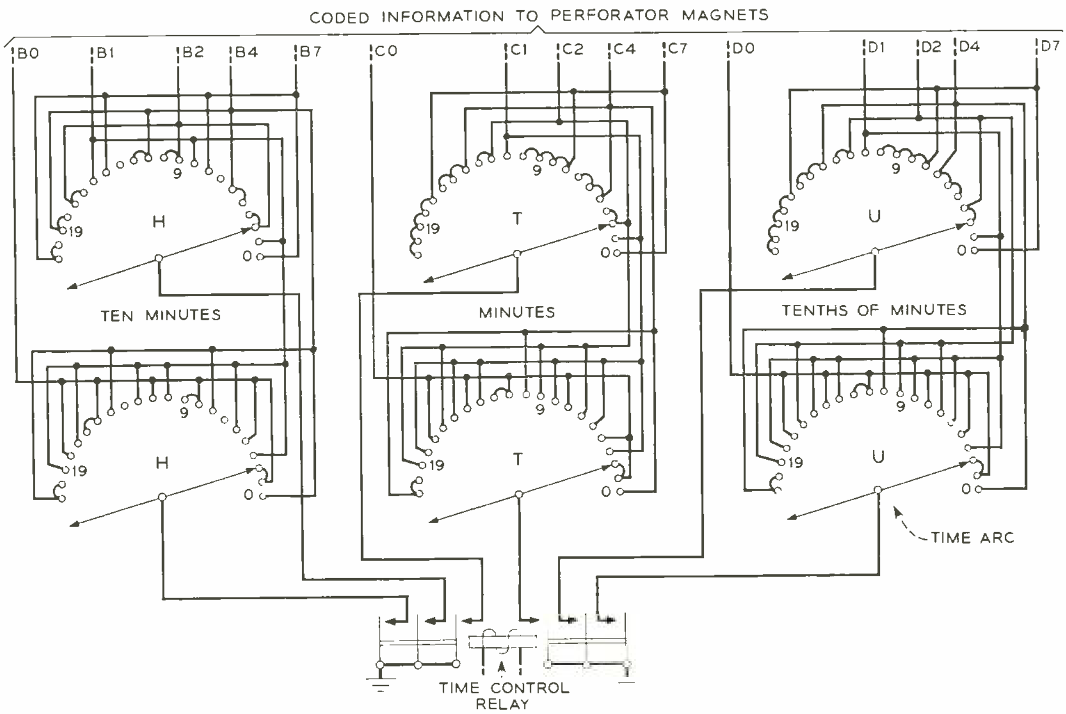


Fig. 3—Simplified diagram of the coding circuit of the selectors.

Besides keeping a running record of time and supplying it to the recorders, the master timer in control, also makes a check every minute to see if the corresponding selectors of the other master timer and of all the recorders are in step with its own. Other arcs of the selectors are used for this purpose by a circuit indicated in Figure 4.

* Record, *December*, 1951, *page* 565.

The No. 4 arc of the U selector controls this test, over a lead multipled to its No. 9 and No. 19 contacts, by supplying ground to a check relay. The actual test is made through contacts of the No. 6 arc. The No. 6 arcs for the U selectors only are indicated in Figure 4, but a similar circuit is provided for all of the timing selectors.

The second cam driven by the timer motor, designated CH in Figures 1 and 4, closes, and remains closed for about 3.5 seconds, one second after each six-second pulse. Between every 9th and 10th six-second pulse, ground on the brush of the U4 arc holds the check relay operated, and thus when the cam-operated CH contact closes following the 9th six-second pulse, relay CK operates. This supplies ground to the No. 6 brush of the U selector of the master timer in control at the time. The brushes of the No. 6 arcs of the corresponding selectors of the other master timer and of all the recorders are connected to relays marked U on the diagram, and if all these brushes are on the same contact as that of the master timer in control, the U relays all operate. At the end of the 3.5 second period, when the cam-operated contact CH opens, relay CK is released. No other action has taken place since all the selectors are in step.

If one or more of the selectors had been out of step, however, one or more of the U relays would not have operated, and as a result ground would have been applied to the CK relay to hold it operated after the CH cam contact had opened. Under these conditions, the next closure of the cam-operated TP contact, which gives the six-second pulses, would operate relay SSF through a front contact of CK. This would sound an alarm to call attention to the fact that at least one of the selectors was out of step. To

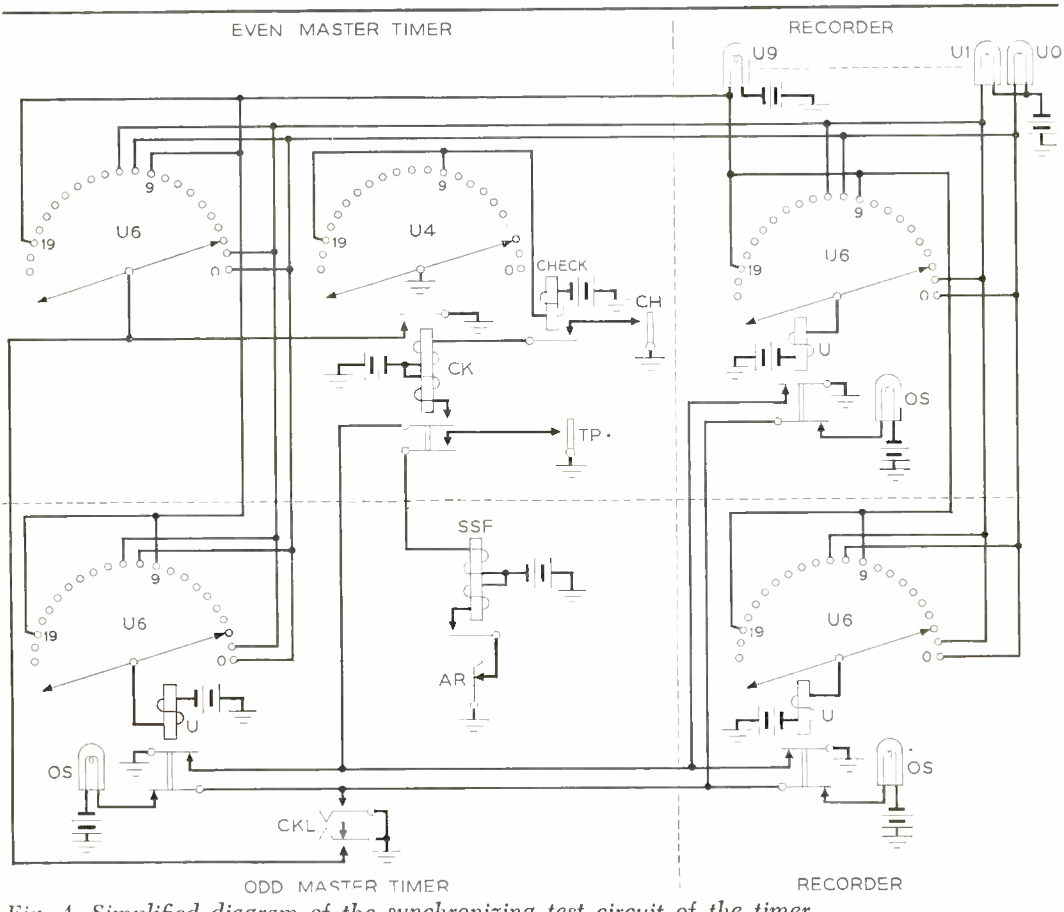


Fig. 4—Simplified diagram of the synchronizing test circuit of the timer.

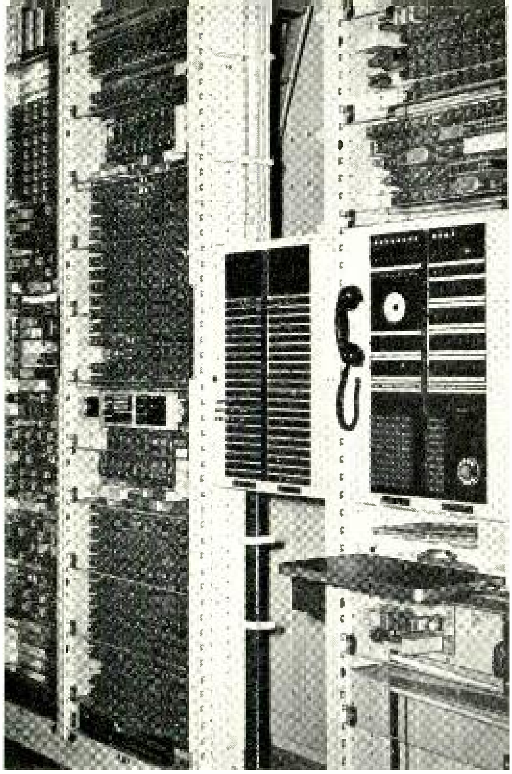


Fig. 5–A master timer frame in the No. 5 crossbar office at Englewood, N. J.

determine which selector it is, the CKL key is operated. This lights a lamp associated with any recorder that has a selector out of synchronism, since as long as a selector is not in synchronization, its U relay will be unoperated.

The No. 6 arcs of the selectors are also used to give a lamp indication of the position of each selector in the master timer "in control." A lamp with one lead connected to battery has its other lead connected to the lead multipling one of the contacts of all the No. 6 arcs of the selectors. Each contact of all the arcs has such a multipling lead with a lamp connected. When the CKL key is operated, ground is applied to the brushes of the selector at the master timer, and thus the lamp connected to the lead from the contact on which the brush is resting will light. As long as this key is operated, successive lamps will light as the selectors step around.

Besides providing these tests every minute to insure that all timing selectors are in step, the master timers are also used to test the operation of the recorders. These latter tests are under control of the odd timer and proceed automatically, but they are started by a key operation. Should trouble be encountered, the test will block, a trouble record will be provided, and a recorder trouble lamp will light. Restoration of the test circuit to normal will then be accomplished by another test key operation. On either normal completion or irregular completion of a test cycle, a test identification entry is perforated in the recorder tape at the end of the cycle. This entry provides information to the accounting center which enables it to skip the test perforations when processing the tape, since some of the test perforations resemble information provided as part of the subscriber call records.

A master timer for a No. 5 crossbar office is shown on the second bay from the left in Figure 5. The lamps below the middle of the bay include the lamps that display the selectors when the CKL key is operated Below these lamps is the even master timer, and above them, up to and including the 206-type selectors, is the odd master timer. Above it is the equipment for the recorder test and the common relays that transfer control from one timer to the other.

THE AUTHOR: W. C. JORDAN joined the New England Telephone and Telegraph Company in 1909 and was engaged in the installation of manual type central-office telephone equipment. In 1919 he transferred to the Laboratories and has since been engaged in developing local dial systems, central office circuits to provide for operator dialing over toll lines, switchboard circuits for the assistance of dial systems subscribers, panel dial systems circuits for completion of local and toll calls, and, more recently, dial systems central office circuits for automatic message accounting operation.

As we all know, the one function of Bell Telephone Laboratories is to provide the technical groundwork that will lead to more and better telephone service at the lowest possible cost. Thus the problems of the operating companies of the Bell System concern us intimately and the teamwork between our engineers and those of the operating companies is necessarily very close. Some of us, of course, because of the nature of our work, see the results of our efforts in behalf of the associated companies only at long range. Others of us, again because of the character of our activities, see them at close range. Some members of the Laboratories have a continuous opportunity to observe the performance of Laboratories developments in actual service. They are the members of the Field Engineering Force of the Quality Assurance Department. These Laboratories people are strong links in the chain of design, manufacture and operation. Each field engineer represents us in a given section of the United States, and has his home and his office in one of the principal Operating Company headquarters cities within his area. Individually, we see them from time to time during their visits to the Laboratories. As a group, we see them occasionally when they have a conference in New York. The photographs on this and the next two pages show them "at work."

J. H. Miller (right), field engineer at Denver, with Neil Mills, Long Lines Equipment Maintenance Supervisor, examine the exterior cover of the antenna for the microwave radio relay station atop The Mountain States Telephone and Telegraph Company building in Denver.

Laboratories People Away From Home

FIELD ENGINEERING FORCE

R. E. Friedley, field engineer, (right) and James Poole, maintenance engineer of The Southern New England Telephone Company examine a step-by-step switch in the Lyme (Conn.) 355A community dial office.

J. W. Van de Water, field engineer at Omaha, (left) observes the "wobble" of the slip rings and checks voltages with P. A. Schoenenberger and E. C. Perrenoud of the Northwestern Bell Telephone Company.

R. V. Dean, field engineer in Dallas (right), points out a defective area in a lead covered cable sheath to S. C. Frost, Jr., Outside Plant Engineering of Southwestern Bell at Dallas, Texas.

R. F. Bloom, (left) chief technical operator, and W. S. Brown, Jr., (right) Central Office Maintenance Supervisor, A T & T Long Lines, discuss with L. E. Gaige, New York field engineer, an engineering complaint concerning a difficulty with the vogad cover associated with a C4 control terminal in the overseas control room in New York.

L. F. Porter, field engineer in Atlanta, with a Southern Bell cable splicing crew in Miami Beach. Left to right, E. T. Stewart, V. D. Bolick, Mr. Porter, M. F. DeVane, H. W. Helton, W. S. Martin, A. A. Fisikelli, and L. A. Mathis.

In the Southern California area of The Pacific Telephone and Telegraph Company, R. E. Johnson, Laboratories field engineer at Los Angeles (left), discusses paper problems and ticket "curling" in automatic ticketing equipment with K. J. Schnelle (center) and C. E. Johnson.

C. L. Black, field engineer in Philadelphia, (center) together with J. E. Leeds (left) and L. E. Grandhomme of Bell of Pennsylvania, examine a "Walkie-Talkie" to be used in a private radio system for a Philadelphia utility company.

Above—S. L. Eppel (left), Detroit field engineer, discusses card feed problems on the No. 5 crossbar trouble recorder with V. E. Walli, Michigan Bell Engineering Department.

Above, right—S. C. Bates, Cleveland field engineer, (left), discusses the annual General Engineering Conference with C. K. Milner, Ohio Bell Chief Engineer. Mr. Milner was himself formerly a Bell Laboratories field engineer.

Right—G. N. Queen, New York field engineer, (left) and G. M. Horne, New York Telephone Company, inspect the wiring in a 507B PBX.

Left—A. B. Easter, line foreman supervisor of the C & P, reads the name plate data on a P3T pole trailer to D. S. Bender, Washington field engineer, as C. C. Spaulding, line foreman, looks on.

Right—T. L. Oliver, San Francisco field engineer, (left) and W. M. McClelland of the Pacific Telephone Company consider some earth auger problems at Palo Alto.

Below, right—L. L. Eagon, Chicago field engineer (right), with L. E. Johnson, Illinois Bell, is testing a KS-13502 tool used for applying a protectant to panel bank contacts.

Below—C. E. Fisher, (right), field engineer at St. Louis and J. Vaughn of the Southwestern Bell testing an M1 carrier subscriber terminal.

Excerpts from Annual Report of the A T & T

Again in 1951 the Bell System rendered more service than in any previous year. An even larger number of telephones was added than in 1950 or 1949. Telephone conversations reached an all-time high. The System expended more than a billion dollars for new construction. Nevertheless, demand for service continued to run ahead of its tremendous building program, and the load on lines and switchboards increased as the year went on.

National defense was—and continues to be—our task of first importance. This is an extremely big job, for military and civil defense communication needs today are even more varied and extensive than in World War II.

Bell Telephone Laboratories, our research organization, and Western Electric Company, our manufacturing branch, are being called on to take an increasing part in the defense program. Because of the special experience and skills they have acquired as members of the Bell System, the Government has assigned to them much important work in designing and producing electronically coordinated weapon and communication systems.

In 1951 the average telephone was made even more dependable—more free from mechanical failure or imperfect operation—than at any time in the past. Because of the pressure of demand, long distance calls over certain routes sometimes took longer to complete than in 1950. On the other hand, new equipment and new methods made it possible to handle an increasing number of calls faster than ever before. Thus, while temporary shortages of facilities slowed some calls, long-range improvements speeded others.

More and more voiceways were provided in 1951 through coaxial cable and radio relay systems. Operators were able to dial many more long distance calls straight through to the distant telephone. In November, an important trial of long distance dialing by customers began in Englewood, New Jersey. Telephone service to farmers continued to expand rapidly. All over the nation, telephone facilities were made ready to serve the growing air defense system. In this task as in others, there was continuing and effective cooperation between the Bell System Companies and the several thousand independently owned telephone companies which connect with our lines to make possible nationwide service.

Telephone taxes, wages and other expenses were substantially higher than in 1950. Notwithstanding these mounting costs, regulatory authorities in a few states denied increases in telephone rates which the Bell System Companies serving those states believe to be clearly justified. All Companies are proceeding with every effort to bring about full recognition of their needs and are continuing to apply for rate increases as and when necessary.

Telephone rates that produce a reasonable profit will always be essential to good service, and good service is vital to our national life. To provide it, we shall continue to need large additional amounts of capital. Our ability to attract and protect the savings of investors and keep on doing a better job in the future depends fundamentally on good earnings and good credit. Financial good health is the basis for real economy in rendering service, for it is this that enables the Bell System to invent, develop, finance and install new and better facilities which improve service, partially offset rises in costs caused by inflation, and save the public money. We are sure most regulatory commissions recognize this, and they will generally hold to the view that rates which produce good earnings are in the public interest.

Operating Review

New systems have been developed to spread air-raid warnings more quickly than in World War II. Private line networks have been installed for the Air Force to speed such warnings from regional control centers to key cities. To transmit the alerts from these key points to police and fire departments, Civil Defense units, hospitals, key industries and others, an entirely new system has been designed by Bell System engineers and is being produced by the Western Electric Company. This will enable the key point to "dial the color" of the alert—Yellow, Red or White. At all points to be warned the degree of alert is simultaneously indicated by colored lamps and a bell that rings a corresponding signal.

With these arrangements it will be possible to alert the entire United States in less than two minutes.

Modern Warfare

Modern warfare requires intricate systems of weapons and of communications. As in the telephone plant, all parts must work efficiently as a whole. Bell Telephone Laboratories has acquired outstanding skill in dealing with such complex problems, and this skill is now being drawn upon by the Armed Forces. One recent result is an advanced type of self-propelled guided missile. Another is a complete system for locating hostile aircraft, tracking them, and controlling the fire of anti-aircraft guns to destroy them. In both instances, important help was received from other industrial laboratories, but the responsibility for planning and for the subsequent development of equipment rested with Bell Laboratories throughout.

Similarly, the experience and skill of Western Electric in producing equipment of this sort has led the Government to ask that Company to take responsibility for important contracts in the fields of radar, radio and guided missiles, as well as for military communication equipment. In addition, Western Electric through its subsidiary, the Sandia Corporation, has continued to operate the Sandia Laboratory at Albuquerque, New Mexico, for the Atomic Energy Commission. The work at this establishment, which is concerned with military applications of atomic energy, is carried on jointly with Bell Telephone Laboratories.

Critical Materials

Great effort is being made to conserve critical materials and employ substitutes. The new telephone set now being installed in large numbers permits use of smaller wires in many local cables. Increasing use of plastic for sheathing cables is reducing consumption of lead. Expedients have reduced the use of other scarce materials and work is being pushed to supplement production of copper-wire cables with cables containing aluminum wires. Bell System Companies have also been recovering scrap copper, which goes into the national pool, at the rate of nearly a thousand tons a month.

Radio relay systems were providing 450,000 miles of telephone channels at the end of 1951 —a distance equivalent to 150 times across the country. The transcontinental radio relay system opened in August is the seventh telephone highway to cross the Western expanse of the country. New radio relay routes being built include routes from Washington, D. C. to Atlanta and from Kansas City to Oklahoma City and several cities in Texas.

Research Improves Service and Holds Down Costs

Among the most significant products of our research in recent years is the transistor. This device is capable of doing many things now done by vacuum tubes, occupies so little space and uses so little power that it will almost certainly open up a new era in electronics. The year 1951 saw important strides in its development, and in preparations for transistor manufacture. In cooperation with the Armed Services, Bell Laboratories scientists last September met with technical experts of the Services and their suppliers to discuss the properties and uses of transistors. The purpose and result of these meetings were to make our knowledge of the new device available to those who can best use it in the defense effort.

In order to increase the inadequate supply of telephone cable, Bell Laboratories and Western Electric are jointly undertaking to develop cables using aluminum instead of copper wires. Until recently such cables would have been too costly. Aluminum wires have to be larger in diameter than copper, making the entire cable larger. This requires more lead in the covering sheath, and lead is both expensive and scarce. However, the development of plastic sheathing for use in place of lead has changed the situation, and good progress is also being made toward solving a second problem: how to splice aluminum wires. Field tests of a trial cable will soon be undertaken.

Timothy E. Shea

D. A. Quarles Named
T. E. Shea Returns

Vice President Donald A. Quarles has been elected Vice President of the Western Electric Company, effective March 1, and has resigned from his position in the Laboratories to accept this new position. Mr. Quarles has also been elected President of Sandia Corporation.

Timothy E. Shea, for many years a member of the Laboratories and recently Assistant Vice President in Personnel Relations at the American Telephone and Telegraph Company, has returned to the Laboratories as a Vice President, taking over the duties which Mr. Quarles has relinquished at the Laboratories. These include responsibility for the military development program and the relations with the Army, Navy and Air Force in connection with that program.

At the same time the Board of Directors of the Sandia Corporation has been increased from six to eight members and President M. J. Kelly and Vice President S. B. Cousins of the Laboratories have been elected Directors.

Also elected a Vice President of the Western Electric Company with Mr. Quarles was G. A. Landry, whom Mr. Quarles is succeeding as President of the Sandia Corporation. In his new post Mr. Landry will be concerned with purchasing and traffic matters in Western Electric Company, and in May he will take over the responsibility for such activities when Vice President D. F. G. Eliot of the Western Electric Company retires under the company's pension plan.

Mr. Quarles has served more than 30 years with the Bell System, having joined the Engineering Department of the Western Electric Company in 1919. This organization became the Bell Telephone Laboratories in 1925. From 1919 to 1924 he was in Transmission Engineering and Research, and then for four years a member of the Quality Assurance Department in charge of apparatus inspection.

He was made Director of Outside Plant Development in 1929 and became Director of Transmission Development in 1940. During the war, the efforts of the Transmission Development Department were largely concentrated on military electronics, particularly radar, in which he took a leading part. He became Vice President of the Laboratories in 1947.

Mr. Quarles is at present Chairman of the Committee on Electronics of the Research and Development Board of the United States Government. He is a graduate of Yale University, Class of 1916, and is a member of Phi Beta Kappa and Sigma Xi. He is a member of many professional and engineering societies. Although now a resident of Summit, New Jersey, he was previously a resident and, at one time, mayor of Englewood, New Jersey.

Mr. Quarles has been active in A.I.E.E. affairs, having served as Chairman of the New York Section in 1941, Director of the Institute 1944-48, Chairman of the Finance Committee 1946-48, and member of the Committee on Planning and Coordination 1946-48. He was instrumental in setting up the A.I.E.E. retirement system in 1945-48 as a member of the Board of Trustees, has served on the Edison Medal Committee (1945-47) and Lamme Medal Committee (1947-50). His technical

Sandia President as Vice President

committee memberships include Electronics (1945-47) and Instruments and Measurements (1945-46). He is currently serving as a member of the Committee on Management and on the Board of the United Engineering Trustees, Inc., and as Chairman of the Finance Committee of the U.E.T.

Mr. Shea has also been with the Bell System for more than 30 years. He received the bachelor of science in electrical engineering degree from the Massachusetts Institute of Technology in 1918. The following year he received the master's degree from M.I.T., together with the bachelor of science degree from Harvard.

Mr. Shea joined Western Electric in 1920 as development engineer at Hawthorne, and the next year he transferred to New York, where he was assigned to the development of filters and networks for transatlantic radiotelephony, carrier telephony and television. In 1929 he entered the sound-picture field, and was later in complete charge of the development of sound motion picture equipment.

Mr. Shea left the Laboratories in 1939 to become Vice President in charge of engineering of Electrical Research Products, Inc., at that time a subsidiary of the Western Electric Company. He was on leave of absence from 1941 to 1945, during which time he was Director of War Research at Columbia University and a member of Division 6 (Underseas Warfare) of the N.R.D.C. He also directed the New London Laboratory for Submarine Research and supervised its scientists and engineers assigned to the submarine fleet based at Pearl Harbor. In recognition of his "exceptional services to the submarine service of the U. S. Navy," Mr. Shea received a Presidential Citation and also a Medal for Merit, the highest civilian award.

Mr. Shea returned to Western Electric in 1945 as Superintendent of Manufacturing Engineering in the Electronics Shops, and in 1946 he was named Assistant Engineer of Manufacture at Western's headquarters. He was named President and a Director of the Teletype Corporation, a Western Electric subsidiary, in 1948. Early in 1950 he was made Personnel Director of Western Electric. On July 1, 1950, he became Assistant Vice President in Personnel Relations at A T & T.

He is a former fellow of the Acoustical Society and the Institute of Radio Engineers, and a fellow and past treasurer of the Society of Motion Picture and Television Engineers. In recognition of his accomplishments, he was awarded an honorary doctorate of science by Columbia University in 1946, and an honorary doctorate of engineering by the Case Institute of Technology in 1949.

DONALD A. QUARLES

Mr. Quarles Nominated for President of A.I.E.E.

D. A. Quarles has recently been nominated for president of the American Institute of Electrical Engineers. Results of mail balloting will be announced at the Summer General Meeting of the Institute to be held at Minneapolis in June.

Frank B. Jewett Fellowships

Five outstanding young scientists have been named to receive the Frank B. Jewett post doctoral fellowships for 1952-53. The awards, designed to stimulate and further the work of researchers in the physical sciences, grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research.

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

Murray Gerstenhaber, who is spending this academic year as a Jewett fellow at Harvard University studying higher mathematics, particularly mapping problems in connection with Riemannian manifolds, plans to attend the University of Chicago, for further study.

Ernest Mark Henley, new approaches to meson theory of nuclear forces at the Institute for Advanced Study, Princeton.

Emin Turan Onat, the mathematical theory of plasticity, particularly to determine a second order theory for the criterion of collapse in the plastic range, at Brown.

Henry Helson, the relations between the Wiener and Kolmogoroff prediction theory and certain questions in analytic function theory, at Yale.

Paul Namon Schatz, to determine the sign of the electric dipole moment of hydrogen chloride, at California Institute of Technology. This moment has usually been assumed to be positive at the hydrogen atom end but this has never been firmly established.

A committee of seven members of the technical staff of the Laboratories determined the winners. Serving on the committee were: Ralph Bown, Chairman, W. O. Baker, J. B. Fisk, S. Millman, L. A. Wooten, T. C. Fry, and H. Nyquist. M. B. Long is secretary of the committee. Members of the board of the Fellowship Trust are O. E. Buckley, Chairman, M. J. Kelly, Vice Chairman, Ralph Bown, A. B. Clark, and D. A. Quarles. J. W. Farrell is secretary.

Plans for New Magazine

In order to do a more effective job of presenting the results of the technical work of the Laboratories and also to handle more effectively the items of news now included in Bell Laboratories Record, it is planned to make some changes in the Laboratories' publications.

As soon as practicable the field now covered by the Record will be divided into two magazines. The first, which will be known as the Bell Laboratories Record, will continue to include what is now in the Technical Section of the Record. The News Section will be covered in a new magazine the name of which is still to be determined.

The new magazine will be published under the general direction of Wesley Fuller, Information Manager. In anticipation of his forthcoming retirement, P. B. Findley has transferred to the Information Department where he can most effectively aid in planning the new magazine. Until the change indicated above

J. A. Burton on TV Discussion Panel Program

J. A. Burton of the Chemical Laboratories participated in a recent panel discussion on *Industries Use of Atomic Energy Isotopes*, televised over Station WATV. The program was under the sponsorship of the Television Council of Higher Education of New Jersey and Seton Hall University. Moderator of the program was Dr. Lawrence Parsegian, Director of the Division of Technical Advisers, New York Operations Office of the A.E.C. The others on the panel were Dr. Crompton, United States Testing Company, and Dr. Nudelman, Beth Israel Hospital. Prof. Daniel T. St. Rossy of Seton Hall was the Master of Ceremonies.

Illinois Bell Executives Visit the Laboratories

Directors and several executives of the Illinois Bell Telephone Company were guests of the Laboratories on two days in late January. They arrived at Murray Hill on the morning of the 24th, where they were welcomed by D. A. Quarles and heard a general talk on transistors by Ralph Bown. A number of laboratories were shown to the visitors and the work explained by E. I. Green, A. V. Hollenberg, P. G. Edwards, G. H. Huber and F. J. Given. At a luncheon in the conference dining room, engineers of the Illinois Company now working at the Laboratories were also guests; and on their behalf P. K. Gilloth expressed the satisfaction of the group in their experience at the Laboratories. Afterward, W. H. Martin spoke on the development of the 500-type telephone set. After visits to more laboratories, demonstrated by R. J. Nossaman, J. B. Fisk, R. H. Colley and J. R. Townsend, and to the free-space room, they heard a talk on military weapons by W. C. Tinus, and saw a demonstration of microwave lenses by W. E. Kock.

On the following morning the directors and their associates gathered at West Street, where they saw the transmission standards and switching apparatus laboratories under the guidance of P. W. Blye and H. N. Wagar and also some of the switching systems laboratories with W. B. Groth, M. E. Esternaux and R. E. Hersey. At noon they left to visit Long Lines headquarters at 32 Avenue of the Americas.

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is made, Mr. Findley will remain Editor of the RECORD.

P. C. Jones has been appointed Technical Editor reporting to Mr. Honaman and will continue as Editor of the *Bell System Technical Journal* and Technical Editor of the BELL LABORATORIES RECORD. J. D. Tebo will report to Mr. Jones.

Manfred Brotherton and Helen McLoughlin will continue to report to Mr. Findley.

Changes in Organization

W. W. Braunwarth, former general supervisor of employment and training in Long Lines, has become a member of Personnel reporting to R. A. Deller, to assist in technical employment activities. He will be located at West Street. Mr. Braunwarth is an engineering graduate of University of Pennsylvania. His Long Lines career, which began in 1929, was interrupted by the war, from which he returned a Lieutenant-Colonel in the Signal Corps.

H. J. Michael of Switching Systems Development has transferred to the American Telephone and Telegraph Company, where he is a member of Administration B Department, reporting to H. S. Sheppard.

Whippany Post Gets Charter

The Whippany Bell Laboratories Post 329 received its permanent charter on January 18 from County American Legion Commander Anthony Frederico at ceremonies held at the William Hedges Baker Post 27. Past Post Commander Robert R. Cordell assisted in the activities.

Officers and members of the newly-chartered post, including the present commander, Albert H. Biegler, were at hand for the ceremonies.

The post was organized in October, 1950, and its members have been active in state and county Legion affairs.


Carol Goble.

WHEN the curtain rises on the Bell Symphony orchestra at Carnegie Hall on March 28, a number of Laboratories members, resplendent in evening clothes, will have their instruments poised awaiting the directing baton of Frederick Kurzweil. The Laboratories musicians will be from all ranks of organization, from mail girl to engineering supervisor. They will include violinist Adele Sacks, a junior clerk in General Service, and A. L. Whitman of Telegraph Engineering, viola. Carol Goble of Switching Engineering will be the Symphony harpist, and W. A. Krueger of Switching Apparatus, bassoonist. There will be Jack Gabriel of Transmission Systems, viola, P. E. Mills of Specifications and Drafting, bass viola, and H. C. Green of Switching Systems Development, clarinet. These are a few of many Laboratories Symphony members.

The Bell Symphony Society program will include the famous *Lincoln Portrait* by Aaron Copeland. The narration will be given by Donald Dickson, the guest soloist. Members of the orchestra are looking to music lovers among their coworkers and friends to make the Carnegie Hall concert a success.

Music Makes Their Leisure A Pleasure

BELL SYMPHONY SOCIETY
SPRING CONCERT

Carnegie Hall, March 28
Donald Dickson, Soloist

Orchestra $2.50—3.00
Box Seats $3.00—3.50
Balconies $1.00—$2.00—$2.50

Order forms will be sent to all members—of the Laboratories

W. A. Krueger.

Herb Green, BTL, Henry Ware, Jr. and John Mahoney, Long Lines.

Adele Sachs.

A. L. Whitman.

. C. Gabriel and P. C. Mills.

Life Members' Club Songfest

A Bicycle Built for Two was one of the many nostalgic airs that filled the Auditorium on January 17 when the Pioneer Life Member Club met for its first 1952 meeting and luncheon at West Street. Twelve rousing numbers were sung with Russell Yeaton directing and Grace Wagner accompanying. Later in the program C. W. Lowe showed colored slides of his trek across the United States.

Following the entertainment the executive council met on the ninth floor. Shown at the meeting are, left to right, seated: H. A. Frederick, A. E. Petrie, N. H. Thorn, H. E. Marting, L. Montamat, A. H. Sass and Margarita G. O'Brien; standing: G. B. Hamm and A. D. Hargan.

Bus Card Campaign

Bus travelers to Murray Hill and Whippany may recognize the invitation *(below)* to join the Laboratories which has been appearing in some sixteen buses serving the area. This 11 x 28 card—one of five designs to be displayed in 220 buses over a three-month period—is part of an intensive campaign by Personnel to recruit the additional people needed to carry out our part in the defense effort while essential work for the Bell System is continued. Both Murray Hill and Whippany now have many attractive openings for unskilled as well as skilled and semi-skilled people. If you know any one who might be interested you can help by having them call Summit 6-6000 or Whippany 8-0160.

Open Wire to Carry More Voices

Many more miles of open wire using strategic copper can now be made to carry up to sixteen voices simultaneously because of a new short-haul carrier system that was described by P. G. Edwards and L. R. Montfort in lectures at West Street, Murray Hill and Whippany. Type O, as the new system is called, provides economical carrier operation from 150 to as little as 15 miles.

Operating over the frequency range from 2 to 156 kc, the new system provides sixteen channels, arranged in four four-channel groups,

in both directions, on a single pair. Frequency space is efficiently utilized through a new carrier technique in which two channels are transmitted on a single carrier, using the upper and lower sidebands. The carriers are also transmitted at reduced level, then amplified for regulation and demodulation purposes at the receiving terminal.

Like its counterpart, the Type N, which was developed for short-haul cable service and which it resembles in materials, Type O takes advantage of radical post-war advances in materials, apparatus and equipment design. Among new features are ferrite coils, complete filter units which plug in like vacuum tubes and die cast supporting frames.

Of some 1,400,000 pair-miles of open wire now used for toll service in the Bell System, only about half are used for carrier at the present time. In supplying additional circuits, Type O is expected to be especially valuable in the South and West where considerable use is made of open wire for toll purposes. Deliveries of equipment for one of the channel groups are already under way.

Whippany Legion Post Sponsors Oratorical Contest

High School children of employees at the Whippany Radio Laboratory have been invited by the Whippany Radio Laboratory Post 329 to participate in an oratorical contest. The contest is being conducted as a part of the American Legion program, designed to stimulate interest in citizenship and the constitution. Suggested topics are, *The Constitution–A Bar Against Tyranny,* and *The Privileges and Responsibilities of an American Citizen.*

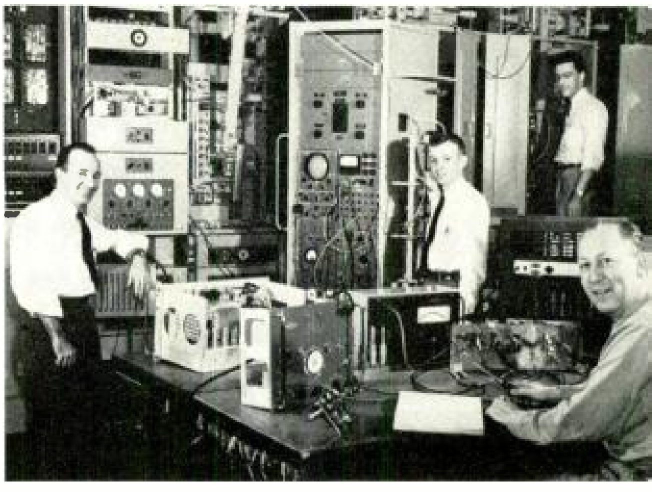
The successful contestants at the Post and County contest will receive medals. The winners of the State and the National contest will receive college scholarships.

Jersey Chemists Meet in Newark

New developments in four major fields of chemical science and technology were reported at the annual day meeting of the North Jersey Section of the American Chemical Society held on January 28. Five hundred and forty chemists and chemical engineers participated in the meeting at which forty-six technical papers were presented. The program also included a Safety Forum which treated problems of laboratory safety with technical films, talks and panel discussions. Arrangements for the meeting were under the direction of V. T. Wallder, Chairman of the House Committee.

At the Polymer Group session which covered some of the latest findings in the fields of plastics and synthetic rubber, two papers from the Laboratories were presented. These were *Measurement of Atmospheric Ozone* by J. Crabtree and R. H. Erickson and *Polymer Carbon and its Derivations* by F. H. Winslow and W. O. Baker.

The main address at the evening session was given by M. E. Strieby, Director of Technical Demonstrations of the A T & T and Managing Editor of *The Bell System Technical Journal.* His address was entitled *Television and Inter-*



The illustration in the advertisement on the back cover was made from the above scene photographed in the microwave laboratory at Murray Hill, except with the men turned around. Appearing left to right are J. A. Githens, B. C. Bellows, E. A. Baker and T. R. D. Collins.

City Television Networks, and in it the operation of a television system was demonstrated with the aid of a working model. Various steps in the development of television leading to the improved system in use today were traced by Dr. Strieby. Miniature transmitters and receivers and samples of coaxial cable were shown, in addition to a model of an early television set.

B. S. Biggs of the Laboratories, Chairman of the North Jersey Section, presided at the evening session.

Other representatives of the Laboratories who attended the meeting were J. B. DeCoste, G. F. Brown, L. G. Rainhart, H. Peters, G. N. Vacca, C. M. Hill, W. L. Hawkins, J. B Howard, and J. F. Ambrose.

R. L. Trent Honored by Eta Kappa Nu

At a dinner held during the Winter General Meeting of A.I.E.E., R. L. Trent of the Laboratories received honorable mention in the Eta Kappa Nu awards to Outstanding Young Electrical Engineers for 1951.

Louis G. Gitzendanner, Section Engineer, General Electric Company, Schenectady, received the main award, and Burton R. Lester, Section Head, General Electric Company, Syracuse, also received honorable mention.

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

Mr. Trent, of the Electronic Apparatus Development Department, graduated from Columbia University in 1941 with a B.S. degree in Electrical Engineering. He came immediately to the Laboratories, where his arrival coincided with the start of military development work, and he was assigned to equipment development for underwater sound (Sonar). He also took part in the AN/TRC-6 radio relay system for the Signal Corps. After the war, he became concerned with radio and television links leading to the transcontinental microwave relay, and later he worked on the terminal equipment for this system. Turning to the transistor development in 1950, he was first involved in circuit work, and is now active in the development of the transistor itself.

Achievements considered by the Jury of Award of Eta Kappa Nu are not limited to those of technical nature; and Mr. Trent's nontechnical achievements are impressive. He is a member of the borough council of Far Hills, New Jersey, on the board of directors of the Bedminster-Far Hills Lions Club, former deacon and now elder, member of the church school faculty and choir of the Bedminster Reformed Church, and member of the Murray Hill Glee Club.

It is also of interest to recall that one of the ten founders of Eta Kappa Nu was, until his retirement in 1948, a member of the technical staff of the Laboratories. E. B. Wheeler who, at his retirement, was Repaired Apparatus Engineer, is one of the group who founded the society, October 28, 1904, for closer cooperation among, and mutual benefit to, students and others in the profession, who, by their attainments in college or in practice, manifest exceptional interest and marked ability in Electrical Engineering. An article about Mr. Wheeler and the founding of the society, written by B. F. Lewis of Switching Engineering, past national president of Eta Kappa Nu, was published in the Society's magazine, *The Bridge,* Fall 1951 issue, Vol. 28, No. 1.

Winter General Meeting of the A.I.E.E.

During the Winter General Meeting of the A.I.E.E., held January 21-25 at the Hotel Statler in New York City, thirteen papers were presented by Laboratories engineers. D. H. Smith presented his paper, *Automatic Regulation of Metallic Rectifiers by Magnetic Control* at the session on *Metallic Rectifiers.* In the *Communication Switching Systems* session, with John Meszar presiding, H. H. Schneckloth spoke on *European Switching Systems* and A. C. Keller on *European Switching Apparatus. Polyethylene Terephtalate–Its Use as a Capacitor Dielectric* was the title of the paper by M. C. Wooley, G. T. Kohman, and W. C. McMahon at the *Conference on Dielectrics.* F. B. Anderson spoke on *A 10-Cycle to 10-Megacycle Gain and Phase Angle Measuring Set* during the *Instruments and Measurements Session.* Conference papers at the session on the *Mechanism of Communication* included B. M. Oliver's paper, *Exploitation of Message Statistics;* L. G. Abraham presided.

R. M. Bozorth presided at the Session on *Permanent Magnets,* where E. A. Nesbitt gave a paper on *Magnetic Structures of Alnico 5.* Mr. Bozorth also presided at a *Conference on High Permeability Magnetic Materials. A Carrier Telegraph System for Short Haul Applications* was presented by J. L. Hysko, W. T. Rea, and L. C. Roberts at the *Wire and Radio Telegraph Systems* session. W. H. MacWilliams presided at the conference on *Digital Computers–New Storage Developments and Applications of Transistors,* where J. R. Anderson spoke on *Ferroelectric Materials as Storage Elements for Digital Computers and Switching Systems,* and J. H. Felker on *Catalog of Digital Computer Designs.* A. C. Dickieson presided at the session on *Mobile Radio Sys-*

tems. O. B. Jacobs spoke on *Magnetic Storms —Their Effects on Communication* at the *Conference on Energy Sources.* At a *Symposium on Germanium Rectifiers and Transistors,* J. A. Morton spoke on *The n-p-n Junction Transistor* and R. L. Wallace on *Circuits for Junction Transistors.*

Pioneer News of the New Jersey Council

New Jersey Pioneers are the dancin'est people! Earl Fisher and the Western Style square dancers filled five sets on the fourth Thursday evening in January. Square dancing is a monthly activity of Pioneers at Murray Hill.

On January 25, over 300 Pioneers, members of the Laboratories and their guests enjoyed the New Jersey Council's first 1952 buffet-dance, at the Hotel Suburban in Summit. Music was furnished by The Manhattaneers. The committee, headed by K. P. Hansen and assisted by L. G. Kersta, H. Geetlein and Ruth King, is to be congratulated on planning another very enjoyable evening of entertainment put on by the New Jersey Pioneer Council.

Still in the planning stage by the Entertainment Committee is a combined Pioneer hobby show and social evening to be held in the Arnold Auditorium; the annual dinner-dance and entertainment in April; and a proposed late spring trip to the Poconos in conjunction with the New York Council.

Camera Club

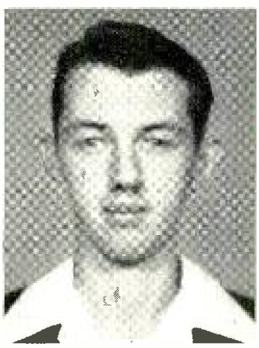
Newcomers to West Street, dyed-in-the-wool shutterbugs and Pioneers who are looking for a new hobby are invited to join the West Street Camera Club. In it they will find a group of men and women who offer good fellowship and help in the pursuit of their common interest, photography. The Club's program consists of lectures on photography, slanted for beginners who have not yet bought their cameras as well as lectures for advanced amateurs, and exhibitions held at regular intervals to give photography hobbyists constructive criticism of their work. Life members of the Telephone Pioneers of America interested in joining the Camera Club will receive notices of meetings by mail. If you'd like to join the Club, call R. P. Jutson on extension 1684 at West Street.

H. A. Doll Gives Demonstration in Burlington

Harry Doll, was guest speaker at the weekly supper meeting of Mebane Exchange Club in Burlington on January 15. Mr. Doll presented moving pictures of the 64 patients in the Central Convalescent Home for Infantile Paralysis Patients in Greensboro. The pictures challenged this club in a way that nothing else could do. The men were entertained as well as informed how the almost $100 per day for a patient is used as they watched the care of the patients.

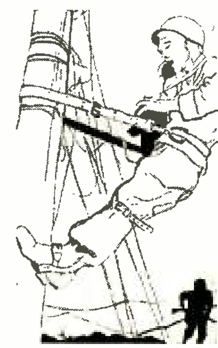
H. W. Straub

F. K. Becker



F. W. Bruehn

CALLED TO ACTIVE DUTY



FRANK K. BECKER, a reservist, has been called to active service with the Navy as a Lieutenant j.g. He has been a member of the Transmission Research Department at the Murray Hill Laboratories.

FRANK W. BRUEHN, a shop mechanic at Murray Hill, has been inducted into the service. At the time the Record went to press, the branch of service which he had entered as a selectee, had not been ascertained.

HERMAN W. STRAUB has been recalled to active service in the Navy with the rank of Lieutenant Commander. A member of Switching Systems Development, his particular interests were common systems, and circuits for manual and toll switchboards.

SERVICE ANNIVERSARIES

Maurice R. McKenney, 35 Years

Immediately after his graduation from the University of Maine in 1915 with a BS degree in Electrical Engineering, Mr. McKenney spent a year teaching at the University. In 1916 he took a job with the Splitdorf Electrical Company in Newark as assistant to the Patent Attorney, A. D. T. Libby, a former Western Electric man, and in 1917 he entered the Patent Department of the Western Electric Company.

After an interval of service in the Army in 1918, he returned to the Patent Department and from then until 1945 he was continuously concerned with patent matters relating to telephone exchange systems, and particularly with automatic switching systems and apparatus. During this time he spent two years or more on a special assignment involving the litigation of a group of telephone exchange patents. In June 1945 he succeeded the late E. W. Adams as General Patent Attorney.

Mr. McKenney has been admitted to the New York State Bar and also to several of the Federal Courts.

The McKenneys live in Summit; they have one son and one daughter who are married, one son at Yale, and one granddaughter. Mr. McKenney's principal recreation is golf.

Angeline McDermott, 35 years

On the first day of spring in 1917, Angeline Stewart McDermott started her Bell System career. Angie, as she is known to most of the Laboratories, originally transcribed dictaphone records. This led naturally to telephone dictation, and Angie was the first girl to be assigned to the telephone in what has since proved to be one of the outstanding services of the Transcription Department. She also developed skill in preparing typed text including mathematical equations, and is a past master in setting up equations and using special removable keys. During World War II she assumed various clerical responsibilities, particularly in connection with telephone dictation. At present, besides special typing work, she is giving clerical service to the supervisors of the Transcription and Secretarial groups.

Angie lives on Long Island. Her interests outside of business include her home, reading, the theatre, walking, needlework and her dog.

Member of the Laboratories Who Will Receive Service Emblems on the March Dates Noted

★★★★★★★

A. McDermott . . . 21st
M. R. McKenney . . 12th

★★★★★★

R. S. Alford 14th
A. J. Busch 21st
P. P. Harvey 27th
C. J. Hay 13th
H. A. Rosenbohm . 30th

★★★★★

E. C. Baacke 8th
J. M. Barstow 23rd
L. P. Brown 31st
F. J. Desmond 3rd
C. C. Engelbart . . 22nd
Helen Grant 7th
G. H. Greb 23rd
J. O. Johnson 7th
J. Kelly 10th
J. H. King 21st
F. W. Koller 21st
W. S. Ross 2nd
H. R. Schneider . . 24th
W. O. Sharp 7th
R. O. Soffel 7th
F. X. Sullivan . . . 22nd
G. A. Wahl 8th

★★★★

Kathleen Ward . . . 30th

★★★

W. W. Bergmann . 17th
J. B. Hays, Jr. . . . 29th
J. H. McConnell . . 15th
L. T. Miller 11th
F. J. Sandor 4th
W. R. Spenninger . 12th
R. W. Ulmer 29th
D. J. Van Slooten . . 8th

★★

J. H. Anderson 9th
L. J. Bierl 2nd
J. R. Bonsiewich . . 5th
Mona Cassidy 23rd
H. Diehl 30th
R. L. Donoghue . . . 9th
W. J. Douglas . . . 11th
R. F. Ewald 30th
W. T. Gerbe 23rd
J. Gerega 2nd
R. G. Kaltenbach . 30th
P. Keane 10th
Anna Loeffler 23rd
D. J. Mahoney . . . 16th
G. T. McCann 2nd
L. D. Michaelson . 2nd
Myra Norris 30th
C. W. Norwood . . 19th
G. A. Palladine 3rd
Ann Reigle 19th
Doris Ribbett 16th
Rose Rupnick 23rd
Isabel Sandifer . . . 30th
J. J. Simon 2nd
A. R. Strnad 30th
P. Tarpey 30th
Dorothy Thom . . . 16th
C. W. Thulin 24th
O. C. Worley 5th
R. D. Wylie 30th

Twenty-one past commanders attended The Old-Timers' Party of the Bell Telephone Post 497 of the American Legion.

Old-Timers' Legion Party

Legionnaires young and old attended the Old-Timers' party of the Bell Telephone Post No. 497 on January 15 at the Terminal Cafe on Vesey Street. Following the color guard to the dining hall were twenty-one of the thirty-one past commanders of the Post. All thirty-one are living, incidentally.

The speaker for the evening was Herbert J. Schroll, Military Communications Manager of Long Lines at 32 Avenue of the Americas. Mr. Schroll's topic was *Military Communications.* The dinner itself was a success and following it old friends went off into groups to renew their acquaintanceship. Everywhere there were hand clasps, hearty welcomes, and the greetings. "Shorty, it must be eight years since I've seen you. Let's join Bill over there and have a talk."

Right—The Color Guard, E. J. McCormack, R. C. Cappy, A. W. Draper, and R. A. Loos.

Left—J. M. Hayward, A. A. Reading, S. G. Timmerman and H. J. Schroll, guest speaker of the evening.

Right—Post Commander J. J. Morrow, C. E. Merkel, Diana Sakelos, John Lea and Florence Lutgen.

RETIREMENTS

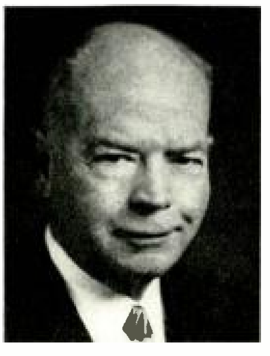
Among recent retirements from the Laboratories are W. A. Boyd with 40 years of service; G. H. Somerville, 35 years; and John Jordan, 20 years.

Walter A. Boyd

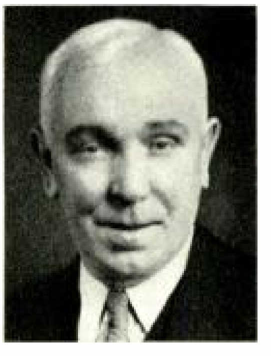
Soon after Walter Boyd left Stevens Tech he joined (in 1911) our Apparatus Development Department as a designer of switching apparatus. During World War I he worked on mechanical design of aircraft radio and submarine detector apparatus; in the early years he also worked on panel switches and the 200 type selector.

When Inspection Engineering (now Quality Assurance) was being organized in 1924, Mr. Boyd transferred to it to handle investigations of switching apparatus. After a few years his responsibilities began to grow; in 1939 he became a supervisor and until retirement he had charge of The Complaint Bureau. In this capacity, one of his important responsibilities was the working out of recommendations where adjustments of major magnitude were involved. He also acted as the Department's office manager and laid out annually the program of Quality Surveys.

W. A. Boyd



G. H. Somerville



John Jordan

George H. Somerville

Since the relay is a key actor in telephone switching systems, every basic design appears in hundreds of forms with different contact arrangements and different windings. For nearly a lifetime George Somerville has been making these modifications, until now there is hardly a telephone relay which has not come under his touch.

Mr. Somerville joined the drafting force of the Laboratories in 1916. With five years on circuits and cable layouts, he transferred to relay studies in what is now Switching Apparatus Development. Here he has been concerned with design of coils, contact arrangements, magnetic circuits, and insulation. He has tested, in the laboratory, relays built to his designs and others'. Among the latter have been many relays of various non-Bell System manufacturers which have shown promise for Bell System use.

During these years Mr. Somerville attended the College of the City of New York and New York University, receiving the degree of B.E.E. in 1941 from New York University. Formerly a resident of the Bronx, where he was chairman of his local Draft Board, Mr. Somerville with his wife has moved to Mount Vernon. On retirement, he has accepted a position with an engineering firm in New York City. Gardening, fishing and color movies will fill in his spare time, if any. His retirement interrupts many years of meeting his close Laboratories friends for Tuesday luncheons.

John Jordan

After some years as a night cleaner, John Jordan became a watchman, first at night, later, in the daytime, when he guarded various entrances to the West Street buildings. For several years past, he has been doing special laboratory service.

Mr. Jordan has returned to Eire, the land of his birth, where his immediate concern will be to restore his health after a long illness.

Forthcoming Retirements

The following forthcoming retirements will be of interest to readers of the Record.

Percy C. Ryder	April 1, 1952
Curt V. Von Zastrow	April 1, 1952
Edward J. White	April 12, 1952
James R. Irwin	May 1, 1952
George C. Vigouroux	May 1, 1952

Because of accrued vacations, the last day worked may be earlier than the date given above.

S. J. Harazim serves a bow string before shooting practice begins.

Six golds are made by Jane Gordon. It was the first time this season a girl on the team had scored a perfect end.

Doreen Byrne and Margaret Monahan select arrows.

Ann Rezek, a guest, Jane Gordon, Doreen Byrne and Margaret Monahan aim for their target.

Archery

The Archery Club at the Laboratories has active groups at Murray Hill, Whippany and West Street. While Murray Hill and Whippany are blest with outdoor ranges, West Street archery enthusiasts travel on Wednesday evenings to the gymnasium of Washington Irving High School where these pictures were taken.

A. L. Jeanne, a picture of precision, is ready to let fly.

A "snow cat" vehicle of the Pacific Telephone and Telegraph Company aids in the rescue of 200 passengers aboard the Southern Pacific Railroad streamliner which was trapped by snow drifts in historic Donner's Pass in the Sierra Nevada Mountains.

Pacific Company Aids in Snow Storm Rescues

When snow storms piled up high drifts in the Sierra Nevadas last January, the telephone and telephone people played major roles in rescue work. One such rescue was that of a Southern Pacific streamliner caught in historic Donner Pass by 18-foot drifts. The conductor of the train struggled a quarter mile through drifts to a lodge where he telephoned for help as efforts to take out 200 passengers were begun. A Pacific Telephone and Telegraph Company "snow cat" aided in bringing out passengers and luggage. The company's efforts, along with those of others, were praised by the railroad.

Another dramatic rescue took place near Reno where two telephone men on their way to the transcontinental radio relay tower atop Mount Rose rescued a rancher's wife and four children. Learning that the telephone company was sending its "snow cat" up Mt. Rose to check the operation of the emergency generator (power supply and alarm wires were down), the rancher, stranded in Reno, appealed to the company to try and reach his snowed-in family.

The rescue party reached the ranch just before the fuel for the stove ran out, and in two trips brought out the entire family. The crew also delivered 500 pounds of food to a ski lodge where several persons were marooned.

Oceana Johnson Interested in Many Hobbies

Oceana Johnson is one of the mainstays of the Women's Activities Committee. Whether the need is for an instructor in a hobby, an organizer for a hobby show, or a skilled worker to turn out handmade items for their bazaar, Miss Johnson is their woman. Her skills range from tatting to bead work, from weaving, Norwegian Hardanger embroidery and rug making, to crocheting and knitting.

Although she has a flair for giving her work a professional finish, Miss Johnson is quick to point out that all of her hobbies are simple to learn; a little time and effort will soon bring dividends in the satisfaction of accomplishment to the neophyte.

"A beginner can easily buy instruction books and material from the five-and-ten cent store for most of the hobbies I have learned," she says. "However, most beginners, when undertaking a new hobby, will find far more practical help from a member of the Women's Activities Committee of the Pioneers."

Miss Johnson is a member of the Transmission Engineering Department where she does computing work and miscellaneous drafting. During World War II she made illustrations for government instruction manuals. She also contributed drawings to E. D. Sunde's book, *Earth Conduction Effects in Transmission Systems.*

Beauty and Household Hints Mark Women Pioneers' Party

Beauty care and household helps were features of the January get-together of the Women Pioneers of the New York Council. Following the demonstration by a Fuller Brush representative, the girls received cosmetic and brush samples. The evening ended with refreshments of coffee and home-made cake.

Mae Keefe, Elsie Weyell, Margaret Tobin, Hattie Bodenstein and Marjorie Broderick were among the forty-two present at the demonstration and party.

News Notes

J. B. Fisk visited the Point Breeze Works at Baltimore where he gave a talk on *Science in the Telecommunications Industry* at the dinner of the Engineer of Manufacturing Department. Mr. Fisk has been elected to the grade of Senior Member of the Institute of Radio Engineers.

At the request of President M. R. Sullivan of the Pacific Telephone and Telegraph Company, D. A. Quarles discussed the Bell Laboratories program of military development work with officers and directors of the Pacific Company and with Public Utilites Commissioners and their Staffs in San Francisco, Olympia, and Portland during the week of January 28.

Recent visits by members of the Chemical Laboratories were, W. J. Kiernan who went to the Hawthorne plant in connection with finishes for carbon deposited resistances; H. Peters, whose visit to the Brush Development Company in Cleveland was in connection with magnetic rubber belts; and V. T. Wallder and B. S. Biggs, who discussed plastic insulated wire problems with the Western engineers at Point Breeze. Polyethylene inspections problems were discussed by J. B. De Coste and B. S. Biggs with Western Electric engineers at the Kearny plant.

A member of the United Nations Postal Administration Joseph Zollman (third from left) spoke on The U. N. Stamp Issue *at the January 14 meeting of Bell Laboratories Stamp Club in the West Street Conference dining room. Mr. Zollman is also secretary of the International Relations Committee of the American Philatelic Association. Left to right, W. S. R. Smith, R. Haard, Mr. Zollman and M. E. Esternaux.*

J. Crabtree, W. L. Hawkins, and R. L. Erickson attended the American Chemical Society's meeting in Newark on January 28 where a paper on *Measurement of Atmospheric Ozone,* co-authored by J. A. Crabtree and R. L. Erickson, was presented.

The Laboratories were represented in interference proceedings at the Patent Office by G. C. Lord before the Court of Customs and Patent Appeals, by H. C. Hart before the Board of Interference Examiners, and E. W. Adams, Jr., before the Primary Examiner.

E. R. Casey and J. W. Falk have been admitted to practice before the New York State Bar.

F. V. Haskell and C. Shafer, Jr., with E. J. Bonnesen of A T & T observed the installation in Michigan of an experimental five-pair wire with a supporting steel line wire core. The new wire is designed to provide additional circuits along an existing cable or open wire lead.

WEEK-END FARMER

THE time for planning your 1952 vegetable garden is now. From *US*, magazine of the United States Rubber Company, comes this story on how to do the job.

First, take time to plan. Lay out your garden on paper. Plant lots of corn. Cut down on string beans, beats, carrots and tomatoes. A dozen tomato plants are all you need for the average family if you take care of them. A single 25-foot row of carrots is ample. Three rows of string beans planted successively should provide plenty. Do plant peas. Include broccoli, it's a dividend crop. Onions are easy to grow and stand up well in storage.

Second, prepare the ground. Your garden will succeed or fail on the basis of soil preparation. Spade deeply and thoroughly. Remove the sod. If you turn it under, it will only grow back to haunt you. Add humus if you can get it. There's nothing like cow manure, but chicken, horse or sheep manure are all good, too. Commercial fertilizer is good, but it does not provide the needed humus. Add lime only if soil is acid.

Third, start planting. Use a string to give you straight rows when seeding. Here are the crops to grow from seed: peas, carrots, beets, beans, corn and spinach. Onions should be grown from sets. Cabbage, broccoli, tomatoes, cauliflower should be grown from plants. See the box on this page for proper planting times. And don't forget to use Spergon and Phygon, seed protectants and they're good crop insurance. Use Phygon on spinach and beets. Use Spergon on all other crops grown from seeds. They give the small plants a better chance of survival. Both chemicals are

YOUR VEGETABLE TIMETABLE

CROP	HOW TO BUY	WHEN TO PLANT	HOW TO PLANT	COMMENTS
Lettuce	seeds (1 pkg. leaf)	as soon as ground can be worked	sow thinly ¼" deep in rows 18" apart	
Endive	seeds (1 pkg.)	as soon as ground can be worked	sow thinly ¼" deep in rows 18" apart	
Parsley	seeds (1 pkg.)	as soon as ground can be worked	sow thinly ¼" deep in rows 18" apart	
Onions	sets (1½ lbs.)	as soon as ground can be worked	plant 1" deep, 1" apart in rows 18" apart	let every 3rd one mature. Use thinnings for scallions.
Carrots	seeds (2 pkg.)	2 or 3 weeks after earliest planting	sow thinly ½" deep in rows 18" apart	
Beets	seeds (2 pkg.)	2 or 3 weeks after earliest planting	sow thinly 1" deep in rows 18" apart	thin—use tops for cooking greens.
Spinach	seeds (2 pkg.)	as soon as ground can be worked	sow thinly ½" deep, in rows 18" apart	use high nitrogen fertilizer.
Peas	seeds (2 pkg.)	as soon as ground can be worked	plant 1½" deep, 2" apart in rows 2' apart	use brush for climbing support
Beans	seeds (3 pkg. bush)	after danger of frost has passed	plant 1" deep, 3" apart in rows 2' apart	no poles needed
Cabbage	plants (24-half red)	as early as plants can be bought	set plants 18" apart in rows 2' apart	mulch
Broccoli	plants (12)	as early as plants can be bought	set plants 2' apart in rows 2' apart	mulch
Tomatoes	plants (12)	as early as plants can be bought	set plants 2' apart in rows 2' apart	mulch—staking optional
Corn	seeds (3 pkg. golden bantam)	after danger of frost has passed	plant 1½" deep, 3" apart in rows 30" apart	thin to 1' apart making 3 successive plantings 10 days apart

This garden is 33 x 60 feet.

powders. Sprinkle them lightly in the seed package before planting.

Fourth, cultivate and mulch wherever possible. You must cultivate your crops to keep weeds down. Cultivate only the top two inches of soil, any deeper will disturb roots of your desirable plants. Don't forget mulching! The mulch is salt hay because it is slow to decompose and contains no weed seeds. Use it for crops grown from plants. As soon as they're in, spread three to four inch layer of hay completely covering plot. Tuck it in close to plants. You can forget them for the rest of the season.

Fifth, side dress crops with fertilizer, three or four times during season. Spread commercial fertilizer lightly on either side of rows.

Sixth, watering is important while plants are young. As crop matures, it is not quite so important unless the weather is adverse.

Seventh, battle insects. Bean beetles are a perpetual pest. Tomato and cabbage worms are sometimes bad. Squash bugs can ruin your squash and cucumbers.

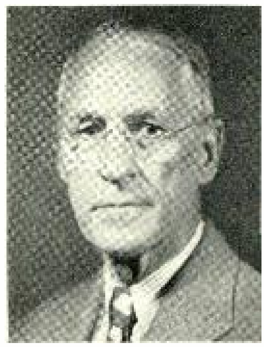
Eight, now comes the happy time—harvesting! Use your own judgment on when the vegetables are ripe. You must check corn ears carefully. They should be filled out, a healthy yellow in color and not watery. Pick beans, corn, peas, carrots and beets too early rather than too late. Onions are easy to tell and incidentally they can be stored for long periods. Leave tops on and hang them in the garage in bunches of six or eight.

A final word of advice. You learn by doing. No story can grow the crop for you. So get out the spade, rake and hoe, and go to it!

RECENT DEATHS

Liss C. Peterson

L. C. Peterson



A. O. Casey

On January 27 Liss C. Peterson, a member of the technical staff, died suddenly at his home in Chatham Township. He is survived by his widow, Mrs. Anita (Krantz) Peterson and his daughters, Sonya and Nina.

We like to believe that there are men of many accomplishments at the Bell Laboratories. Some we notice particularly because of their friendly interest in the many people, technical and non-technical, whom they meet here. They are the ones who stop in the corridors to speak to you and inquire about you, whoever you are. Others we notice because of the interesting and varied subjects which they discuss at lunch. Some are nature lovers, and we see them at noon wandering about the grounds, picking odd wildflowers or just enjoying the outdoors. Some we remember because they work hard at their jobs and accomplish things which make them known far and wide.

It is truly astonishing when all of these qualities are found in one man, as they were in Liss Peterson. At home as at the Laboratories his interests were varied. He was friendly and knew all sorts of people. He was scholarly and read deeply in history and philosophy. He loved and understood music, and many of his friends have enjoyed string quartets at his home. He was public-spirited in his interest in promoting the performance of music and in his interest in the public schools. His love of nature was shown in his long walks near his home and in eastern Pennsylvania, and in his gardener's fascination both with working the soil and with poring over seed catalogues with friends.

With all this, Liss Peterson was a hard and productive worker in various technical fields. When he came to the Department of Development and Research of A T & T in 1925 he first worked in the field of inductive coordination. In 1930 he was transferred to the Laboratories and worked for a time on coaxial cable systems. In 1937 he turned his attention to the theoretical studies of the operation of vacuum tubes and particularly in microwave systems. This led him to important inventions in connection with microwave tetrodes and other devices. Perhaps even more important, his work served as a foundation for understanding many phenomena in other types of tubes, such as traveling-wave amplifiers. After 1945 he transferred his major activity to the field of acoustics and contributed to the theory of the cochlea. He applied to transistor circuits some of his earlier results on generalized properties of transmission networks, and more recently has been investigating the statistical analysis of signals. As an out-of-hours activity, he met with some of his associates to read and discuss books on such subjects as information theory and quantum mechanics.

In this country Liss Peterson's technical status was attracted by numerous publications and by his membership in the Institute of Radio Engineers and the Acoustical Society of America. But he came originally from another land, for he was born in Varberg, Sweden. He received his E.E. degree from the Chalmer's Institute of Technology at Gothenburg in 1920, and after further studies in the Techniche Hochschule in Berlin and the Techniche Hochschule in Dresden he served in the Signal Corps of the Swedish Army. In 1951 his achievements in his new country were recognized in his native Sweden. For his "important contributions to the field of telecommunication and especially for his theory of noise generated in vacuum tubes" he was elected a Fellow of the Royal Society of Letters and Science at Gothenburg.

W. C. Dorgan

L. R. Cox

In the death of Liss Peterson many at the Laboratories lost a dear friend, and the art and the Laboratories have lost an original and enquiring mind.

(*The* RECORD *is indebted to Mr. Peterson's long-time friend J. R. Pierce for this biographical note*).

A. OSBORNE CASEY

A. Osborne Casey, a retired member of the Laboratories, died on December 13. He was born August 8, 1876, and was graduated from Union College in 1899 with a B.S. degree. Before joining the Engineering Department of the Western Electric Company in 1918 he had several years of experience in general engineering work. All of his career in the Laboratories was spent in the Apparatus Development Department, in connection with the preparation of manufacturing information on relays, repeating coils, resistances and other central office apparatus. Mr. Casey retired in 1938. He was a resident of West Hempstead, N. Y., and is survived by his wife.

WILLIAM C. DORGAN

Mr. Dorgan got his early telephone experience as inspector and as repairman of private branch exchanges for the Southern New England Telephone Company. At the outbreak of the war, after nine years of service with that company, he left his position of wire chief to engage with an outside concern in manufacturing and testing telephone and signal apparatus for the Army. In 1918 he returned to the Bell System, this time joining the Western Electric Company, in its Engineering Department which is now the Laboratories. Here he first took charge of installing radio telephones on the patrol boats protecting New York harbor. On the completion of the war, he joined a newly formed group engaged in writing the method of operation of the early panel dial circuits. Later he engaged in relay time studies, analyzing and testing the circuits used in interconnecting the manual and panel systems. He had been engaged in laboratory work with the carrier telephone group of the Toll Systems Department before World War II.

With the outbreak of the war Mr. Dorgan transferred to Whippany where he remained until the time of his death. His first work at that location was the preparation of manufacturing information pertaining to maintenance and replacement parts for shipboard radar. Later he prepared technical descriptions of components for radio and radar equipment for the assignment of Government Agency part and stock.

Mr. Dorgan was active in the First Congregational Church of Chester where he had been a trustee. He is survived by his wife and a son Elliott Dorgan.

LESLIE R. COX

Leslie R. Cox was born in Norris City, Illinois, February 7, 1893, and educated at the University of Purdue from which he received the degree of B.S. in Electrical Engineering in 1922. Following graduation he joined the Western Electric Company at Hawthorne. At the completion of the students' course at Hawthorne he engaged in writing installers' specifications for panel machine-switching exchanges. After a few years outside of the Bell System, he joined the development group of the Laboratories in 1929. His principal interest since had been the development of carrier terminals for broad band systems, particularly modulators and their carrier supply.

He played a large part in the development of many of the circuits for L3 terminals, both carrier and pilot supply. He had also contributed to the development of terminal modulators and demodulators.

An Army veteran, he saw action in Germany and France during World War I and was a member of the American Legion. His other affiliations were the Diamond Hill Community Church and the Masonic Order.

Mr. Cox, who had nephritis for many years, died on January 27. He is survived by his wife Flora, a son L. R. Cox, Jr., a senior at Purdue, and a daughter Mrs. Elia Lefler.

"The Telephone Hour"

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

March 3	Jascha Heifetz, *violinist*
March 10	Marian Anderson, *contralto*
March 17*	Eileen Farrell, *soprano*
March 24	Bidu Sayao, *soprano*
March 31	Clifford Curzon, *pianist*
April 7*	Blanche Thebom, *mezzo soprano*
April 14	Ezio Pinza, *basso*
April 21	Jose Iturbi, *pianist*
April 28	Zino Francescatti and Michael Rabin, *violinists*

* At Carnegie Hall.

Engagements

Mary Anne Bowe*—Thomas J. Doherty*
Jean Helm*—Harry G. Yeager, Jr.
Violet H. Olsen*—William L. Schicke
Helen Schifano—Clifford A. Sjursen*

Wedding

Mary D. Bland—Thomas A. Maras*
Elinor Brodhead*—Kenneth F. Wilson, Jr.
Mary Therese Lehrbach—Laurance A. Weber*
Olive Moore*—Thomas S. McIntosh
Marilyn Stevens*—Ralph T. Hepplewhite*

Births

Robert, January 11, to Mr. and Mrs. William Eichinger. Mr. Eichinger is a member of the Potentiometer Shop at Whippany.

Georgie Canadé, January 16, to Mr. and Mrs. Henry G. Raupp. Mr. Raupp is in the Research Drafting Department.

William David, January 10, to Mr. and Mrs. William T. Sears. Mr. Sears is a member of Switching Systems Development.

* Members of the Laboratories. Notices of engagements, weddings and births should be given to Mrs. Helen McLoughlin, Room 1321, Ext. 296.

News Notes

PROFESSOR JOHN C. LILLY of the Eldridge Reeves Johnson Foundation and the University of Pennsylvania visited Murray Hill on January 25. In 1942 he was appointed an assistant professor of biophysics at the University of Pennsylvania, in addition to his position on the staff of the Johnson Foundation. Professor Lilly discussed *Forms and Figures in the Electrical Activity of the Cortex-Auditory System.*

G. Q. LUMSDEN has been appointed chairman of Sectional Committee O5—Wood Poles, of the American Standards Association. Mr. Lumsden succeeds R. H. Colley. It was under the guidance of Dr. Colley and the late R. L. Jones that the committee, in 1929, sponsored species standards for pole timbers and standards for their dimensions. These universally accepted, country-wide standards facilitated pole line construction particularly under joint use agreements between power utilities and the telephone companies. In 1948 a new specification bringing all species into one standard was adopted under Dr. Colley's chairmanship. This standard introduced several new species of pole timbers and played a prominent part in the relieving of a critical supply situation in the pole market. Most of these new pole species, for example, western larch, are being used on a broad scale today.

J. A. MORTON spoke on *Recent Developments in Transistors* at the January 9 meeting of the Lancaster Subsection of the Institute of Radio Engineers. Mr. Morton described the important advantages of transistors in systems requiring miniaturization, reliability and ruggedness.

IN A MEETING HELD on January 3, the Murray Hill Popular Orchestra elected U. A. MATSON, executive chairman; L. J. SPECK, orchestra director; W. H. KOSSMAN, secretary-treasurer; J. F. POTTER, librarian, and C. H. WALLSCHLEGER, talent director.

PROFESSOR PAUL HERGET, of the University of Cincinnati, visited Murray Hill on January 18. Professor Herget is now professor of astronomy and director of the astronomical observatory at the University of Cincinnati.

His scientific activities have been chiefly in mathematical astronomy, the computation of orbits, and methods of computation. Professor Herget spoke in the Arnold Auditorium on *The Discoveries of the Moons of Jupiter.* He pursued the subject from the discovery of the first four moons by Galileo, the first addition to the solar system in recorded history, to that of the twelfth moon during the last few months.

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