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R. P. ASHBAUGH
Outside
Plant
Development

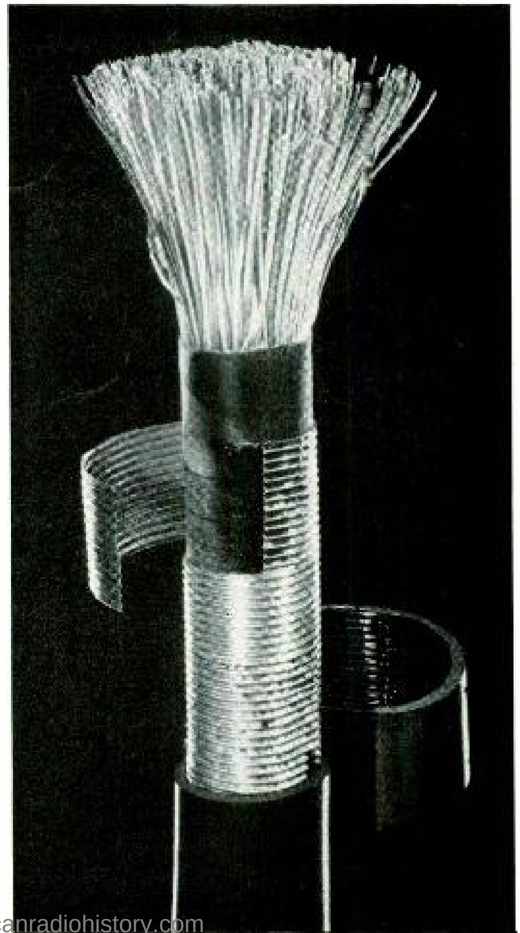
ALPETH CABLE SHEATH

A new type of cable sheath is now being produced in considerable quantity at both the Kearny and Hawthorne Works of the Western Electric Company. This is the first commercial manufacture of Alpeth, a composite covering of aluminum, water-resistant cements and polyethylene developed by the Laboratories as a possible substitute for sheaths made of lead alloys, which have been used for three score years to protect the insulation of telephone cables.

The innermost portion of the new sheath consists of a strip of thin aluminum folded around the cable core. This strip is corrugated transversely to provide flexibility of the cable. Cement is placed between the overlapped edges and the aluminum is then flooded with another cement and the sheath completed by an extruded outer covering of polyethylene. The name Alpeth is coined from the words *al*uminum and *polyeth*ylene.

Alpeth sheath owes its immediate appearance to the present world shortage of lead. Its beginnings, however, date much further back to the early 1920's, when the first alarm was raised about a shortage of the world's lead supply.

At that time, the lead used for cable sheath was restricted to brands known as chemical leads. The effect of this first alarm was an investigation begun and carried through which allowed certain other leads



Dissected Alpeth cable showing inner wrapping of paper, corrugated aluminum layer and outer covering of polyethylene to be used as admixtures with chemical leads. This extended the field of supply adequately for the large cable schedules of the late 1920's.

The Laboratories were interested not only in the availability of sufficient lead of the right types but also in developing better sheath than was then obtainable. Cable sheath must first of all keep out moisture. In addition, it must be sufficiently pliable to allow the cable to be bent and strong enough to protect the core from mechanical damage. It must be resistant to corrosion and be workable to get it in place on the cable core. Lead comes the closest among the metals of having all these characteristics. Its chief shortcoming is that when it is subjected to vibration and repeated stresses over a long period, as occurs with aerial cable sheath, lead, under some conditions, will develop cracks which admit moisture to the cable.

Any thin metal layer will keep out moisture if an initial seal can be assured and then maintained. However, a thin layer of any of the common metals such as copper, brass, steel, aluminum, or zinc cannot be extruded over a cable core as is done with lead. Therefore, such a metal covering would have to be formed around the core and the edges sealed. Welding or soldering the seam at commercial operating speeds to produce a seal which will remain perfect during reeling or other necessary flexing has never been accomplished satisfactorily. Neither could a smooth layer so formed be bent as required without buckling. The solution to this latter problem was to corrugate the smooth strip transversely as noted above. The question of waterproofing and providing strength, rigidity, corrosion resistance and other necessary qualities was solved by using a composite layer, each member of which when bonded to the others would reduce the possibility of faults occurring at the same point to a negligible factor. The initial work was therefore directed toward a design to consist of a thin corrugated metal layer over the cable core, then a layer of plastic and another layer of thin corrugated metal, all bonded together to prevent displacement with any normal working. With materials and methods of manufacture then considered practicable, it was felt that a triple barrier was essential in order that the desired superior structure could be obtained.

A study of the toughness, ductility and solderability of various metals led to the selection of brass as most suitable. Equipment then had to be designed and built to corrugate, form and solder this covering. The next problem was that of selecting a plastic to provide rigidity and some resistance to water penetration. A vulcanized material, such as the rubber used for insulating purposes, seemed to have the desired characteristics but was not desirable from the standpoint of ability to manufacture or its cost. Thermoplastics were also not so well developed as today and nothing the market offered was suitable from the cost standpoint. Research engineers of the Laboratories worked on this problem and developed a thermoplastic material based principally on reclaimed rubber. Extrusion of this compound was considered the desirable method of application but was not practicable at the time, and it was therefore applied as longitudinal strips formed around the cable core and joined by a pinched-off seam.

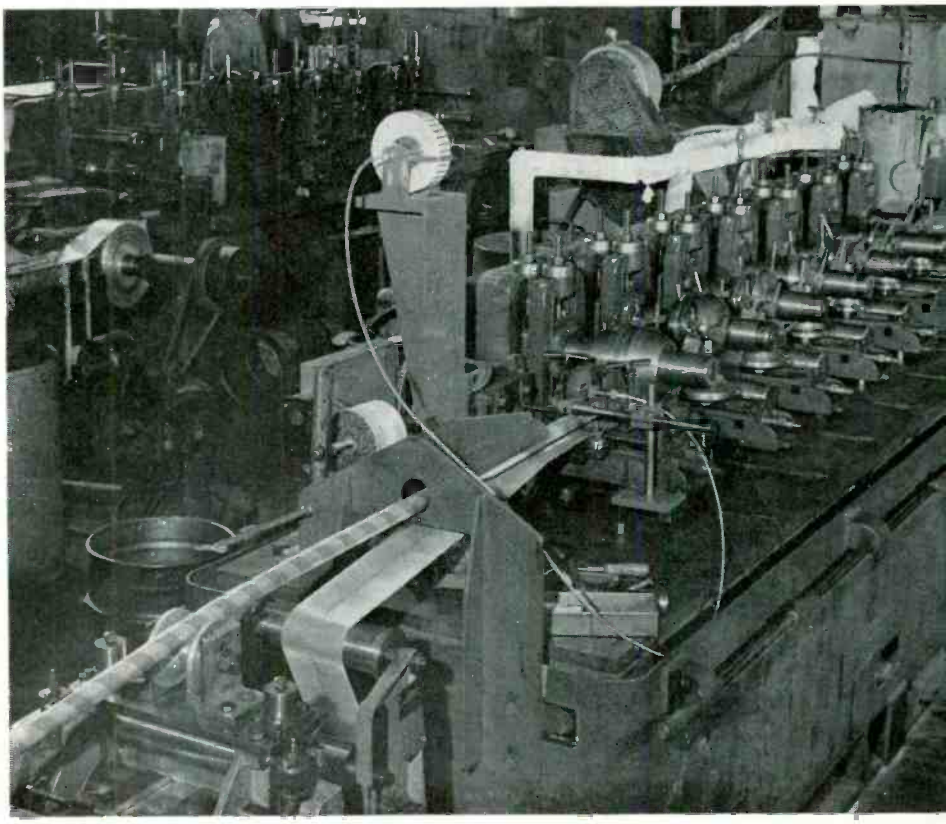
Various trial structures were manufactured, examined and tested and in the early 1930's a laboratory field trial was made. The cable used had a corrugated brass covering over the core with soldered seam, a flooding of asphaltic cement, a layer of thermoplastic compound, a second flooding and an outer brass covering applied the same as the inner one. This first trial cable was buried in the ground and it therefore had the standard jute protection applied over the outer brass covering. The cable was virtually hand made and the principal effort for the next couple of years was to devise equipment to manufacture further trial cables on a machine-made basis. A second cable similar to the first except for some differences in the protective coverings was buried at the Chester field laboratory, and subsequently two lengths without protective coverings were installed there aerially.

While these cables were undergoing service tests, a careful study was being made of the economies of the new sheath. This study led to replacing the inner soldered brass by a thin corrugated steel tape from which the solder was omitted. The entire sheath could then be applied in one pass through the machine. A trial cable of this design was manufactured and installed aerially at Chester.

At this stage there was sufficient confidence, based on the results of laboratory and field tests, to justify a service trial and it was proposed to install from 10 to 20 miles of the new sheath aerially. Such a trial would give field experience with handling and splicing and then the whole structure could be evaluated from both a service and an economical standpoint. It was not to be at that time, however, for the country was at war and there were other places where the effort and material could be better applied. The whole development was suspended.

The project was reviewed shortly after World War II and it was agreed to proceed with the development essentially as it had been left. Before any material action had been taken, however, a real lead shortage developed. Bell System needs now called for exchange area cable production to be increased from a nominal output of 30 billion conductor feet to at least 50 and possibly 60 billion. The country's deficient lead supply indicated at that time that lead could not be obtained for more than about 60 per cent of this production. It was quickly decided, therefore, that the Laboratories and the Western Electric Company working together should make an all-out effort to specify and produce composite sheath for a portion of the cable output.

By taking advantage of what had been learned from the trial installations and by a thorough study of the metals and plastics fields, a triple-barrier design was defined sufficiently to enable the Western Electric Company to proceed with the designing of proper manufacturing equipment and to



The conductors of Alpeth cable are bound together at the Western Electric Company plants with a wrapping of paper tape over which is folded a corrugated aluminum ribbon whose overlapped edges are sealed with a viscous cement. The aluminum is then flooded with a layer of cement and the sheath is completed with an extruded outer covering of polyethylene investigate sources of supply for the required materials. This study resulted in the following decisions: The inner material would be aluminum because of its availability and desirable physical characteristics which provide adequate conductivity. The plastic would be extruded polyethylene or polyvinylchloride, depending on supply and further evaluation of the two materials, and the outer metal would be brass, probably lead coated.

As the work progressed, it became evident that the full manufacturing equipment could not be set up for production as rapidly as the increase in core production required. It was decided, therefore, to dispense temporarily with the brass cover and to concentrate on a two-layer structure consisting of aluminum and polyethylene, i.e., Alpeth sheath. The chief demerit of this structure is the risk that its life in outdoor exposures may be shortened by the lack of protection that would be afforded by a cover of brass. Its chief merit, which is far more important, is that it is enabling the telephone companies to obtain cable that is vital in their struggle to meet the demand for more widespread telephone service.

Although the immediate urge for large-scale use of Alpeth sheath arises from the necessity to cover large quantities of cable before brass sheath can be made available, it has inherent advantages which point to the possibility that it may become a permanent alternate type of cable sheath. It is lower in cost than either brass sheath or lead sheath. It is well suited for use in ducts and because of its light weight and flexibility it will in many situations permit the use of longer lengths, thus reducing the number of splices required. Tests show it to be greatly superior to lead sheath in resistance to fatigue failure. Only a large-scale field trial, which the present emergency program provides, can determine whether there are offsetting disadvantages.

Trial cables of Alpeth sheath were made in a pilot plant early in 1947 and commercial cables became available in October of that year.

THE AUTHOR: R. P. ASHBAUGH graduated in Electrical Engineering from Ohio University in 1910 and joined the Laboratories in 1911. Two years later he entered the lead-covered cable development group and has been in that work continuously since. He went to Japan in 1922 to supervise the placing and splicing of the first toll cable installed in that country and remained to work with the engineers of the Sumitomo Cable Works on problems of toll cable design. He returned to the United States in 1924 and was located at the Hawthorne Works of the Western Electric Company until 1938 and since then at their Kearny Works. During this entire period he has been mostly concerned with development problems and he has been actively connected with many of the refinements in quadded cable design as well as the developments on fine wire cables, such as pulp insulation and unit type cables. He now has charge of the development work on exchange area cables.

HISTORIC FIRSTS: TRANSLATION

By the early years of this century the rapid growth of the telephone system had already brought many complications into the methods of switching in large cities. In looking ahead to future needs, it became evident that before many years had passed, difficulty would be experienced even in finding enough operators to fill the steadily increasing number of switchboard positions. Some form of mechanical switching seemed essential. The only method that had achieved any appreciable success up to that time, however, was the step-by-step system, which did not seem well suited to the very large centers, partly because of its comparatively small switching unit. It was suggested, therefore, that a switch designed to accommodate 500 lines, instead of 100 lines as did the step-by-step switch, would be more desirable.

E. C. Molina

A 500-point switch, however, brought up new difficulties. The step-by-step switch had been designed to accommodate lines or trunks on a decimal basis: ten rows of terminals each with ten sets of terminals in the row. This was done for the very simple reason that our numbering system is a decimal one. Each subscriber in a 10,000-line office is in a telescoping series of decimal groups, and the groups he occupies and his exact position in the smallest group is specified by the four digits of his number. In dialing subscriber No. 2647, for example, the first digit selects the second of ten groups of 1,000 subscribers, the second digit selects the sixth of ten groups of 100 subscribers, the third digit selects the fourth of ten groups of ten subscribers, and the fourth digit selects the seventh subscriber in the latter group.

With a 500-point switch, on the other hand, this decimal grouping is inherently lost. The subscribers would naturally fall into groups of 500 instead of 100, and if the switch were to be used most efficiently non-decimal groups would appear throughout the switching chain. The problem that had to be solved was thus how to control these non-decimal selections when the subscriber numbering and dialing are both on a decimal basis.

A solution was proposed by E. C. Molina late in 1905, and its adoption shortly afterward permitted work on the panel system to proceed rapidly. What he proposed was an arrangement between the dial and the selectors that would translate the decimal number dialed into non-decimal directions of the type required for controlling the selectors. A patent application for a Translating and Selecting System was filed on April 20, 1906, and Patent No. 1,083,456 was issued to Mr. Molina.

The solution Molina proposed for translating between decimal and non-decimal systems was—as is often true of broad basic inventions—very simple in principle. Suppose that as a result of dialing a decimal number a set of registering selectors or relays is operated to positions that indicate the number decimally. Elsewhere is a group of non-decimal selectors that will be used in establishing a connection to the number dialed. The translating arrangement conceived by Molina employed two sets of interconnected terminals. One set, through its connections to various combinations of contacts of the registering apparatus, would convey information as to number dialed in decimal form. The other set of terminals was connected to the operating magnets of the non-decimal selectors. By running cross-connections between these two sets of terminals in a suitable manner, the number on the registering apparatus could be made to operate any desired combination of selectors.

This description gives the essence of the invention rather than its original application, and many variations of the same basic scheme have been used. It is employed not only for translating a decimal subscriber number to a non-decimal method of finding it, but for translating the office code to selecting instructions for finding and connecting to an idle trunk in the group running to the desired office. In this latter application, one of its great advantages is the resulting flexibility. It permits the various groups of trunks to be assigned among the switching frames as desired, and to be changed as needed to meet changing conditions of load. Only the transfer of a few cross-connections is required to meet any change in the position of the trunks.

Translating systems based on the same principles are employed extensively also in the crossbar system, and are applicable wherever a transition is needed from decimal to non-decimal control. For nearly half a century translating circuits have been basic in all the large switching systems. T. D. Lockwood, Patent Attorney at the time the patent was applied for, said it was one of the most fundamental inventions on which he had ever filed.

THE LICENSE CONTRACT

CHICAGO, SEPTEMBER 18—Following discussions between officials of the American Telephone and Telegraph Company and the Special Telephone Committee of the National Association of Railroad and Utility Commissioners, the Committee announced today that the company stated that, effective October 1, 1948, and until further notice, the payments by the Associated Companies for services rendered by the A T & T under the license contract will be reduced from 1½ per cent of the Associated Companies' revenues to 1 per cent on a slightly different revenue base. Based on present revenues, this will reduce the current annual payment of about $35,000,000 by approximately $11,000,000.

The propriety of the payment of a percentage of revenues for license contract services has been the subject of considerable controversy in certain rate proceedings and the Committee met with the A T & T officials in an attempt to develop procedures under which the actual costs would be billed to each company for services rendered it. It was the position of the A T & T that a cost plan would be impracticable and that it would result in greater controversy. The A T & T officials stated that this substantial reduction should help to minimize controversy, and it is the Committee's opinion that it should tend in that direction.

The Committee announced its intention, however, to continue its study of the problem.

This news item is of interest in connection with the article by Mr. McHugh which begins on the opposite page. The article is quoted from Bell Telephone Magazine, *Summer,* 1948, *and was prepared before the change in the license fee became effective.*

KEITH S. McHUGH
Financial
Vice-President
A T & T

THE LICENSE CONTRACT

Fabian Bachrach
KEITH S. McHUGH

The license contract is a contract between the American Telephone and Telegraph Company and each of the operating telephone companies of the Bell System. Under it, all work together to provide a coördinated nation-wide communication service. Each operating company does locally the work that can best be done locally, and the A T & T is responsible for work that can best be done by a central organization.

If one single big company were providing telephone service everywhere, it would be natural, and in fact essential, for it to have a central staff of people carrying on research, handling patents and financing, assisting the local operating areas and divisions, and making studies and developing methods to the benefit of the service in all places where the company operated.

The same functions are equally necessary when, as in the Bell System, several companies, rather than one big single company, have the responsibility together.

Having several companies, each responsible for providing service in its own territory, has been of great importance in making it possible for the Bell System to give the best telephone service in the world, for it has aided in decentralizing responsibility and authority so that local people who know local conditions have the freedom and ability to act as circumstances require.

But the centralization of certain work has likewise been of the utmost value. And since we have several companies, instead of one big company, assurance that this central work will be performed is provided by a contract between the A T & T, which does the work, and each of the Bell System operating companies.

The name "license contract" goes back to the early days of the business, when local companies were first licensed to use Bell telephones; but for years the contract has guaranteed that the operating companies will get the benefit of important services rendered by the parent company, including research, financing, and engineering. To reimburse the A T & T, the operating companies pay a percentage—since 1929 it has been 1½ per cent—of their operating revenues (excluding certain minor items). This is payment for value received and for services rendered.

Each of us knows from his own knowledge that both local and centralized work are needed to give good telephone service. It takes telephone people in Memphis to provide service in Memphis, others in Spokane to give service in Spokane, and so on in every community.

And in each operating company headquarters there are people who work on problems that affect the service in all the areas where the company operates. Their work is part of the cost of providing service, just as the wages of every operator and craftsman are part of the total cost.

The same is true of the central group at Bell System headquarters, who are working on problems that are common to all the companies. And just as some of the revenues of each operating company must be used to pay the cost of work done in its own headquarters, so likewise some of the revenues of all the companies are used to pay the cost of work that is done at Bell System headquarters.

There are two main reasons for centralizing certain functions:

First, it is economical and efficient—it is just plain horse-sense—to do central work on common problems and make the results available to all concerned. Duplication of effort is avoided, waste prevented, progress quickened.

Second, coördination is needed. This is particularly important in our business, because the very essence of telephone service is to interconnect people wherever they may be, and the over-all quality of the service in one place depends on, and contributes to, the quality of telephone service in other places.

The centralized services rendered by the A T & T under the license contract fall into five groups. Let us look briefly at each:

1—Research and Development

The contract provides that the A T & T will maintain facilities for constant research. Bell Telephone Laboratories (owned by the A T & T jointly with the Western Electric Company, the System's manufacturing and supply unit) render this service. Each step forward in telephone progress has depended on research. Alexander Graham Bell's invention was only the first of thousands of inventions needed to create the telephone system. Starting from scratch, Bell Telephone Laboratories, which grew out of Bell's original attic workshop, have developed switchboards, cables, better telephone instruments, modern dial apparatus, and a whole vast array of devices and systems. Without these there could be no telephone service as we know it today.

This great research organization—the largest industrial laboratory in the world—employs a staff of outstanding scientists. For each operating company to try to duplicate it would be not merely wasteful—it would be utterly impossible, for there wouldn't be enough competent scientists to go 'round.

The cost of research is a major item of expense among the license contract services. The return in value to the operating companies and to telephone users, however, is tremendous, for research has enormously increased the scope and quality of Bell telephone service and has lowered plant and operating costs—below what they would otherwise have to be—by hundreds of millions of dollars. (Just to give one example: Sixty years ago the cost of wire in telephone cable, per pair-mile installed, was more than ten times the cost per pair-mile in today's 2121-pair cable.)

The A T & T pays the cost of Bell Telephone Laboratories' basic research and development work, including the acquiring of new fundamental knowledge. Western Electric pays for development and design work specifically related to Western's products, and this expense becomes part of the total cost of equipment that Western makes and sells. For example, the A T & T would pay for developing a new metal alloy which might have various uses, and Western would pay for the design of a particular product in which the alloy was used.

2—Operating Advice and Assistance

The license contract provides that the A T & T shall maintain a staff to give the operating companies assistance in all phases of telephony. The General Departments of the A T & T comprise this staff. They furnish advice and assistance to the companies in general engineering, plant, traffic, commercial, accounting, patent, legal, administrative, personnel, treasury and all other matters contributing to the efficient and economical conduct of the business.

This staff analyzes experience and results in all territories, and in consultation with the operating companies develops new methods which afford the basis for coördinated improvement of service. Such centralized work is essential to bring about the orderly, economical introduction of improved equipment and more efficient practices. It makes it possible readily to bring the total System experience to bear on any particular operating problem in a particular area. Similarly, it enables all the companies to realize gains on a broad front by using or adapting methods that have been found advantageous through localized trial and experiment. If there were no centralized staff, each company would have to duplicate its work, at much higher cost.

3—Patent Rights

The A T & T owns or has the right to use patents covering most of the apparatus and equipment used to provide telephone service.

The operating companies not only obtain the right to use these inventions and those coming along in the future; the contract also obliges the A T & T to defend the companies and to save them from loss from any patent infringement suits brought against them for using recommended apparatus. These rights and this protection are of very great value to the operating companies.

4—Financial Advice and Assistance

The A T & T provides financial advice and assistance to the operating companies, including help in securing capital funds for service improvement and expansion. An important part of this is that the A T & T obtains money from investors and keeps a pool of funds available. The operating companies can borrow from this pool on short notice. This enables them to keep their own cash balance low, get money for construction as needed, and repay it later. The cost of financing is kept down—the money is on hand when wanted.

5—Availability of Materials

The A T & T agrees to maintain arrangements for the manufacture of telephone apparatus and materials under its patent rights; the operating companies are assured of a dependable source of top quality products at reasonable prices.

The payments made to the A T & T by the operating companies are for necessary services and valuable rights. The companies cannot efficiently or economically perform these services for themselves, nor can they obtain the rights and services elsewhere. The A T & T makes no profit out of the arrangement; in all but one of the last ten years the cost to the A T & T in rendering the services, excluding any return on capital, has been more than the payments made by the operating companies.

Could each company pay its share of the actual total cost of the services, instead of paying a percentage of revenue? In principle, either basis could produce satisfactory results, although experience over the years shows that the former method would have cost the operating companies more. Also, use of a percentage of revenues has the practical advantage of being simpler.

When an operating company increases its rates to customers, payment of a percentage of revenues means of course that the amount paid to the A T & T for the license contract services is also somewhat increased. However, expenses of the A T & T in rendering the services are also going up, for the same reasons that oblige the operating companies to increase their rates. Increasing the license contract payments proportionately with increased revenues helps to make the payments come closer to meeting the actual cost of rendering the services.

A nation-wide telephone system is possible only through coördination; the license contract has provided the coördinating link; the improved service and lowered cost that have resulted through the years have been of great benefit to telephone users.

Unlike a purely investing company, which exists simply to invest money, and all of whose costs are incurred for the benefit of its stockholders alone, the A T & T incurs its expenses to improve and make more efficient the operations of the telephone companies in which it owns stock. Like the wages of telephone operators, these expenses are necessary and advantageous to users; they are a worth-while expenditure in the conduct of the business.

The very ownership of the operating companies by the A T & T is the end result of financing their needs for capital to build telephone facilities. In the early days, as we have seen, local people who were starting telephone exchanges obtained licenses to use Bell telephones. Many of these local companies found it hard to raise capital to build plant, so the A T & T raised money and advanced it to them, taking stock in return. Even then, a central source of capital was needed to develop local as well as long distance telephone service.

Out of these beginnings, and out of the need for centralized research and for standardization of methods and apparatus, the Bell System of today developed. The financing activity of the A T & T, the conduct of research, the performance of the centralized part of the over-all Bell System telephone job, and the maintenance of a corporate organization for these purposes, are all essential services which cannot be eliminated without seriously impairing the efficiency of the Nation's telephone service. They have been, in fact, of fundamental importance in giving this country far more telephone service, of better quality and value, than exists in the rest of the world. Long experience has demonstrated the need for both centralization and decentralization—for doing local work on local problems, central work on common problems. And the license contract, which grew out of the original licensing of Bell instruments, has contributed essentially to the unmatched progress of the telephone in America.

ATOMIC ENERGY

In four chapters, Dr. Darrow's latest volume, *Atomic Energy,** carries the reader over the basic physics of nuclear fission. Since the material was originally presented as the Norman Wait Harris lectures at Northwestern University, Dr. Darrow has wisely preserved the colloquial style. As a result, the text is as easy to read as the lectures must have been easy to follow. It is not always appreciated by writers and speakers that a new idea requires a definite length of time to sink into the reader's mind. During that time, the eyes (or ears) should be occupied with relatively "easy" material which does not claim too much from the reader's attention. This is the rhythm of effort, "work, relax, work, relax" which is natural to man in all his activities.

Beginning with a description of the atom, Dr. Darrow describes the properties of its electrons, protons and neutrons, and outlines the forces that hold them together and force them apart. He shows how the nucleus can be rearranged by bombarding it, and what happens when heavy nuclei, such as uranium, are broken up. Finally, he describes the chain reaction, in which the neutrons set free by fission produce still more neutrons.

Passing briefly over the "nuclear bomb," Dr. Darrow reviews some of the peaceable applications and products of fission, such as power production.

Atomic Energy is recommended to readers who are interested in nuclear fission, but yet lack the time or the background to profit from the more elaborate texts that are available on the subject.

**Atomic Energy,* by Karl K. Darrow—John Wiley & Sons; $2.00.

R. L. CARBREY
Transmission
Research

DECODING IN PCM

In the experimental PCM system recently described in the RECORD,* the speech waves are sampled 8,000 times a second, and the magnitude of each sample is transmitted as a seven-place group of on-or-off pulses. This permits any of 128 values of the sample to be transmitted, corresponding to the numbers from 0 to 127 that may be represented by a seven-digit binary number. At the receiving end of the circuit, these seven-place pulse groups must be decoded as fast as they come in—96,000 groups per second for a 12-channel system—and in their place must be generated successive pulses of voltage proportional to the values of the samples they represent. From these reconstructed samples, the original speech waves are synthesized.

In the binary number system, only the digits 0 and 1 are used, and since in a group of on-or-off pulses only two values of the pulse are recognized—either on or off—the two systems are equivalent. In any numbering system, the digits in successive places from right to left are coefficients of increasing powers of the base of the system. Thus, the decimal number 105 is interpreted as $1\times10^2+0\times10^1+5\times10^0$, or $100+0+5$. In a binary system, on the other hand, the above number would be written 1101001, and since the base is 2, it is interpreted as $1\times2^6+1\times2^5+0\times2^4+1\times2^3+0\times2^2+0\times2^1+1\times2^0$, or $64+32+0+8+0+0+1$, which is also equal to 105. Although all non-zero digits in a binary number are 1, the value they represent depends on their place, and is 1 only in the right-hand place, while in successive places reading to the left it doubles for each place. The values represented by a 1 in each place of a seven-digit binary number are shown in line 2 of Figure 1. Above these are numbers to identify the seven places from right to left, and beneath them is the pulse group representing the number 105.

*RECORD, *September*, 1948, *page* 364.

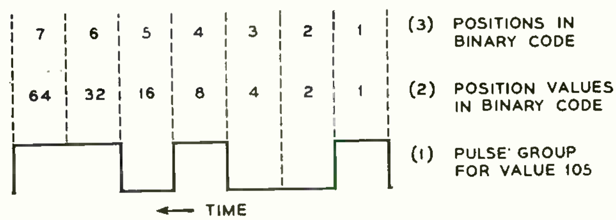


Fig. 1—Line 1 shows a pulse group for a sample value of 105, while line 2 shows the relative values contributed by pulses in the various positions. Line 3 shows the seven pulse positions of a code numbered in the order in which they are generated and received

In the coding tube* used with the experimental PCM system, the codes for the various values of the sample are generated in the right to left order, and thus the pulses corresponding to the number, shown in line 1 of Figure 1, would flow over the transmission path in the order indicated: a pulse in number 1 position is generated and received first, one in the second position, second, and so on.

If the true magnitude of the quantized sample is to be reconstructed at the receiving end, each pulse of a code group should contribute an amount proportional to the figures on line 2 of Figure 1. These

*RECORD, *October*, 1948, *page* 411.

are shown graphically in Figure 2 plotted against their time of arrival on a time scale in terms of the pulse period P. A pulse in position 1 is assumed to arrive at time O, and pulses in successive following positions arrive at successive pulse periods later. After a complete code interval, which would be at the time marked T in Figure 2, the sum of the various contributions

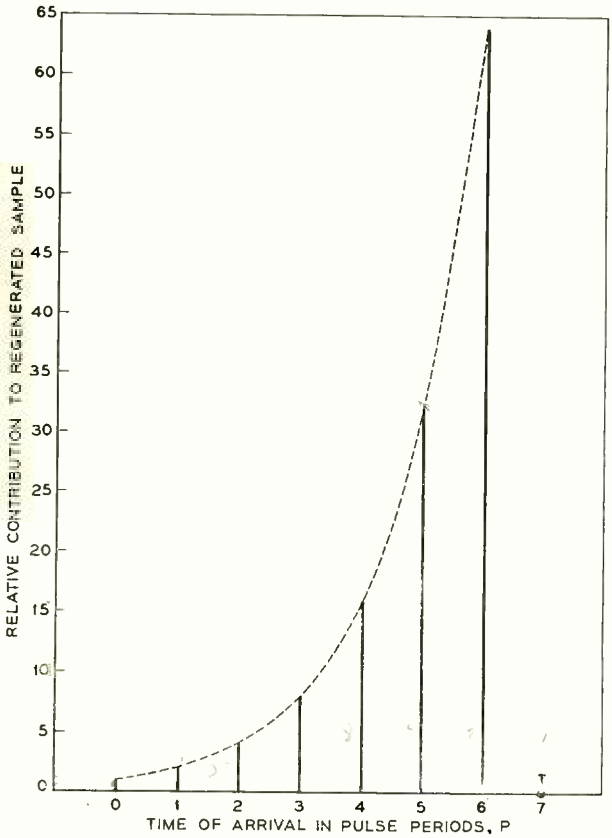


Fig. 2—Relative contributions of pulses in each position of a code plotted against the time of arrival in pulse periods

should be available for creating the reconstructed sample. At this time, T, a pulse in the first position of the code will have been at the receiver for a period equal to 7P, while one in the seventh position will have been there a time 1P.

A simple method of having the proper values of the various contributions available at time T was proposed by C. E. Shannon. It takes advantage of the fact that a charge on a capacitor shunted by a resistor will decrease exponentially, and thus will follow a curve similar to that of Figure 2 but in the reverse order. If the voltage on the capacitor were v at time O, then after n pulse periods of duration P it would be $ve^{-Pn/RC}$ where R and C are the values of the shunting resistor and the capacitor. By a simple mathematical change of base, this expression may be written as $v \times 2^{-kPn/RC}$ where k is a constant due to the change of base. By the proper selection of the resistor and capacitor, RC is made equal to kP; so that $kP/RC = 1$. With this change, the voltage after some number n of pulse periods would be $v/2^n$.

If the value of v is made 128, then the voltage after one pulse period would be 64, after two periods it would be 32, and so on up to seven periods, after which the voltage would be 1. If each pulse as it arrives were allowed to charge a capacitor to 128 volts and the voltage of the capacitor then decreased as described above, the voltage on each capacitor at time T would be exactly at the correct value to represent the value of the pulse in the binary system. Thus a pulse in the first position would decrease over a period 7P, and at time T would be 1, while one in the seventh position would decrease over an interval of only 1P, and would thus be 64. This is shown in Figure 3 where, to the same time scale as in Figure 2, capacitor charge and discharge curves are shown for pulses in each of the seven positions. It will be noticed that at time T each has decreased to the required values.

To secure automatic summing of the charges of the successive pulses, only a single capacitor is employed, and to it each pulse contributes its charge as it arrives. The charge and discharge cycles for code 105 would thus be as shown in Figure 4, and the charge remaining at time T is exactly the same as would be obtained by adding the charges for the proper set of pulses in Figure 3.

As a first step in any such process, it is necessary to secure a set of correctly spaced pulses of equal height and width, so that the capacitor will be given exactly the same charge for each pulse. In passing over the transmission path, the original pulses are distorted; a code started out as shown in line 1 of Figure 5 might be received as indicated in line 2. To secure from them a set of pulses of uniform size, the pulses received are first passed through an amplitude "slicer," which is set at one-half the average pulse height. As long as the value of the incoming signal exceeds the setting of the slicer, its output is constant, but when the incoming signal is below the setting of the slicer, its output is zero. For code 105, therefore, the output of the slicer would be as shown on line 3.

This output is passed to a "gate" circuit which is under the control of precise timing pulses. These timing pulses are generated locally by the receiver synchronizing equipment, and their spacing is based on the average arrival time of a very large number of code pulses; thus the spacing is independent of the noise or other distortion. At each timing pulse, the gate opens for 0.4 microsecond. If there is output from the slicer at this time, a 0.4 microsecond pulse will leave the gate. In Figure 5 these timing pulses are indicated on line 4, and the resulting pulses leaving the gate are as shown on line 5. This is a code exactly like that transmitted, so far as the information contained is concerned, but the pulses are much narrower. At a regenerative repeater station, a similar process may

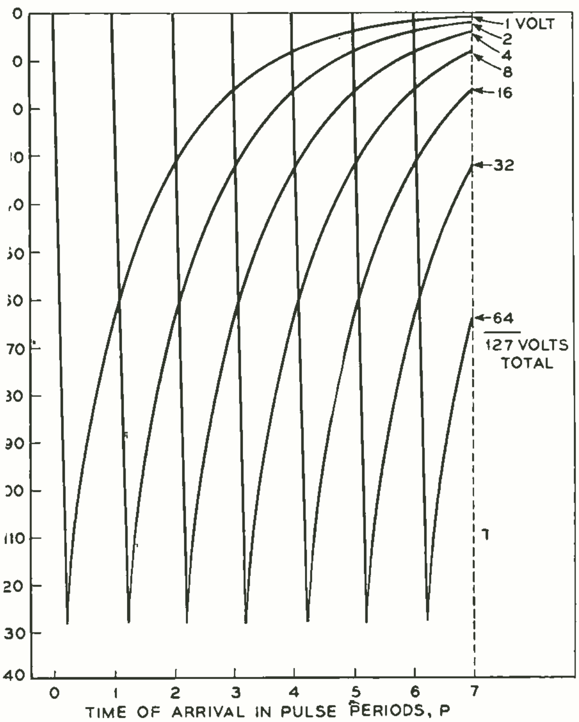


Fig. 3—Charge and discharge curves for pulses in successive positions. The charge remaining for each pulse at time T is the correct value of its contribution to the reconstructed sample. The time scale is the same as that used in Figure 2

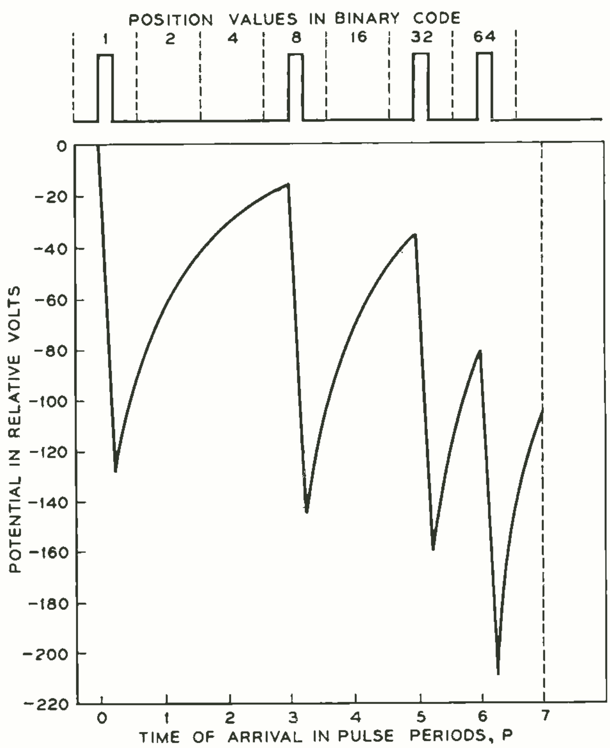


Fig. 4—Charge and discharge curves for code 105 when each pulse contributes the same amount of charge to a single capacitor that is used to secure automatic summing of the charges of the successive pulses

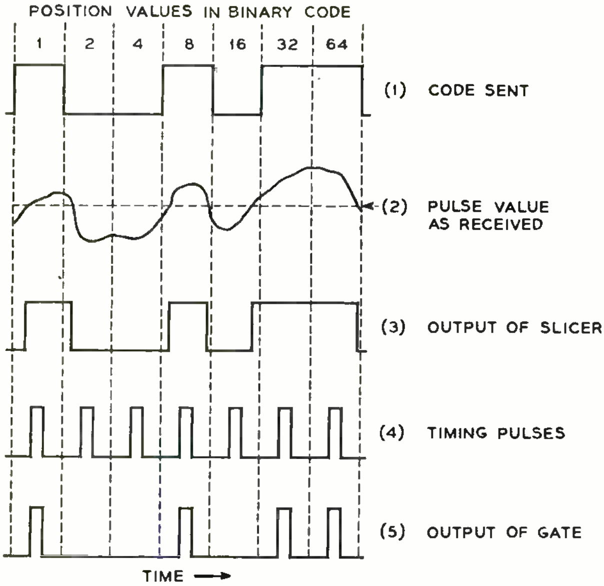


Fig. 5—Successive steps in pulse regeneration at a receiver. Line 1, code as sent; line 2, code as received; line 3, output from slicer; line 4, timing pulses; line 5, output from gate

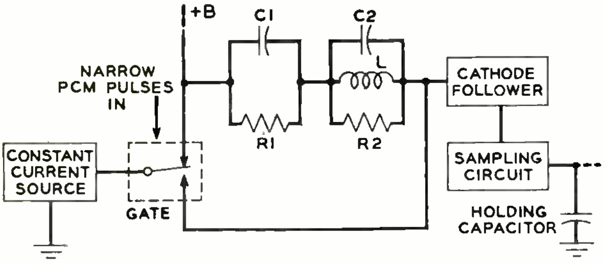


Fig. 6—The decoder uses two capacitor discharging circuits in series. In the left-hand circuit a capacitor is shunted by a resistor, and discharges exponentially. In the right-hand circuit the capacitor is shunted by a resistor and a resonating inductor, and discharges as an exponential sinusoid

be used with an additional step that widens out the pulses to their full normal width for transmission over the next section of the circuit. At terminals, however, they are used as they are for decoding.

Although the single capacitor and resistor of the basic Shannon proposal would always give the correct value of the code at time T, the fact that the discharge curve which represents the voltage is rapidly decreasing makes a correct determination depend on very precise location of the sampling time T. A change suggested by A. J. Rack to make such precise timing unnecessary was to use a second capacitor, shunted by both a resistor and an inductor, in series with the original capacitor. This arrangement is indicated in Figure 6. The values of the second capacitor, C2, and the inductor, L, used with it are such as to make the added circuit resonant at the code-pulse frequency of 672 kc. The second resistor, R2, is adjusted so that an oscillation developed across the resonant circuit will be reduced to exactly one-half amplitude for each cycle.

If these two discharge circuits were isolated, the voltages across them after a pulse of charge would be as indicated by the dashed curves of Figure 7. In the left-hand circuit of Figure 6, the voltage would decrease exponentially, while in the right-hand circuit it would oscillate with exponentially decreasing amplitude. With the two circuits connected together as in Figure 6, these two voltages are combined, and give a resultant as indicated by the solid line of Figure 7.

This combined curve, it will be noticed, is horizontal over regions one code period apart. At time T, therefore, when the value of the charge of the capacitor is determined, the voltage is not changing, and may be determined even when there is some inaccuracy in the location of T.

As indicated in Figure 6, each pulse of a code connects the constant-current charging source to the capacitor circuit for 0.4 microsecond, and then disconnects it. At time T, after all pulses of a code have been received, the sampling circuit, under control of the timing pulses already mentioned, connects a holding capacitor to the circuit to receive a charge corresponding to the voltage of the circuit at that time. Immediately afterward, this voltage will be passed to the expandor circuit as one sample of the speech wave to be synthesized.

After one group of pulses has been decoded, it is necessary for capacitors C1 and C2 of Figure 6 to be discharged before this circuit is used to decode the next group of pulses. To permit this to be done, the decoders are used in pairs as indicated in

Figure 8. In the experimental system of which this is a part, one such circuit decodes the signals for twelve voice channels. Codes representing one sample of each of the twelve channels are transmitted one after another, and then another set of twelve samples is transmitted. These successive samples enter the slicer at the left of Figure 8, and then are distributed alternately to the two decoders by an electronic switch, which in the diagram is represented by a rotating brush and commutator. The upper branch decodes all the odd-numbered channels, and the lower branch, all the even channels. While the odd-channel branch of the circuit is decoding a group of pulses, the capacitors of the even-channel branch continue to discharge. By the time the next group reaches the even-channel branch and has been decoded, the charge from the previous group will have decreased to a negligible value.

Between the sampling time, T, for one code in the odd-channel branch and the corresponding time for the next code in the same branch, there are fourteen code-pulse intervals—seven while the even-channel branch is decoding, and seven while the odd-channel branch is decoding its next group of pulses. Since for each code-pulse interval the voltage is decreased one-half, or 6 db, it will be decreased $(\frac{1}{2})^{14}$ or about 84 db after fourteen intervals. In Figure 4, for example, the value of the voltage at time T at the end of the code

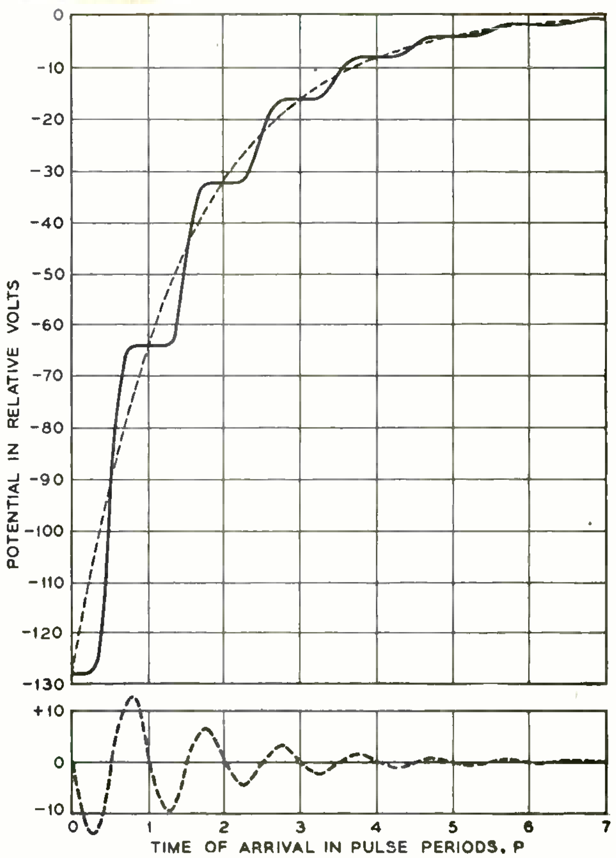


Fig. 7—Curves in dashed lines represent the discharge of left and right circuits of Figure 6, while their combination is shown by the solid-line curve

THE AUTHOR: R. L. CARBREY graduated from the University of Colorado with a B.S. in E.E. degree in 1940. He then joined the Outside Plant Development Department as a member of the Technical Staff, and worked at Point Breeze on coaxial and toll cables until 1942. During the war, he was transferred to the development group of the Radio Research Department for work on the SCR-545 radar receivers, and later on multiplex pulse modulation systems. In 1944 he transferred to the Transmission Research Department to continue work on PCM with which he has since been occupied.

shown is 105. During the next seven pulse periods, while the other decoder is acting, this will be reduced $(\frac{1}{2})^7$ or to a little over 0.8. When the next group of pulses arrives at this decoder, therefore, there will be a vestigial signal of 0.8 remaining from the previous decoding. Before it contributes to the decoded value of this next group, however, it will suffer attenuation during another seven code-pulse periods, just as does the pulse in the first position of Figure 3. At the next sampling time, therefore, it will be about six thousandths of one per cent of its original value, or 84 db down, which is too small to produce a noticeable effect.

By using this comparatively simple decoding circuit in pairs, the pulse groups are thus not only rapidly and accurately decoded, but carry-over from a sample of one channel to a sample of another, which would appear as crosstalk in the system, is automatically avoided.

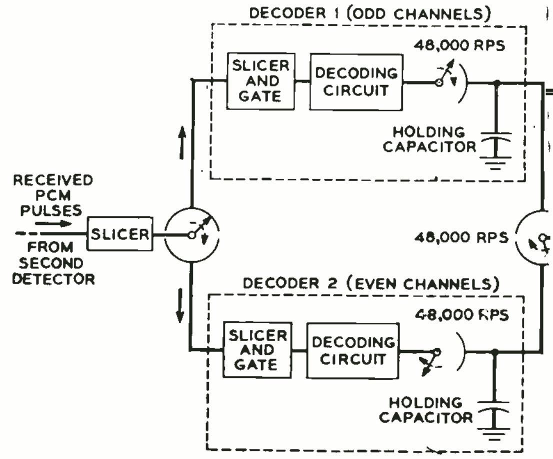


Fig. 8—The complete decoding circuit includes two discharge circuits as shown in Figure 6 arranged to be used for alternate code groups

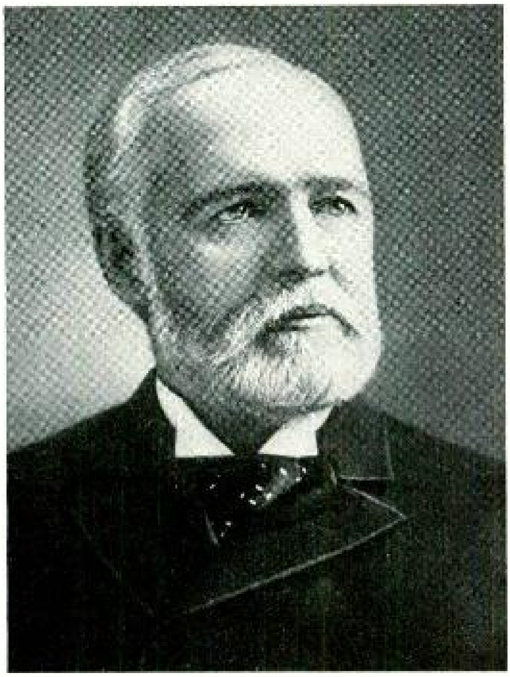
COAXIAL ANTENNA ARRAY FOR MOBILE SERVICE

Studies aimed at more efficient use of the radio frequency spectrum by mobile telephone service called for coöperation by Outside Plant personnel with Transmission Engineering on the design of a multi-channel antenna. The photograph on the front cover of this issue of the RECORD shows an array of six coaxial antennas. These are mounted on a new type of support and a new mast, both designed by J. H. Gray of Outside Plant Development. One of the requirements is to maintain rigidity for the antennas under high wind and ice loads. In this first design, the 62-foot mast is of self-supporting tubular steel construction, starting with a 14-inch diameter at the base and decreasing to 3½-inch diameter at the top. The arms holding the antennas are adjustable to obtain different alignments and orientations as desired.

R. B. HILL
General
Staff

JOSEPH P. DAVIS—PIONEER IN UNDERGROUND TELEPHONE DISTRIBUTION

Within three years after the inauguration of the commercial telephone business, the streets and house tops of the larger cities were fast becoming unsightly from the mass of overhead telephone and telegraph wires. With the lofty poles and cumbersome roof structures supporting them, these wires proved highly vulnerable to sleet storms, which caused frequent and serious disruption of the expanding communication services.

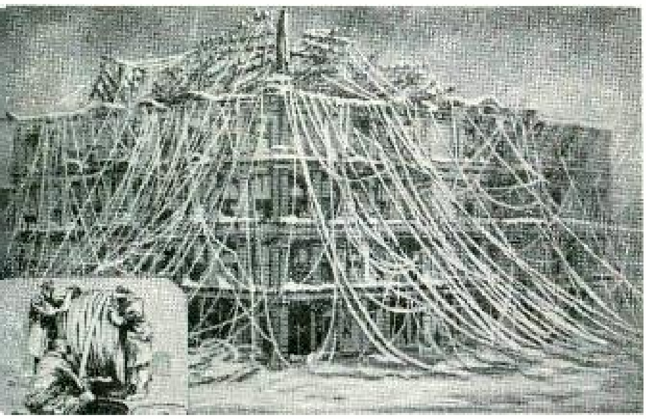


Joseph P. Davis in his later years

Such was the situation faced by Col. W. H. Forbes, President of the parent Bell Company, when in 1880 he retained Joseph P. Davis, City Engineer of Boston, to become Consulting Engineer of his young organization. Mr. Davis—a graduate of Rensselaer Polytechnic Institute in Civil Engineering in 1856—had made his mark as a civil engineer on many public works projects, both in this country and abroad. His new assignment, which he took over on March 1, 1880, was to devise a suitable method of placing telephone wires underground in cables so that the possibilities of this method of telephone transmission could be determined.

Mr. Davis designed the first "drawing-in"* underground conduit system ever constructed for telephone cables. The trial was carried out on a modest scale in the vicinity of the main office in Boston, but because of the long period required to obtain the necessary permits from the city, its construction was not completed until late in 1882. Three-inch wrought-iron boiler tubes, encased in concrete, were employed for the duct material, and manholes were placed at intervals to permit the cables to be drawn in and spliced. Great care was taken to exclude water from the finished structure. So correct were the methods employed that the conduits were reported as still in use nearly thirty years later.

Although little fault could be found with Mr. Davis' conduit system, the telephone cables which were drawn into it—the best available types at that time—could be used only in very short lengths. They employed wires insulated with gutta-percha, rubber, and cotton impregnated with a moisture-proofing compound, and proved to have extremely poor transmission characteristics due to high electrostatic capacitance.



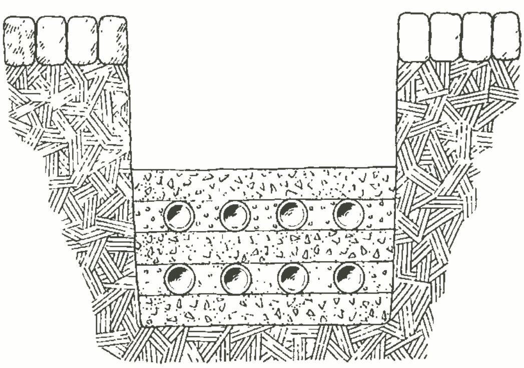
Central Office Building at 40 *Pearl Street, Boston, showing the damage to the roof structure and wires from the January,* 1881, *blizzard*

The overhead wire situation was steadily becoming worse, however. Within a comparatively few years, the Metropolitan Telephone and Telegraph Company, operating in Manhattan, had so many roof fixtures that it was obliged to maintain a special force of roofers to keep the rented roofs in repair. The pole lines, which occupied both sides of the principal streets, were carrying as many as 150 to 200 wires. Moreover, the development of high-tension currents, first for electric lighting and later for street railway purposes, seriously impaired, and in some cases rendered inoperative, the service given over the grounded telephone wires. As J. J. Carty once put it, an electric light circuit across the street from the telephone circuit would make a noise in the telephone like a sawmill.

In the middle 1880's, therefore, the Metropolitan Telephone and Telegraph Company also employed Mr. Davis as Consulting Engineer to make a start in putting the telephone wires underground in New York City. Although the available types of cable were still far from satisfactory, more than 20,000 miles of wire had been put underground in that city by the end of the year 1890, and good progress had been made in other cities, using the methods formulated by Mr. Davis. Iron pipes and creosoted wood ducts (called "pump logs") were the favorite conduit materials used during this period. A few years later vitrified clay—in single and multiple duct form—came into extensive use.

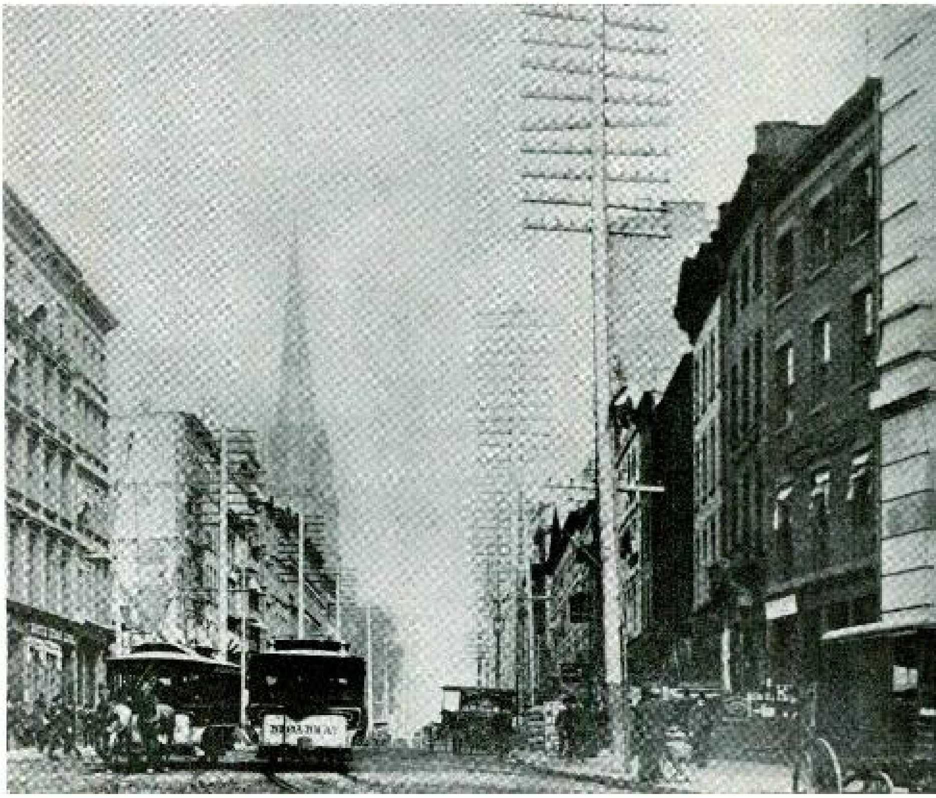
On January 1, 1891, a new department of the parent Bell Company (then the American Bell Telephone Company) was formed to supplement the work of its other technical departments: the Mechanical Department, headed by Hammond V. Hayes, which was conducting experimental and development work; and the Electrical and Patent Department. The new department, called the Engineers Department, was to undertake fundamental work in standardizing plant construction and operating methods, and Mr. Davis was placed in charge of it as Chief Engineer. During the three preceding years, a Cable Committee, of which Mr. Davis and Mr. Hayes were members, had been at work developing improved types of cables, and successful experiments with manila-paper insulation had made available a twisted-pair, dry-core cable of low electrostatic capacitance. Another feature of this cable, although not the result of the work of Mr. Davis' department, was a continuously extruded lead sheath which insured that the core would remain dry. This new cable, when used with the recently developed solid-back transmitter, gave satisfactory transmission over several miles, and greatly accelerated the removal of the grounded iron wires from the streets and house tops of the cities, and their replacement by metallic-circuit underground cables. It was now possible, for the first time, to engineer the telephone plant on a scientific and economical basis, employing a permanent type of distribution system.

First telephone "drawing-in" underground conduit system using three-inch pipes, constructed in Boston in 1882



In this work of reconstruction, the talent and experience of Mr. Davis proved invaluable. He formulated the methods employed throughout the entire Bell System, not only in constructing the conduit systems, but in determining their size and location as well. He and his engineers made periodic visits to all the principal cities of the country, and gathered data for use in the preparation of comprehensive conduit plans for those cities, showing in which streets the tending about fifteen years into the future, but what was believed to be the proper number, location, and size of the central offices as well.

Since its inception, this work has been of the utmost importance to the operating companies of the Bell System by enabling them to keep abreast of the continually advancing requirements of the business and minimizing expensive reconstruction work which would otherwise have been necessary.



Pole lines on lower Broadway, New York City, in 1882, *looking north from Bowling Green*

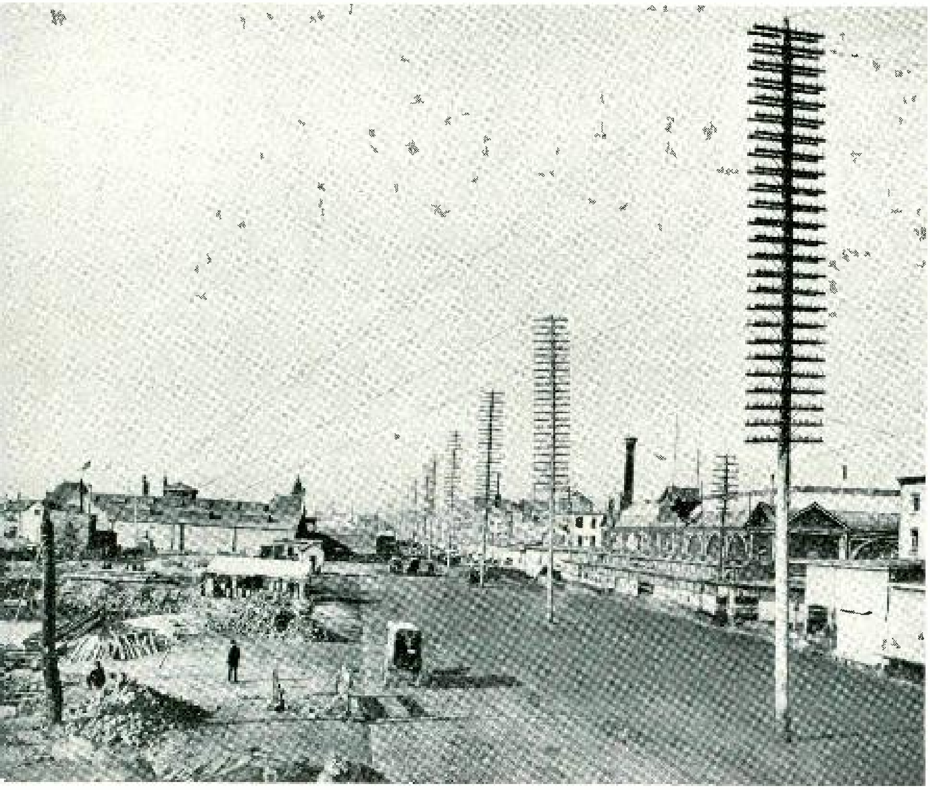
conduits should be placed and the number of ducts to install, taking into account both existing and future requirements. In later years this work was broadened to include a definite forecast of the future development and telephonic requirements of each city. The resulting development plans (or fundamental plans, as they came to be called) showed not only what was considered to be the most economical size and distribution of the conduits and cables, for a period ex-

During the year 1894, the Mechanical Department of the parent Bell Company, which had up to that time been a separate department, was combined with the Engineers Department, with Mr. Hayes, as Electrical Engineer in charge of the Mechanical Department, reporting to Mr. Davis, as Chief Engineer. The interior organizations and duties of the two departments were kept separate, however, for eight years, or until 1902.

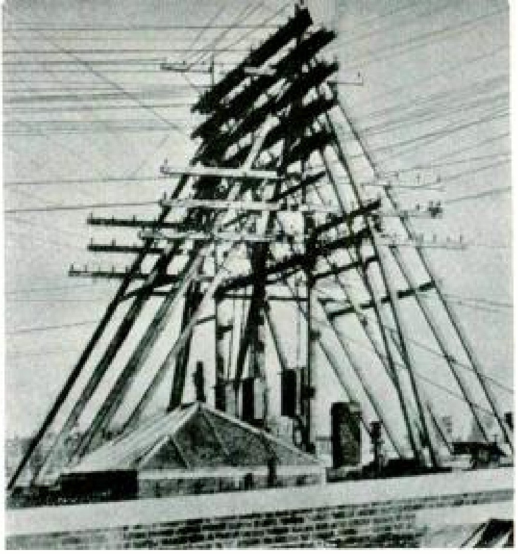
In April, 1902, these two departments were merged into one organization—the Engineering Department. Mr. Davis, whose eyesight had been failing for some time, remained in nominal charge, as Chief Engineer, but the affairs of the department were administered by an Engineering Committee consisting of Mr. Hayes, F. A. Pickernell, and W. S. Ford.

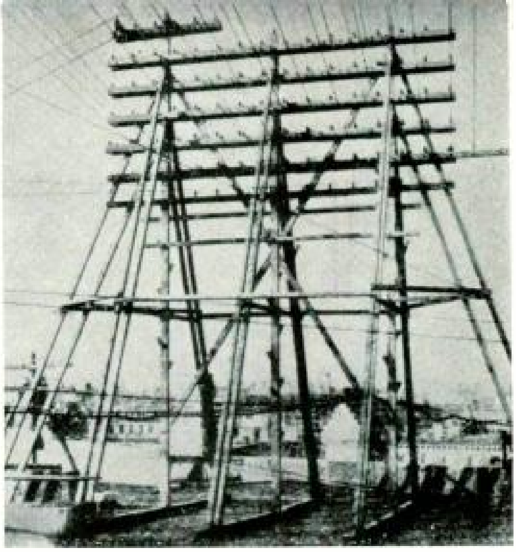
On January 1, 1905, Mr. Davis resigned as Chief Engineer and was succeeded by Mr. Hayes. He remained as Consulting Engineer, however, until December 31, 1908, when his eyesight became so bad that he was compelled to relinquish all work. He died at his home in Yonkers, N. Y., on March 31, 1917, in his eightieth year. He had never married.

During his twenty-eight years in telephony, Mr. Davis probably held a larger number of important positions than any other Bell System engineer during an equal period. He was Consulting Engineer with the parent Bell Company during the greater part of the period from 1880 to 1891; Chief Engineer from 1891 to 1905; and Consulting Engineer from 1905 to 1908, and was one of the incorporators of the American Telephone and Telegraph Company, which at that time acted only as the Long Lines Company. He was also one of the incorporators of the Metropolitan Telephone and Telegraph Company in 1880, and of its successor, the New York Telephone Company, in 1896, and during most of the period from 1880 to 1908, served as a Vice-President, a Director, and a member of the Executive Committee. He was for many years a Director of the New York and New Jersey Telephone Company and of the Empire City Subway Company, and for several years was President of the Hudson River Telephone Company, and of the Westchester Telephone Company. He was a member of the Cable Committee and of the Switchboard Committee, both of which met at frequent intervals during the late 1880's and early 1890's.



West Street pole line, New York City. Erected in 1887 to carry long-distance wires to Boston and Buffalo

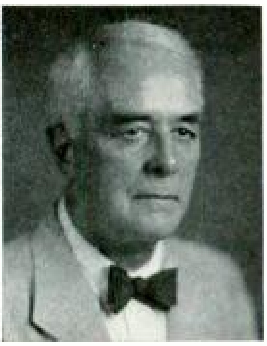




Roof structures in Boston in the early 1890's

Mr. Davis was a Director and Vice-President of the American Society of Civil Engineers; a member of the Society of Telegraphic Engineers and Electricians of England; the American Institute of Electrical Engineers; the American Society of Mechanical Engineers; and the Boston Society of Civil Engineers.

For a man who was by nature shy and retiring, whose many honors and responsibilities came to him unsought, and who during the later years of his life was handicapped by failing eyesight, his achievements, both within and without the telephone field, constitute a record of which any man might be proud.



THE AUTHOR: Roger B. Hill received a B.S. degree from Harvard University in 1911 and entered the Engineering Department of the American Telephone and Telegraph Company in August of that year. For several years thereafter he was engaged principally in appraisal and depreciation studies. When the Department of Development and Research was formed in 1919, he transferred to it, and since then has been largely concerned with studies of the economic phases of development and operation. He has been a member of the staff of Bell Telephone Laboratories since 1934, first in the Outside Plant Development Department and later in the Staff Department. In addition to his work on the economic side of the telephone business, Mr. Hill has exhibited a great interest in the early history of the telephone art, and has assisted with the preparation of several books and articles dealing with that subject.

WIDE BAND CRYSTAL FILTER FOR CARRIER PROGRAM CIRCUITS

F. E. STEHLIK
High Frequency Networks

To keep pace with the growth of nation-wide broadcasting networks, terminal equipment has been developed that permits broadcast programs of 8 kc band width to be transmitted over the broad-band carrier systems already in use for telephone messages.* With this equipment available, only terminal changes are required to substitute a program channel for a group of voice channels or vice versa.

One of the most difficult development projects of the new program terminal equipment was the channel-selecting band-pass filter. It must be possible to set up very quickly either a transcontinental or a local broadcasting network by switching shorter links as required. It must be possible also to make taps to the circuit at short intervals to supply local broadcasting stations or to receive programs from local studios. At each such point the switching is done at voice frequencies, and on a carrier circuit there is thus a demodulation and a modulation at each switching point. For each step of modulation and demodu-

*Record, *September*, 1948, *page* 377.

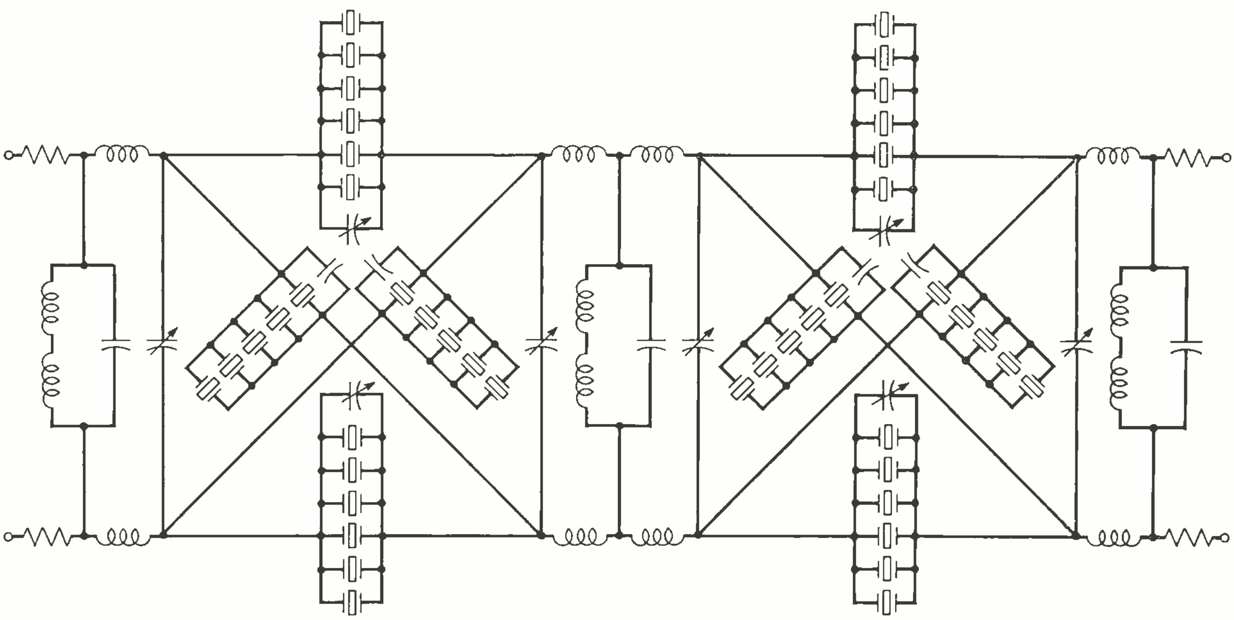
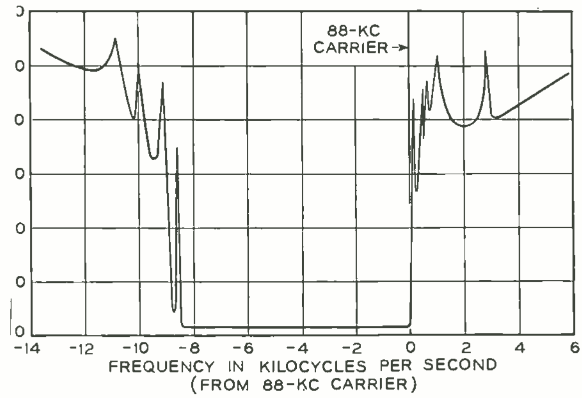


Fig. 1—Schematic of the new program band filter. The filter consists of two complex lattice sections containing crystal elements and two ladder sections containing coils and capacitors

lation, moreover, the program must pass through the channel-selecting band-pass filter, and the total distortion of the channel will include the sum of the distortions introduced by each of these filters. On a long network, the program may be transmitted through as many as twenty of these filters in tandem. The distortion requirements on each band filter thus are made extremely severe since program quality objectives for over-all transmission must be met with these many filters.



. 2—*Insertion loss characteristic of a typical filter for broad-band carrier system. The sharp cut-off ob- ied near the carrier is evident from this curve*

To save frequency space and thus permit the largest practicable number of telephone messages to be transmitted over the carrier circuit that also includes program facilities, the single-sideband method of transmission is used. This reduces the program frequency space by fifty per cent over the double-sideband method ordinarily used in commercial radio broadcasting. However, the use of single-sideband transmission imposes two additional difficult requirements on the band-pass filter. First, the filter must transmit all the program information to within about 40 cps of the carrier. Second, two of the filters in tandem in a program link must provide at least 40 db of discrimination to the unwanted sideband beginning at 40 cps on the other side of the carrier. In this application, lower sideband transmission was selected, with the carrier located at 88,000 cps. To secure this sharp cut-off in a filter at these frequencies, extremely stable low-dissipation filter elements are required. Computations indicated that minimum Q's of 80,000 were required. The only known method of realizing this performance was by using wire-supported quartz crystal plates* vibrating in a vacuum.

To secure high-grade program transmission, the filters for the new carrier program circuit are designed to transmit a band about 8,400 cps wide. The usual filter configuration using crystal elements, however, could not be designed to pass a band wider than 7,300 cps at a carrier frequency of 88,000 cps. The physical structure of quartz is the limiting factor here, as has already been discussed in the Record.† To secure a band width nearly ten per cent of the carrier frequency, it was necessary to use a more complicated filter configuration. This increased the pass-band distortion slightly due to the additional low-Q elements required.

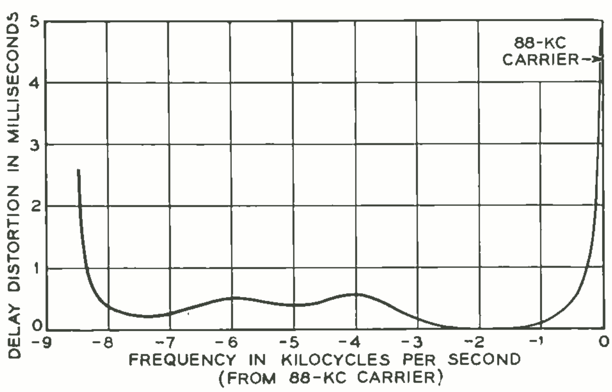


Fig. 3—*Delay distortion over the pass band of a single filter. When more than six filters are used, equalization is required*

In addition to suppressing the unwanted sideband above the carrier, the filter must provide sufficient discrimination above and below the pass band to prevent crosstalk of the adjacent message channels into the program channel and vice versa. This requirement must be met by each filter, while

*Record, *April*, 1945, *page* 140.

†Record, *June*, 1935, *page* 305.

the unwanted sideband requirements can be met by the combined discrimination of the two filters of a link.

In the analysis of these various requirements, such considerations as the design limitations imposed by the quartz crystal elements, and manufacturing tolerances and procedure, resulted in the design shown schematically in Figure 1. The filter consists of two complex lattice sections containing crystal elements and two ladder sections containing coils and capacitors. The separate identities of the ladder sections have been lost due to the electrical transformations performed to realize the wide band and to reduce the number of elements required in manufacture. Each lattice section requires twenty-two crystal elements, six in each series arm and five in each cross arm.

All crystal units are of the divided plating type, and thus each plate provides two identical crystal elements—one to be used in each of the corresponding arms of the lattice section. All are of the +5 degree X-cut type,* and are wire supported. They vary considerably in width and thickness to secure different values of inductance, but since the range of resonant frequencies is small, the lengths are all approximately the same. In addition to the twenty-two balanced crystal plates, the filter includes eight adjustable and seven fixed capacitors, three adjustable and four fixed balanced retardation coils, and four resistors.

A typical insertion loss characteristic of the new filter is shown in Figure 2. The distortion in the pass-band from 40 to 8,000 cps below the carrier is about 0.35 db, and in going from there out to 8,400 cps, it increases only 0.25 db. The extremely sharp cut-off obtained near the carrier is evident from this curve.

*Record, *February,* 1944, *page* 282.

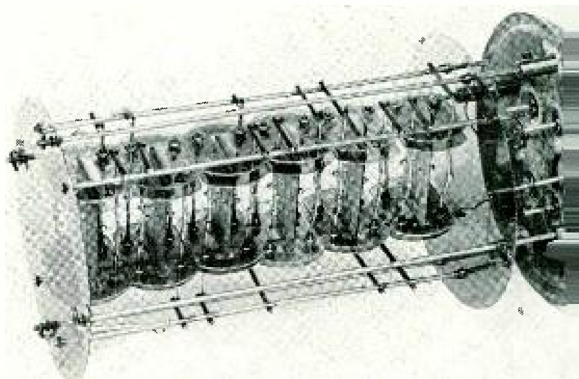


Fig. 5—Mounting arrangements of the quartz plate.

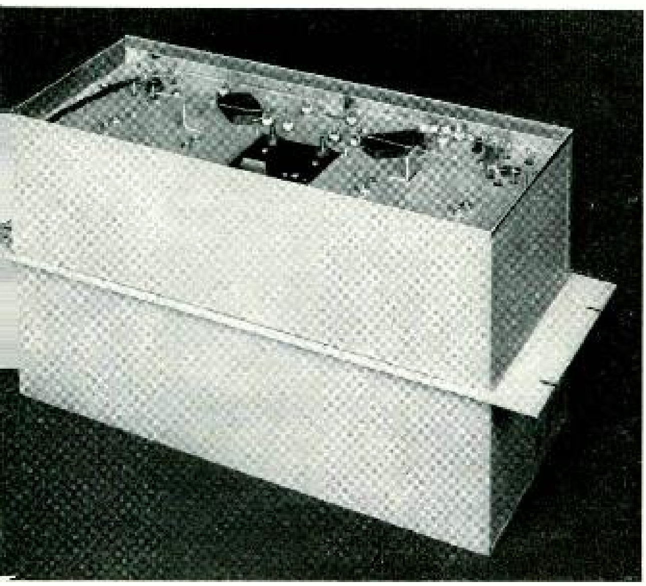


Fig. 4—The filter mounts on the two sides of a seven-inch mounting plate for the standard nineteen-inch relay rack. After adjustment of the variable capacitors and coils has been made from the adjustment side of each base plate, one of which is shown exposed above, the can covers are sealed in place

Another type of distortion which is undesirable on high-quality program circuits is delay distortion. For this filter, it is shown in Figure 3 as computed from the measured insertion phase-shift curve. When not more than six filters are in tandem, the delay distortion does not exceed the desirable limit set for the system. When more than six are to be used in tandem, however, equalization is required. A delay equalizer has therefore been designed for installation in each program terminal to minimize this distortion.

The completed filter weighs thirty pounds and occupies seven inches of mounting space on a standard nineteen-inch relay rack. Its components are contained in two rectangular cans, one on each side of the mounting plate, as shown in Figure 4. After

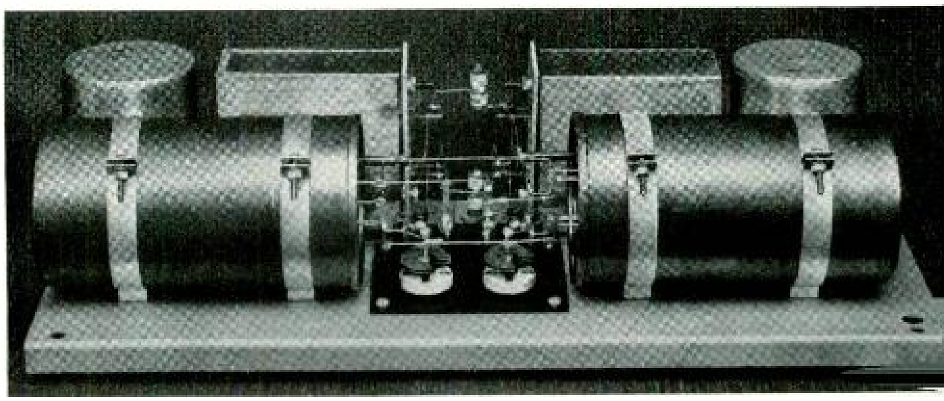


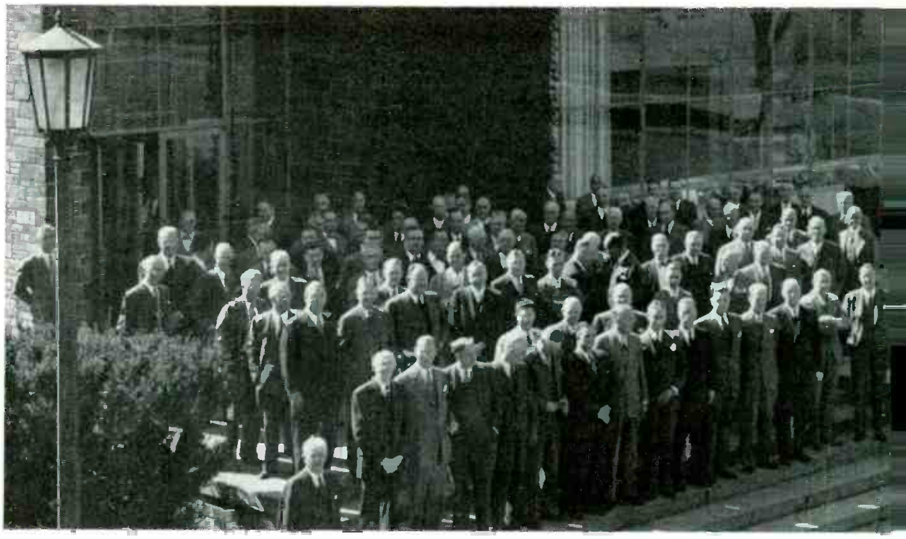
Fig. 6—One of the two base plates that carry the components of the filter

adjustment of the variable capacitors and coils has been made from the adjustment side of each base plate (one shown exposed in Figure 4), the can covers are sealed in place. The other side of each base plate mounts the major part of the filter components, as shown in Figure 6. The two rectangular cans contain fixed retardation coils, and the two smaller cylindrical cans contain adjustable retardation coils. The two large cylindrical cans house the eleven balanced quartz plates for one section. The arrangement of plates within one of the cans is shown in Figure 5.

To secure and maintain the desired performance of this filter, it is essential to use low-loss materials as insulators in the crystal lattices and to insure that their characteristics do not vary with humidity changes or because of dirt and other impurities that may settle out of the air. For these reasons the filters are adjusted, tested, and hermetically sealed in an air-conditioned room where the relative humidity does not exceed forty per cent. Since manufacture started about the beginning of 1946, several hundred of these filters have been made, and are functioning satisfactorily in the telephone plant. Of the more than 150,000 miles of program transmission circuits used in interconnecting more than 1,000 radio stations, about one-quarter are obtained from the new program facilities over the broad-band carrier systems.

THE AUTHOR: Frank E. Stehlik received the B.E.E. degree from the Polytechnic Institute of Brooklyn in 1933, and the M.E.E. degree in 1935. After a year of graduate study at Yale University, he then joined the Technical Staff of the Laboratories in June, 1936. With the Apparatus Development Department, he first engaged in the development of quartz crystals for filters, and later worked on the design of filters and networks employing quartz crystals. During the war he designed filters and networks for a number of war projects. At the present time, he is designing high-frequency networks for the L3 carrier system.

NEWS AND PICTURES OF THE MONTH



BELL SYSTEM PRESIDENTS VISIT MURRAY HILL

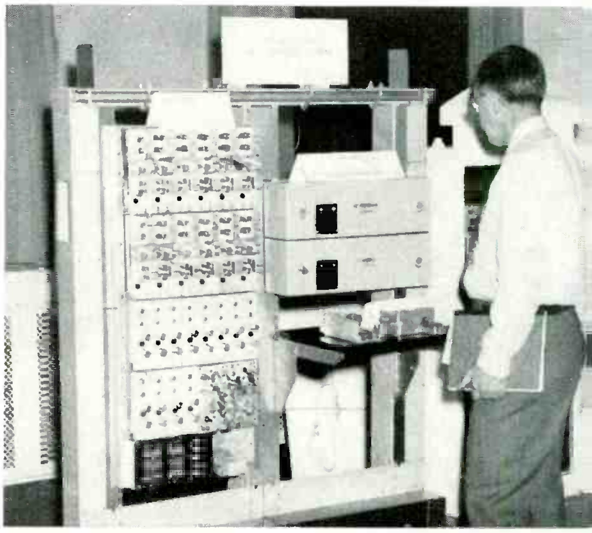
At Murray Hill on October 4, a group of Bell System executives attended a review of Laboratories work, with emphasis on forward-looking developments. The group consisted of presidents of Bell System companies, vice-presidents of the A T & T, and members of the staffs of both the field and headquarters groups.

After a welcome by O. E. Buckley, the work in switching systems and transmission was presented by A. B. Clark; in apparatus components by D. A. Quarles; in station apparatus and outside plant by W. H. Martin; and in research by Ralph Bown. The visitors participated in discussions after each presentation. The above picture was taken as the group moved from the Arnold Auditorium to the restaurant for lunch.

A number of exhibits of current activities were on display for the visitors. The following day they were viewed by employees of the Laboratories at Murray Hill. Later in the week they were on exhibition in the auditorium at West Street.

Edna Ruckner, Mary Mallard and Catherine Callahan look over a display of crystals

A type-N carrier telephone terminal attracted the interest of engineers



McHugh Elected to BTL Directorate

Keith S. McHugh, vice-president of the A T & T, has been elected to the Board of Directors of the Laboratories. He succeeds William H. Harrison, former A T & T vice-president, who recently was named president of I T & T. From 1929 to 1934, Mr. McHugh served as commercial engineer with A T & T. He was then an assistant vice-president for four years and since 1938 he has been a vice-president. He was in charge of the Information Department until he was recently named the financial vice-president.

Murray Hill Men Return From Europe

R. M. Bozorth and C. Kittel have returned to Murray Hill from European trips.

Dr. Bozorth was one of four delegates to the Assembly of the International Union of Pure and Applied Physics meeting in Amsterdam, Holland, of which Dr. Darrow was a vice-president. Dr. Bozorth presented an invited paper on the subject *Ferromagnetic Domains* at an international conference on the Physics of Metals. He also spoke before colloquia at the Universities of Cambridge, Göttingen and Geneva, and visited universities and commercial laboratories in England, France, Switzerland and Holland.

Mr. Kittel spoke on *Microwave Resonance Absorption in Ferromagnetic Substances* before the International Conference on the Physics of Metals at Amsterdam and before the Physical Society Conference on Radio Frequency Spectroscopy at Oxford. He also investigated magnetics research in Holland, England, France and Switzerland. His crossings were made on the *Nieuw Amsterdam*.

President's Certificates of Merit

Eight members of the Laboratories were among those who received the President's Certificate of Merit for outstanding services in the Armed Services during World War II in three recent presentation ceremonies in New York, held jointly by the Army and Navy. In all, there were over eighty scientists and engineers in the metropolitan area who were thus honored as former members of the wartime Office of Scientific Research and Development. A list of the Laboratories' men and citations follow:

Arthur Forrester Bennett—"For outstanding services in the development of acoustic torpedoes during the recent war period."

Hendrik Wade Bode—"In recognition of your outstanding services from December, 1940, to September, 1945, in fire control."

Ralph Bown—"In recognition of your outstanding services from June, 1940, to December, 1945, as a charter member of the Microwave Committee."

Harvey Fletcher—"For outstanding services in the field of acoustics in various responsible capacities during the period from October, 1940, to June, 1946."

Thornton Carl Fry—"In recognition of your outstanding services from July, 1940, to April, 1946, as member of and consultant to the Fire Control Division; as deputy chief of the Applied Mathematics Panel; and as chairman and active director of the work of the Army-Navy N.D.R.C. Committee concerned with fire control measurements and man machine studies."

Robert Waldo King—"In recognition of your outstanding services from November, 1940, to June, 1946, while holding a number of successive and concurrent important appointments with the Office of Scientific Research and Development."

U. S. Navy Photo

A. F. Bennett and Harvey Fletcher discuss their awards with Rear Admiral Walter S. DeLany, Commander of the Third Naval District, who made the presentations

Walter Archer MacNair—"In recognition of your outstanding services from September, 1943, to December, 1945, as a member of the Airborne Fire Control Section of the Fire Control Division of the N.D.R.C."

William Hennick Martin—"In recognition of your outstanding services from June, 1941, to September, 1945, in the field of sonar design and transducer engineering for the Navy."

Knox Charlton Black also received a certificate for work done while he was a member of the Laboratories' Transmission Development Department.

THOMAS SHAW RETIRES

BY OTTO BLACKWELL
Assistant Vice-President A T & T

Thomas Shaw was born in old England but his most formative boyhood years were spent in New England, right where the history of New England began, at Plymouth, Massachusetts. His family settled there when he was twelve, having moved to America when he was eight.

At seventeen Mr. Shaw first became a Bell System employee, and admits he slept on the job, since the telephone company furnished a bed for its night operator shift of seventy-two hours per week. The subscribers evidently slept well, and serving them did not keep him from school attendance or from a nine-hour day job during one summer vacation.

He graduated in 1905 with the B.S. degree in Electrical Engineering from the Massachusetts Institute of Technology. One of his instructors was a young man named Frank Jewett. When Dr. Jewett appeared with an enthusiastic recital of developments he had undertaken in Boston for the American Telephone & Telegraph Company, Mr. Shaw signed up immediately with that company. The "loading" of telephone lines was then the outstanding project in telephone transmission development, and Shaw was selected to work on the new forms of coils required. Thus began his career as an expert in the many forms and applications of inductances and coils.

In September, 1907, the headquarters of the company transferred from Boston to New York; Mr. Shaw is one of the last two, in active telephone service, of the engineers involved in the move.

For many years, development work on loading constantly increased in importance. Mr. Shaw and the group of engineers who assisted him were the center of the loading coil work in the American Company. In succession came the loading of open wire phantoms, loading of duplex cable, special loading for the Boston-Washington cable, coils stabilized with core air gaps to meet requirements of repeater operation over transcontinental distances, loading of cable lengths in open wire carrier systems, and the combined application of coils and repeaters in 19-gauge cable pairs for very long circuits. In exchange loading the coils were reduced in size by successive stages until the present coils have less than one-fortieth the volume of the original coils, making loading economical for large amounts of 22 and 24-gauge local cable pairs.

At the luncheon given to Thomas Shaw on his retirement. Seated, left to right, O. B. Blackwell, Mr. Shaw, M. L. Almquist and O. E. Buckley. Standing, left to right, W. H. Martin, G. W. Gilman, W. H. Osborne, J. J. Pilliod and William Fondiller

Mr. Shaw's twenty-one patents, of which eight are joint with others, suggest the pioneering character of the work which was being done.

Mr. Shaw's first published paper was in 1914, on "Neutralizing Transformers and Their Use in Telephone Circuits," in *The Electric Journal*, published by the Westinghouse Electric & Manufacturing Company. It concerned the overcoming of induced voltages from electrified railways, a subject to which Mr. Shaw made very valuable contributions. In 1926, on the twenty-fifth anniversary of the commercial application of loading, Thomas Shaw for the American Company and William Fondiller for Bell Telephone Laboratories were the joint authors of a sixty-page definitive article on "Loading for Telephone Circuits."

Mr. Shaw's paper on "The Conquest of Distance by Wire Telephony," published in the *Bell System Technical Journal*, October, 1944, first disclosed him as an accomplished historian and author. This paper was written to commemorate the retirement of Dr. Jewett. The editorial foreword to the paper, after stating the decision to have such a paper written, states "the task of compiling the history has fallen upon the shoulders of a single individual, and we believe a very competent one. Mr. Shaw is to be congratulated in capturing to an unusual degree the spirit of the period which intervenes between the introduction of the loading coil and the completion of the first transcontinental line. * * * Needless to say, he has been aided by the fact that he was himself a participant in much that he relates."

Mr. Shaw will continue to be a resident of Hackensack, New Jersey. His immediate effort will be directed to finishing a comprehensive history of loading in the Bell System, on which he was working at the time of his retirement.

Club Constitution Being Revised

Bell Laboratories Club will revise its constitution because of the redistribution of Laboratories personnel. E. K. Eberhart, club president, has appointed a committee with G. N. Thayer, chairman; R. E. Coram, Whippany representative; J. J. Harley, Murray Hill representative; J. C. Kennelty, F. J. Singer and W. C. Toole, New York representatives. As the Record went to press, a draft of the revised constitution had been prepared and readied for discussion at the October 27 meeting of the club. Revisions or additions made at this meeting will be incorporated in a draft which will be presented for final action at the November meeting.

Changes in Organization

In anticipation of H. M. Trueblood's retirement, which will be in the spring of 1949, the organization reporting to G. W. Gilman, Director of Transmission Engineering, has been reconstituted as follows:

Mr. Trueblood has been appointed Assistant Director of Transmission Engineering and will assist Mr. Gilman in the administration of the Transmission Engineering Department.

P. W. Blye has been appointed Transmission Systems Engineer, responsible for the transmission engineering of wire systems.

A. C. Dickieson has been appointed Radio Systems Engineer, responsible for the transmission engineering of radio systems.

M. L. Almquist and C. H. G. Gray have been appointed Transmission Studies Engineers, responsible for general transmission engineering studies.

C. A. Lovell and D. B. Parkinson receive Potts Medal Awards from Richard T. Nalle, President of the Franklin Institute, at the Medal Day ceremonies held on October 20, in Philadelphia, "in consideration of their combined contributions, both to the theoretical and practical design of the Electrical Gun Director"

E. F. Watson continues in his capacity as Telegraph Engineer, responsible for the transmission engineering and development of telegraph systems.

F. B. Llewellyn and H. Nyquist continue as Consulting Engineers, responsible for consulting activities.

Effective as of the same date, A. H. Schirmer, Protection Engineer, was transferred to Outside Plant Development, reporting to T. C. Henneberger, Plant Systems Engineer.

During the Months of July, August and September, the United States Patent Office Issued Patents on Applications Filed by the Following Members of the Laboratories

B. S. Biggs
C. R. Blazier
G. M. Bouton
N. W. Bryant
F. W. Clayden
E. E. Crump
M. R. Dungan
I. E. Fair
J. B. Fisk
K. E. Fitch
C. J. Frosch
C. S. Fuller
A. G. Ganz
R. W. Gillespie
W. M. Goodall
D. A. S. Hale
H. C. Harrison
A. D. Hasley
J. R. Hefele
R. A. Heising
E. W. Houghton
W. F. Kannenberg
W. V. K. Large
C. W. Lucek
F. S. Malm
W. P. Mason (3)
F. G. Merrill
G. E. Mueller
G. S. Phipps
C. E. Pollard
J. B. Retallack
V. L. Ronci
C. F. P. Rose
E. E. Schumacher
R. J. Shank
O. A. Shann
J. C. Slater
P. T. Sproul
J. Strand
W. D. Stratton
B. S. Swezey
W. A. Tyrrell (2)

San Francisco Host to Telephone Pioneers

Delegates from sixty chapters representing 126,000 members of the Telephone Pioneers of America in all parts of the United States and Canada gathered in San Francisco recently for the Golden Gate Meeting of their General Assembly. Members of the Laboratories attending were: M. B. Long, Vice-President of Section 10 of the National Association; and H. H. Lowry, Vice-President, and Hattie Bodenstein, Secretary, of the Frank B. Jewett Chapter.

The meeting of the General Assembly was opened by Carl Whitmore, President of the Pioneers' Association. A welcoming address was made by John M. Black, general chairman of the San Francisco General Assembly Committee and Vice-President and General Manager of the Pacific Company's Northern California-Nevada Area. The roll was called by Association Secretary S. T. Cushing, who also gave his report, followed by the report of Treasurer F. A. Wiseman.

Meetings of the Assembly covered practically every subject of interest to the Pioneers. Panel discussions were led by delegates from the various chapters.

Football Games of the Illini to Be Televised

A microwave relay system using TE type apparatus has been placed in service by Illinois Bell from Urbana to Danville, where it joins the coaxial cable for transmitting televised football games of the University of Illinois to Chicago or over the Mid-West network. Terminal equipments for the microwave circuit are located on the roof of the press booth of the stadium at Urbana and on a tall building near the telephone office in Danville, about 32 miles away. A single intermediate relay station is mounted on a small platform supported by two 60-foot poles.

A radio extension of the Eastern television network has also been placed in service by Bell of Pennsylvania, on short notice, to enable transmission of programs from Philco's transmitter site at Wyndmoor, Pa., over the East Coast network. The eight-mile circuit employs one intermediate relay.

Mobile Service Traffic Report

General mobile telephone service traffic reports received from fifty-six cities offering service on urban frequencies and from sixty-nine cities having highway frequencies show a total of 174,569 calls made to and from 5,559 mobile units during a recent month. On both urban and highway channels, 59 per cent of all calls originated at mobile telephones. On urban channels, 3.3 per cent of all calls were toll, while on highway channels 22.5 per cent were toll.

Bell System Wins Distinguished Service Award for Its Training Methods

The Bell System received the second annual Distinguished Service Award of the Special Devices Association for outstanding accomplishment in the development of training techniques at a dinner of the association at the Navy Special Devices Center, Port Washington, L. I., on September 18. Membership of the association is made up of

What's on Your Chest?

Two chest X-rays a minute, 700 a day, will be made at the Laboratories by experts of the New York City Department of Health and the New Jersey State Department of Health. Regardless of how recently you have had a chest X-ray, you are urged to participate; the examination will require only a few minutes. X-raying begins on November 9 at Whippany and on November 15 at West Street and Murray Hill. Details will be given in a desk-to-desk notice.

Naval Reserve officers and civilians who have served or are serving in the Special Devices Center of the Navy's Office of Naval Research.

The award, first made in 1947 to the General Motors Corporation, was presented to Clifton W. Phalen, Vice-President of the A T & T, by Rear Admiral Luis de Florez, founder and first director of the Special Devices Center. The award is in recognition of peacetime advances in the development of training techniques as a measure of national preparedness.

Eye Protection Program

Safety goggles are commonplace for jobs where eyes might be injured. For those who wear eyeglasses regularly, the goggles are a nuisance, and likely to be mislaid or forgotten. So Personnel has set up a procedure under L. E. Coon, Safety and Health Supervisor, by which each department of the Laboratories provides and maintains an approved type of safety eyeglasses. Those who are exposed to eye hazards may have their eyes examined by a physician and have the physical measurements and fittings by an optician. More than 1,500 members of the Laboratories, at the various locations, have received safety glasses for work in Development and Building Shops and in chemical and physical laboratories.

. E. Coon, Safety and Health Supervisor, center ar, recording data while an optician measures the ipillary distance of a member of the Laboratories ing fitted with Ful-vue super-armorplate lenses for fety glasses required for eye protection in his work

Trains on Central and New Haven Get Telephone Service

Mobile telephone service for train passengers was considerably expanded recently with the opening of service on two trains of the New York Central System and four trains of The New York, New Haven and Hartford Railroad Company.

On the longest single stretch of train telephone service to date—the 436 miles between New York and Buffalo—the service is available on both of the New York Central's new streamlined *Twentieth Century Limiteds*. Service is provided through eight land stations,

An attendant on one of the New York Central System's two new Twentieth Century Limiteds *places a telephone call for a passenger in an adjoining booth*

seven of which are operated by the New York Telephone Company and the eighth by an independently owned company. These stations comprise the New York-Albany-Buffalo highway mobile telephone system, which has been in operation a year, serving cars and trucks.

On the New Haven road, four lounge cars on the two *Merchants Limiteds* and the two *Yankee Clippers* are equipped for mobile telephone service furnished through the highway system already in operation between New York and Boston. The service is provided jointly by the New England Telephone and Telegraph Company, The Southern New England Telephone Company and the New York Telephone Company.

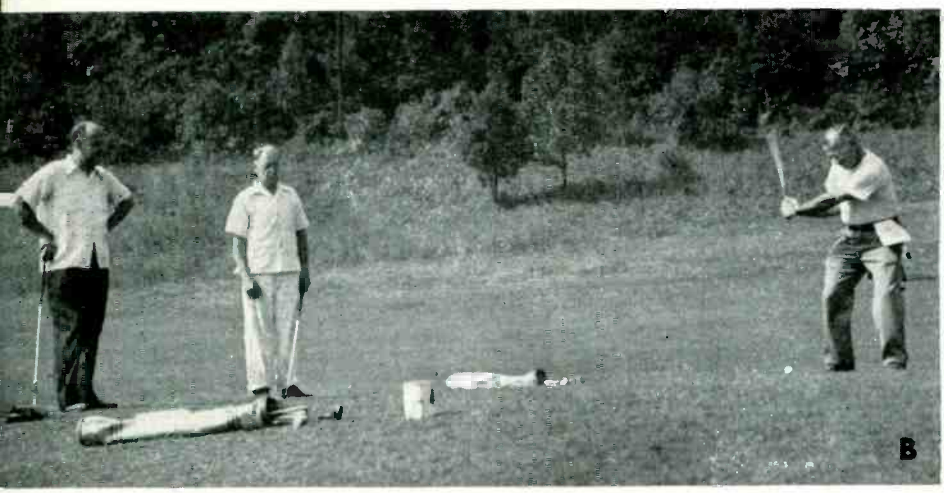
Golf Tournament in New Jersey

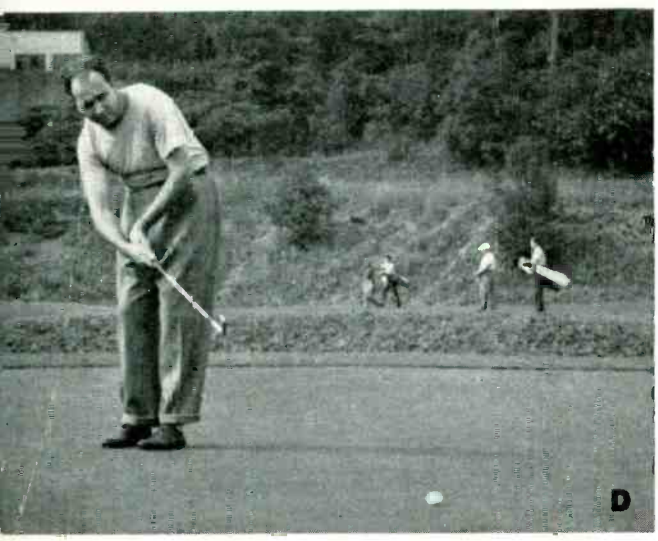
Fifty-four members and guests of the Bell Laboratories Club participated in the golf tournament held on October 2 at the Essex County Country Club. Winners in the various classes were:

Class "A"—A. Jankowski, low gross; J. F. Lawrie, second low gross; O. Cesareo, low net; W. W. Carpenter, Jr., second low net; and D. K. Gannett, A. E. Hague and H. M. Yates, kicker's.

Class "B"—R. D. Fracassi, low gross; E. H. Van Seggern, second low gross; C. W. Christ, low net; J. F. Hanley, second low net; and J. M. Hardesty and W. L. Whinn, kicker's.

Class "C"—H. T. Reeve, low gross; E. G. Morton, second low gross; G. Palladine, low net; W. W. Bergmann, second low net; and S. H. Lovering and A. F. Schweizer, kicker's.





A—Finishing up on the 18th hole at Essex County. Left to right, W. F. Malone, chairman of the golf committee, J. G. Whytock, and E. K. Eberhart, president of the Club

B—One of the threesomes. Left to right, Stanley Lovering, A. S. Page, and O. Cesareo

C—W. H. Whinn expects to drive over a brook some 200 yards ahead

D—W. J. King nearly sank this 35-foot putt

Voices Go to Boston by Cable, Back by Radio

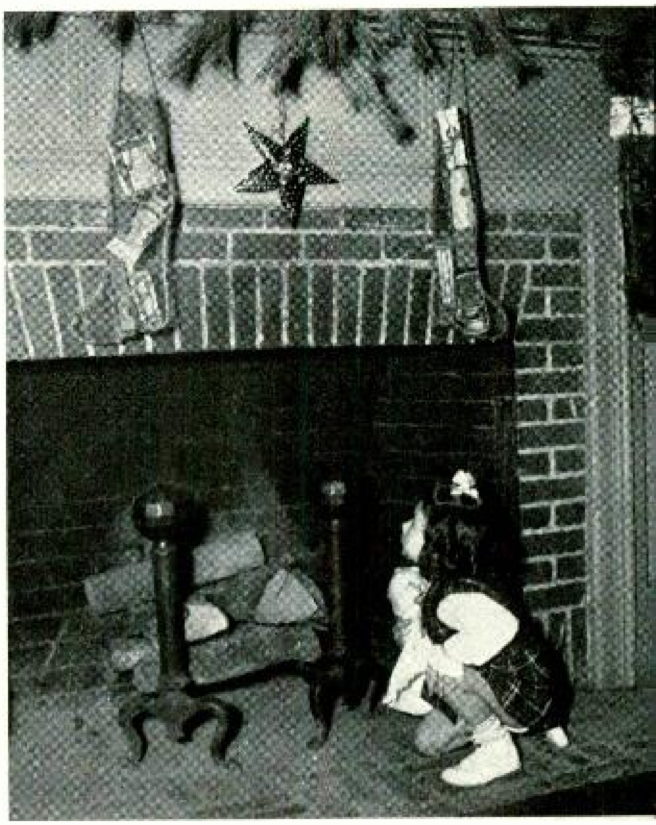
When you talk to someone in Boston, your voice will go by cable but your friend's voice may return by radio. Here is the reason for this unusual way of setting up long distance circuits. The New York-Boston microwave radio system is capable of transmitting television programs and large blocks of telephone message circuits. At the present time, all of the radio facilities toward Boston are regularly required for television service to Boston television stations, while the television traffic in the return direction is not so heavy. The extra radio channels are, therefore, available for the transmission of telephone message channels from Boston to New York, but not from New York to Boston. By operating approximately three hundred message channels by radio, practical experience of great value is being gained.

An arrangement of this sort presents no particular problem to telephone engineers because most long distance talks are on a "four-wire basis." That means to a telephone man that the talk goes one way on one pair of wires and returns on the other pair. These two paths are entirely independent and frequently are routed through different telephone cables. Generally it is only between your telephone and the long distance office that voices are transmitted both going and coming over the same pair of wires.

International Relations Group off to a Brilliant Start

Thirty Murray Hill members attended the first luncheon meeting on October 11 of the International Relations Group, of which H. W. Dudley is chairman. Following the luncheon, the group transferred to the auditorium to accommodate sixty others who were not able to attend the luncheon because of space limitations. The meeting was devoted to statements of purpose of the Group and to election of officers, who, in addition to Mr. Dudley, are: H. E. Mendenhall, vice-chairman in charge of programs; A. Herckmans, secretary-treasurer; and Marguerite Van Nest, luncheon secretary. On October 18, one hundred and thirty-six people attended the second meeting of the Group, at which Miss Van Nest and J. R. Townsend headed a panel discussion on the subject, *Politics of Powers—(1) Russia.*

People at West Street or other Laboratories locations, who may be interested in these meetings and would like to receive notices, should get in touch with Mr. Herckmans, Murray Hill 1C-221, Ext. 2196.



WILL SANTA COME THIS YEAR?

This little girl at the Greenwich House will soon be looking for Santa again. Have you made a contribution or donated a toy to assure that her Christmas will be a happy one? If you haven't, there's still time to help the Doll and Toy Committee fill the quota of toys requested by sixty-five charitable organizations and hospitals

News Notes

IN A TALK before the executive conference group on October 14, M. J. KELLY reported on the general situation in Europe, including recovery and reconstruction. He spoke particularly on the status of telephone research and development and of technical education. Dr. Kelly visited seven countries: Sweden, Denmark, Holland, Belgium, Switzerland, France and England.

A. B. CLARK gave a lecture on *Communication Trends* to the Air Command and Staff School of the Air University on September 21 at Maxwell Field, Montgomery, Alabama. The audience numbered approximately 450. Mr. Clark also gave a talk to the Long Island Area Operating Conference of the New York Telephone Company at Absecon, N. J.

Franklin L. Hunt Retires

Franklin Hunt's career in engineering physics really began with a set of tools left him by his father. At first he played with them; later in school he learned to use them. Then he studied chemistry and physics in high school, and these subjects, with mathematics, were his subject at M.I.T. After his graduation in 1909, he held various instruction posts at "Tech" and studied at Harvard, from which he received his A.M. in 1913; the "Duane-Hunt Law" in X-ray spectroscopy is a landmark of those days.

Followed a year of study in Berlin and three years of teaching until in 1917 Dr. Hunt took up aircraft instrument development at the U. S. Bureau of Standards, and later became chief of that section. In 1919 he received his doctorate in physics from M.I.T. and was sent overseas for a year by the Bureau to study foreign developments in aircraft instruments. His final work at the Bureau was on X-ray spectroscopy *in vacuo*.

As an incident of its acceptance of electrical recording, Victor Talking Machine had strengthened its research staff; one of the newcomers was Dr. Hunt, others came over from the Laboratories to continue the developments which they had begun here. In 1929 they returned and brought Dr. Hunt with them.

The Laboratories, in introducing to the motion picture industry a sound recording system, from microphone to projection film or disc, had also introduced a new set of problems; the acoustic design and use of stages. A new laboratory, now Section L at West Street, had been built with a sound stage among its facilities, and Dr. Hunt was put in charge of a group to study such things as microphone placement, sound levels, wall treatment, types of recording on both film and disc; in short, all factors met with in studio operation. This work continued until 1935, when enough groundwork had been done to turn the remaining problems over to the industry. Twelve papers and three patents record his contributions to the art.

Dr. Hunt then transferred to Publication, where he became an associate editor of Bell Laboratories RECORD. In 1942, with the completion of Murray Hill No. 1, he became Publication's representative there, and added to his duties the reception of distinguished visitors. In the ensuing six years, he has coordinated the plans for extending the Laboratories' hospitality to some six thousand Bell System executives, members of utility commissions, engineers and scientists, all of them with a strong professional interest in how we do our work and in the facilities of this outstanding laboratory building.

Following a few months of leisure, Dr. Hunt plans to resume one or other of his early activities, college teaching or biophysics.

News Notes

WILLIAM FONDILLER took part in a Conference on the Administration of Research, held at the Pennsylvania State College from September 13 to 15, participated in by representatives of government, industry and the universities.

RALPH BOWN and WILLIAM SHOCKLEY gave a lecture-demonstration on the Transistor in the Department of Interior auditorium in Washington on September 24 before an assembly of 700, including officers and technical civilians of the Army and Navy, members of the patent office, the Federal Communications Commission and representatives of The Chesapeake and Potomac Telephone Company. The demonstration, showing the use of the Transistor as an amplifier, oscillator and video amplifier, was arranged by HENRY KOSTKOS with the assistance of Frank Fansher of The Chesapeake and Potomac Telephone Company.

HARVEY FLETCHER has been appointed a member of the National Research Council and assigned to the Division of Engineering and Industrial Research for the period ending June 30, 1951.

J. M. RICHARDSON participated in the *Phase Transition Conference* at Cornell University.

C. S. FULLER attended meetings of the Council of the American Chemical Society in St. Louis and of the committee on publications of the Society of which he is a member.

H. A. BIRDSALL and C. A. CHASE consulted the Schlichter Jute Cordage Company in Philadelphia on jute yarn problems. Mr. Birdsall has been elected secretary of A.S.T.M. Committee D-6 on paper and paper products.

J. B. DE COSTE attended conferences at Point Breeze on plastic insulation and sheathing for wire and cable.

N. Y. PRIESSMAN, H. F. DIENEL and G. K. TEAL examined silicon carbide varistors at the General Electric Company, Pittsfield.

K. G. COUTLEE gave a talk on *Electrical Quality Control of Mica* at an A.S.T.M. symposium on mica held in Philadelphia in September. He also showed a Kodachrome moving picture which demonstrates the use of the two mica test sets developed by the Laboratories.

A. MENDIZZA and C. C. HIPKINS visited Western Electric shops at Winston-Salem and Burlington to discuss finishing and corrosion.

K. G. COMPTON, C. C. HIPKINS, A. MENDIZZA, W. J. KIERNAN, R. J. PHAIR and H. G. ARLT participated in the annual conference at Hawthorne on finishes.

W. E. CAMPBELL visited Philadelphia as a member of an American Petroleum Institute subcommittee which is responsible for a project on the measurement of oil viscosity by torsional crystals being carried out by The Franklin Institute.

E. E. SCHUMACHER and I. V. WILLIAMS, at Hawthorne, discussed problems on metals; and F. G. FOSTER, methods of measuring plating thickness.

J. P. GUERARD conferred at the American Brass Company and Chase Copper and Brass Company, Waterbury, Connecticut, on the manufacture of high quality copper tubing.

L. E. ABBOTT discussed wave guide tubing at Revere Copper Company, Rome, N. Y.

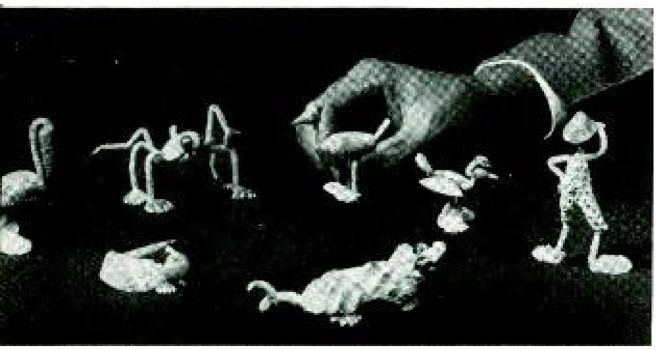
F. M. WIENER has written on *Phase Characteristics of Condenser Microphones* in the Letters to the Editor section of the September *The Journal of the Acoustical Society of America.*

C. J. CALBICK and R. D. HEIDENREICH attended a conference on electron microscopy in Toronto at which Mr. Calbick gave a paper on *Comparison of Inorganic and Organic Replicas* and Mr. Heidenreich gave two papers: *Oxide and Polystyrene Silica Replicas* and *Thin Metal Sections for Electron Microscopy and Electron Diffraction.* Mr. Calbick has been appointed chairman of the nominating committee of the Electron Microscope Society.

Mrs. Myrtle Miller, top-flight archery teacher, gave a demonstration and lecture at West Street to old and prospective members of the Archery Club. Arrows shot across the auditorium to the bull's-eye by Mrs. Miller are being checked by W. J. Rutter, whom she taught at her camp and archery school in Vermont. New members of the Laboratories' Archery Club will receive their instruction from C. N. Hickman of the Laboratories, one of the country's outstanding archers

A. G. SOUDEN, F. J. SCHNETTLER and J. H. SCAFF went to the General Electric Company, Schenectady, to discuss powder metallurgy.

L. N. HAMPTON, C. V. OBST and M. SALZER visited the Teletype Corporation to confer on the production of the KS-13834 perforator.



Florida Zoo

Vacation and relaxations, idle beach hours and imagination, shells, pipe cleaners and plastic wood, combined by C. B. Feldman, produced the amusing creatures shown above.

The tired and dejected pelicans who inhabit the St. Petersburg municipal pier inspired the figure at the left. The lizard has had its tail pinched and is examining his rear quarter in outraged amazement. "Jet Propulsion," the modern bird with the sun shade, is coming in for a two-point landing. Colonel Abernathy, retired, is shown wearing his tropical uniform at a reunion of the Regiment.

They are figments of the same mind* that in the Laboratories workaday world wrestles with problems of new transmission systems such as the 96-channel pulse code modulation system described by Mr. Feldman in the September issue of the Record.

*Some of them are the figments of Mrs. Feldman's mind.

News Notes

Timothy E. Shea, formerly a member of the Laboratories and recently assistant engineer of manufacture of Western Electric, has recently been elected president and a director of Teletype Corporation.

W. R. Lundry changed some gain equalizers on the L1 system in preparation for television service in Terre Haute, Toledo and Cleveland.

J. W. Smith consulted a Government agency on submarine equipment and R. J. Phillips attended a conference on tactical use of submarines, during recent trips to Washington.

E. S. Willis witnessed laboratory tests on the initial installation of A3 channel bank equipment in St. Louis.

P. P. Debye, W. S. Gorton and J. B. Little attended the Instrument Fair held in Convention Hall, Philadelphia.

H. J. Smith consulted the C. F. Church Company at Springfield, Massachusetts, about plastic molded parts.

E. St. John visited the Standard Electric Time Company in Springfield, Massachusetts, to discuss requirements for a new electric stop clock.

A. W. Daschke attended the Instrument Society of America Convention in Philadelphia. He went to the General Electric Company in Lynn, Massachusetts, for conferences on meters.

H. T. Balch and W. C. Hunter observed the installation and operation of fixed station radio transmitting equipment in Chicago.

C. R. Taft and H. A. Baxter conferred on a new submarine project at General Mills, Minneapolis.

A. M. Garblik and J. G. Matthews inspected aircraft radio equipment undergoing evaluation tests at Wright Patterson Air Force Base.

H. L. Rosier is representing the Laboratories at the Patuxent River Navy Test Station during air-to-ground radio propagation tests.

At Burlington, tool-made sample tests of radio telephone equipment were conducted by R. D. Gibson and W. M. Knott.

Each day that Muriel Warren spends at West Street running the L elevator brings her closer to the realization of her dream of studying opera in Italy. A prima donna, she has already appeared with opera companies in Boston and in Rochester, New York

AT WINSTON-SALEM, F. E. GISSLER studied the off-channel squelch modification of a new radio receiver and E. H. JONES, standardization problems.

T. A. MCCANN attended the cutover of the new Humboldt crossbar central office in Chicago with H. W. HERMANCE and C. W. MATTSON of the Chemical Laboratories to extend laboratory studies that are being made of switching contact performance.

W. P. MASON, who sailed for Europe August 28 on the *Mauretania*, delivered two papers: *Electrostrictive Effect in Barium Titanate Ceramics* and *Measurement of Shear Elasticity and Viscosity of Liquids by Means of Ultrasonic Shear Waves*, the latter co-authored with H. J. MCSKIMIN, before the VII International Congress of Applied Mechanics in London. He also visited a number of laboratories in England, Holland and Switzerland during his six weeks' trip.

C. BREEN inspected the No. 4 toll crossbar installation in Chicago and discussed pre-cutover and maintenance problems with the Long Lines people. He also visited Cleveland to inspect the No. 4 installation.

NEWTON MONK and S. B. WRIGHT have written *Technical Aspects of Experimental Public Telephone Service on Railroad Trains* for the Waves and Electrons Section of the September, 1948, *Proceedings of the Institute of Radio Engineers*.

PIERRE MERTZ has been appointed to the Society of Motion Picture Engineers committees on *Admissions* and on *Television* and to the Board of Editors; and J. H. WADDELL has been appointed chairman of the committee on *High-Speed Photography*, and a member of the *Standards* committee.

R. C. TERRY and W. L. DAWSON appeared before the Board of Appeals at the Patent Office relative to applications for patent.

THE LABORATORIES were represented in interference proceedings before the Board of Interference Examiners at the Patent Office by W. L. DAWSON.

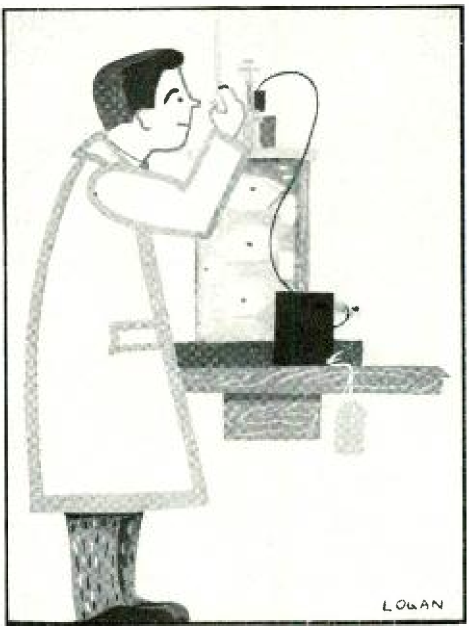
A. J. SNYDER was at the Patent Office in Washington during September relative to patent matters.

BELL TELEPHONE COMPANIES added 28,612 telephones in rural areas of the United States during August. This brought the total gain for the first eight months of the year to 226,516.

F. M. WIENER visited the Psycho-Acoustic Laboratory at Harvard and M.I.T. on general acoustic matters.

A. W. HAYES and G. SANDALLS, JR., together with M. A. Davis, R. F. Davis, D. A. Langworthy and W. D. Mitchell of the A T & T, and F. W. Berry of Western, visited Chicago, where they discussed a number of problems in connection with coin telephone service with representatives of the Illinois Bell Telephone Company and the Western Electric Company.

R. M. BURNS was in Washington for a meeting of National Research Council Advisory Committee of Deterioration Prevention.



Harvesting crystals at Murray Hill

C. A. BIELING attended the National Instrument Conference at Philadelphia, September 16.

A. C. WALKER gave a talk on *Growing Piezoelectric Crystals* before a joint meeting of the Western Pennsylvania Sections of the Institute of Radio Engineers and the American Chemical Society at Emporium, Pa.

W. O. BAKER attended a conference at the Office of Naval Research in Washington as a member of the Advisory Panel on Physical Chemistry.

J. B. HOWARD attended the annual meeting of the Electron Microscope Society of America at the University of Toronto, September 9-11.

W. H. DOHERTY presented a paper on *The Operation of AM Broadcast Transmitters Into Sharply Tuned Antenna Systems* before the West Coast meeting of the Institute of Radio Engineers in Los Angeles. He also visited several FM broadcast stations on the West Coast.

RECENT DEATHS

G. T. Papineau
1906-1948

W. H. Sorg
1906-1948

A. E. Bowen
1900-1948

George T. Papineau, October 7

A member of the technical staff, Mr. Papineau had been engaged in the development of vacuum tubes since he joined the Laboratories in 1927. His particular work was the design, development and maintenance of the test equipment for small tubes in Electronic Apparatus Development. In this connection, he worked on tubes for radio and telephone use, particularly on those for radar and coaxial-carrier systems. After hours, building radios was his hobby and he had devoted much time in his home laboratory to the development of homemade equipment for reproducing music.

William H. Sorg, October 7

Mr. Sorg came to the Laboratories early in 1943 to serve as a mechanic in the Murray Hill Development Shops Department. The following year he was promoted to instrument maker and in that capacity served various Murray Hill engineering groups on important war development work and, later, telephone development projects. His outside activities included service as special officer on the Chatham Township police force, participation in various civic affairs of his community, and active membership in the Laboratories' Club bowling league.

Arnold E. Bowen, October 15

In 1934, when Mr. Bowen transferred to the Laboratories at Holmdel, he began the third phase of his Bell System career, the first phase of which began in 1920, when he joined The Southern New England Telephone Company at New Haven to work during summer vacation. The following three summers he worked for the D & R of the A T & T. Meanwhile, he had obtained his Ph.B. from the Sheffield Scientific School at Yale University and had done a year of graduate work while assistant in the Physics Department. In June, 1924, Mr. Bowen joined the D & R permanently and began the second phase of his telephone career, a ten-year period devoted to problems in the field of inductive coördination, particularly on the technical problem of coefficients of mutual inductance between ground return circuits and on the propagation of carrier currents over power lines.

With the D & R consolidation in 1934, he went to Holmdel, where he played an important part in the pioneer work there in progress on waveguide transmission and its various applications. This included not only the development of the waveguide as a transmission line, but also methods of generating very short

Final stage of processing in the Blueprint Department, where 185,000 prints a month are turned out. Carmela Filardo trims blueprints, Vivien Fitzgerald trims them further to exact size, while Winifred Madoule writes in the drawing number and Mary Keane, standing, assembles and compiles the orders waves, methods of measuring their attenuation, and methods of amplifying these waves when they have become too weak to be useful. Among Mr. Bowen's more prominent developments were waveguide circuits which made possible the adaptation of the Klystron amplifier to higher frequencies. Various forms of these circuits are now in use in the New York-Boston radio relay system. Sixteen patents issued and twelve patents pending bear witness to his contributions to the field of microwave development.

Because of the stockpile of fundamental elements produced by Mr. Bowen and his associates which were on hand at the time of Pearl Harbor, the Laboratories were enabled to develop, on short notice, new forms of radar, some of which made possible the accurate aiming of naval guns at night, while others permitted accurate bombing from airplanes either through overcast or darkness. In the latter connection, Mr. Bowen was called to special service in September, 1942, as major in the A.A.F. on anti-submarine coverage in the Caribbean Sea. He was released later that year, called up again in 1943, this time to regular service. He then spent nearly three years in Washington on the Staff of Air Communications as Officer-in-Charge of Section No. 7D on airborne radar and was promoted to rank of lieutenant colonel. Upon release from the Army in 1945, Mr. Bowen returned to Holmdel and to further study of microwave amplifiers. This led to new and greatly improved methods, some of which will be used in the New York-Chicago radio relay system.

News Notes

M. A. Froberg, H. T. Langabeer and F. W. Anderson observed noise measurements on power room busbars at Boston and Malden.

R. R. Gay, at the Power Equipment Company's plant in Detroit, inspected preliminary designs of rectifiers to be used on the TD-2 system.

H. J. Berka discussed operating room fluorescent lighting problems with engineers of the Bell of Pennsylvania at Philadelphia.

F. F. Siebert observed recent charging machine designs at the Hertner Electric Company's plant in Cleveland.

V. T. Callahan visited the Cleveland and Detroit plants of the General Motors Corporation in connection with Diesel engine designs.

C. S. Knowlton recorded battery voltage variations in the Boston and Providence areas.

D. E. Trucksess discussed selenium rectifying cells with the General Electric at Lynn.

N. V. Mansuetto supervised the installation in Madison and Hartland, Wisconsin, of repeater equipment for the N1 carrier systems.

E. von der Linden spent a few days in Hawthorne on current engineering problems.

R. H. Miller discussed the New York Telephone Company's order for A4A toll crossbar equipment with their engineers in Albany.

"The Telephone Hour"

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

November 15	*Jussi Bjoerling*
November 22	*Marian Anderson*
November 29	*Sidney Harth, Theodore Lettvin and Paul Olefsky**
December 6	*Fritz Kreisler*
December 13	*Lily Pons*

* Winners of the 1948 Walter W. Naumburg Musical Foundation Auditions (Harth, violinist; Lettvin, pianist; and Olefsky, 'cellist).

Engagements

*Myra Brown—*Allan J. Rosselet
*Anita Garcia—*Joseph A. Kotaski
*Stella Pluta—John Jersitz
*Mary Lou Powers—Martin B. Kelly
*Marie Vitelli—James G. Cusick, Jr.

Weddings

*Janet Brown—*Guy F. Boyle
*Carmella Cosentino—Richard Basile
*Mary Gargiulo—Arthur Leva
Shirley Griffiths—*W. S. Ballantyne
*Margaret Lavery—Joseph P. McGrady
*Winifred Lowther—Frank Koenig
*Anne Pluta—Adam Bartos
*Elizabeth Schmidt—Nicholas Zauner
*Irene Walsh—Joseph Leahy

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

F. G. Colbath attended a conference in Washington at which additional facilities for the Government Interdepartment PBX were under consideration.

J. T. Motter discussed No. 5 crossbar equipment with the local telephone engineers at Philadelphia.

O. J. Morzenti, Systems representative at the Western Electric Company at Duluth, visited the Laboratories to discuss manufacturing scheduled for No. 5 crossbar equipment.

J. Meszar, G. A. Locke and A. A. Burgess visited Hawthorne on September 15 and 16 in connection with the AMA system.

November Service Anniversaries of Members of the Laboratories

40 years
J. F. Hunter
Irving MacDonald

35 years
A. E. Hague

30 years
H. J. Battaglia
Lorenzo Miles
Alfred Muller
Leah Smith
C. V. Wahl

25 years
J. S. Edwards
A. M. Elliott
George Head, Jr.
A. A. Huebner
H. Jones
C. F. Knepper
R. D. Long
J. J. Martin
E. J. Murphy
G. A. Persons
C. H. Slauson, Jr.
James Sweeney
L. T. Wilson
Alphons Wurmser

20 years
F. W. Amberg
W. L. Bond
M. O. Fichter
G. E. Hanan
E. J. Hapgood
A. L. Jeanne
C. E. Kempf
R. J. Kircher
Beatrice Koukol
C. F. Mattke
O. J. Morton
H. O. Schroder
J. L. Sharon
A. F. Swenson
F. J. Voinier

15 years
A. E. Anderson
G. W. Rust

10 years
H. V. Berlin
Mary Dormer
A. O. Jagau
J. J. Jansen
Alice Putnam
Margaret Thomas

H. W. Augustadt, W. R. Goehner, R. F. Massonneau, P. L. Wright and W. D. Mitchell of the A T & T visited the Audichron Company in Atlanta in connection with automatic time announcing machines.

W. D. Mischler, C. G. Arnold, B. Dysart and F. T. Chinn of A T & T observed tests at Dallas, Sweetwater and El Paso, Texas, of initial installation of super groups 9 and 10 on L1 coaxial system.

W. G. Domidion, Jr., W. H. Goodell, Jr., and W. W. Tuthill participated in the initial line-up and testing of the type TE microwave radio equipment installed on the Chicago-Milwaukee and the Toledo-Detroit microwave radio relay projects which went into service on September 20. Television programs originating in St. Louis and Chicago were transmitted via coaxial cable to Toledo, Cleveland and Buffalo. From Chicago and Toledo these programs were transmitted via microwave radio relay to Milwaukee and Detroit.

B. A. Fairweather and J. W. Geils spent two weeks at 32 Avenue of the Americas making tests on new A3 channel banks. Similar tests were made at St. Louis by R. L. Tambling, J. C. McCoy and E. S. Willis. At the completion of the local tests, systems tests were made between New York and St. Louis.

A. L. Matte, N. Monk and A. L. Whitman attended the annual convention of the Communications Section of the Association of American Railroads at Colorado Springs.

A. A. Heberlein with E. F. Reddy of Western discussed production problems associated with the KS-5727 vacuum-tube tester at the Hickok Electrical Instrument Company in Cleveland.

J. W. Beyer, B. Dysart, W. F. Miller and F. A. Muccio have been conducting L1 system regulator tests between El Paso and Los Angeles. O. D. Grismore, F. A. Hinshaw and J. P. Radcliff have completed L1 line tests at Albany, Buffalo and Cleveland.

L. G. Abraham, R. H. Badgley, K. E. Gould and L. W. Morrison were in Chicago in connection with the opening of the Mid-West Television Network on September 20. This network connects Chicago, Milwaukee, St. Louis, Toledo, Detroit, Cleveland and Buffalo.

D. R. McCormack attended the fifteenth annual meeting of the Technical Drawing Associates in Washington, where he addressed the meeting on *Bell Laboratories Reproduction Processes* and on *The Application of Microfilm as an Economical Means of Conserving Storage Space for Inactive Papers Requiring Permanent Retention.*