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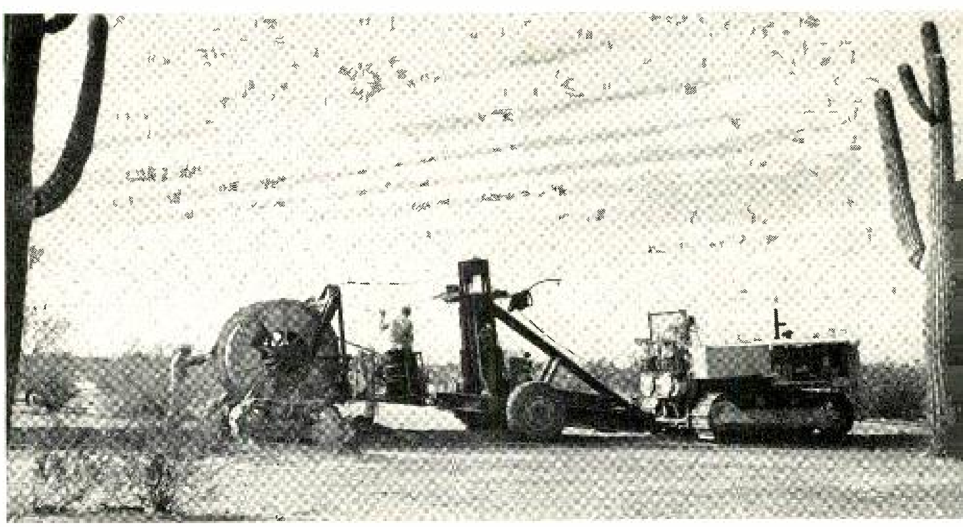
Modified tape armor and Lepeth sheath cable

W. C. ROYAL
Outside Plant Development

An improved cable-protection design known as "Modified Tape Armor" and a composite lead-polyethylene sheath designated Lepeth, have been developed recently into a covering that is expected to furnish better buried cable protection at less cost.

A large portion of the coaxial and balanced pair toll circuits in the Bell System plant is enclosed in cable that is buried in a plowing operation. As compared to similar aerial cable, exposure of the circuits to physical damage is thereby reduced and the magnitude and rate of variations in temperature which materially affect transmission are greatly decreased. However, buried cables are subject to a variety of hazards which have to be considered in the design of the required protective armor, exposed as it is to accidental physical damage from sharp tools or rocks, to chemical attack by soil elements, to electrolytic corrosion and to impairment by rodents or even termite attack. Also, the circuits themselves have to be electrically shielded against interference from power lines and static, and in many regions a special provision against harm from lightning strokes must be incorporated in the system.

Among the several protections which have been developed over the years to suit the



A Long Lines plow train placing buried toll cable in the southern Arizona desert.

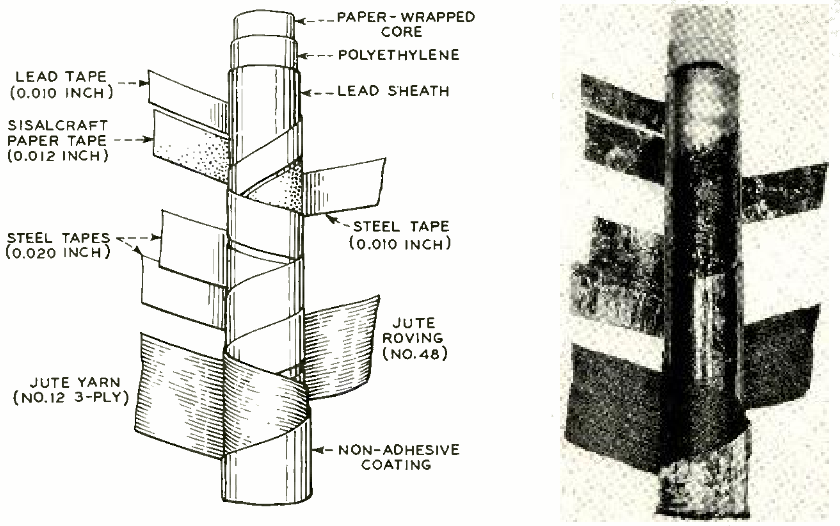


Fig. 1—Modified tape armor cable details.

need in specific areas or conditions, one of the more generally used has been tape armor. This armor* consists of heavy steel tapes spiraled over a paper and jute bedding, an arrangement that mechanically protects the underlying lead sheath and shields the internal circuit wires against external electrical fields. For those purposes it has been satisfactory.

When lightning strikes in the vicinity of a buried tape armored cable a part of the stroke current may flow in the cable, which offers a comparatively low impedance path. The current flows along the tapes in both directions away from the stroke point thus causing voltage drops along the tapes. When this occurs a potential difference is produced between the steel tapes and the lead sheath since these two metals are not in direct contact. The voltage involved is determined by such factors as the magnitude of the lightning stroke, the earth resistivity and the resistance of the steel tapes, and it will sometimes be high enough to cause an arc between steel tape and lead sheath. Experience has shown that the explosive expansion of gases at the arc is at times sufficient to crush the sheath. The newer modified tape armor protection was developed to prevent such arcing by establishing electrical contact between steel and lead, while still retaining the mechanical and corrosion protection qualities of the earlier types of cables together with their shielding properties.

As illustrated in the sketch and photograph of Figure 1 the modified tape armor design consists of 0.010-inch lead tape alternated with 0.012-inch sisalkraft paper tape laid over the sheath, and over them a single 0.010-inch steel tape and an outer protection of two 0.020-inch steel tapes. Since experience had shown that a steel tape directly over a lead sheath sometimes damaged the lead when the cable was handled, the first layer of lead and paper tapes is provided to protect the sheath against the 0.010-inch steel, which serves principally as a buffer against the heavier outer steel tapes. The paper tape is alternated with the lead tape for economy. A covering of one or two layers of jute, the greater number being used on larger diameter cables, is added over the outer steel tapes. Floodings of asphalt compound are applied over the lead sheath, and over each subsequent serving of tape and jute, to help preserve these materials. It was determined that this could be done without destroying electrical contact between metal tapes and lead sheath, and laboratory tests have shown that there is no harmful arcing between them under powerful surges of simulated lightning strokes.

Tests on the modified tape armor have

*Record, *June*, 1930, *page* 465.

shown that it has excellent handling qualities and will withstand the treatment associated with manufacture and installation with a good margin of safety. This type of armor can be applied to all cables from the very small to the largest size with minor machine changes, which is an added advantage from the manufacturing standpoint. This is reflected in reduced overall costs of the cable.

Among the special armors developed in the recent past one type designed for particularly severe lightning areas, known as thermoplastic copper protection, has been described earlier.* The principal components were two tapes of rubber thermoplastic compound, each 0.045 inches in thickness, plus an outer 0.010-inch corrugated copper shield. The lightning protection afforded by this combination comes from the high dielectric strength of the thermoplastic compound and the high conductivity of the copper tape. The copper shield is more vulnerable than steel tapes and the thermoplastic compound is a rather soft material which offers relatively little support to the copper tape. Cases of dielectric failure have occurred as a result of damage during installation, and from stones denting the copper subsequent to installation. There have also been cases where termites have gone through the seam of the copper shield and damaged the thermoplastic tapes.

Although thermoplastic copper-protected cable has been widely used with general success despite these limitations, it was desirable to develop a design which would be less susceptible to physical damage and lower in cost, while still retaining good lightning protection qualities. These objectives were attained by combining Lepeth sheath with the modified tape armor as described. Lepeth sheath is a polyethylene jacket with a surrounding lead sheath. The mechanical support afforded by the polyethylene permits a substantial reduction in thickness of lead sheathing.

Polyethylene as a jacket provides a high dielectric strength of 20,000 volts d-c, or more, between the cable conductors and the sheath, and the lead supplies a path of fairly low resistance. Thermoplastic cement is flooded over the polyethylene during the lead sheathing operation to provide a bond between the polyethylene and lead, and to prevent gas or water from flowing between the two. Should a hole develop in the lead, the seal between the polyethylene jacket and the lead sheath prevents water from coming in contact with more than a small area of the plastic. It would take many years for enough water to diffuse through a small area of polyethylene to cause serious trouble in the cable circuits.

Lepeth sheath is used where the high dielectric strength of the polyethylene is desirable, without outer protection or with any of the standard armors, depending on the field service conditions. Its most frequent use is in combination with modified tape armor.

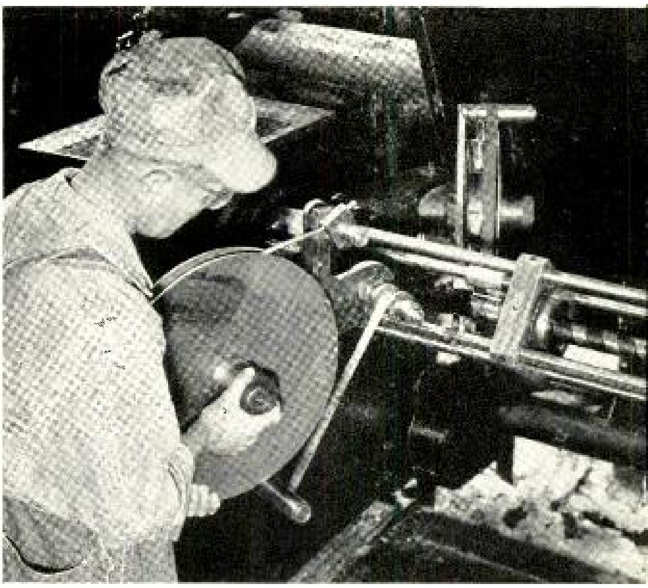
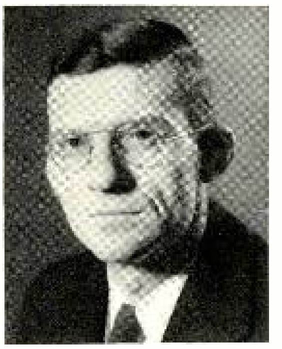


Fig. 2—A Western Electric operator places a roll of lead tape on the taping head which applies the lead and paper over the asphalt coated sheath.

Lightning protection afforded by modified tape armor in combination with Lepeth sheath is expected to be satisfactory for cable routes where the earth resistivity does not exceed 2000 meter-ohms and against stroke currents up to 100,000 amperes. This is based on the polyethylene jacket having 20,000

*RECORD, *July*, 1945, *page* 248; and *April*, 1948, *page* 149.



THE AUTHOR: W. C. Royal joined these Laboratories in 1928 following graduation from the University of Colorado with an E.E. degree. All of his time with the Laboratories has been spent in cable design and development as carried on by the Outside Plant groups located at the Western Electric factories. After a year and a half at Hawthorne and approximately a year at Kearny, he was assigned to the Point Breeze plant in Baltimore. During World War II he transferred temporarily to the Western Electric Company to work on cable being manufactured for the Signal Corps. In recent years, Mr. Royal has been concerned primarily with the development of composite sheaths and protective coverings for toll cable.

volts d-c dielectric strength (the test voltage it is required to withstand at the factory) which is equivalent to approximately a 28,000-volt impulse or lightning voltage. Earth resistivities of between 2,000 and 5,000 meter-ohms are rather infrequently encountered on cable routes and only in rare instances does the resistivity exceed 5,000 meter-ohms.

For those particular locations where the lightning condition is expected to be such that the Lepeth sheath with modified tape armor does not give sufficient protection, copper shield wires placed in the ground a few inches above the cable during the plowing-in operation will provide the additional protection required.

Equipment at the Point Breeze Plant of the Western Electric Company has been developed to apply the new type of armor which is now in commercial production; Figure 2 shows one stage in the process. It is expected that a considerable amount of cable having the modified tape armor will be manufactured, a large part of it in combination with Lepeth sheath. Since most of this cable would formerly have been made with thermoplastic-copper protection, use of the improved design will result in appreciable savings to the Bell System.

This Month's Cover

To study the ejection of electrons from solid bodies, the apparatus shown on the cover of this issue has been devised by H. D. Hagstrum of Physical Research. A focussed beam of positively charged atoms (ions) is obtained by electron impact. It is controllable over a wide energy range from about a thousand to below ten electron volts. Routed through electrostatic focussing lenses, it impinges on a target mounted inside a spherical electron collector. The electrons ejected under various conditions are counted and their velocities are determined. F. J. Koch is shown at the control panel.

Studies and investigations of this nature are important to a better understanding of the functioning of cold cathodes in the glow-discharge tubes that are used extensively in the Bell System, and the studies also contribute to the fundamental knowledge of properties of matter.

JAMES G. FERGUSON
Switching
Systems
Development

Design patterns for No. 5 crossbar

No. 5 crossbar has already a broader potential field of application than any previous dial system, and it is better adapted than any to accept new services and features as they are developed in the future. The novel method of handling calls that has been devised and many of the new circuit features have already been briefly described in the RECORD.* Not less novel are some of the general equipment patterns which have been introduced to enhance the versatility of the system in providing services and at the same time insuring economy in production and maintenance.

Because No. 5 provides so many services, the deviations from office to office will be more pronounced than ever before. It is unlikely that two central offices will be identical in numbers of switch frames of the various types, or in the equipment provided on them. Some of the things which will combine to make each office different are: the numbers of subscribers, the kinds of service they require, the number of times they call, the durations and destinations of their calls, the number of central offices in the same building and in the community, and the nature, variety, and number of interconnecting circuits required to provide for the flow of traffic between the office and all other connecting offices.

All of this implies custom building, and custom building is expensive. It was unusually urgent to keep it within bounds in No. 5 by devising standardized equipment patterns which would not only provide innumerable necessary combinations of services initially, but also enable facilities to be added and traffic distribution to be rearranged to care for growth, change, and the introduction of new features. The primary objective in equipment design for the No. 5

*RECORD, *March*, 1949, *page* 85.

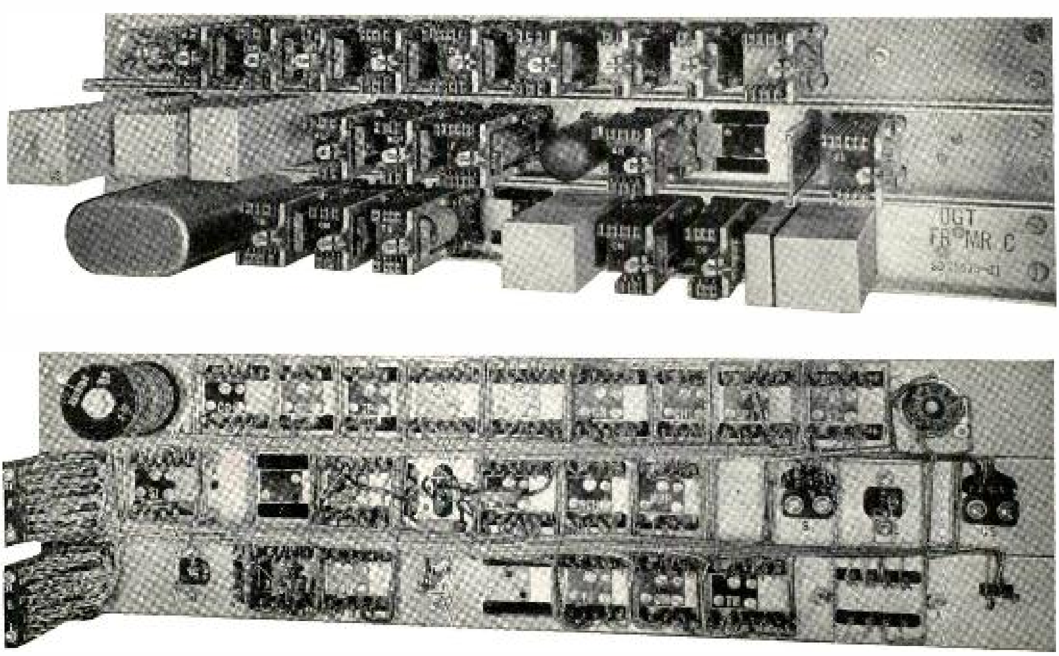


Fig. 1—Front and rear views of a typical functioned unit.

system was to exploit to the fullest extent the great flexibility inherent in the switching plan and, at the same time, to standardize all arrangements in the fewest patterns, with the fewest parts and assemblies for most economical manufacture, engineering, installation, and maintenance. In spite of the fact that flexibility and standardization are frequently incompatible, they have been combined to an unusual degree in No. 5.

Although no two offices are expected to be exactly alike, there are features within each that will be the same. Some are required in varying numbers in all offices, others are optional and specified more or less frequently. To meet this situation, a standard package was designed for each basic combination of features and these packages are used as the building blocks for all frame equipments. These standard basic units, which are generally not larger than one or two square feet in area, are re-used wherever practicable to concentrate demands on the smallest number of items.

These small subassemblies are called functional units. Frequently, an auxiliary service not required in every office employs one or two relays which cannot be economically packaged apart from a related functional unit. Each such option is coded separately for engineering and administration reasons. It may be furnished always or only as required, depending on which arrangement is more economical. All functional units can be bench assembled, wired, and tested, and straight line assembly methods can be employed where justified. Interconnecting wires, precut to length and preskinned, are run along the surface of the mounting plates which support the components and they are connected as run. A new wire with plastic insulation was developed for this purpose which reduces wiring congestion, fire hazard, and contact troubles from lint. The elimination of the wire cutting operation at the bench avoids wire clippings in the units. A typical functional unit of the type discussed is shown in Figure 1.

Frame equipment arrangements were similarly standardized to accommodate all needed groupings of functional units completely interconnected and tested in the factory. To make each frame as self sufficient as possible, it is equipped not only with its

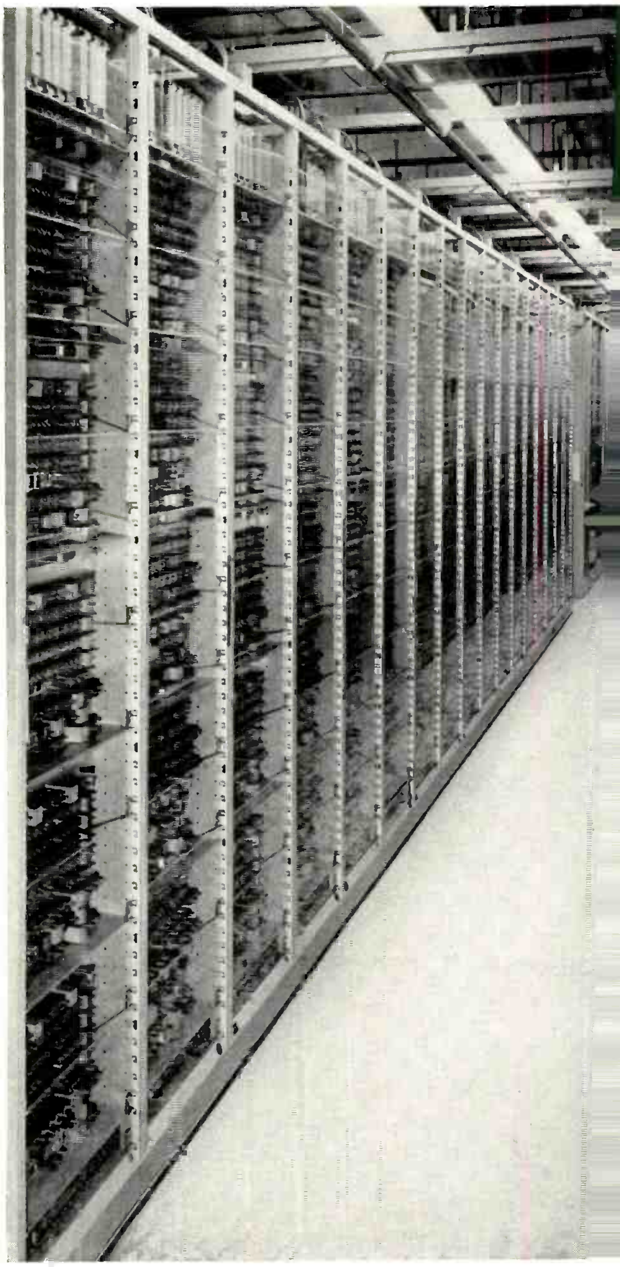


Fig. 2—Section of typical No. 5 office showing frames, covers, cabling, and lighting.

particular complement of functional units, but with fuse panels, test equipment, appliance outlets, talking battery filters, terminal strips, and all other items that serve it. Every frame arrangement permits the frame and its common equipment and wiring to be manufactured apart from its functional units. At a later stage in the assembly, units and frames can be brought together in a flexible manner to provide all needed services. Many combinations can thus be assembled from a few standard frames and a relatively few functional units. Each office can be engineered and manufactured with just the features it needs with as little custom building as practicable.

Patterns were developed for frameworks, fuse panels, testing facilities, and all other frame equipment and wiring to enable a few parts and assemblies of each type to be brought together in different ways to constitute each standard frame, and to permit it to serve any combination of functional units to be mounted on it. Parts, assemblies, and patterns were reduced in number by organizing the frame equipments of all types into a few families with strong family resemblances.

Where at all practicable, one frame unit combination was standardized for use on all jobs. The line link, trunk link, and number group frames are in this category. For other frames, except one type which mounts assortments of trunk and miscellaneous units, ways were found to standardize the frame equipment and wiring apart from its units, and to provide full flexibility to care for its various complements of units without too great reaction on production. Even in the one exception where the frame equipment and wiring as well as the unit complements vary widely from job to job, a pattern was developed which reduced the custom building and made it relatively easy to administer. As a result, a large proportion of No. 5 frames are fully equipped, wired, and tested in the shop, and field installation is reduced to setting up the frames on the office floor, interconnecting them with interframe cables and testing the components and the system as a whole before turning it over to the Telephone Company. A section of a typical No. 5 office is shown in Figure 2.

Another novelty of the new office is the frame construction. Heretofore, most switch frames have used angle, channel, or I-beam steel sections. In the No. 5 system, the uprights are of sheet metal formed into a rectangular box section, which is much lighter and stiffer than former types; formed sheet metal sections are also used for the other structural members. Front and rear covers of a new design are incorporated in the frame in a way that enables frame areas to be covered to any extent desired in one consistent manner. This not only avoids a variety of strip covers and sender type casings, but it frees from cover restrictions the arrangement of apparatus on units and of units on frames.

Cable rack and cabling have been simplified. Much of the effort in planning and arranging switchboard cable on the job has been avoided by adopting a basket type cable rack in which cable is laid without being confined by clips or sewing. Instead of one for each line of frames, one rack over each wiring aisle serves two lines of frames. Each frame has power feeders terminated in solderless connectors which the installer can quickly patch to supply grids in the office for battery and 110 volt service. Appliance outlets are equipped in each frame when it is assembled, and all in one line of

THE AUTHOR: James G. Ferguson graduated in electrical engineering from Queen's University, Canada, in 1923, and then spent three years in Montreal engineering step-by-step equipment for the Northern Electric Company. He then joined the Systems Development Department of the Laboratories where he has specialized in equipment development; step-by-step central offices and PBX's and station systems prior to the war; in radar and radio during the war; and in No. 5 crossbar since the war.

frames are patched together and to a ceiling receptacle by flexible cable. The installer will usually have no conduit to install for these services.

Fluorescent lamps hung from the ceiling will provide improved illumination at two levels, a high level of illumination for maintenance at an individual frame and a lower level for general office lighting. This can be installed by the building contractor before the frames are ready to be put in place, and thus the Western Electric Company installer is freed of the responsibility for mounting and connecting of lights on all frames in an office except the main distributing frames.

MAGNIFICENT PERFORMANCE

An editorial which appeared in the April 15 issue of Forbes *magazine.*

American Telephone and Telegraph Co. never ceases to astound this writer. *Forbes* recently moved its offices, and by the nature of this business we couldn't afford to shut down any normal operations at all. One of the more complicated aspects of the move, it seemed to me, would be on the telephone side—switchboards, extensions, no interruption of service, etc. But New York Bell Tel made it less troublesome than arranging for a new window washer. One of their engineers came in, heard the problem, learned what was wanted; ahead of the deadline the new telephone set-up was functioning fully, and we never missed a call.

The job wasn't merely done well—it was done *pleasantly*, helpfully, courteously. The Tel men didn't just do a telephone installation—they did a public relations job along with it.

Here is a public utility, a "monopoly," exposed daily to millions of contacts with millions of people, that enjoys a public favor unmatched by almost any other major corporation in America. Remarkable, when you realize that countless times in a day countless people *could* get mad at the operator, at the service department, and so forth. The public relations job of A T & T could be the biggest nightmare imaginable, from the viewpoint of opportunities to irritate the public!

Why, instead, is it considered a prime example of free enterprise?

Because a great many years ago able men foresaw the peculiar dangers the System faced; they were not Johnny-come-lately in the field of public relations. They began, from president to telephone operator in Podunk, to practice Public Relations before the term was invented.

Today all Americans, and thousands of investors, benefit from the ability and foresight of A T & T's management.

Radioactive isotopes in timber preservation studies

Exploratory studies at the Laboratories indicate that radioactive isotopes as tracers offer a versatile and sensitive means for observing in the laboratory the complex movements of water and preservatives in telephone poles. This article describes initial experiments conducted cooperatively by L. H. Campbell and L. R. Snoke of the Outside Plant Department and J. D. Struthers of the Chemical Laboratories as early as March, 1949.

Preservation of telephone poles, which involves first conditioning either by artificial seasoning, such as heating or steaming, or natural drying followed by impregnation with a preservative, depends critically on the mechanics of liquid movement in the wood. In turn the movement of liquid involves countless small capillaries, membranes, and openings of molecular size in the wood, as well as complicated temperature and pressure relationships. With existing methods of study, it has been possible to determine the amount of water or preservative present in a piece of timber, but difficult to apply these methods to analyzing the exact location or relationship of these materials to specific parts of the cellular structure. Radioactive isotopes incorporated with water or preservatives such as greensalt, creosote and pentachlorophenol offer the possibility of locating and measuring concentrations of liquid or preservative in any part of the structure.

The tests described in this article were made with a water solution of strontium chloride to which radioactive isotopes of strontium (Sr^{89} and Sr^{90})* had been added. In view of similarities in the movements of all liquids in timber, it was felt that the information obtained with water might cover the general problems associated with the use of tracer isotopes. The results are now serving as a guide to the study of tagged water-soluble salt preservatives such as greensalt, and will be adapted to the organic preservatives when suitable methods of incorporating tracer isotopes with them have been worked out.

Slices of wood are cut with a microtome for Geiger counter tests.

A piece of untreated southern pine pole timber, twelve inches long and five inches in diameter, was impregnated by a hot and cold soaking procedure in the radioactive solution. After the timber had absorbed approximately 100 per cent of its own weight of the solution, it was removed and discs one-half inch thick were cut. Radioautographs, Figure 1, were then made of the dried disc samples by pressing a cross-sectional face against an X-ray film for exposure

*The isotopes were obtained from Oak Ridge National Laboratory on allocation by the U. S. Atomic Energy Commission.

times ranging from two to six hours and then developing the film in the usual manner. The darker area on the film registers the points of the more intense emanation and therefore of higher concentration of the isotopes in the wood.

As may be seen by comparing the radioautograph, Figure 1, of a section with an ordinary photograph of a similar untreated section, Figure 2, the radioactive tracer has given a good reproduction of the cross-sectional structure of the timber. The clear areas show the knots, checks (cracks) and heartwood where the radioactive solution did not penetrate. In the photograph, Figure 2, of the cross-section appear the alternating light and dark bands corresponding to the spring and summer growth which together constitute the annual growth ring of a tree. In the radioautograph, the summerwood again appears darker, indicating that it absorbs more of the radioactive strontium. The value of the radioautograph lies primarily in the fact that the impregnant can be studied *in situ* without destroying its relationship with the wood. With the sample kept intact, changes in this relationship caused, for example, by variations in drying may be recorded through a sequence of radioautographs.

Close examination of the radioautograph reveals an even darker area at the borders of certain summerwood bands indicating higher concentration of the active solution. This finding suggests that a different type of wood structure may be present in the transition phase of growth from springwood to summerwood. Likewise, in the inner part of the sapwood which immediately surrounds the heartwood, there is a darkened area which almost obliterates the banded appearance prevalent in the outer sapwood, indicating again a higher concentration of the radioactive strontium. It can be seen further that there are rather extensive light or bleached areas in the sapwood extending across several annual rings, which obviously represent low retention of the solution. There were other pertinent phenomena encountered in this initial work which will require further experiments to explain.

In the seasoning or drying of timber, the movement of the water toward the outside may take place by a capillary passage of liquid water, or by evaporation of the water within the cells followed by the diffusion of the vapor to the outside, or a combination of the two. The light shading of the springwood in Figure 1 suggests, for reasons beyond the scope of this article, the possibility that the discs dried principally by capillarity rather than by vapor diffusion. It was concluded that if such were the case a radioautograph of the radial face would show a concentration of salt at the upper edge where it intersects the cross-sectional face, from which final evaporation took place with a resultant deposition of the salt. Figure 3 is

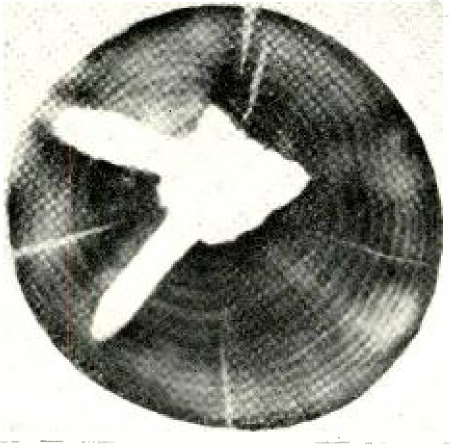


Fig. 1—Radioautograph of cross-sectional face of southern pine that has been treated with radioactive strontium.

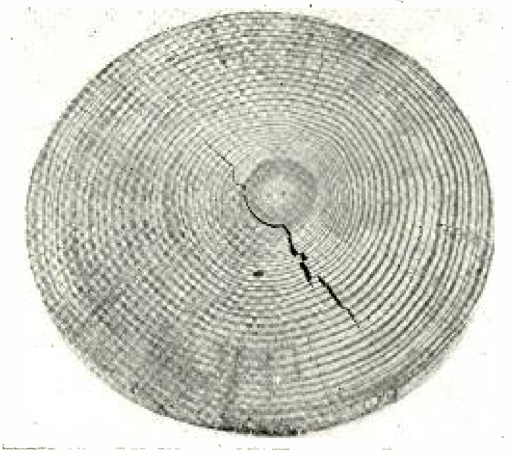


Fig. 2—Photograph of cross-sectional face of untreated southern pine showing spring and summer growth bands.

a radioautograph of the radial face showing such a deposition of strontium, substantiating the interpretation which was made of Figure 1. It is felt that a radioautograph of a wet disc would have revealed more details concerning water movements and retentions, especially if the drying of the wet disc had been restricted to a radial direction. Techniques will be developed which will permit these features to be covered in the continuing work.

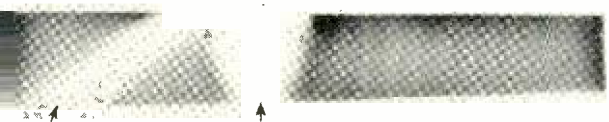


Fig. 3—Radioautograph of radial face of disc (Figure 1) shows heavy deposit of strontium at top and sides which were exposed during drying.

While the degree of shading of the radioautographs provides a grossly qualitative interpretation, the Geiger counter data are relied upon for accurate quantitative relationships: for the counter measures the number of particles being emitted from the radioactive material, and, from that count, the exact quantity of the material in the sample can be determined. Figure 4 shows graphically, from Geiger counter data, the concentration of the solution in the sapwood of the impregnated timber immediately after its removal from the radioactive solution. The data were obtained by slicing on a microtome sections 125 microns (0.004 inch) thick from the springwood bands, from the outside toward the center of the timber, and measuring the radioactivity in each section with the counter. The resulting curve shows the diminishing concentration of the water solution from the outside toward the center of the timber. The rise in the curve at an approximate depth of one and one-quarter inch marks the area of high salt concentration around the heartwood. Since the counter data presented in Figure 4 were taken on samples from the wet specimen, they cannot be compared directly with the radioautograph of the dry disc in Figure 1. Furthermore, there are some differences between the counter data on wet samples and the radioautographs of the dried disc which could not be resolved in this initial work.

To check the apparent higher concentration shown by Figure 1 in the dark borders of the summerwood, equal tangential slices, 80 microns (0.003 inch) in thickness, were cut on the microtome (see page 249) starting in the springwood and progressing through the next summerwood band into the following springwood band. The Geiger counter data which were obtained gave supporting evidence of the gross qualitative features shown in the radioautographs of these areas.

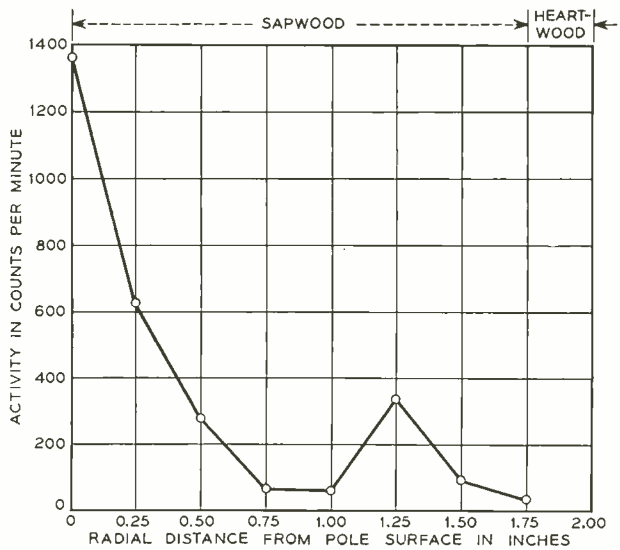


Fig. 4—Geiger counts disclose decreasing concentration of strontium towards interior of pole.

The results of these exploratory tests are so encouraging that additional tests are now under way. Future investigations will be pointed toward an understanding of the fundamental relationships of wood and preservatives, important in timber preservation.

Historic firsts:

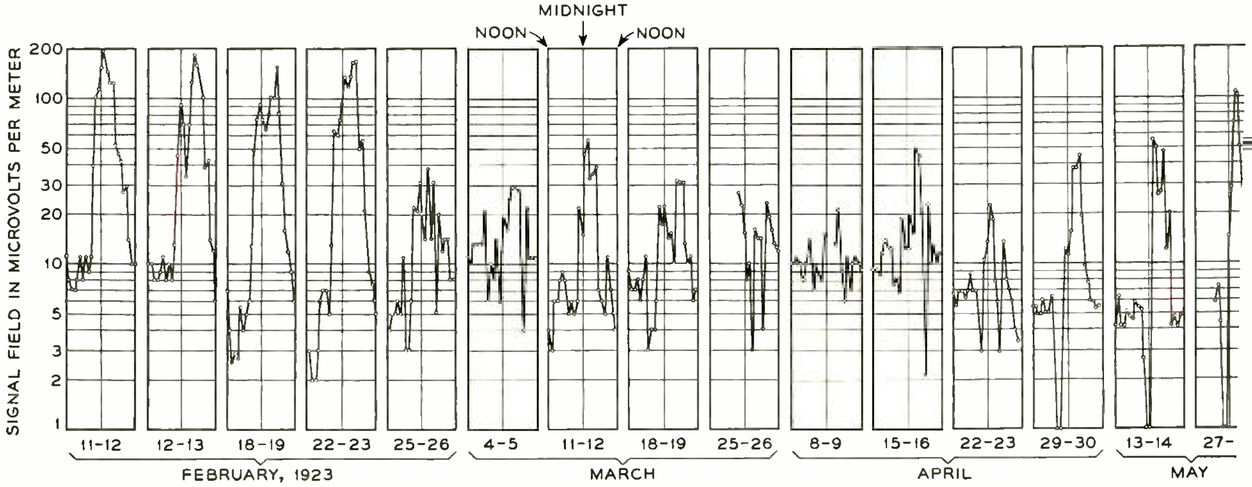
Sun spots and radio

For the first commercial transatlantic radiotelephone channel, put into service by the American Telephone and Telegraph Company in 1927, transmission was at the longer wavelengths – using frequencies in the neighborhood of 60 kc. At this frequency the energy usually received at the distant end during the daytime is not particularly subject to variations in the ionosphere. All the more recent channels, however, have been operated at the shorter wavelengths—using the sky wave exclusively. It has been found that, in general, better and more economical transmission is possible at these higher frequencies. In spite of this fact, the long wave channels have never been abandoned, although they are retained primarily as a standby. Put in its briefest form, the reason for their retention is sun spots.

For many years prior to the opening of commercial transatlantic service, the Bell System had been experimenting with radiotelephone transmission, and successful one-way transoceanic telephone transmission had been achieved as early as 1915.* Long before this, in connection with early long-distance radiotelegraph tests, the general features of long wave radio transmission had been discovered. It was known, for example, that attenuation over land was greater than over water, that attenuation was less for the longer than the shorter wavelengths, and that signal fields were generally higher at night than during the daytime. Measurement techniques were not adequately developed, however, nor were the measurement programs extensive enough to develop an adequate picture of normal transoceanic transmission.

With the possibility of commercial radiotelephone service in view, the American Telephone and Telegraph Company began a series of weekly measurements of transatlantic transmission in 1922. Measurements at 57 kc revealed very plainly the general transmission pattern, better transmission at night and poorer by day, but after two months of testing, a weekend test suddenly

*RECORD, *September*, 1943, *page* 5.



Normal alternation between day and night radio transmission for twenty-four hour tests during period fr February 11 to March 28, 1923.

showed transmission very little better at night than during day and at times even poorer. Engineers had been cognizant of irregularities in radio transmission for some time but, because of inadequacies of quantitative transmission data, attempts to correlate them with other natural phenomena were not conclusive. Glazebrook's *Dictionary of Applied Physics*, for example—which was published in 1922—speaks of "the negative results of the inquiries promoted by the British Association Radiotelegraphic Committee into the possible connections between wireless telegraphic phenomena, auroral displays, and magnetic storms."

This departure from good nighttime transmission encountered in the spring of 1923 is evident in the accompanying graph, which shows the normal alternation between day and night transmission for various twenty-four hour tests during the period from February 11 to 25, but decidedly irregular transmission between then and the latter part of April when the normal cycle showed signs of returning. Similar abnormalities were experienced in late September and early October. In an effort to correlate these transmission irregularities with magnetic storms, C. N. Anderson—who was in charge of the studies—wrote to both the Department of Terrestrial Magnetism of the Carnegie Institution and to the U. S. Coast and Geodetic Survey. Both the correspondents reported that there were no storms on the dates indicated. The Coast and Geodetic Survey, however, added that there had been a magnetic storm on September 26 and 27.

Since the field strength measurements had been made only on weekends, which were the only times the channels were available for test, there were thus no measurements available for September 26 and 27. It then occurred to Anderson that the disturbances of radio transmission might still be caused by solar emanations, usually associated with sun spots, as were the magnetic storms, but because of a longer period for recovery, the disturbed radio conditions would still be present after the magnetic storms had disappeared. With this in mind, he went back over his transmission measurements and compared them with data on magnetic storms and found that in all cases a magnetic storm had preceded or accompanied the periods of disturbances in radio transmission. Later studies completely verified this correlation between abnormal radio transmission and solar disturbances first established in October, 1923.

These and other transmission phenomena were reported by Anderson in the *Bell System Technical Journal* for July 1925. The presence of radio transmission disturbances after the magnetic storms had disappeared make it appear as if the magnetic disturbances were related to *changes* in solar emanations, and the disturbances in radio transmission to their presence. Although these solar emanations affect the nighttime sky wave fields of long waves as well as the sky waves at shorter wavelengths, the daytime long-wave fields are not only undiminished but are actually somewhat increased. Short-wave transmission, on the other hand, at all times is affected by disturbances in the upper regions of the atmosphere. To insure good daytime transmission during disturbed periods is the principal reason that the original long-wave transatlantic channels have been retained to the present time.

Improvements in crystal units for precise frequency control

A. W. WARNER, JR.
Transmission Apparatus Development

In modern communications, wherever a precise control of frequency is needed, it is almost universal practice to use a quartz crystal unit. To a large extent, maximum utility of communication channels, both for wire-line carrier and radio relay, depends on the degree of precision and stability of frequency that can be attained. Therefore, the search for better crystal units at reasonable cost goes on continuously.

Piezoelectric materials convert electrical energy to mechanical energy and vice versa, thus permitting the mechanically vibrating crystal to be electrically driven. Oscillator circuits for this purpose have been highly developed; thus the problem of increased accuracy lies principally in the improvement of the mechanically vibrating piezoelectric crystal plate and its supporting unit.

Quartz is a highly stable and mechanically strong material, capable of vibrating with a very low temperature coefficient of frequency and with a very high "Q" or efficiency. It is therefore ideally suited as a frequency-control element for oscillators. The problem is to devise a means of coupling these properties to an electrical circuit without introducing loss or affecting the frequency. It is the quartz plate, plus the physical coupling devices, such as the electrodes, the mounting wires for physical support and electrical connection, and the housing that comprise a quartz crystal unit. The precision with which the quartz is shaped, the degree to which the effects of such shaping and distortion are removed, the accuracy with which electrodes are mounted, and the degree of contamination are all factors in the design of a quartz crystal unit for precise frequency control.

During World War II, the demand for quartz crystal units was enormous. To meet the need for millions of crystal units in the five to ten megacycle region, the fundamental high-frequency plated crystal unit was developed, and for the first time a rugged and inexpensive crystal unit, quickly and precisely calibrated, was made available. This is a crystal unit consisting of an accurately ground and etched quartz blank on which is directly condensed a thin film of twenty-four carat gold to form an electrode on each side. Electrical connection and physical support are provided by spring mounts cemented to the crystal plate, and the whole is enclosed by a bakelite case.

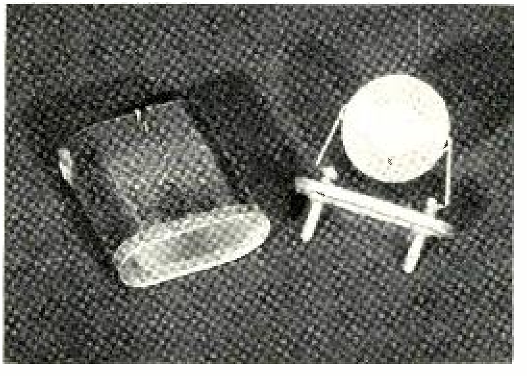


Fig. 1—One of the overtone crystals removed from its unit cover.

Toward the end of the war, several improvements were made in high-frequency plated crystal units. A metal and glass hermetically sealed holder was substituted for bakelite, and its size was standardized. Such a holder is necessary to forfend the effects of foreign materials on the resonant frequency of a quartz crystal plate. To maintain a stability in service of one part in ten million, which is not uncommon, it is necessary to avoid changes or contaminations of the surface of the order of a thousandth of a microgram. Because of this, and also because complex modes of vibration due to reflections from the edges of the crystal plate often obscure the precise measurement of units in process, it is not surprising that many people consider some aging—change in frequency with time—as unavoidable. Theories of release of strains and "normalization" of the metal-to-quartz bond are often used to explain small frequency changes after manufacture. Although release of strains and changing elastic constants can cause frequency aging, the major part of what has been called "normalization" in this type of crystal unit has been found to be due to a gain or loss of matter either within the vibrating system itself or in its surroundings. Since a change in mass of only a few hundredths of a microgram may affect the behavior of the crystal, extreme precautions must be taken. Vapor within the sealed container may readily carry masses of this magnitude to or from the face of the crystal, or two or more metals forming an electrode may diffuse and thus change the distribution of the mass to a harmful degree.

When the need arose for a crystal unit that would combine the ease of manufacture and operating characteristics of the five to ten megacycle plated crystal units with operation at still higher frequencies, the overtone plated crystal unit shown in Figure 1 was developed, extending the frequency range to 100 megacycles. An overtone crystal unit is one that is designed to operate on an overtone of its principal mode of vibration, much as a violinist causes a string of his violin to vibrate at a high frequency by lightly touching the string at one-half or one-quarter of its length. By using an overtone mode of vibration, the manufacture of extremely thin and fragile quartz plates is avoided, and stability and Q are improved.

With the development of the plated overtone crystal unit, the problem of interfering complex modes of vibration due to edge reflections disappears. This is because the ratio of frequency of operation to the dimensions of the quartz blank is increased to such an extent that the edge of the plate is so many wavelengths away from the vibrating portion that it has no effect on it. Essentially, only the small volume of the crystal between the two centrally located electrodes is vibrating. Since with these overtone crystals the frequency is high enough, fifteen megacycles or higher, to avoid the effects of the edges, and since the crystal is supported at its edges where there is no motion, mounting problems also disappear, and only the problems of contamination and aging need be solved to achieve a more stable and predictable frequency standard.

It attempting to solve these latter problems, a greater effort was made first of all to assure that all parts were as clean as possible at the time of calibration and assembly. A special degreaser, invented by D. M. Ruggles, was used to clean the partial assemblies to a degree impossible with commercially available degreasers. The crystal unit covers, shown in Figure 1, are made of nickel silver, and an acid dip treatment was added to the cleaning process to completely remove any surface coating. The crystal units were vacuum baked and filled with dry air. To obtain air sufficiently vapor free to insure that no matter would be deposited on the crystal face, the air used to fill the holders was first dried by exposure to calcium chloride to remove most of the water vapor, and then filtered through glass wool. It was then

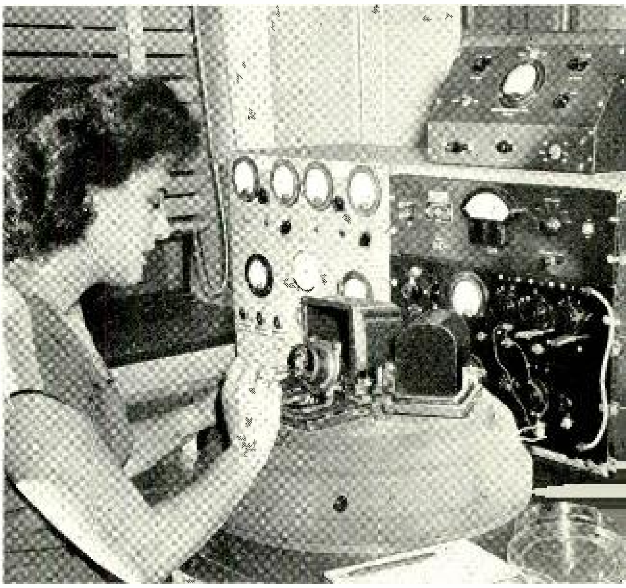


Fig. 2—One of the crystal plating units in the Laboratories.

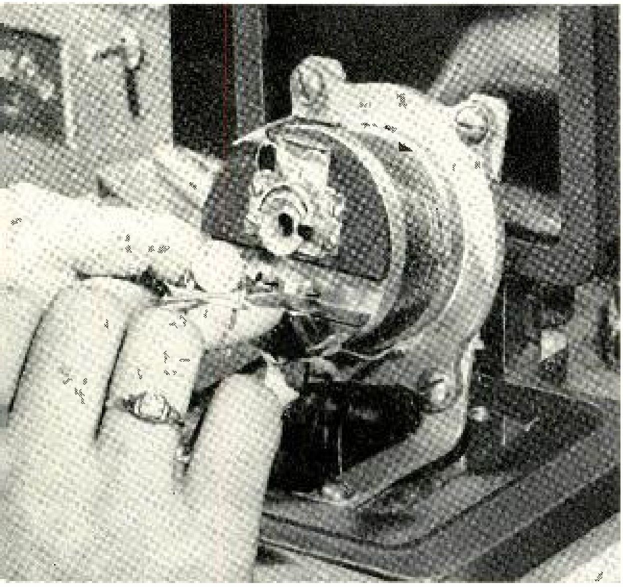


Fig. 3—A close-up of Fig. 2 showing a crystal being placed in the plating unit.

passed through a tube containing phosphorous pentoxide, a chemical that reacts violently with water vapor. To remove any other substance remaining that might condense or form vapor, the water-free air was passed through a cold trap at −70 degrees C. The use of pure gold electrodes, finely lapped and etched quartz plates, and hermetically sealed cases served to keep aging to a minimum. These operations were so successful in arresting the small change in frequency following the calibration of the crystal units to their final frequency, that greater precision was called for in the calibration procedure itself.

High-frequency plated crystal units of Bell System manufacture, including the overtone type, are individually brought to the exact desired frequency, within a small tolerance, by adding a small amount of metal to the electrode while the crystal unit is operating in an electrical circuit. The equipment for accomplishing this is shown in Figure 2, and in greater detail in Figure 3. It consists of: a vacuum system fast enough to reach a pressure of 10^{-4} mm of mercury in about thirty seconds; a gold loaded tungsten filament to vaporize the gold, and a masking device to limit the added gold to the area of the electrodes. By means of an automatic turret, one crystal unit can be loaded into the apparatus while another is being pumped, and while still another is being calibrated. As many as 120 crystals per hour have been calibrated in this type equipment under ideal conditions.

With the stability of the overtone type crystal unit greatly improved by the new cleaning and sealing procedures, a smaller frequency tolerance could be established, and accordingly better methods of controlling the added metal were worked out and put in use. An improved masking technique, which locates the mask within a few thousandths of an inch of the vibrating position of the quartz plate by contact with the quartz plate itself, was successfully introduced into the calibrating fixture to restrain the added gold to a specified area. Closer temperature control, a better vacuum, and circuits capable of measuring crystal unit frequencies to one part in 10^6 during calibration were also developed and put in use.

THE AUTHOR: A. W. Warner received the B.A. degree in Physics and Mathematics from the University of Delaware in 1940 and the M.S. degree in Physics from the University of Maryland in 1942. He spent one year as instructor in physics at Lehigh University and another in the Engineering Department of Western Electric engaged in the design of testing equipment for quartz crystal units for the armed services. In 1943 he joined the Technical Staff of the Laboratories and engaged in the development of high-frequency quartz crystal units. At present he is designing crystal units for the L3 carrier system.

These improvements in cleaning and calibration have made possible better crystal units for our entire series of plated oscillator crystal units and, with the overtone crystal unit, have resulted in a ten-fold improvement in stability and frequency tolerance. It now appears possible for the first time to make a low cost, compact, crystal unit for secondary frequency standard use, within 0.0005 per cent in frequency and with a variation of less than three parts in ten million per month (0.00003 per cent). In an oven 2 in. x 2 in. x 4 in. there is now operating at the Laboratories a twenty megacycle unit in a one tube (dual triode) oscillator circuit whose cyclic variation is less than two cycles (0.00001 per cent) and whose monthly aging rate is of the order of two cycles. If a clock were to be operated by such a standard, it would take six months to accumulate an error of only one second!

As a generalization, it might be said that the nearer we approach pure unadulterated quartz and uniform pure clean gold for the parts involved in the vibrating system of a plated crystal unit, the greater will be the stability. It is not possible to achieve this goal in all frequency ranges, because of the suspension or mounting requirements at low frequencies, and other limitations at very high frequencies, but there is a large range of frequencies in which these techniques permit meeting new standards of precision, stability, and low cost.

An electrical analog of the inner ear

An electrical network that simulates the mechanical action of the inner ear has been designed and built by members of the Transmission Research Department to solve a mathematical equation that occurs in a theory of hearing originated by L. C. Peterson. It provides means for checking the mathematical theory under various conditions more readily than is possible by numerical calculations. Duplicating the action of the cochlea of the inner ear, the network sorts out the frequencies present in the sound waves entering it, causing them to appear at different places along the network.

The cochlea, which looks like a tiny snail shell, transforms the sounds entering it into electrical impulses in the thousands of nerves leading into the brain. It consists of two channels separated along their length by the basilar membrane, which moves under the influence of the sound pressures. Each region along the membrane responds readily only to a range of frequencies: the nearer end responding to the higher frequencies and the farther end to the lower, with intermediate frequencies affecting intermediate positions. Tiny hair cells embedded in the membrane send out electrical impulses that are carried to the brain by the auditory nerve. More impulses are sent where the motion of the membrane is greatest, so that the cochlea acts as a crude frequency analyzer.

In detail, the network built to reproduce this action is a transmission line of 175 sections, each section being composed of inductors and capacitors. The values of the components differ from section to section in the same manner as the mechanical constants of the cochlea. The shunt element in each section corresponds to the basilar membrane, and is a series resonant circuit, the resonant frequency ranging from about 17,000 cycles at the first section to 500 cycles at the 175th section. The voltages at various points along the line correspond to the amplitude of motion of corresponding points along the basilar membrane. These voltages are available at jacks for analysis. Measurements made show reasonably good agreement with observations on the cochlea.

This network, designed and constructed by B. P. Bogert, will be described in detail in a forthcoming issue of the RECORD. A technical paper by Peterson and Bogert describing the dynamical theory of the cochlea appears in the May issue of the *Journal of the Acoustical Society of America.*

Sender link frames for No. 5 crossbar

RICHARD A. SWIFT
Switching Systems Development

When a call from a No. 5 crossbar office requires pulsing to another office, a marker must connect a sender to the outgoing trunk to pulse out the digits for the called number. Depending on the type of office to which the trunk is connected, any of four types of pulsing may be required, and a different type of sender is used for each. After the marker has received the called number from a register, it selects both a trunk link frame that has an idle trunk circuit to the desired destination and an idle sender of the proper type. Since the trunks to any one destination will in general be distributed over a number, and perhaps all, of the trunk link frames, and since the senders of each type must be available to all trunks of that type, it is necessary to provide a flexible means of connecting any sender to any trunk that requires its type of pulsing. This is accomplished by having the trunks and the senders appear on crossbar switches of a sender link frame.

Such a frame carries a maximum of ten crossbar switches having trunks connected to their verticals and senders to their horizontals. All the trunks assigned to one switch are associated with the same trunk link frame, and there may be as many as four of these switches associated with trunks connected to one trunk link frame. Senders are arranged in groups depending on their type of pulsing, and all senders of a group are multipled to all switches of all sender link frames that have trunks requiring that type of sender. The only exception is where there are more than ten senders of one type. Under this condition, the senders are divided into two groups, and each group will be associated with a different set of trunks. Omitting this latter arrangement, the association of trunk link frames, senders, and sender links is indicated in Figure 1.

Since flexibility is desired in associating trunks and senders with sender link frames, there is no fixed pattern of connecting the trunks to the verticals of the sender link switches or of connecting senders to their horizontals except that, as already mentioned, any one sender link switch serves trunks of only one trunk link frame, and any one sender is always assigned to the same horizontal of all the sender link switches to

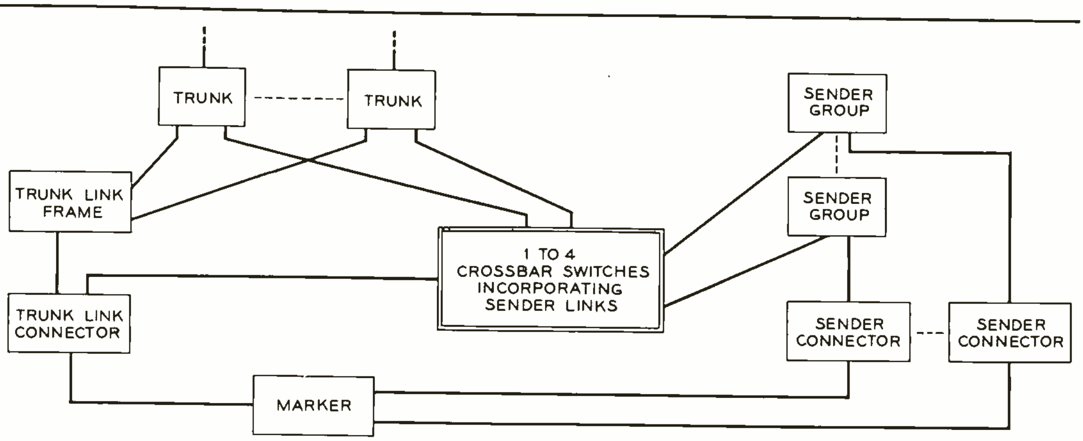


Fig. 1—Block diagram showing connecting paths to the sender link switches from the various trunks, sender groups, and trunk link connectors.

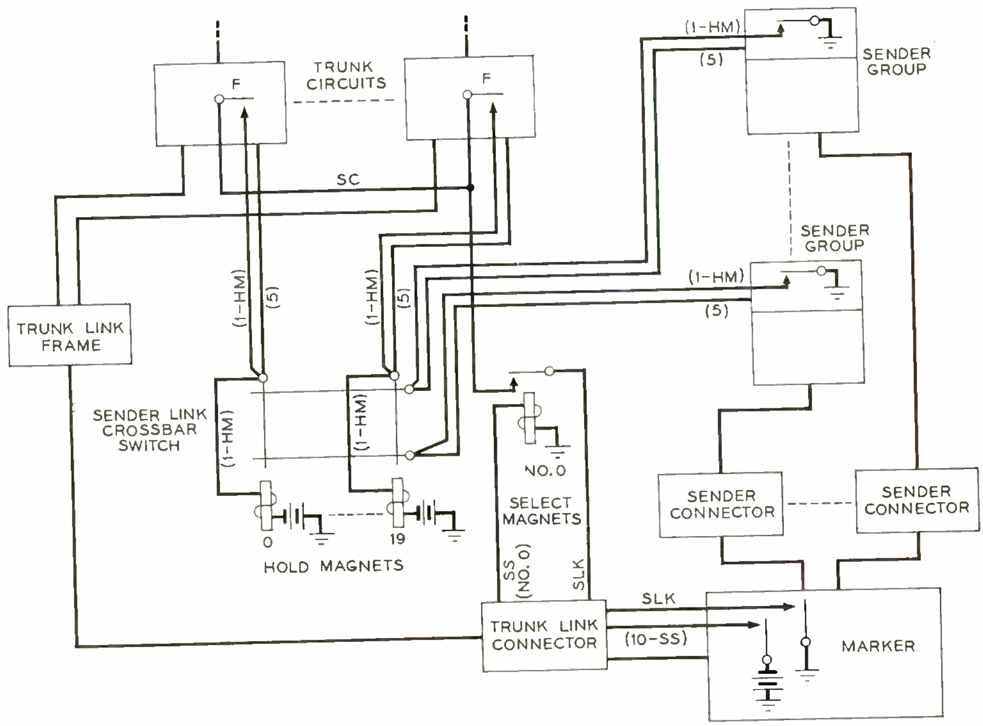


Fig. 2—Paths over which the select and hold magnets of the sender link switches are operated.

which it is connected. The marker has no direct access to the sender link switches but operates the proper select and hold magnets through the trunk link connector and sender it has selected for use. How this is accomplished is indicated in Figure 2, which shows one of the four possible crossbar switches comprising the sender link for one particular trunk link frame.

After the marker has seized a sender, it obtains from it the horizontal level to which that sender is connected on the sender link switches. The marker has ten SS leads running to the connectors for all the trunk link frames, and from the connector these leads run to the select magnets of the sender link switches associated with that trunk link frame. The No. 0 SS lead is connected to the No. 0 select magnet of all of the sender link switches associated with the trunk link frame selected; the No. 1 SS lead is connected to all the No. 1 select magnets, and so on. After the marker has received the proper level number from the sender, it connects battery to the corresponding SS lead, and as a result the corresponding select magnets of these sender link switches are operated.

The marker connects ground to an SLK lead, which is also extended to the sender link switches through the trunk link connector. Through contacts associated with the operated select magnets, this SLK lead is connected to an SC lead that is multipled to all the trunks appearing on the same switch.

The sender link switches are of the six-wire type—each crosspoint consisting of six contacts. Two of the contacts connect to the tip and ring conductors of the trunk and are used for pulsing; the other four are used as control leads between sender and trunk. Each hold magnet of the sender link switches is connected to an HM lead that forms one of the six leads connecting the trunk circuit to the vertical of a sender link switch. After the marker has seized the trunk, the SC and HM leads are connected together in the trunk circuit. As a result, the proper hold magnet is operated from the ground on the SLK lead in the marker, through the trunk link connector, the contacts associated with the

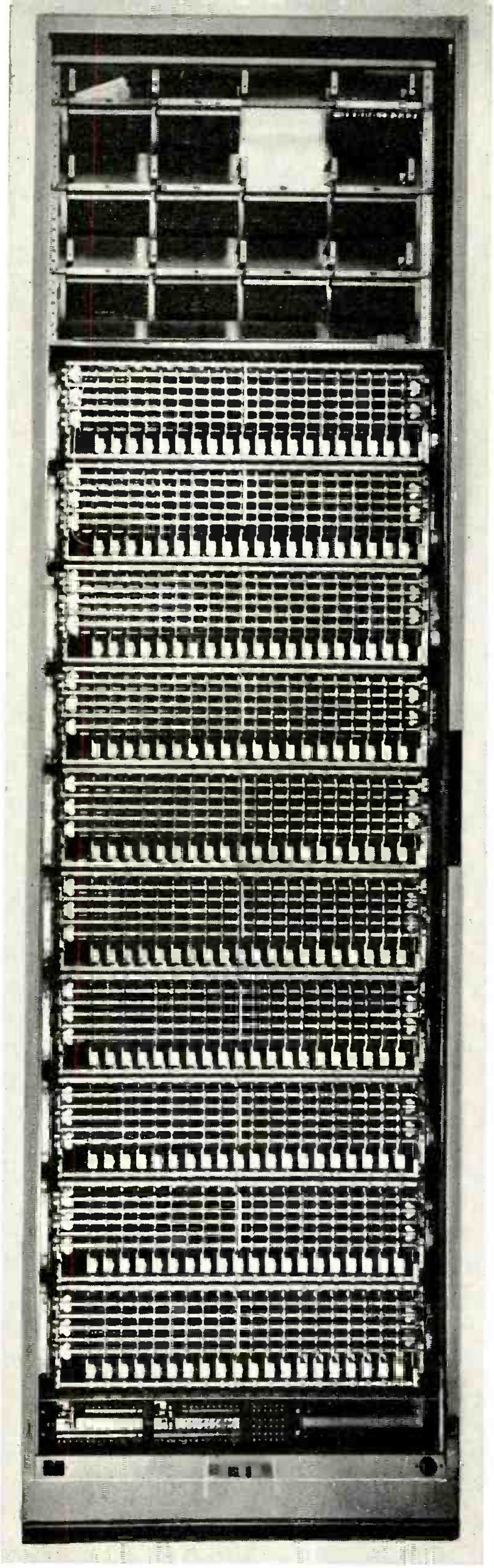
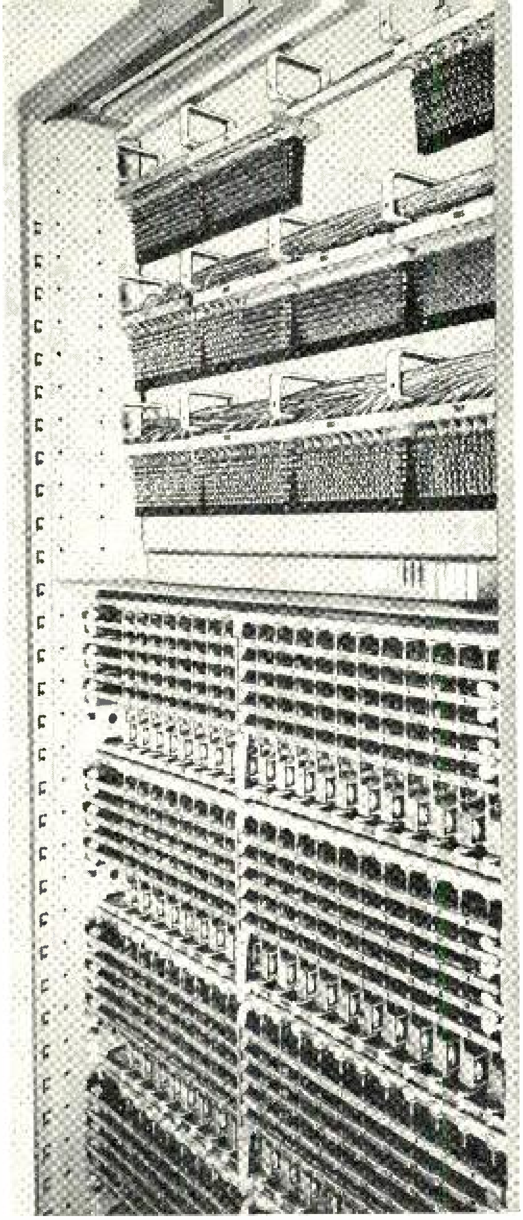


Fig. 3—Front view of an outgoing sender link frame for the No. 5 crossbar system.

select magnets that have been operated on the sender link frame, over the SC lead to the trunk, and thence over the HM lead to the hold magnet for that trunk. As a result of operating the hold magnet, the proper sender is connected to the selected trunk through the six crosspoint contacts. The sender then grounds its end of the HM lead to keep the hold magnet operated after the marker has released, and to notify the marker that the connection has been established.

The marker has already transmitted the pulsing information to the sender, and after it has ascertained that the connection between sender and trunk has been properly made, it disconnects itself from both the sender and trunk link frames. After the sender has transmitted its pulses, the connection between trunk and sender is released.

Sender link switches are mounted on standard frames that have fuse panels on the bottom and terminal strips at the top. The latter are used for connecting the trunks to the switch verticals, and the SLK lead and the ten SS leads to the trunk link connector. On one of the side uprights of the frame is a jack strip used for maintenance. Each such frame will mount ten switches, and as many frames are used as are needed to take care of all of the trunks. Since the only restriction on the assignment of the ten switches of a sender link frame to trunk link frames is that one switch cannot be associated with more than one trunk link frame, a single sender link frame may provide twenty trunks for each of ten trunk link frames, forty trunks for each of five trunk link frames, or any other division that does not assign the twenty trunks of one switch to more than one trunk link frame. Additions may be made at any time either by adding switches to existing frames or by adding new frames. A front view of one of the frames in the Western Electric shop is shown in Figure 3 and the upper part of the frame in the Media office is shown in Figure 4. The eight terminal strips in the two lower rows and the two at the left in the top row take care of the 200 trunks that may be served by a single sender link frame, while the terminal strip at the upper right is for the SLK lead and the ten SS leads. Jumpers from the rear of the trunk terminal strips run directly to the switch verticals and may be readily changed when



a trunk is moved from one sender group or one trunk link frame to another. Leads from the senders are cabled directly to the horizontals of the switches.

Because of the method of operating the select and hold magnets of the sender link switches, it is not necessary to restrict one switch to one type of trunk or one type of sender. The major limiting factor is the total number of trunks of one type and the number of senders required to serve them. If, for example, there were only five senders of each of two types, both groups of senders could be connected to the horizontals of the same sender link switch, and thus two types of trunks could be served by that switch. When a single switch must serve two types of trunks, each having access to ten senders, the horizontal multiple of the switch is cut. This permits one part of the switch to serve one group of trunks and the other part another group.

To make the senders more accessible to the markers, the ten possible senders on the levels of one sender link switch are divided into two subgroups, and each subgroup is served by a separate sender connector. This permits two markers to use senders of the same type and complete calls on two trunk link frames at the same time.

Fig. 4—Upper half of an outgoing sender link frame in the Media office.

THE AUTHOR: R. A. Swift, after graduating with the B.S. degree in Electrical Engineering from Union College in 1943, entered the Army Signal Corps as a radar maintenance officer. While with the Army he attended Harvard, M.I.T., and other radar and electronics schools, and served in Hawaii as a radar officer and, after the conclusion of hostilities, as a depot supply officer. Upon release from the Army in 1946, he joined the Laboratories as a Member of the Technical Staff. Since that time he has been associated with the development of No. 5 crossbar as a member of the trial installation and equipment engineering groups and is now engaged in local signaling studies.

Electron tube research laboratory at Murray Hill

Because many new electron tubes have clearances so small that a particle of dust or lint might ruin them, the vacuum tube research group at Murray Hill work in air-conditioned, dust-free laboratories turning out experimental models of new oscillators, amplifiers and special devices. Each operation in the intricate construction process requires special facilities. Cleanliness is the watchword in the entire area. A centralized vacuum cleaning system, with outlets in each room, is used to pull dirt and dust from every surface. Spraying operations are done in a unique, "wet-wall" booth—the liquid on the walls trapping any material which might escape into the rooms. All polishing and grinding is done with wet abrasives to keep down dust contamination.

The workers wear nylon coats and gloves to reduce the chances of lint and dirt settling from clothes to the workbenches.

Top—A general view of the assembly area in which the bench work is done in building vacuum tubes used by the electron dynamics research group. Left to right, Emily Dominguez, Julie Darr, P. M. Ness, G. E. Helmke, Margaret Weichardt and R. E. Azud.

Above—P. M. Ness at "wet-wall" booth sprays chemical coating onto a cathode.

Below—R. E. Azud (left) checks the temperature of a hydrogen furnace with an optical pyrometer. R. J. Marten is at the bench in the center and A. D. Errico at the glass lathe.

The cathode ray sound spectroscope

K. H. DAVIS
Transmission Research

Since the basic commodity handled by the Bell System is speech, it is quite natural that detailed studies of the many aspects of speech and its transmission should be carried on in Bell Telephone Laboratories. Curiously enough we are only beginning to learn just how speech is constructed. Although its general make-up has been known for many years it has not been understood clearly why the sounds of speech as enunciated by different individuals may be alike phonetically and still have different frequency and energy distributions. When we are able to separate the factors that convey intelligence from those that are more concerned with characteristics of the speaker or his manner of enunciation, we shall be able to apply new principles to the problems of telephone communication. The cathode ray sound spectroscope is one of the instruments that is enabling us to separate these various factors.

In the past, sounds have been analyzed in terms of energy change and of frequency components of the energy as a function of time,* and speech has even been synthesized†, permitting experiments in which the ear may evaluate the effects of modifications in the character of speech sounds. Visual records, too, in both permanent and transient form, have been made¶ and used for such purposes as teaching the deaf to talk or as an aid in teaching diction or correct pronunciation of a foreign language. The devices used for making these records, however, are much too slow for any extensive statistical study.

To obtain permanent records from which accurate measurements can be made and to make analyses of large quantities of speech sounds, a new cathode ray sound spectroscope has been developed. This device is designed to present the data to be recorded in the form of a series of amplitude versus frequency pictures.

A typical spectrogram is shown in Figure 1 (a). In these pictures, the frequency is represented horizontally, the range extending from 100 to 4,000 cycles per second; the

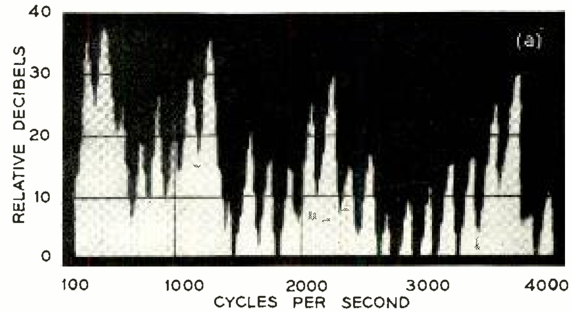


Fig. 1a—A typical record of amplitude versus frequency analysis of speech sound.

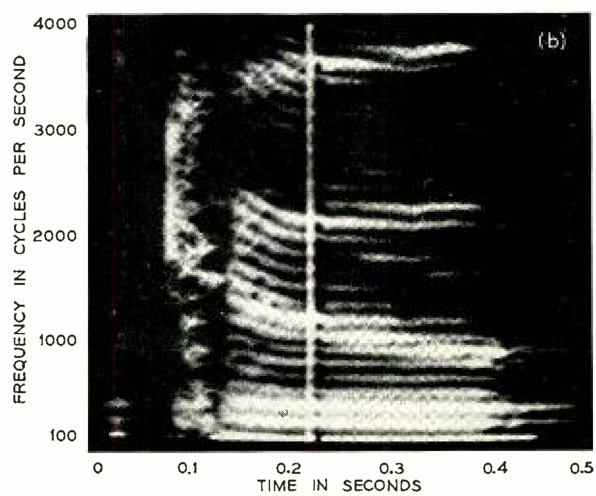


Fig. 1b—A time-frequency portrayal for the amplitude-frequency picture. The vertical line indicates the time at which Figure 1(a) was taken.

*Record, *December,* 1939, *page* 122 *and December,* 1936, *page* 98.
†Record, *August,* 1948, *page* 333.
¶Record, *January,* 1946, *page* 7.

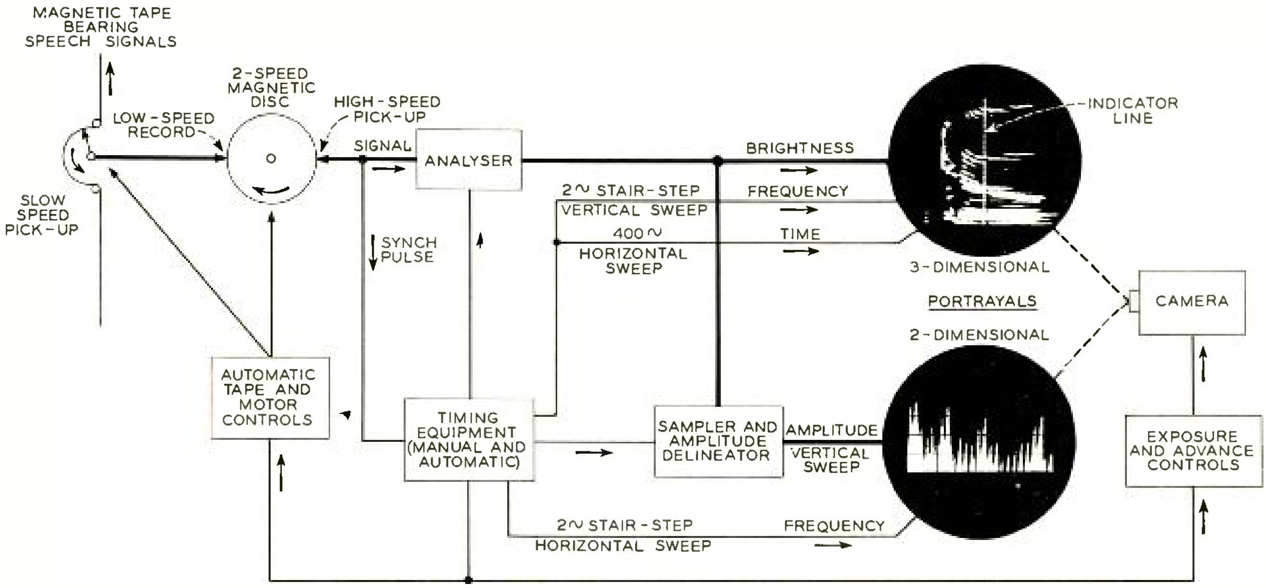


Fig. 2—Functional diagram of the sound spectroscope.

amplitudes of the frequency components are represented vertically on a decibel scale; and the changes in the amplitude-frequency pattern with time are expressed by the changes in the pictures as the series progresses. By adjustment, the interval between pictures in the series may be varied from a minimum of 2.5 milliseconds to a maximum of 40 milliseconds, depending upon the desired detail of the analysis.

For convenience in studying the data, a "three-dimensional" portrayal is made simultaneously with each two-dimensional picture, as shown in Figure 1 (b), using a second oscilloscope. The time axis is the abscissa, frequency the ordinate, and amplitude indicated as brightness of the trace. The bright vertical line on this three-dimensional picture indicates the time at which the associated two-dimensional picture is located.

In analyzing sound at "*n*" points along the frequency scale, two general methods are available: (1) A direct method, in which *n* parallel filters are used for making *n* simultaneous analyses distributed across the frequency band, and (2) an indirect method in which the sound is recorded and then *n* successive analyses made using a single filter with the aid of heterodyne methods. Experience with an earlier sound spectrograph* established that analyzing filters for speech studies should have a band width a little narrower than the frequency of the lowest pitched voice normally encountered (45 cycles) or a little wider than the highest pitched (300 cycles), if consistent types of patterns are to be obtained for the full range of pitches. The wide band filter has proven most useful for portraying the broadly selective action of the vocal system and the narrow band filter for resolving the individual harmonic components of the voice as indicated by Figure 1 (a). The new spectroscope has been equipped initially with a narrow filter whose pass band is equivalent to 45 cycles in the audio frequency range; a wide band filter may easily replace the narrow band filter if desired.

Assuming that the audio frequency range to be studied is 100 to 4000 cycles, the number of points along the frequency scale at which analyses should be made to obtain reasonable detail would be about 200. Generally speaking, it is quite possible to conceive of an analyzer having 200 filters, operating directly from a signal, and providing a continuous analysis of the signal

*Record, *January*, 1946, *page* 7.

with the amount of detail required for the sound spectroscope. It is somewhat harder, however, to conceive of a practical means for recording this result in permanent form with desired time discrimination, because the results are obtained too quickly for normal photographic processes.

The new spectroscope effectively provides a 200-filter analysis by the use of one filter 200 times over. Under these conditions, it is necessary to use recorded signals and to reproduce them repeatedly; hence, this analysis takes 200 times as long to make as it would with a 200-filter device. The advantages, however, are that the filter can be changed readily to vary the kind of analysis, and the amount of equipment required is kept to a minimum. To offset the lengthened time, a 200:1 speed-up of the signal is used, as described below.

Figure 2 shows a functional diagram of the spectroscope. The sounds to be analyzed are recorded on magnetic tape and picked up at the point marked "Slow Speed Pick-Up." The tape remains stationary and the magnetic pick-up head rotates, so that a 0.5 second sample is picked up repeatedly. One of these repetitions is recorded on the two-speed magnetic disc which is rotated at 2 rps and will thus hold a 0.5 second signal sample without overlapping. A synchronizing pulse is recorded along with the sound signal to be used in the analyzing process.

When the signal to be studied is of short duration, less than 0.5 second in length, it is possible to omit using the magnetic tape and record the sample directly from a microphone. This is especially convenient in analyzing short words or single syllables and can also be used to advantage for vowel or consonant sounds.

After the signal is recorded on the two-speed disc, the disc is then speeded up to 400 rps, i.e., 24,000 rpm, and the signal is picked up by the high speed pickup head. It now takes only 2.5 milliseconds for the original 0.5 second signal to be repeated once. The original frequency band of 100 to 4000 cycles per second is increased by this 200:1 speed-up so that it now becomes 20,000 to 800,000 cycles per second.

The analyzer shown in the block diagram of Figure 2 is of the heterodyne type. Here the high frequency signals are modulated by a carrier oscillator, and the modulator is followed by the narrow band filter whose mid-band frequency is 1.2 megacycles. The frequency of the carrier oscillator is automatically shifted in steps, a new step for each revolution of the disc. As a result of the modulation process, a different frequency band of the signal is transmitted through the analyzing filter for each carrier oscillator step. The rectified signal from the analyzing filter is used to modulate the spot intensity on the three-dimensional portrayal oscilloscope. This voltage is also sampled once every revolution of the high-

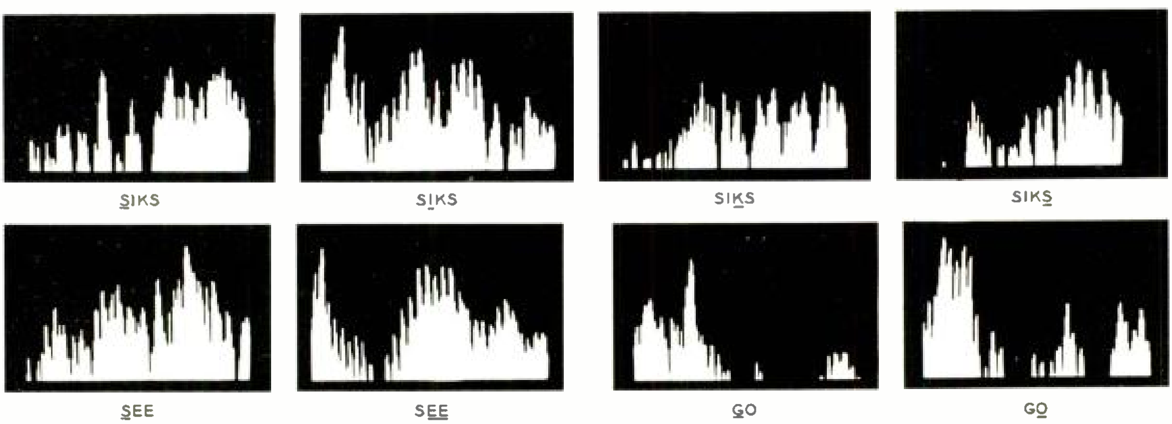


Fig. 3—Samples of sound analyses—the parts of the words "six," "see," and "go."

speed disc and used to produce the vertical deflections on the two-dimensional portrayal oscilloscope. All of the timing operations necessary to perform these functions are derived from the synchronizing pulse recorded with the original signal as mentioned previously. Specifically, a sampling pulse is derived from the synchronizing pulse, and delayed by a phase shifting network any amount from zero to a full revolution of the disc.

Shifting of the point on the periphery of the disc at which sampling occurs may be accomplished either manually or automatically. Under manual control, the phase shifting network is operated by a dial associated with the timing equipment; under automatic operation, a stepping mechanism, controlled by the timing pulse and a counting mechanism, moves the dial.

The portrayal oscilloscope is provided in duplicate, one for monitoring purposes and the other for making permanent records of the results. Automatic switching makes it possible to perform the entire operation of analyzing and photographically recording a sample of speech. Under this arrangement, when the first 0.5 second sample has been recorded on the two-speed disc rotating at 2 rps, the disc is then brought up to the high speed. The camera takes a sequence of pictures, one per second, in which the sampling time for each frame is advanced by any predetermined desired increment. When the analysis of the entire 0.5 second sample is completed, the disc is slowed down to the original 2 rps speed, the tape is moved forward to the next position for analysis, the new speech sample recorded on the disc, and the disc returned to high speed for a new sequence of analyses.

Operating the magnetic disc at such a high speed as 24,000 rpm posed a mechanical problem in that a high degree of precision was required to insure true running. The amplitude stability of the signal depends upon maintaining a constant gap between the pick-up head and the magnetic coating on the disc. The head must not be in contact, as excessive friction would occur; yet the gap must be kept small to enable it to recognize, without excessive loss, the shortest wave length recorded on the disc. Actually, the high speed pick-up is 0.0005 in. from the surface of the disc with a variation of less than ± .0001 in.

Figures 3 and 4 show some samples of two-dimensional analyses made by the spectroscope. In producing Figure 3, the word "six" was recorded directly onto the magnetic disc from a microphone. After viewing the analysis with the monitoring oscilloscope, photographs were taken of the two-dimensional portrayal at the indicated parts of the word, to determine the frequency-energy distributions for each phonetic element. Similarly, the words *see* and *go* were analyzed. Figure 4 shows groups of vowel and consonant sounds recorded in the same manner. They serve to illustrate one type of use of the instrument. Specific sounds can be studied readily by visual observation on

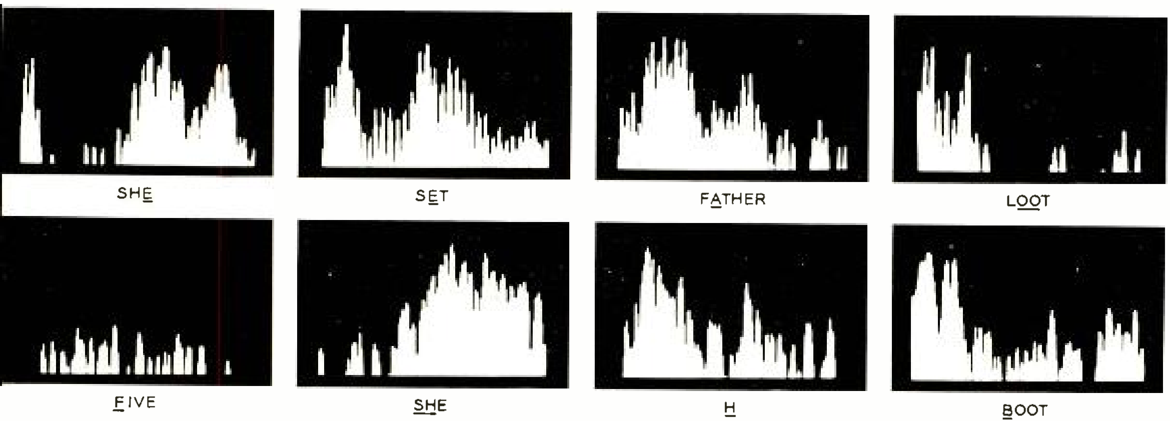


Fig. 4—Samples of parts of words—vowel and consonant sounds.

the monitoring oscilloscope and, when a section of particular interest is found, it may be photographed by pressing a button. After the film has been processed, the recorded material is available for study.

The rapidity with which samples of sound may be analyzed with this spectroscope makes it particularly valuable in studying speech sounds on a statistical basis, in order to determine the average values of important characteristics for the sounds and their expected variations. The spectroscope will be used in the laboratory to analyze a large number of speech sounds and to make permanent records by photographic methods, with the object of increasing our knowledge of speech and our ability to transmit it and make use of its characteristics.

THE AUTHOR: Following his graduation from Bowdoin College with a B.S. degree in 1929, K. H. Davis joined the Transmission Research Department of the Laboratories as a Member of the Technical Staff. His work in this department was concerned with terminal equipment for a Trans-Atlantic cable and later, on various kinds of terminal equipment for radio circuits and long land lines. During World War II he was engaged in work of a secret nature for the Armed Forces. Since the war, he has been working on automatic speech switching and speech printing problems.

"The Prophets Guessed Wrong"

From Long Lines' "Items for Management"

As far back as 100 years ago there were prophets of doom (like Karl Marx) who predicted that the machine age would gobble up all the wealth, take most of the jobs away from workers and create a generally sad state of affairs.

This dark prophecy was correct on only one point—there *was* a so-called "machine age" coming. But it now turns out that the machines men feared have been responsible for the biggest labor force, working the shortest hours, at the highest wages in world history.

Technological progress has been made in the telephone industry, as in all others. But in our business the effect upon workers has been called by former U. S. Secretary of Labor Frances Perkins "an almost perfect example of technological change made with minimum disaster."

This record is due to conscientious planning which, in the vast majority of cases affected by mechanization, enables regular employees to continue in telephone jobs.

Today, seven out of every ten Bell System telephones are dial, but there are about twice as many operators as there were ten years ago—when only a little more than half of the telephones were dial.

As for Long Lines, the total force has just about doubled in the last ten years. There are 2,500 more men and 9,300 more women in the organization than in 1939.

Electrical and mechanical improvements in the telephone business make possible better and faster service for the public at lower cost. As a result, telephone usage and growth have increased. This has meant more jobs, both for men and for women. And it is typical of "the miracle that is America"—which the prophets of a century ago could not possibly foretell.

Annual Meeting of AT & T Stockholders

In his address to stockholders of AT&T at their annual meeting on April 19, President Leroy A. Wilson reviewed the major happenings of the last five years; the tremendous demand for telephone service, the biggest construction program in System history, the increase in telephone employment, and in the wages and material cost. As a result, the System has had to obtain more than 3½ billion dollars in new capital—most of it by borrowing. As a result, the proportion of debt in the System's total capital has gone up from less than a third to slightly more than a half.

More than 12 million telephones have been added in the five years and the waiting list is down to two per cent of telephones in service.

"Also during this eventful postwar period," said Mr. Wilson, "new services, new and improved equipment, and better and more economical operating methods have been introduced and continue to come into wider use. Steady improvement of equipment and methods is essential to keep on increasing the quality of service and to keep the cost as low as possible. Technical improvements alone however will not today insure the long-range financial security of the Bell System. The rise in the cost of doing business has been so steep that increases in telephone rates have been and are essential . . .

". . . earnings must be adequate to make the Company's stock attractive to new owners, and that these earnings continue to be sufficient, as additional shares are issued, to insure a stable return and protect the investment of existing stockholders and new stockholders as well. This is the foundation of everything we are trying to do, and it is just as important to telephone customers and employees as it is to the stockholders—for investors' money is essential to give customers the service they want, good service is essential to win customers and thereby maintain good jobs for employees, and good earnings are essential to attract and protect the savings of investors . . .

". . . wage increases in the Bell Telephone Companies in the last ten years total about twice as much annually as the increases authorized in telephone rates. It is also a fact that present wages average about double what they were ten years ago. Bell System wage policy is to pay wages that compare favorably with those paid for similar skills by other concerns in the communities where the Bell Companies operate. To do less would assuredly be bad for telephone service, for in order to give good service it is necessary to attract and keep competent people. On the other hand, payment of unduly high wages would be unfair to telephone customers who pay the bill.

"The success of the business depends on meeting every single one of its problems and meeting all of them wisely and well. Nothing less will do. It goes without saying that this demands the utmost acceptance of responsibility by management, complete devotion to the best interests of the business as a whole, and the capacity and willingness to exercise leadership no matter what obstacles must be overcome. This is true today in our business just as it is true in every other phase of our national life.

Stockholders chat with President Leroy A. Wilson at the close of the annual meeting.

"It seems to me therefore that there is one other problem even more important than those I have just mentioned. That is to find, develop and hold the future leaders who can be depended on to manage this business well and guide it to greater achievement in the years that lie ahead. This is an absolutely essential part of your present management's obligation to carry this enterprise firmly forward. It is the key to success in the long run, for no business succeeds without good management and good management does not just happen. It has to be selected, developed and encouraged. Nothing will help more—nothing will better serve to attract the leaders we shall need in the future—than the encouragement and support that you stockholders give to management efforts . . ."

Submarine Cable Links Key West-Havana

Late at night on April 30, a submarine cable was spliced at Key West. Soon after midnight engineers were talking between Key West and Havana over all 24 channels of a new carrier system, and in the morning Oliver Jacobs in Havana talked with Oliver Buckley in New York over the cable which they had jointly invented and for which a patent had been issued to them in 1935.*

This is an unusual cable. It is capable of transmitting a large number of telephone channels for great distances under the sea by the incorporation of vacuum tube amplifiers in the cable itself. To make such undersea repeaters practical the inventors proposed assembling them in flexible pressure-resistant tubes which could be made a part of the cable structure, power for the repeaters being supplied over the cable from generators at the shore ends.

The design of the cable was a long range project of the Laboratories under the direction of J. J. Gilbert and it called for the development and application of many new techniques. Among these techniques, most of them requiring an unusually high degree of precision, were the fabrication of vacuum tubes capable of functioning, unattended, for many years, and their incorporation in a cable sufficiently flexible for deep-water laying yet rugged enough to withstand the pressures encountered over a mile down on the ocean floor.

The system consists of two cables, one for transmission in each direction. They are of the coaxial type, with the inner conductor insulated from its surrounding tube by a solid layer of polyethylene. The cable is protected from abrasion and corrosion and given mechanical strength by heavy wrappings of jute and a protecting armor of steel wire. Three amplifiers, housed inside specially constructed cylinders, are built into each of the cables about 40 miles apart. At these places, the cable bulges from its ordinary diameter of about an inch to approximately three inches for a distance of about 25 feet.

Repeaters for the cable were assembled in special air-conditioned space, set up at Murray Hill. Construction of the detail parts was supervised by L. F. Willey and B. Slade; assembly into completed repeaters by O. B. Jacobs and E. M. Boardman. Watertight enclosures were applied at West Street under the direction of W. M. Bishop, W. P. Frawley, C. N. Anderson, A. H. Lince and T. Aamodt, with advice from a committee consisting of J. R. Townsend, A. C. Keller and V. R. Ronci. The cable itself was made by the Simplex Wire and Cable Company at Boston. The repeaters were spliced as it was loaded on Western Union's cable ship *Lord Kelvin*. With J. J. Gilbert, the project engineer, on board, as well as D. E. Thomas, N. C. Youngstrom, C. H. M. Quintana, and Mr. Boardman, it proceeded to Key West.

Previously, a quantity of cables had been shipped to Miami, lightered to Key West, and laid by Long Lines Plant people from the shore to Sand Key Light, a stretch of eight miles, too shallow for the *Lord Kelvin*. Careful surveys of this area had been made by Mr. Youngstrom.

As the *Lord Kelvin* steamed southward, the engineers had filled the ship's cable storage tanks first with cold northern sea-water and later with warm water from the Gulf Stream. By making frequency-vs-loss measurements at

*No. 2,020,297; see also BELL LABORATORIES RECORD, Vol. 20, pages 238 and 275.

Landing the East cable at Havana. One of the rowboats, familiar to tourists, stands by to cut the cable free from the barrels.

the two temperatures they gained valuable information. Arrived in the Straits of Florida, two days were spent checking depths noted on the charts, particularly off the Cuban coast where there are numerous deep chasms in the ocean floor to be avoided. Because of the current through the Strait of Florida, observations on the ship's direction and speed through the water would not give its track over the bottom accurately enough for cable-laying, so buoys were set out which had targets to be picked up by the ship's radar.

On April 21, the ship picked up the East cable at its Sand Key end, spliced it to the cable aboard and paid out some 30 miles, where the cable was cut and the end buoyed. The ship then proceeded to Havana, where on the 24th the end of the cable was sent ashore, buoyed by barrels and pulled by a winch line from a truck. When this end had been landed and the barrels cut free, the ship started north, paying out the cable with its two repeaters. Meanwhile, technicians of the Cuban Telephone Company were splicing in a third repeater which was to be submerged just off the Cuban shore.

Arriving at the buoy late on the 25th, the cable was spliced, and immediately tested through the three repeaters from Key West to Havana. Every channel was soon pronounced OK and the ship left to lay the West cable by the same procedure. Its final splice was made about ten o'clock on the night of the 30th.

Two twelve-channel banks of a broad-band carrier system were shipped by Western Electric from Kearny direct to Key West and Havana. The group bays, which were specially designed, were built at Kearny and tested at Graybar-Varick before shipment. Power supplies, which were engineered for the project by G. W. Meszaros, H. H. Spencer and R. R. Gay, were built and tested at West Street, and tested again after installation at Key West by Messrs. Spencer and Meszaros.

During the final testing, H. A. Affel, O. B. Jacobs and C. H. Osterholz were at Havana, and Messrs. Ilgenfritz, Bishop, Greenwood and Meszaros at Key West.

TV Signals "Bounced" Over Hill By "Mirror"

Microwaves act in many ways like light waves and telephone engineers recently took advantage of that fact to "bounce" television signals over a hill with an aluminum "mirror."

A new video station, WNBF-TV, had asked the New York Telephone Company to provide a link between its Binghamton, N. Y., studio and its transmitter station on Ingraham Hill, three and a half miles away. Land line facilities would have been unduly expensive so the telephone company's engineers decided upon a microwave installation which beams television waves over a line-of-sight pathway.

The station's transmitter building is hidden behind the hill but its antenna tower rises above the crest. The engineers mounted a dish-type microwave antenna on the roof of the telephone building in town and aimed it at the tower. Mounting a receiving "dish" on the electrically energized tower would have posed certain insulating problems but the engineers neatly sidestepped them. They attached a 7-foot square aluminum "mirror" on the tower at an angle which would reflect the microwave beam down to a "dish" on the roof of the transmitter building behind the hill. This "mirror" has been "bouncing" the microwaves over Ingraham Hill for several months and all hands are agreed that the installation is a complete success.

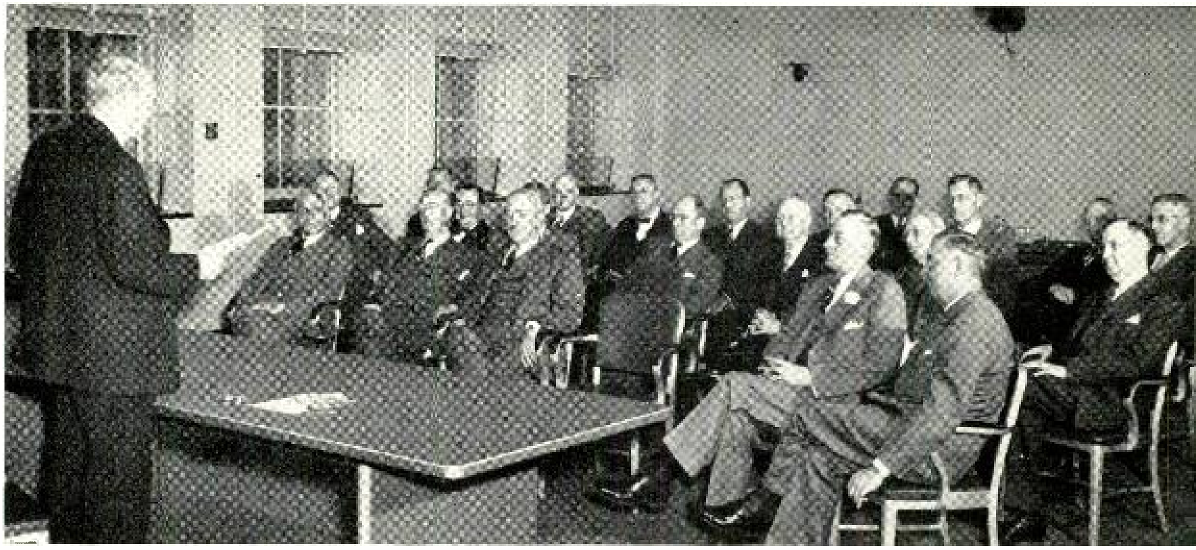
Dr. Kelly Visits Technical Groups in Europe

M. J. Kelly returned recently from a month's tour of England and continental Europe, where he lectured extensively and visited the leading universities and telecommunication research centers.

In London, Dr. Kelly addressed the Royal Society on *The Bell Telephone Laboratories—An Example of an Institute of Creative Technology.* He also participated in the Society's Conference on Higher Technological Education, at which he spoke on the patterns of technical education in the United States. We train, in proportion to our population, many more engineers than does England, Dr. Kelly pointed out in his speech at the Education conference.

"If 30,000 is taken as our normal present level of engineering graduates per year," he said, "I estimate that we are training on the order of ten times the number of engineers as is England, when our population is only some three-fold that of yours. This disparity, I believe, is mainly due to the difference in the area of use of the engineer in the industrial society of the two countries.

"We now use the engineering graduate in a considerably wider range of our technological activities than is your practice," Dr. Kelly said. "Some 30 years ago we used him almost entirely to develop and to design. There were very few engineering graduates in manufacturing engineering, in the supervision of manufacturing operations or in the operations of the service industries such as electricity, gas and telephone. As technology became more complex it was in-



O. E. Buckley welcomed the Directors of the Bell of Pennsylvania and the Diamond State Telephone Company who visited the Murray Hill Laboratories on April 21. The Directors held their Board meeting at the Laboratories. They also visited various locations to see metallurgical work, crystal growing, wood preservation, rubber, plastic, and electronics developments.

creasingly difficult to realize the maximum benefit from the output of our young research laboratories when so large a fraction of the technological operations were done and directed by men without engineering training."

Describing the continuing increased use of engineering graduates in the United States, Dr. Kelly pointed particularly to the present use of engineers in areas beyond the professional operations of development and design.

"I am confident," he declared, "that our technological progress would have been much slower and our country's industrial strength of a considerably lower order if our technical education system had not supplied the large volume of adequately trained engineers for use in the management and technical operations of an ever-increasing area of our industrial society."

Dr. Kelly visited the telephone administrations of England, France, Holland, Sweden and Switzerland, and conferred on trends in telecommunications research and development. He lectured at the Technical University in Zurich, and visited Oxford and Cambridge Universities, the Sorbonne and the Collège de France. At Dollis Hill, in England, he addressed members of the research laboratories of the telephone administration. At Harwell, he visited the British government's Atomic Energy Laboratories. He also visited in Munich at the headquarters of Siemens & Halske, who before World War II were the largest manufacturers of telecommunications equipment in Europe.

The work and achievements of the Laboratories are widely recognized abroad, Dr. Kelly reported.

"Through our publications and the frequent visits of Europeans to our Laboratories," he said, "we are well known by all the administrations, the telephone equipment manufacturing companies and the universities." *The Bell System Technical Journal* and the *Bell Laboratories Record*, he found, are read quite generally by the technical people of the administrations and the manufacturing companies.

Economic conditions in Europe were generally better, Dr. Kelly said, than at the time of his visit in 1948. All rationing of consumer goods has been discontinued in the countries he visited except for England, and restrictions there, he found, are considerably less severe than in 1948.

Dr. Kelly was accompanied on the trip by A. C. Keller and H. H. Schneckloth, who visited the telephone administrations' research and manufacturing organizations in England, France, Switzerland, Sweden, Holland and Belgium. The three met at key cities on the continent during their visit.

9:15 A.M. — *First step after the Bulletin has been written occurs when Anna Kiernan receives the "copy" in Transcription. Here she hands it to Elizabeth Rullo, who will type it on stencils, one for the front and one for the back. Mrs. Rullo can do this in about 25 minutes.*

9:45 A.M. — *The stencils have now gone next door, where Isabel Polantino discusses the mimeographing job with Mary Sullivan. A stencil can be used only about a thousand times, so six sets must be made for each issue of the Bulletin. Martha Garbarino, right, is checking copies from the first stencils, already run.*

HIGH-SPEED BULLETIN FOR NEWS

The *Information Bulletin,* which recently has been appearing on the desks of everyone in the Laboratories, is issued by the Publication Department whenever there is news of interest to employees. There is no fixed schedule; when there is a story, there will be an *Information Bulletin.* Going to press is a high-speed job, from the moment the material is collected to the time, a few hours later, when the finished *Bulletin* arrives in your "In" basket. The series of photographs, taken during the production of a typical issue, shows some of the many people who help do this job of giving prompt, accurate and interesting information.

10:00 A.M. — *The mimeographing is now in full swing, with two machines running at top speed in order to turn out the necessary 6,000 copies. Stacks on table in foreground are being sorted for mailing to Murray Hill, Whippany and other Laboratories locations.*

10:45 A.M. – *By now, first copies can be distributed while the others are being run. These shown were brought down one floor in the mail elevator, from which they are being removed by Catherine Aiello and Beatrice Pask. In a few minutes the girls will go back up for more.*

11:00 A.M. – *In the Mail Room, Frederick Conti packs a suitcase full of Bulletins to be put on the next car to Murray Hill. Muriel Mumbrauer and Doris Hitchen assist in the sorting operation. Copies will continue to roll from the "press" for another two hours.*

11:15 A.M. – *Helen Racz receives a copy at her desk on the 6th floor, from Caroline Gentile. Miss Racz, when she has read the Bulletin, will add it to a file where she is keeping them for future reference.*

Telephonic Invention Revealed

We acknowledge our debt to *Long Lines Reporter* for this item.

A telephonic invention of a former Senator was recently brought to light by *Telephony* magazine. Used to terminate too-lengthy interviews, this device required three pieces of equipment: one dummy telephone set, one hidden button connected to the telephone bell, and the ingenuity of its user.

The Senator's rules for the application of this equipment were: Kick hidden button and set phone ringing. Remove receiver and say, "Yes, this is he . . . right away? . . . The Vice President? . . . And the Secretary of State? . . . But I'm in the middle of an important conference! . . . Well, if it's really necessary . . ."

By this time, the visitor was reaching for his hat, eager to advance the lawmaker's career by getting out of his way. The Senator fondly regarded this contrivance as his own invention, and christened it the "nullaphone," but we've heard tell that many a busy man gets the same results by a prearranged signal with his PBX telephone operator.

Exhibit Shows Laboratories Developments for Telephone Service

Many devices to be used by telephone patrons and which were developed here are included in an exhibit, which was opened at the annual meeting of A T & T stockholders in New York on April 19. It was visited by about 3,000 stockholders and employees at the System headquarters before it started out "on tour."

There are six principal displays in the exhibit. One is made up of practically every type of telephone instrument—ranging from the commonplace handset to a telephone for explosive atmospheres—and various types of special signaling devices. Another display shows how telephone service can be tailored to the customer's needs by means of button telephones, key equipment, and manual and dial PBX installations. To illustrate the way telephone service is engineered to fit specific requirements, the display includes a large stack of blueprints used in designing the huge PBX installation for the new United Nations headquarters in New York City.

The record-breaking expansion and improvement of rural telephone service is featured in a third display. Another depicts the vast networks of telephone routes provided by the Bell System to serve the nation. This includes long distance, overseas, and other general services as well as some idea of the extensive private line networks furnished for the government, the press, radio and television broadcasters and other businesses.

An activated display demonstrates private line and exchange teletypewriter services. Messages typed out on one machine are printed on a nearby teletypewriter so that the visitor sees how the printed word can be flashed from office to office or across the country. A map of the United States showing private line and TWX routes helps him visualize these services.

A final display, entitled "Teamwork for Service," gives a graphic explanation of how the combined efforts of the Laboratories, the operating telephone companies, the Western Electric Company, and the American Telephone and Telegraph Company are needed to provide the best possible service.

B. B. Webb accepts a farewell gift from W. Fondiller at a retirement party. Mr. Webb is now living at Geneseo, New York.

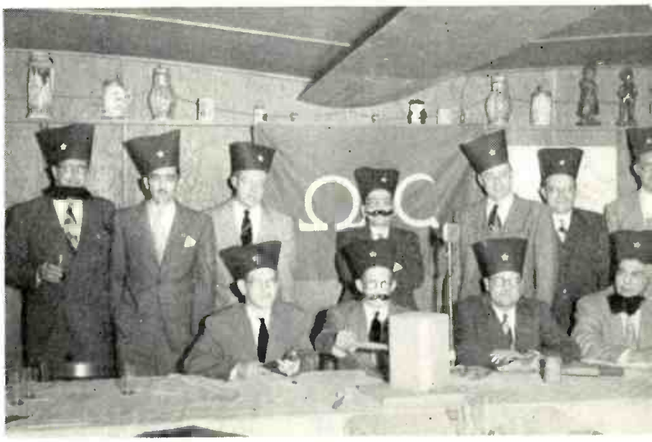
Not in Seattle, Please

Laboratories people who are used to dialing WE 6-1212 to find out if it's going to rain should resist the impulse when in Seattle. That number is or maybe *was* assigned to a telephone Plant man. The story came to light last winter when a radio broadcaster mistakenly announced that Seattle had a weather-announcing service. Results are preferably to be imagined rather than experienced.

Spring Festival

Nearly a hundred members of the Laboratories gathered at Willow Brook Inn at Fair Haven, New Jersey, on May 5 to take part in the annual dinner of the Deal-Holmdel personnel. To the gathering at dinner, Toastmaster W. A. Tyrrell introduced a score and more of visitors from other locations. Songleader L. R. Lowry, with an assist from A. B. Crawford at the piano, brought forth an excellent grade of congregational singing in some of the more robust of the popular canticles. G. M. Eberhardt, using a tape recorder which he had modified to handle two channels, burlesqued some of the highlights of radio history.

Stuart Hight, the Whippany Hillbilly, put on a dance for which he made the music on a "no hands" harmonica. Some of Murray Hill's latest philosophy was discussed by R. C. Platow, who demonstrated that a good story may be even better when told backward. In slightly more serious vein was the presentation by Ralph Bown of an oversize thirty-year emblem; it was accepted on behalf of the Monmouth County crowd by H. T. Friis.



Members who performed in pseudo business meeting. Standing, left to right, R. C. Shaw, E. L. Chinnock, B. C. Wood, A. G. Fox, W. E. Legg, S. D. Robertson and W. E. Kock; and at table, S. E. Miller, W. A. Tyrrell, W. W. Mumford and E. H. Turner.

R. Bown, right, presents H. T. Friis with oversized "button," symbolizing thirty years' existence of the Deal-Holmdel groups.

The boys do a ukulele number. Left to right, W. W. Mumford, W. C. Jakes, Jr., E. L. Chinnock, S. E. Reed and W. E. Legg.

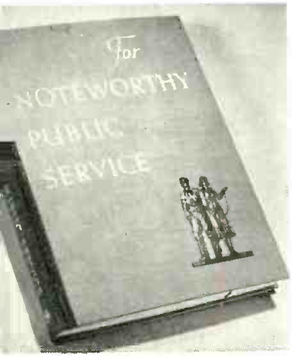
Most ambitious of the program's acts was a meeting of a "subversive cell" to report on the completion of its "thirty-year plan" for the sabotage of Radio Research. Horn spectacles and a false nose, in one case gave the wearer a less-than-purely coincidental resemblance to an executive among the audience.

W. A. Tyrrell coordinated the imaginations of a number of authors and actors; W. M. Sharpless made sure that cider was available for those who wanted it, while W. W. Mumford tied the whole program together.

The Murray Hill Chorus

For the third consecutive year, the Murray Hill Chorus of the Bell Laboratories Club presented a program to the patients of Veteran's Hospital at Lyons on Sunday evening, April 30. Also taking part was the Murray Hill Rhythm Trio consisting of Harry Geetlein, piano; Johnny DeFeo, guitar; and Ray Biazzo, string bass. The chorus was directed by Leo Collins with Capitola Dickerson, accompanist.

The choral numbers, comprising madrigals and early American, and popular music, were selected from the fifth annual Spring Concert of the Chorus, which was presented at Summit High School on May 18.



Vail Medal Stories Told in New Book

Heroism and drama are packed into the pages of *For Noteworthy Public Service,* a new book published by the Bell System in a limited edition, describing the deeds of telephone employees which won for them gold and silver Vail Medals. It contains 132 stories of outstanding acts of loyalty, devotion to duty and courage performed by the telephone men and women who received the awards.

Sponsored by the Vail Memorial Fund and produced by the A T & T Information Department, the book describes gold and silver awards made from the inception of the Fund in 1920 through 1948. In addition, all bronze medal awards are listed alphabetically in the back of the book.

Murray Hill Rhythm Trio

The Murray Hill Rhythm Trio consisting of Johnny DeFeo, guitarist, Ray Biazzo, bass viol, and Harry Geetlein at the piano, gave their second musical show on Thursday, April 27 in the Arnold Auditorium. There were two performances. The Trio played several rhythmic arrangements and presented Cathy Egan, singer, in two popular rhythmic selections.

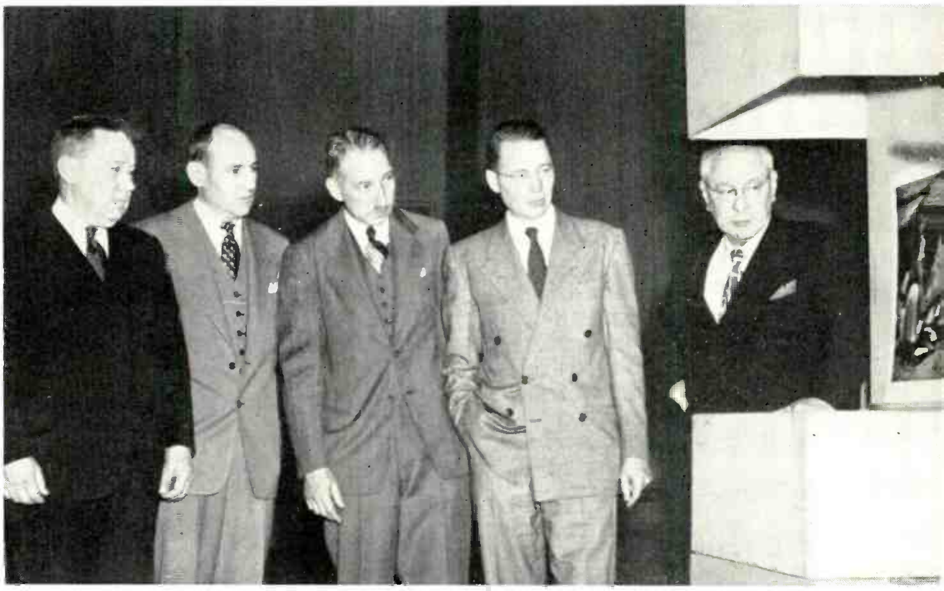
A new surprise aggregation was presented also. The unit, to be known as the "Dixieland Band," is composed of Larry Specht, trombone, Tony Prestigiacomo, trumpet, Henry LeCour, clarinet, Ray Chegwidden, tenor saxophone, Frank Dempsey, drums, and the members of the Trio. The "Dixie" unit played two selections which climaxed a very enjoyable show. The photographs were taken by W. S. Suydam.

Freehand Drawing Exhibition at Murray Hill

The forty-three drawings which were displayed at Murray Hill recently were the work of members of the Freehand Sketching Class of Out-of-Hours Course 117. Led by D. H. King, the class met for sixteen one-hour sessions. Very few of the class members had had previous training or experience in graphic illustration.

The objective of the class was to present the

Judging for the Annual Photographic Print Salon—Robert Pope, D. W. Bodle, E. Von Nostitz W. K. Ogden and E. Alenius examine an exhibit print in the "light box."



fundamentals involved in graphically illustrating one's ideas and to develop the ability to visualize an object or an idea to the point of its becoming an actuality to the originator of the idea. When an object or idea is visualized completely it can be drawn. The degree of perfection of a drawing depends on practice and practice results in technique.

Owing to the large enrollment (59 originally) it was impossible to give very much individual instruction and actually the agreement to tackle a class of such dimensions was in the order of an experiment.

The second half of the school period saw a reduction in the class membership from 59 to 49. The attendance despite business trips, sickness and other reasons was high and did not go below 42 (which was due to a sleet storm). The 43 drawings placed on display prove that the experiment was a success.

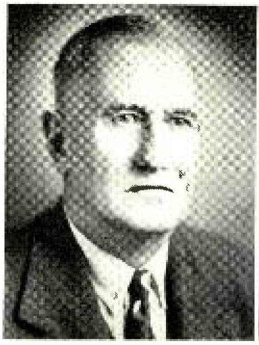
D. H. King, instructor of the freehand sketching class, watches the reactions of visitors to the exhibition.

Photographic Print Salon

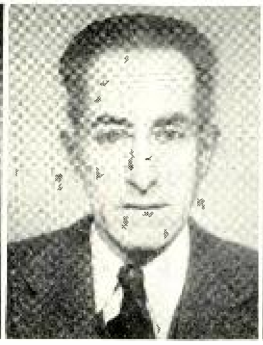
The Annual Photographic Print Salon, held jointly by the Bell Laboratories Camera Clubs of Murray Hill and New York, has announced the 1950 contest winners, following the judging of prints on April 28 in the Arnold Auditorium. Seventeen contestants submitted 77 prints which were judged by E. Alenius, E. Von Nostitz and W. K. Ogden. Robert Pope was chairman of the Print Committee and D. W. Bodle, chairman of the Black and White Committee.

Winners in the *Restricted Class* were: First R. P. Jutson, cup; Second A. T. Calvano, silver medal; Third E. L. Younker, bronze medal; and Fourth R. P. Jutson, ribbon. *Landscape and Seascape* First W. S. Suydam, cup; Second J. F. Neill, silver medal; Third J. F. Neill, ribbon; Fourth J. F. Neill, ribbon; Fifth A. H. Hearn, bronze medal; and Sixth D. W. Bodle, ribbon. *Children and Pets* First J. F. Neill, cup; Second A. H. Hearn, silver medal; Third W. S. Suydam, ribbon; and Fourth Thomas Musca, ribbon. *Still Life* First R. S. Kennedy, cup; Second R. S. Kennedy, ribbon; and Third C. N. Anderson, ribbon. *Portraits* First W. J. Rutter, cup; Second J. F. Neill, silver medal; Third C. N. Anderson, bronze medal; Fourth D. W. Bodle, ribbon; and Fifth N. C. Norman, ribbon.

RETIREMENTS



W. B. Prince



R. A. Horsburgh

R. E. Ottman

Among those retiring from the Laboratories are W. B. Prince with 43 years of service; R. E. Ottman, 36 years; R. A. Horsburgh, 31 years; Elsie Dittmar, 27 years; and Maude Marks, 20 years of service.

William B. Prince

"When you hear the signal, the time will be . . ." for you to remember Bill Prince, who had a lot to do with designing the time-of-day circuits now used in New York and elsewhere. And if you set your watch in front of 195 Broadway, you can give a thought to Mr. Prince, who designed the circuits of "The World's Most Accurate Public Clock."

Entering Western Electric's student course in 1906 with a B.S. from Virginia Polytechnic, Mr. Prince came to West Street in 1908. He started in the Circuit Laboratory, and by 1915 he was supervising the commercial construction of telephone repeaters. At one time he had charge of case costs, and equipment and circuit files, but for most of his career he has designed manual circuits. Notable were the circuits for straightforward trunking with its familiar "zip-zip" tone. During World War II he worked on current toll engineering and the No. 6 toll board.

Mr. Prince played football at V.P.I. and still likes to watch the game. He and Mrs. Prince expect to continue in their Forest Hills apartment, seeing something of these United States in the summertime.

Robert A. Horsburgh

Bob Horsburgh, like most of us, has had a quiet life, highlighted by the usual family events —his marriage, the birth of his children, the death of one of them. But his most thrilling experience came to him in the blackness of a stormy night when the frantic ringing of a bell on an island near his camp told that something had gone wrong. Neighbors tried to send off boats; none of their motors would start. But Bob's motor started, purred away through rain and spray, drove his boat, with two lads bailing, out through the waves until they found a man unconscious in a life jacket. Ashore, artificial respiration revived the man.

It was not chance that Bob's motor started on the first pull. All his life he has been building things, keeping them running. And as he goes into retirement, he thinks he will open a little shop where he can go on making things work.

After leaving school, Mr. Horsburgh worked awhile for General Electric, came to us in March 1919 as an electrician in the maintenance force. While working on a set of life-test racks for the Tube Shop, his ability was appreciated by the late Roy Mercner, who arranged for a transfer to Apparatus Development as a laboratory mechanic. In the next quarter-century, he built from engineers' sketches and descriptions hundreds of modifications of dial switching devices and machines to test them. During the war, he worked on several forms of electronic airplane crew-trainers, then returned to his work on crossbar, with which he had been associated as a mechanic since its inception.

A widower, Mr. Horsburgh is far from lonely; he has two daughters, three sons and eight grandchildren. Leaving the Bronx, he will spend next summer at Broadalbin on the Sacandaga Reservoir, and next winter in Florida.

Robert E. Ottman

After graduating with the degree of B.S. in Electrical Engineering from the University of Pennsylvania in 1910, R. E. Ottman remained for a year at the University as an instructor. He then joined the American Telephone and Telegraph Company and for two years carried on maintenance work in the Philadelphia toll office. In 1915 he joined the Physical Laboratory where he spent the next five years in the development of cords and protection apparatus.

Mr. Ottman then transferred to Systems Development and he has since then been engaged in toll work principally in the development of various types of toll testing and toll switchboard equipment. His first work in this department was in connection with the power equipment for the initial Key West-Havana cables. He then worked on the specifications for the toll line and repeater equipment for the Stockholm-Goteborg and Tokyo-Yokohama cables. Following this he was concerned with determining the engineering requirements for the 135-cycle ringing generators, including the layout of machines and associated equipment; the development of the start-stop distributor signaling system for straight-forward toll lines used between New York and Philadelphia; the design of relay rack arrangements for phantom and composite equipment; and the early development of the No. 5 toll test board and the No. 3 toll switchboard. He has been associated with the design and development of the No. 8 test and control board, the No. 17 toll-test board and improvements made in the No. 1 toll switchboard. During the war he did current engineering on toll

Elsie Dittmar Maude Marks

switchboards, notably for the No. 6 toll board, an expedient to utilize odd sections of central office and PBX boards. He has continued in current engineering, notably with the No. 3 CL toll board.

Mr. and Mrs. Ottman and a daughter will continue to live in their home near Basking Ridge. That six-acre tract, which he bought last year, will yield him a lot of satisfaction, and no doubt a certain amount of food if his plans for farming are as accurate as for toll equipment.

Elsie Dittmar

Following her request for retirement on May 1, Elsie Dittmar assumed a civil service position in the courthouse of the county seat of Freehold, New Jersey, her home town. A graduate of Montclair State Teachers College, Miss Dittmar had been a teacher in New Jersey public schools and in the Department of Agriculture before she joined the Laboratories in 1922. During her twenty-seven years of service she had been a member of the Publication Department where she had done clerical work in connection with the circulation of the Record until 1932, and in the Plant Department where she served as receptionist at West Street until 1941. When that function was taken over by the Publication Department, she transferred to the Accounting Department and worked with the voucher group at Fourteenth Street and at Eighteenth Street during the war. In 1945 she transferred to the Central Files Department as a member of the Record Files in the Davis Building. Early this year she returned to the West Street building.

Miss Dittmar has been always active in civic affairs in her home community. She is a trustee of the Mollie Pitcher Chapter 198, Order of the Eastern Star, a member of the Board of Directors of the Freehold Area Y.M.C.A. and Chairman of the Day Camp Committee of Freehold. She is also a trustee from Monmouth County for "Y" Summer Camps for Boys and Girls at Medford Lakes where they maintain 500 acres. Miss Dittmar is a charter member and treasurer of American Legion Auxiliary Post No. 54, and an active member of the Business and Professional Women's Club.

Maude Marks

With her retirement this Spring, Maude Marks has found time to cultivate her flower garden and to tend it as she did in prewar years. She has begun to redecorate her bungalow in Franklin Square where she lives with her pets, and she is making weekly trips around Long Island in her car, visiting greenhouses to buy plants and shrubs for her garden.

For the past year Mrs. Marks had been a member of the Central Instrument Bureau and the Electrical Testing and Inspection group. She had maintained and kept up to date the card file index of all the 20,000 instruments the Laboratories has on loan to engineers scattered throughout the New York, Murray Hill and Whippany Laboratories. She was particularly valuable in that work because of her broad knowledge of instruments and equipment, gained when she was a stock clerk and prior to that a technical assistant and laboratories mechanic in Building T. Mrs. Marks had done experimental tube construction work in the Electronic Apparatus Development Department for most of her years in the Laboratories. During the war she had worked on such developments as the magnetron.

M. J. Kelly Elected Pioneer President

M. J. Kelly was elected President of the Frank B. Jewett Chapter of the Telephone Pioneers of America at the annual business meeting held on May 4 at noon in the West Street Auditorium. H. J. Delchamps was elected first vice-president and Edna Ruckner, second vice-president for the coming year. The secretary and treasurer, appointed by the president in accordance with the constitution of the chapter, are Hattie Bodenstein and G. A. Brodley.

At the Pioneer annual meeting—M. J. Kelly, H. J. Delchamps, Edna Ruckner and J. J. Kuhn.

C. H. G. Gray, F. A. Korn and J. W. Quinn were elected to serve on the Executive Committee from 1950 to 1952. J. F. Kearns, A. G. Jensen and Dorothy Storm will continue to serve on the Committee until 1951.

Holmes Company Sold

The New York Telephone Company has sold all of its stock in Holmes Electric Protective Company, a wholly owned subsidiary, to Grinnell Corporation, whose principal office is in Providence, R. I., it was announced April 22. The Holmes Company provides an electric protective burglar alarm service to many of the leading businesses in New York City. The sale also carries with it control of two subsidiaries of the Holmes Company engaged in a similar business in Philadelphia and Pittsburgh. The Grinnell Corporation is an old established business, having been founded in 1850.

A spokesman for the purchaser stated that no changes are being made in the Holmes organization or in the quality of service to be provided to customers.

J. Meszar Discusses AMA

On April 24 at West Street and at Murray Hill April 27, J. Meszar presented a description of the automatic message accounting (AMA) system from the layman's point of view. Mr. Meszar described, in simple terms, the basic features of the system. He showed the coding technique used and illustrated by slides some parts of the mechanisms employed for recording, computing, sorting, summarizing and printing the call data.

To supplement the lectures, which concluded the Laboratories' Out-of-Hour Series for 1949-50, inspection trips to the laboratory where an AMA system is in operation were made on several evenings.

Murray Hill Bridge Club

The team-of-four bridge tournament, main event of the second half of the 1949-50 bridge season at Murray Hill, has been completed. Winners were: *First scratch team* Margaret Ely, Marion Gray, J. P. Griffin and W. T. Jervey. *Second scratch team* J. Bardeen, W. H. Brattain, L. B. Cooke and T. J. Grieser. *First handicap team* H. G. Arlt, R. A. Ehrhardt, C. A. Webber and J. G. Whytock. *Second,* Dorothy Thom, Muriel Kossuth, R. Black and G. F. Schmidt.

Edith Sairs, who recently assumed duties as nurse in the Whippany Medical Department.

Miss Ely and Miss Gray also won second place in the Metropolitan Commercial Bridge League Pair Championship tournament.

June Service Anniversaries of Members of the Laboratories

40 years

J. G. Brearley

35 years

J. T. L. Brown
I. E. Cole
J. R. Fry
S. D. Morrison
Albert Tradup
S. H. Willard

30 years

T. M. Benseler
C. E. Brooks
W. K. Burke
E. T. Burton
Emily Callagy
G. B. Crofutt, Jr.
J. F. Dalton
F. S. Farkas
H. W. Flandreau
W. J. Galbraith
G. A. Hurst
Herbert Keppicus
S. R. King
F. A. Korn
H. R. Nein
N. A. Newell
G. H. Peterson
G. A. Pullis
J. A. Ratta, Jr.
F. W. Treptow
G. J. Wismar

25 years

F. G. Buhrendorf
Elmer Graf
J. P. Guerard
V. J. Hawks
F. E. Haworth
R. S. Kennedy
J. G. Kreer, Jr.
Howard Morrison
Ramon Ortega
F. F. Shipley
C. B. Sutliff

20 years

V. L. Behnke
M. C. Biskeborn
Michael Brosnan
Howard Christensen
T. J. Dolly
T. F. Egan
N. J. Eich
W. L. Filmer
R. E. Friedley
Willard Gabel
M. B. Gardner
R. J. Gotta
R. O. Grisdale
J. R. Haynes
L. H. Hinrichsen
L. W. Hussey
J. T. Kenny
A. P. King
B. J. Kinsburg
J. J. Kleimack
E. V. Kuzela
J. F. Lawrie
J. C. McCoy
Erna Merseburger
G. E. Perreault
G. M. Phillips
J. P. Radcliff
N. O. Rae
F. F. Romanow
O. W. Schaefer
G. A. Smith
Bernhard Stauss
Patrick Sullivan
J. J. Tanski
V. P. Triolo
August Uhl
R. L. Vance
R. F. Wick
J. A. Word

15 years

F. B. Combs
G. H. Day
Mary Dunham
C. W. Haas, Jr.
H. A. Hilsinger, Jr.
Margaret Jaeger
T. M. Morris
J. L. Schweitzer
Michael Sheehan

10 years

Herbert Baker
W. J. Blanch
Jane Cassidy
A. H. Doblmaier
H. E. Earl, Jr.
E. O. Fuchs
J. E. Galbraith
H. Z. Hardaway
J. H. McGuigan
J. D. Ontka
R. M. Scheller
W. A. Sumner
Sara Warmington
J. A. Whitaker, Jr.

News Notes

O. E. Buckley visited the territory of the Northwestern Bell Telephone Company, and on April 3 gave a talk in Omaha, Nebraska, at a luncheon at the Blackstone Hotel, given by President E. J. McNeely, for a group of Omaha business men. Dr. Buckley spoke on the work of the Laboratories with particular reference to operator toll dialing, transmission developments and the significance of mechanization and miniaturization. He closed with a look ahead at research for the distant future. On April 4, in Des Moines, Iowa, he gave a similar talk at a luncheon of the Iowa Independent Telephone Association in Hotel Fort Des Moines, at the invitation of the Association's President, Clyde McFarlin. At a recent annual meeting of the National Academy of Science, Dr. Buckley was unanimously elected a member of the Council of the Academy.

D. A. Quarles, R. R. Hough and J. F. Wentz attended a meeting of the Radar Panel of the Research and Development Board on board the *U.S.S. Saipan*.

R. Bown spoke on *The Interface Between Research and Development* at the meeting of the Deal-Holmdel Colloquium at Deal on May 5. Following the meeting a dinner was held at Willowbrook Restaurant's Rathskeller at Fair Haven. Mr. Bown was present at a meeting of the Industrial Research Institute at Rye, New York, and acted as discussion leader at a group meeting on the subject of *Training Programs for Research Personnel*. He also attended a meeting, on April 17-18, in Washington of the Advisory Board of the Naval Ordnance Laboratory, of which he is a member.

J. W. McRae visited the Western Electric at Hawthorne on April 20 to discuss the manufacture of metallized paper capacitors for the new station set. He also talked to a group of professors and deans from the universities in the Chicago area on the subject of *The Bell Laboratories and Its Work*. This talk was given in connection with the *Looking Ahead with the Bell System* exhibit.

The 1950 Medal for Leadership in Research was awarded posthumously to Frank B. Jewett on April 26 by The Industrial Research Institute at Rye. Frank B. Jewett, Jr., received the medal at a luncheon at which R. Bown, R. M. Burns and O. B. Blackwell were present.

"Telephone Hour"

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

June 5	*Todd Duncan*
June 12	*Jose Iturbi*
June 19	*Igor Gorin*
June 26	*Zino Francescatti*
July 3	*John Charles Thomas**
July 10	*Lucile Cummings*

* From Hollywood

D. D. Haggerty congratulates G. W. Galbavy of Murray Hill who has accepted the inter-area bowling trophy on behalf of the Murray Hill Bowling League, first winner of the trophy.

R. K. Honaman filled a series of speaking engagements for the Mountain States Telephone and Telegraph Company between April 14 and 21. He addressed the chapter of the Instrument Society of America at the Sandia Base, and business and industrial organizations in Albuquerque, Colorado Springs, Grand Junction, Salt Lake City and Denver. He spoke to Colorado Society of Engineers and a meeting of Bell System supervisors in Denver. Total attendance at these meetings was about 1500. Mr. Honaman was in Indianapolis on May 4 as guest speaker at the 30th annual convention of the Indiana Telephone Association where he discussed recent Laboratories developments and their application in the telephone business.

E. E. Schumacher has been invited by the British Institute of Metals to deliver the annual Fall lecture at Bournemouth, England, in September. His subject, *Communications Metallurgy—Metallurgy Behind the Decimal Point.*

The Laboratories were represented in interference proceedings at the Patent Office by R. J. Guenther before the Board of Interference Examiners.

P. H. Smith attended an Antenna Symposium at the Naval Electronics Laboratory in San Diego where he presented a paper on a newly developed microwave antenna.

R. E. Poole spoke on *Bell Telephone Laboratories and Military Electronics* before the Instrument Society of America at the University of New Mexico, Albuquerque.

H. S. Wertz and S. N. Turner were at the Patent Office in Washington on questions relating to patent matters.

F. E. Nimmcke attended a conference in San Diego of Western Electric Senior Field Engineers stationed along the West Coast. He discussed with them new developments associated with Navy radar projects.

Philip C. R. Curley, son of John Curley, has been appointed as official representative to the Pax Romana World Student Congress at Amsterdam, the Netherlands. The trip will be the second of three trips abroad this year. In October Mr. Curley will sail for France where he will take a two-year course at the Institute of Political Studies in Paris.

Souvenir presented to H. A. Larlee by members of his group on the occasion of his 45th anniversary in the Bell System. Alice Loe was the artist.

H. T. Langabeer and H. M. Spicer discussed designs for new motor driven switches with the Albert and J. M. Anderson Manufacturing Company in Boston. Mr. Spicer also conferred with engineers of the General Electric Company at Schenectady on power control apparatus.

N. B. Hannay, J. J. Lander and L. A. Wooten attended the M.I.T. Conference on Physical Electronics, at which Mr. Hannay presented a paper on *Conduction Processes in Oxide Cathodes* co-authored by D. MacNair.

H. M. Yates, left, and J. V. Elliott, right, played for the championship of the Murray Hill Spring Table Tennis Tournament on April 2 on the stage of the Arnold Auditorium. Mr. Elliott won in three straight games.

V. T. Callahan made tests on the new automatic diesel engine alternator set on trial at the Salisbury, North Carolina, office.

A. F. Burns and H. J. Berka discussed recent lamp developments with engineers of the General Electric Company at their Nela Park lamp laboratories in Cleveland.

J. B. Kelly conducted selenium rectifier power tests on the L1 carrier route in the vicinity of Atlanta, Anniston and Birmingham, Alabama.

E. E. Helin and J. J. Strodt made tests at the Fort Wayne factory of the General Electric Company on a new type antenna motor for use on the T-33 system.

M. A. Froberg and R. R. Gay discussed power supplies for the 1A key equipments with the Western Electric Company at Haverhill.

Patricia Munther is in charge of the Technical Information Library at Whippany. She is shown putting current material on one of the several magazine racks she maintains in various buildings at that location.

S. C. Del Vecchio was in Media in connection with the removal of reed keyset trial equipment.

Harriet Filmer participated in conferences on transcription problems and Government security regulations at Winston-Salem and Burlington during April.

E. Hartmann supervised construction in Chicago of apparatus for measuring the response characteristics of the new G1A handset and apparatus for stabilizing the U-type receiver.

The recently publicized machine which illustrates error-detecting and error-correcting codes was demonstrated to several groups by B. D. Holbrook, designer of the circuits.

J. B. De Coste presented a paper on *Environmental Cracking of Polyethylene* at the Detroit meeting of the American Chemical Society.

R. M. Burns and W. O. Baker attended the Council meeting of the American Chemical Society in Philadelphia.

B. M. Bowman and M. Whitehead went to Pittsfield to discuss matters relating to tantalum electrolytic capacitors.

J. Meszar, P. W. Swenson, P. Husta, W. W. Werring, O. M. Hovgaard and F. P. Balacek visited Allentown to discuss transitor and relay production techniques.

D. A. McLean observed the manufacture of capacitor paper at Westfield, Massachusetts.

Credit for being the last survivor in the Laboratories of the Clinton Street works of Western Electric was given last month to Victor Langborgh. Now it appears that Mr. Langborgh's retirement has not extinguished the breed: L. A. Leatherman, of Power Development, was a PBX tester there in 1916. Are there any others?

RECENT DEATHS

Mary Upton
1911-1950

Mary Upton, May 2

Death came suddenly to Mary Upton—she had been recuperating from a heart ailment when she was fatally stricken. Her life had been a full one. She was active in many Bell Laboratories Club activities, notably the Women's Bowling League of which she was chairman from 1947 to 1950, the Doll and Toy Committee, of which she served as New York chairman in 1949, and the Systems Department Chorus. She had also served on the Intercommunications Communion Breakfast Committee for the past six years.

Miss Upton joined the Laboratories in 1936 as a member of the Transcription Department. In July, 1937, she transferred to the Traffic Department and remained a member of that group until her recent death.

Miss Upton was the daughter of the late J. W. Upton, who was in charge of the Development Shops from 1906 to 1936.

Barth Vander Els, May 2

Mr. Vander Els, a member of the Technical Staff, died during working hours at the West Street Laboratories. He was graduated from Paterson Preparatory High School and had studied at New York University. He had worked at Wright Aeronautical Corporation for two years before joining the Western Electric Company, nearly twenty-six years ago. At Western he had been concerned mainly with the installation and testing of central office equipments, first on panel and later for crossbar local offices. With the introduction of toll crossbar, he developed testing facilities and methods used during the installation of these offices. These methods contributed materially to the later splendid performance of the No. 4 type toll crossbar systems. About a year ago he transferred to the Laboratories to aid in the development of the No. 4A toll crossbar system which will be used in the nationwide dialing plan.

Mr. Vander Els was a resident of Waldwick, New Jersey, and had long been active in community life. He was a member of the Board of Health for several years and its president from 1944 to 1948. At the time of his death he was vice-president of the North Bergen Nursing Service and a member of the A. I. E. E. and Telephone Pioneers of America.

Benjamin Messenger, April 12

During World War II, Benjamin Messenger was recruited by the Laboratories through agreement with Consolidated Edison to do design drafting on radar and other military developments in the Systems Development Department. Mr. Messenger was born in Scotland where he studied electrical engineering in the Glasgow Technical College and later served five years apprenticeship as a draftsman. He had been nineteen years with Consolidated Edison and was a drafting supervisor before joining the Laboratories. At the end of the war he became a permanent member of the Laboratories and remained in Systems, doing drafting work at Graybar on the Boston-New York radio relay link and later on the New York-Chicago radio relay link. Last fall he transferred to Murray Hill as a member of Transmission Systems Drafting which became a part of the Apparatus Engineering Department in January of this year. He died during working hours at the Murray Hill Laboratories.

B. Vander Els
1900-1950

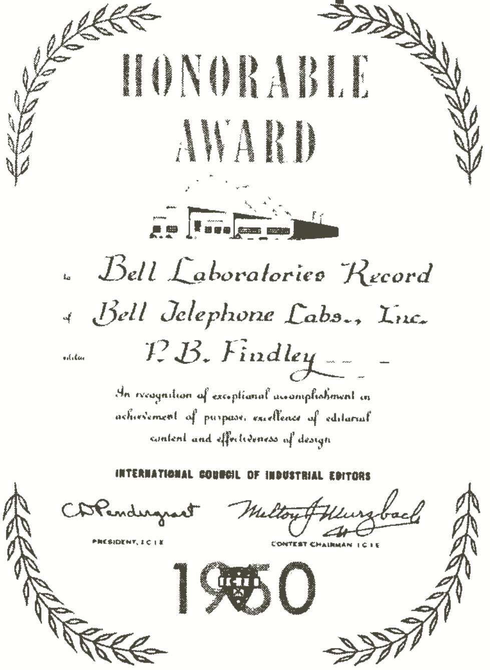
B. Messenger
1902-1950

News Notes

J. F. Ambrose and J. B. Howard attended the American Chemical Society meeting in Detroit.

R. W. Hamming, E. G. Andrews, A. E. Joel and O. J. Murphy attended the Conference at Rutgers University on March 29 on Automatic Computing Machinery.

D. R. Brobst visited the Tonawanda Plant of Western Electric to discuss switchboard cable and enameled wire.



The RECORD *was one of the "Highest Award" winners in the 1950 International Industrial Publication Contest—one of the 50 selected for this honor out of nearly 600 entries. The percentage scored was 93.*

R. M. C. GREENIDGE and B. SLADE went to Haverhill, Massachusetts to confer on resistor redesign problems.

N. J. EICH and J. L. GARRISON visited the Western Electric Company at Haverhill in connection with preproduction models of the packaged transistor amplifier for the card translator.

G. R. GOHN participated in the two-day New England conference of the Institute of Metals, April 21-22, in Providence. Mr. Gohn spoke before the Fatigue Symposium on *Fatigue and its Relationship to the Mechanical and Metallurgical Properties of Metals.*

V. E. LEGG, at Pittsburgh, attended a meeting of A.S.T.M. Committee on magnetic testing.

J. B. HARLEY, F. LOHMEYER, J. G. NORDAHL and A. E. RUPPEL visited the General Electric Company at Syracuse on April 20 and 21 to discuss equipment for mobile radio systems.

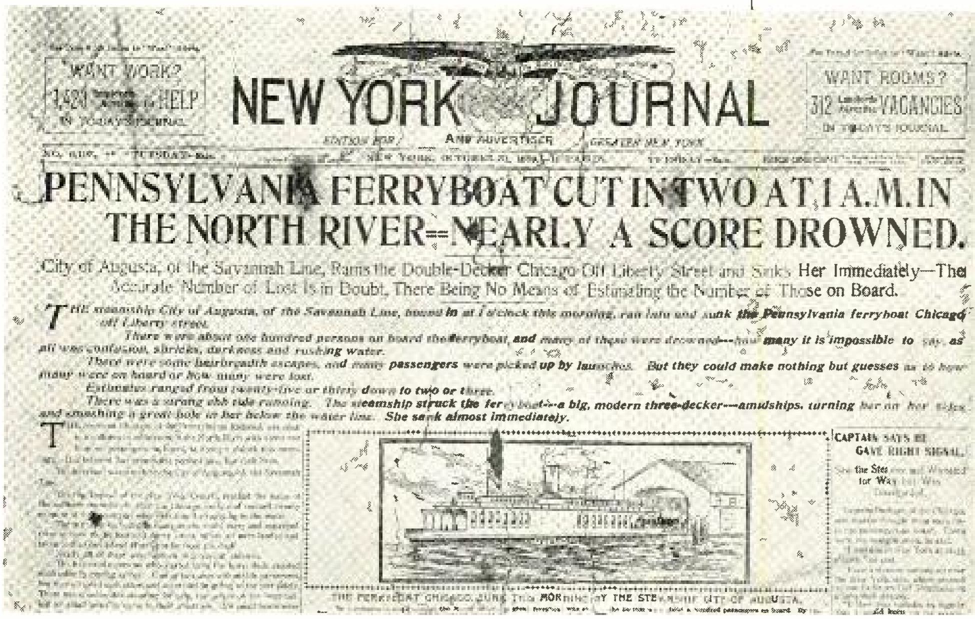
F. E. GISSLER, on four round trips to Washington between April 16 and April 19, observed the operation of the unattended "Coin Box" radio telephone equipment that has been installed in the Pennsylvania Railroad Company's parlor car *John Adams.* W. E. REICHLE observed the operation of this system on April 18.

J. R. PIERCE presented an invited paper on *Physical Aspects of Postwar Microwave Amplifiers* at the American Physical Society meeting in Washington, April 27. S. MILLMAN and A. V. HOLLENBERG attended the meeting.

J. R. HAYNES gave a talk on *The Mobility and Lifetime of Injected Holes and Electrons in Germanium* at the Physics Colloquium of Columbia University.

M. A. LOGAN visited Burlington regarding the manufacture of Naval Ordnance equipment.

D. T. OSGOOD visited Winston-Salem in connection with a test set for M1 carrier.



WANT WORK?

NEW YORK JOURNAL

AND ADVERTISER

WANT ROOMS?

PENNSYLVANIA FERRYBOAT CUT IN TWO AT 1 A.M. IN THE NORTH RIVER—NEARLY A SCORE DROWNED.

City of Augusta, of the Savannah Line, Rams the Double-Decker Chicago Off Liberty Street and Sinks Her Immediately—The Accurate Number of Lost Is in Doubt, There Being No Means of Estimating the Number of Those on Board.

THE steamship City of Augusta, of the Savannah Line, bound in at 1 o'clock this morning, ran into and sunk the Pennsylvania ferryboat Chicago off Liberty street.

There were about one hundred persons on board the ferryboat, and many of these were drowned—how many it is impossible to say, as all was confusion, shrieks, darkness and rushing water.

There were some hairbreadth escapes, and many passengers were picked up by launches. But they could make nothing but guesses as to how many were on board or how many were lost.

Estimates ranged from twenty-five or thirty down to two or three.

There was a strong ebb tide running. The steamship struck the ferryboat—a big, modern three-decker—amidships, turning her on her sides and smashing a great hole in her below the water line. She sank almost immediately.

CAPTAIN SAYS HE GAVE RIGHT SIGNAL.

Times do change. The newspaper, shown above, is dated October 31, 1899. It was found in the false ceiling of one of the areas at West Street during the rehabilitation of the building. Christopher Hartley restored it sufficiently for a photographer to copy it.

R. K. Potter discussed *The Portrayal of Noise* before the U.R.S.I. meeting on April 18 in Washington.

W. P. Stiebitz visited Milwaukee in connection with temperature studies on N1 carrier field trial installation.

H. B. Noyes conducted tests of crosstalk at video frequencies in exchange area cables in Pittsburgh.

Iden Kerney and S. Brand spent several weeks at Milwaukee in connection with tests on program facilities.

G. R. Frost gave a talk on *Functional Building Blocks of Switching Systems* on April 17, and A. E. Ritchie on *A Telephone Switching System as an Example of the Application of the Switching Art* on April 24, at the Communication Division and New York Section of the A.I.E.E. and I.R.E.

H. J. Keefer, H. W. Hermance and T. F. Egan made dust studies on switching apparatus in Pittsburgh.

E. G. Andrews visited Pittsburgh, April 3-5, and Providence on April 28 to attend conferences on digital computers.

P. B. Murphy visited Fort Bliss and El Paso, Texas, on April 3-7 to discuss digital computers.

W. A. MacNair, J. Meszar and A. E. Ritchie participated in conferences at M.I.T. on April 25 on instruction in switching.

H. J. Keefer and C. W. Mattson visited Tonawanda in connection with the field installation of new relays in No. 5 crossbar office.

V. T. Wallder presented a paper on *Weathering Studies on Polyethylene for Wire and Cable Applications* at the Detroit meeting of the American Chemical Society.

B. McWhan, P. A. Jeanne and W. C. Ball visited Troy in connection with ringing conditions on rural lines exposed to inductive interference on power lines.

F. Kuchas visited St. Louis and J. J. Lukacs visited Centerline, Michigan, in connection with No. 5 crossbar.

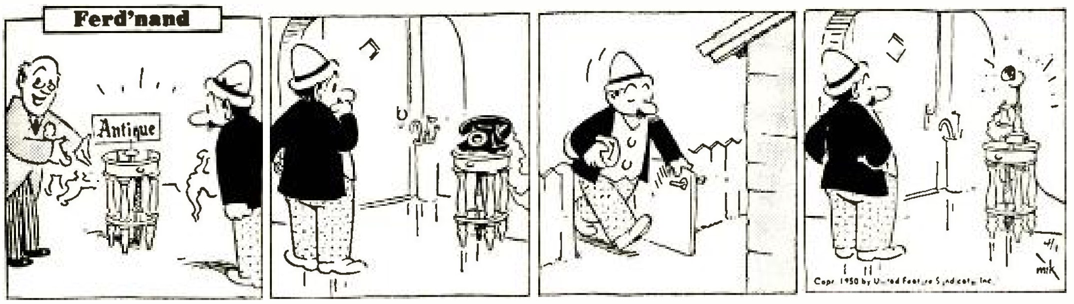
R. B. Curtis and R. C. Pfarrer visited Albany in connection with the cutover of A4A toll system.

C. L. Beckham to traffic measurements at the No. 5 office at Towson, Maryland.

At a conference to discuss the work of the Solid State Research Group held in the Arnold Auditorium at Murray Hill on April 19, the subject of the program was *Ferroelectricity.* Talks on *A Review of Experiments on and Theory of Ferroelectrics* by P. W. Anderson, and *Potassium Niobate, Sodium Niobate, and the Perovskite Sister-Structures* by Elizabeth A. Wood were presented.

Elizabeth A. Wood presented a paper on *Polymorphism and Twinning in Potassium Niobate and Sodium Niobate,* and B. T. Matthias one on *Dielectric Properties of Potassium Niobate* on April 10 at the meeting of the American Crystallographic Association at Pennsylvania State College.

H. J. Williams spoke on *Recent Experiments on Ferromagnetic Domains and Domain Walls* at a meeting of the New York Section of the American Physical Society at the University of Buffalo.



R. C. Gee has been reelected to serve on the Board of Education of Saddle River Township.

J. K. Galt has been elected a member of the Executive Committee of the Summit Association of Scientists.

The Laboratories were represented in interference proceedings at the Patent Office by G. T. Morris, G. C. Lord and F. Mohr before the Board of Interference Examiners; and R. T. Holcomb before the Primary Examiner.

A. M. Garblik is assisting the Western Electric engineers at Winston-Salem in eliminating initial production problems on aircraft telephone equipment.

R. A. Sykes, I. E. Fair, B. S. Woodmansee, G. T. Kohman, A. C. Walker and E. Buehler attended a symposium covering frequency control devices held, April 26-27, at Squier Signal Laboratories, Fort Monmouth.

B. McMillan talked on the *Information Theory* at a meeting at New York University of Pi Mu Epsilon on April 19.

C. Kittel gave a series of talks on *Recent Progress in Ferromagnetism* to the Chicago telephone engineers, the Physics Colloquium of the University of Chicago, the A.I.E.E. meeting at Duluth, the Sigma Xi at Notre Dame University, the Physics Colloquium at the University of Illinois, and the A.I.E.E. meeting at Milwaukee.

R. C. Fletcher has written on *Helix Parameters Used in Traveling–Wave-Tube Theory* and H. W. Bode and C. E. Shannon on *A Simplified Derivation of Linear Least Square Smoothing and Prediction Theory* in the April 1950 issue of the *Proceedings of the I.R.E.*

W. O. Baker spoke at the Princeton Chemistry Colloquium on *Mechnical Waves and Polymer Molecules.*

H. W. Hermance and T. F. Egan made several trips to Philadelphia for studies of sequence switch maintenance.

R. M. Burns, K. G. Compton, E. A. Thurber, H. C. Theuerer, and U. B. Thomas attended a convention of The Electrochemical Society in Cleveland.

E. J. Becker and F. J. Biondi visited the General Electric Company in Schenectady to discuss dew point instruments.

H. M. Cleveland visited the Machlett Laboratories with members of the Allentown Laboratory to discuss materials.

I. L. Hopkins attended A.S.T.M. committee meetings at Old Point Comfort, Virginia.

L. E. Abbott attended the combined A.I.E.E.-American Welding Society meetings in Detroit on electrical welding.

I. V. Williams was elected chairman of the American Standards Association Sectional Committee B32, on Wire and Sheet Metal Gages.

During the American Physical Society meeting in Washington, April 27 to 29, J. R. Pierce presented a paper on *The Physical Aspects of Postwar Microwave Amplifiers;* E. J. Murphy, *Hydrogen Bond Energy from A.C. Conduction Data on Ice;* W. A. Yager, J. K. Galt, F. R. Merritt, Elizabeth Wood and B. T. Matthias, *Ferromagnetic Resonance in Single Crystals of Nickel Ferrite;* C. Kittel, *Theory of Magnetic Dispersion in Ferrites;* J. Bardeen, *Theory of Infra-Red Absorption in Silicon and Germanium;* J. K. Galt, B. T. Matthias and J. P. Remeika, *Properties of Single Crystals of Nickel Ferrite;* and W. Shockley, *Fundamental Processes of Magnetization Shown by Movies.* R. M. Bozorth presided at the session devoted to *Ferroelectricity; Ferromagnetism; Electron Optics.* J. A. Becker and H. B. Briggs also attended the meeting.

". . . and then one day she looked in the Yellow Pages of the Telephone Directory and found him listed under 'Bachelors, Eligible.'"

W. E. Campbell presented a paper *The Lubrication of Sliding Electrical Contacts* at the annual meeting of the American Society of Lubricating Engineers in Detroit. He was elected a director of the Society.

L. Egerton, J. R. Fisher, W. F. Janssen, M. D. Rigterink, and A. W. Treptow attended the annual convention of the American Ceramic Society in New York City.

A. Mendizza visited Sandy Hook, New Jersey, and State College, Pennsylvania, on an inspection trip of A.S.T.M. hardware tests. Mr. Mendizza was appointed chairman of Subcommittee XVI of Committee A5, A.S.T.M. on Testing of Hardware.

J. B. De Coste and V. T. Wallder visited the Columbus office of the Ohio Bell Telephone Company to discuss the outdoor exposure of station wires.

F. M. Thomas and D. F. Skelton visited the Frontier Bronze Corporation in Niagara Falls to discuss aluminum casting problems.

V. F. Miller and W. J. Rutter were at the General Electric Company, Pittsfield, to discuss engineering questions on maintenance tools.

M. Salzer visited No. 5 crossbar offices in Catonsville, Md., Towson, Md., Glenolden, Pa., and Cranford, N. J. in reference to the introduction of new maintenance apparatus.

W. E. Kock has written on *Microwaves and Sound* in the March issue of *Physics Today*.

Engagements

*Antoinette Fandetta—Robert Damore
*Mabel Glidden—John A. Cooney
*Jann Goehner—*Philip T. Packard
*Mary Janet Graceley—Thomas J. Lyness
*Catherine Graham—John F. Phraner
*Agnes McLean—William E. Murphy
*Helen Miller—Frank J. Tykowski
*Beverly Raquet—Edward J. Otten

Weddings

*Wilma Griffin—Charles Zaleske
Irma Johnson—*Robert M. Mikulyak
*Louise Magliaro—Samuel J. DeMasi

*Members of the Laboratories. Notices of engagements and weddings should be given to Mrs. Helen McLoughlin, Section 11A, Extension 296.

E. A. Thurber conferred on vapor-phase deposition processes at the Battelle Institute in Columbus, Ohio.

O'My—the Accident Maker—the gremlin you'd like to blame for accidents—but can't

Courtesy American Mut

Good boy—split some fuel for her, Dan'l—show her how skillful you are when it comes to any kind of dangerous work.

That's fine—she looks worried. She should be—seeing your foot halfway up the log, the axe slicing through the punky wood to meet it.

Ha, ha! It's happened! And course he forgot to pack a first a kit—but I'll help get him to a doct —yet—ho-ho-ho!