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The V3 repeater

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Transmission Equipment Engineering

There has been an increasing tendency during the last ten or fifteen years toward reducing the size of many apparatus components. The Laboratories had carried on work in this direction prior to the war, and it was accelerated during the war because space in planes, tanks, and ships is always at a premium. As a result, new techniques and materials became available that have radically altered our previous conceptions of the size needed for various units. The term "miniature" has been properly applied to many of the results of these efforts, and many circuit components, such as resistors and capacitors of good quality, are now commercially available in sizes undreamed of before the war. One possible and desirable application of this miniature design seemed to be the voice-frequency repeater. Such repeaters are used in large quantity throughout the telephone plant, and a substantial reduction in size would not only bring savings in manufacture but would economize in the space required in repeater stations and simplify maintenance. The V3 repeater, which is now available, takes advantage of the miniature techniques so well that the complete unit is not much larger than the vacuum tube alone of the V1 repeater that preceded it.

The V3 repeater comprises two amplifiers, one for each direction of transmission. A number of years ago, a repeater included certain associated equipment, such as hybrid coils, equalizers, and filters as well as the amplifying circuit proper. One of the great advantages of the V1 repeater was

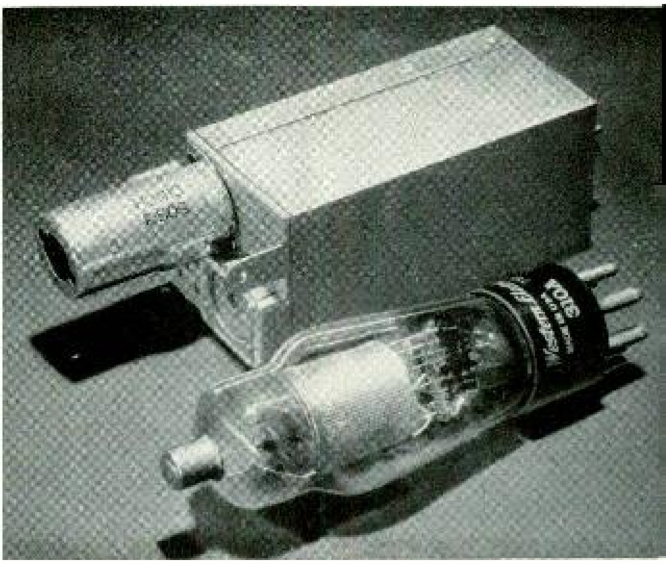

Fig. 1—The V3 repeater with one of the tubes from the V1 repeater in front of it for comparison

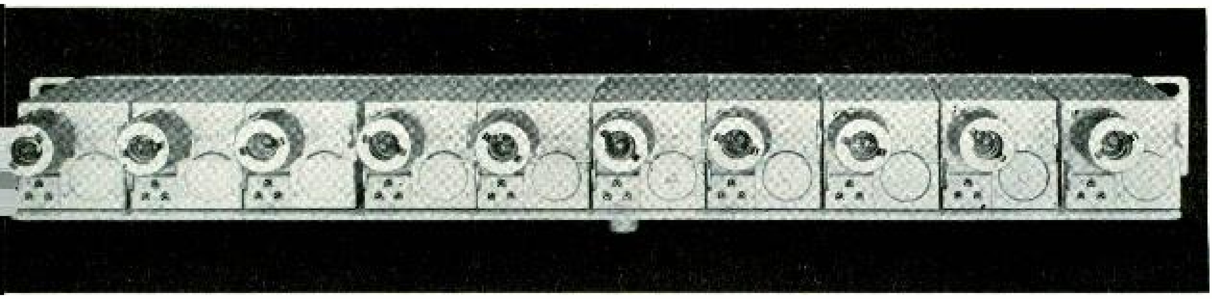

Fig. 2—One row of ten V3 amplifier units, comprising five repeaters, as mounted on a relay rack

the separation of these components into two groups: one to be associated with the line equipment, to which its characteristics are most closely associated; and the other to include only the amplifying circuits. In both the V1 and V3, this latter element alone is sometimes called a repeater.

Each V3 repeater, in this restricted sense of the word, includes two of the amplifiers shown in Figure 1. Besides the vacuum tube, the components of each such amplifier unit consist of two transformers—one for the output and one for the input—a gain potentiometer, six resistors, four capacitors, and three jacks. Each of these units is considerably smaller in size than those used with earlier repeaters.

The tube is essentially a 6AK5 type but, with a 20-volt instead of a 6-volt heater, is coded the 408A. This tube mounts on the front plate of the amplifier, where it is readily accessible, and carries its own shield, which greatly reduces its sensitivity to coupling with adjacent circuits. Also mounted on the front plate is a very small carbon potentiometer, which is logarithmically tapered over a range of approximately 40 db. A transparent shield over the control dial prevents its being disturbed accidentally while permitting it to be readily adjusted by rotating the top in one direction or the other with the finger. Three pin jacks—two for monitoring and one for a cathode activity test—complete the equipment on the front.

A radical decrease in size is obtained in the input and output transformers—coded the 656A input transformer. Two of these transformers are mounted in a single can that occupies most of the space within the amplifier housing. The small capacitors and resistors are secured at their ends by two phenol-fiber strips and lie between the transformers and one side of the housing. A view of one of the repeater units with the cover plate removed is shown in Figure 3.

In the rear end of the amplifier housing is an eleven-pin plug by which the amplifier is connected to the line circuits. This plug-in feature is another novelty with the V3 repeater. If for any reason an amplifier has to be replaced, it is merely pulled out and a new one inserted in its place.

The structure consists of a flat U-shaped

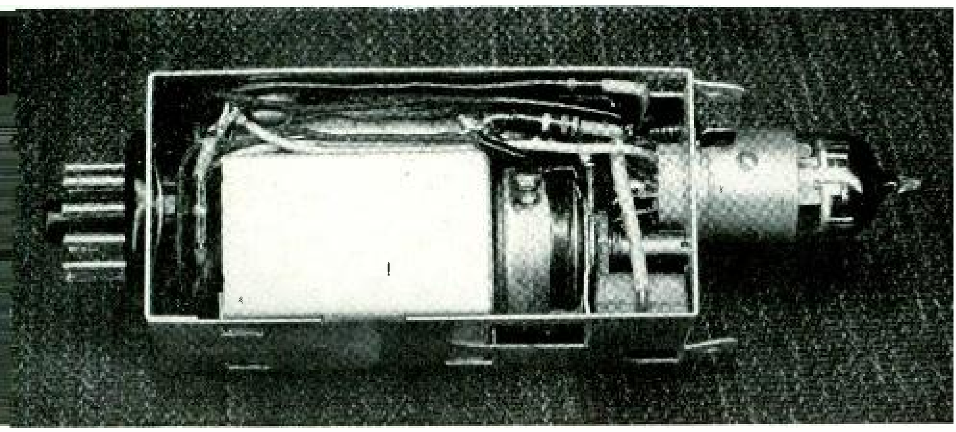

Fig. 3 — Interior of one of the V3 repeater units

piece of thin steel closed at one end and with the other end closed by the molded front plate. The transformers, capacitors, and resistors are held in place chiefly by the compression of the sides of the U when it is screwed to the front plate. Over this assembly slips a thin aluminum box open at both ends. The ends of the unit are thus closed by the plastic plate at the front and by the base of the U, in which the plug is mounted, at the rear. Ten of these units, constituting the amplifiers for five repeaters, occupy 1¾ inches in height across a nineteen-inch relay rack as shown in Figure 2. Relative to the V1 repeater, the size reduction is about six to one.

Standard bays provide 300 V3 repeaters (600 amplifiers) complete with fuses, a telephone set, and an auxiliary testing panel. This is eight to ten times the capacity of the maximum equivalent bay of thirty or thirty-five V1 repeaters without fuse panels. This additional saving is made possible by eliminating the patching and testing jacks, which are unnecessary with plug-in amplifiers, and by replacing the individual filament-adjusting resistors by a common adjustment on the fuse panel.

Not only has the design been successful in providing a repeater that can be used as a replacement for the V1 in one-sixth the space, but manufacture has been simplified and current drain reduced. Large scale manufacture is already under way, and before the end of this year the V3 will be in extensive use in the telephone plant.

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THE AUTHOR: FLOYD A. MINKS left Mississippi A. & M. in 1927 to join the field installations group of these Laboratories. Two years later he transferred to a development group working on toll transmission equipment. He remained here until he joined the Army in 1941. After various assignments with the Signal Corps, he became Director of the Eatontown Signal Laboratory and later was Director of the Technical Liaison and Investigation Division, GHQ, in Tokyo. With the rank of lieutenant colonel, he left the Army in 1946 to return to the Laboratories, where he resumed his work on toll transmission systems chiefly in connection with voice-frequency equipment and power-line carrier systems.

Bell System patents and patent licensing

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Vice-President, A T & T

From "Bell Telephone Magazine," Winter Issue, January, 1949

Inventions originating in Bell System companies play an important rôle in the telephone business in this country. They also have extensive application in other industries. This article discusses Bell System policy in patenting its inventions and in licensing others to use them.

What is a patent, and why is it of direct benefit both to the inventor and the public? The granting of a patent under our law is in principle a simple exchange of values between the inventor on one hand and the public on the other. The public receives a clear, permanent and open disclosure of an invention which might otherwise be kept secret. The inventor receives on his part an exclusive right to his invention for the duration of the patent period (seventeen years in this country), which is intended to allow time to develop the product, get it into manufacture, market it, and derive a profit from it. At the end of this period, anyone may use the invention.

The Bell System's interest in patents comes about both by the nature of its business and from the extensive work of research and development which it carries on in order to be able at all times to furnish the public the best possible telephone service. This activity of research and development is of long standing and is essential to satisfactory and continuing progress in the constant effort to find new and better ways of doing the job in an industry involving intricate apparatus and many complex operations.

Origin of Patents

Out of the research and development work carried on by Bell System scientists and engineers come many inventions. These inventions contribute significantly to the art of telephony and improved service to the user. Most of them originate in Bell Telephone Laboratories, the System's research and development organization. Some also originate in the American Company itself, in the Western Electric Company, the System's manufacturing organization, and in other companies of the Bell System.

It is the practice to apply for United States patents upon the more important of these inventions so that the Bell System's right to use its own inventions in furnishing communications service may receive the assurance provided by the patent laws.

Another reason for applying for patents on these inventions is that a patent establishes a right in an invention which enables the patent holder to grant licenses to others and thus to realize values of the invention in addition to the values derived from using the invention himself. Bell System patents often have a trading value in acquiring the right to use inventions of others which are needed in furnishing the best possible communications service; in fact, licensing others to use the Bell System's patented inventions is sometimes the only way by which such rights can be obtained. Beyond this, patents are valuable assets in that others often are willing to pay royalties for the right to use the System's patented inventions.

Licensing Agreements

Some 600 license agreements under which rights are granted to more than 400 widely varied businesses are in effect. Negotiations are in progress with a number of other concerns and requests for licenses are coming in steadily. Some of the important uses for which licenses have been granted under Bell System patents are telephone instruments and switchboards; submarine and other types of cable; loading coils, repeaters and carrier systems; radio communications systems; broadcast transmitters and receivers; sound recording and reproducing apparatus; hearing aids; public address systems; and medical and scientific equipment.

It is the Bell System's policy to make available upon reasonable terms to all who desire them non-exclusive licenses under its patents for any use. In order to realize the value of the inventions, it is necessary to employ different types of patent license agreements in different situations, of which the following are some illustrations:

(a) Licenses are exchanged with other patent owners, either with or without royalties, so that each gets the particular rights he desires under the patents of the other.

(b) Licenses are granted to manufacturers to make, use and sell apparatus to others on a royalty basis.

(c) Licenses are granted on a royalty basis to those who desire to use specified apparatus in their own businesses (as distinct from those who sell such apparatus to others). Such licenses include the right to have the licensed apparatus made by anyone for the licensee.

Most of the System's license agreements fall within (a) or (b) above, or a combination of the two. For example, licenses are granted to manufacturers covering telephone systems and apparatus for sale to operating telephone companies, both Bell and non-Bell.

Where the proposed licensee has patents upon inventions which the System desires to use in the communications business, a non-exclusive license under such patents is always expected and any difference between values involved is adjusted through royalties.

In all cases, the System seeks to fix the terms of licenses to others under System patents, whether in the form of royalties or licenses to it, or both, in such a way as to be reasonably related to the value of the patented inventions covered by the license.

Foreign Patent Licensing

What has been said above relates to the licensing of concerns and individuals in this country. The same general philosophy applies to patent license negotiations with foreign concerns, although there are different conditions, such as patent and other laws, trade and currency regulations, etc., which must be considered in such negotiations. Proposed patent license agreements with foreign concerns are reviewed with the State Department to be sure that they are consistent with our Government's foreign economic policy.

For the general convenience of all those desiring licenses under Bell System patents, the Western Electric Company has been designated as the agency to make agreements for rights under Bell System patents.

Volume 26—Bound Copies and Index

Bound copies of Volume 26 (*January,* 1948 *to December,* 1948) *will be available shortly at* $2.75, *foreign postage* 25 *cents additional. Remittances should be addressed to Bell Laboratories Record,* 463 *West St., New York* 14, *N. Y. A separate index to Volume* 26 *of* Bell Laboratories Record *is available upon request*

CONTACTS

P. W. SWENSON
Switching Development

A modern telephone office of the crossbar type contains nearly 2,000,000 precious-metal contacts for establishing the connections for 10,000 subscribers' lines. Almost 1,000 relays, with an average of seven contacts per relay, are involved in establishing a call from one subscriber to another. When the operations per call are multiplied by the 50,000 average daily calls that may be handled by such an office, and by the number of days in a year, the total number of relay contact operations per year is over a hundred billion.

The operating frequency of the contacts varies widely. Some are in hard working common-control circuits that serve to connect the talking circuits, and operate once or more for each usage of the circuit, whereas, others are in circuits that are held for the subscribers' conversation time, and consequently operate less frequently. The operations for the bulk of the contacts vary from about 50,000 to 15,000,000 annually.

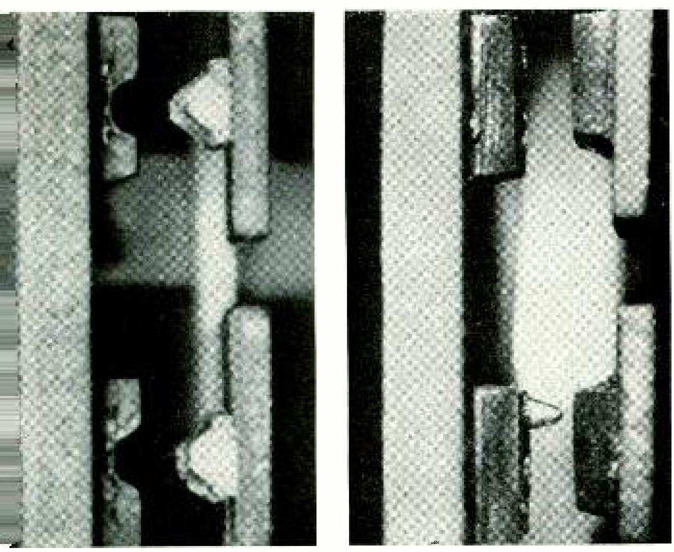

Fig. 1—An example of contact erosion of a palladium contact is shown in the photograph at the left and of contact build-up on a silver contact in the one at the right. Both contacts were unprotected

Telephone switching contacts may be broadly classified into two groups: (1) noble or precious-metal contacts, and (2) base-metal contacts. Precious metal is generally used for butt-type contacts, such as those on relays, whereas base metals are generally used for the sliding-type contacts. New common-control systems are composed entirely of contacts of the butt type. The chief advantage of precious-metal contacts is that they do not readily oxidize or tarnish under atmospheric conditions, and consequently do not develop high resistance. Base-metal contacts, on the other hand, do oxidize and tarnish and consequently do develop high resistance. Very high or uncertain contact resistance will prevent or interfere with proper circuit operation. In a talking circuit, instability of resistances of even less than an ohm may introduce objectionable noise.

The precious metals include gold, silver, and the six so-called platinum metals, which are platinum, palladium, iridium, ruthenium, osmium, and rhodium. Of these, platinum and its iridium alloys, palladium, silver, and gold alloys have been used extensively for contacts at one time or another. In the Bell System, platinum was originally used for contacts almost entirely. No. 1 metal, which is a gold-silver-platinum alloy, was introduced between 1915 and 1920. Palladium contacts were introduced about 1925 for use in place of platinum contacts, and about 1932 for use in place of No. 1 metal contacts. These changes from one type of precious metal to another have been guided primarily by the availability of the metals or by market price. Platinum-iridium, since it is very expensive, has been used only on a limited basis to meet unusual conditions. Silver contacts were first used on relays in the Bell System in the No. 1 crossbar system, which was introduced about 1937. Silver contacts, of course, tarnish, and consequently develop a limited amount of contact resistance. Although the resistance is not great enough to be objectionable in relay-switching circuits, it causes objectionable noise in talking circuits. Consequently, silver contacts are not used in talking or transmission circuits in crossbar switching systems.

Contact performance is principally affected by contact erosion, which is the loss, or transference of contact material that occurs when switching electrical circuits. The life of a contact is terminated by the loss of the total erodible volume of contact material. Contact sticking or locking is generally due to a transference of metal from one electrode to the other, thereby resulting in a projection on one contact and a cavity on the mating contact. Snagging of the build-up in the cavity results in a locked contact. Contact welding, an often misused term, is almost non-existent with telephone-switching contacts, since the currents that are switched are rarely over 0.5 ampere and generally under 0.1 ampere. Examples of contact erosion and building-up are shown in Figure 1.

In designing contacts for telephone switching, three objectives must be kept in mind: dependability of operation, long life, and low cost. In most cases, these are not all compatible, and it is necessary to consider the function of the contact in the system in deciding which should be allowed the dominating influence. Where possible service failure is involved, dependability becomes a major consideration, but when there is little hazard of service failure, long life and low cost assume greater influence. Cost includes both the annual charges on the first cost of the apparatus, and the annual maintenance charges. It is thus affected by both the life and the dependability of the contacts.

With the introduction of the No. 1 crossbar system, employing large numbers of U-type relays, the outstanding contact trouble was the locking of the relay contacts. This is a mechanical phenomenon, and is due to the snagging of the worn and deformed surfaces of the contact. The elimination of contact locking and the hazardous circuit operation resulting therefrom has been one of the most important contact problems in recent years.

Other contact troubles occurring are contact bridging and open contacts caused by dirt. Contact bridging is the shorting of small contact gaps by a conducting bridge when the contact is open, the bridge being composed of material of the contacts. Con-

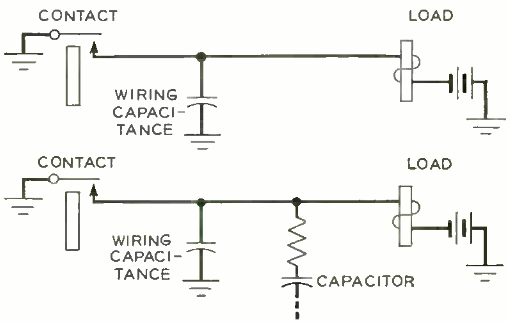

Fig. 2—Circuit of an unprotected relay contact above, and of a protected contact below

tact bridging is generally associated with contacts of sensitive relays, which have small contact gaps. Open contact or dirt troubles are caused by non-conducting particles on the contact surfaces. Twin contacts are used on all the apparatus of the crossbar system except a few special purpose relays, and greatly reduce the amount of open contact trouble. To eliminate open-contact trouble entirely, it undoubtedly will be necessary to obtain a cleaner environment for contacts in the future, and studies along these lines are now in progress. Emphasis is also being placed on securing a more effective twin contact action.

New apparatus and techniques are being used in the new No. 5 crossbar system and have been added to some extent in other crossbar systems. Considerably more palladium contacts are used in the No. 5 system than in the No. 1 system. Silver is generally used for infrequently operated and unprotected contacts. Palladium contacts are used in talking or tone circuits or where low-contact resistance is required. Wherever they are adequate, silver contacts are used because they are less expensive. However, for high operations, the more expensive palladium contacts are more economical because of their lower maintenance cost. Bi-metallic palladium contacts are used on the crossbar switch, and in the near future will be used also on relays. These consist of a layer of palladium on top of a layer of nickel, and consequently are less expensive than contacts that are composed entirely of palladium.

Although the choice of the most suitable metal for various contacts is of primary importance, the amount of erosion or build-up that occurs can be considerably reduced by the use of contact protection. A typical unprotected circuit is indicated in the upper part of Figure 2. With the contact closed, current is flowing through it and through the winding of one or more relays from battery, and the connecting wiring—represented by the capacitor in Figure 2—is discharged. When the contact opens, this current is suddenly interrupted. The rapid decrease of current in the load inductance creates a sudden rise in voltage of the order of hundreds of volts. This high voltage increases the charge on the wiring and breaks down the small gap at the barely opened contact. Across this now conducting gap the capacitance of the wiring discharges, resulting in a current surge of about 3 amperes peak value. This heavy flow of current lasts for only a very brief interval, and as it ceases, the contact gap again opens, causing another rise in voltage, and another resulting arc. This process repeats itself with extreme rapidity as the contacts separate until the energy stored in the inductive circuit of the load has been dissipated to the extent that it is incapable of breaking down the increasing gap of the opening contact.

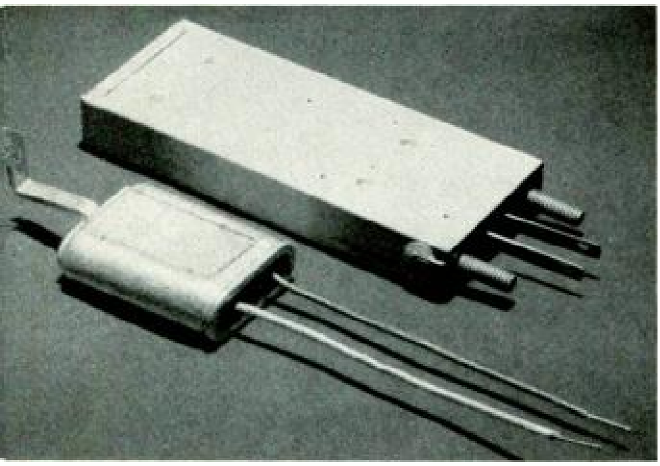

Fig. 3—Relay contact protecting networks. The 184 type at the left and the 181 type at the right

The capacitance of the wiring to ground, although it provides the surges of current that flow across the opening gap, also provides some shunt escape for the electromagnetic energy of the relay winding. If it were large enough, as it sometimes is when there is a large amount of wiring, the current to ground through the wiring capacitance would prevent the voltage from rising to a high enough value to break down the gap. As a rule, however, this capacitance to ground of the wiring is too small to offer any relief. Contact protection is secured, therefore, by connecting an additional capacitance and resistance to ground (or battery) from the circuit, as shown in the lower diagram of Figure 2, thus providing an adequate shunt path for the interrupted circuit current. If an adequate amount of capacitance is provided in the contact protection network, the voltage across the contact will be maintained below the breakdown or ionizing potential of the opening contact gap, and consequently no arcing will occur. In general, contact protection is specified wherever more than four million contact operations are expected over a period of forty years.

Two types of contact protection networks are now used in the Bell System, the 181 type and the 184 type. In the 181-type contact protecting network, a 0.5-μf capacitance generally is employed. The unit is mounted on the apparatus, or front, side of the frame and consequently requires additional equipment space. To provide less expensive protection that does not require additional equipment space, the 184-type contact protection network has recently been developed. It is shown in Figure 3 beside the unit of the 181 type. Only 0.1μf is used in the 184-type network, which is smaller in size and mounts on the wiring side of the frame—the mounting lug, evident at the left in the photograph, being clamped under one of the mounting screws of the relay.

Typical oscillograms showing the voltage at the contacts when unprotected, and when protected with 181- and 184-type networks, are shown in Figure 4. The cloudy effect at the left for the unprotected con-

Fig. 4—Oscillograms of voltage at contacts during opening. At left, an unprotected contact; middle, a contact protected with a 184*-type network; and at right, a contact protected with the* 181*-type network. Duration of each trace,* 1.5 *milliseconds*

tact is the rapidly repeated arcing mentioned above. The peak voltages for the unprotected contact are about 1,000 volts. This arcing is absent on both the protected circuits. With the 184-type protection, the voltage rises at a higher rate and to a higher peak value than with the 181 type because the protecting capacitance is smaller, but there is little or no advantage in using more than enough capacitance to avoid the arcing. The abrupt initial voltage rise that occurs for the protected contacts, which is normally engineered not to exceed 50 volts, is caused by the resistance in series with the contact protection capacitance. This resistance is provided to protect the contact when it closes the circuit and thereby discharges the capacitor.

Contact protection, much of which is of the 184 type, is used extensively in the No. 5 crossbar system, and has greatly reduced the locking of relay contacts. Most of the working contacts of the common-control circuits are protected. It is estimated that approximately 20,000 contact protectors are provided per 10,000 lines of No. 5 crossbar equipment. Considerable additional contact protection has also been specified recently for the No. 1 and other crossbar systems.

THE AUTHOR: P. W. Swenson graduated in 1927 from Worcester Polytechnic Institute with a B.S. degree in Electrical Engineering. He immediately entered the Systems Development Department of these Laboratories. After spending a year in the manual systems laboratory group, he transferred to the relay design group, where he remained until 1941. He then was transferred to the contact studies group. During the war, Mr. Swenson worked on relay and contact problems of various war switching equipments, and in 1945 took charge of a group engaged in fundamental relay studies. Since 1947 he has been in charge of the relay and contact groups of the Switching Development Department.

Splicing coaxial conductors

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Outside Plant Development

Since the first commercial installation of coaxial cable in 1936, the expanding network has incorporated two major structural types and two sizes of conductor, as well as minor changes in structural details.* This progression of physical forms, together with growing transmission experience and revisions of objective for the characteristics of the complete system, have influenced the methods developed for splicing coaxial conductors and the special tools and materials that are required.

During this period, the procedures for joining two coaxials have been a series of compromises between the transmission ideal—a splice which would duplicate exactly the impedance of the cable itself—and the practical performance of relatively complicated manual operations by cable splicers in manholes, on aerial platforms and in open pits dug in the ground, with such tools and equipment as the field forces of the associated companies could reasonably be expected to carry and use.

The first coaxials installed were about 0.270 inch in inside diameter and had hard rubber insulating discs. Some years later the insulating discs were changed from hard rubber to lower loss polyethylene. Recently, a larger size coaxial having an inside diameter of 0.375 inch was introduced and is the present standard. Briefly, this coaxial consists of an inner conductor of solid copper wire 0.1004 inch in diameter, polyethylene insulating discs spaced at one-inch intervals, an outer tubular conductor of copper 0.012 inch thick with a longitudinal seam, and an outside double layer of steel tapes, each about ⅜ inch in width and 0.006 inch thick, applied so that the gaps of the inner layer are covered by the outer one.

Two basic types of conductor joining are involved in the present standard splicing method. The inner conductors are connected by a pressed sleeve, and the outer ones by a rolled sleeve. Figure 1 is a cross-sectional view of a complete joint, showing all the components in their final positions. The principal steps in splicing are shown in Figures 2 through 11. In the photographs, the splicer is at work on the right-hand side of the last of the eight coaxials. The remaining seven right-hand coaxials have already been prepared for joining to those on the opposite side. In actual field operations, all the coaxials on each side are thus prepared before any splice is completed. This permits electrical tests to be made between the inner and outer conductors of the two cables just prior to connecting them.

As shown in Figure 2, a copper ring is slipped over the coaxial and crimped at a predetermined point with specially designed coaxial pliers. This tool not only does the crimping but holds the coaxial during other splicing operations, such as cutting the outer conductor. The crimping ring locks the steel tapes in place and keeps them from further unwinding during subsequent operations in which it is necessary to loosen the tape ends.

To hold the steel tapes of the completed splice, a short copper sleeve is slipped in place, as shown in Figure 3. The outer conductor is cut by grasping it with the coaxial pliers at the desired point, Figure 4, pulling it back with long-nose pliers and tearing it against the sharp edge of the pliers. The 10-gauge inner conductor is then cut, Figure 5, so that it projects about ½ inch from the end of the outer conductor.

*RECORD, *June*, 1937, *page* 325; *January*, 1941, *page* 138; *September*, 1945, *page* 321; and *November*, 1946, *page* 393.

A steel bushing is pushed into the end of the coaxial, Figure 6, by a special tool called the coaxial scale, until the bushing is about ¼ inch back from the end of the outer conductor. This scale not only serves thus as a mandrel but also as a measuring device for dimensioning the splice. The bushing provides the base on which the copper outer sleeves are subsequently rolled, since the outer conductor itself is much too weak mechanically to withstand the high compressive forces involved in making the rolled sleeve joint. Figure 7 shows the operation of placing the long copper sleeve that will subsequently be used to join the outer conductors.

The opposite coaxial is prepared in essentially the same manner except, as illustrated in Figure 8, only a short copper sleeve is placed to hold the steel tapes, since the longer one, for joining the outer conductors, is already in position on the opposite side of the splice.

Inner conductors are joined by a pressed brass sleeve, using a sleeve presser, as shown in Figure 9. Extra insulating discs are then snapped over this inner sleeve to insure its concentric support, Figure 10, and the larger copper sleeve, for joining the outer conductors, is pushed into position. This is followed by rewinding the loosened steel tapes and positioning the short copper sleeves, as shown in Figure 11, which illustrates a joint ready for rolling. The final operation is the rolling of the entire joint with the special tool shown.

The use of three sleeves, the two short ones to hold the steel tapes, and the longer one to join the outer conductors, was the suggestion of E. L. Alford. Prior to this improvement, a longer single sleeve was used to perform both functions. It had the disadvantage, however, that the operation of sliding the single sleeve over the steel tapes sometimes created copper slivers which caused short circuits or low dielectric strength between the inner and outer conductors when the sleeve was placed in its final position.

Joints made by the present method develop substantially the full tensile strength of the component conductors. Their effect on transmission is to increase the capacitance of the splice about 1.4 mmf over that of an equivalent length of unspliced conductor. At the top frequency of the present L1 carrier system, this impedance irregularity is of the same order of magnitude as that attributable to the differences between adjacent splicing sections of the cable itself.

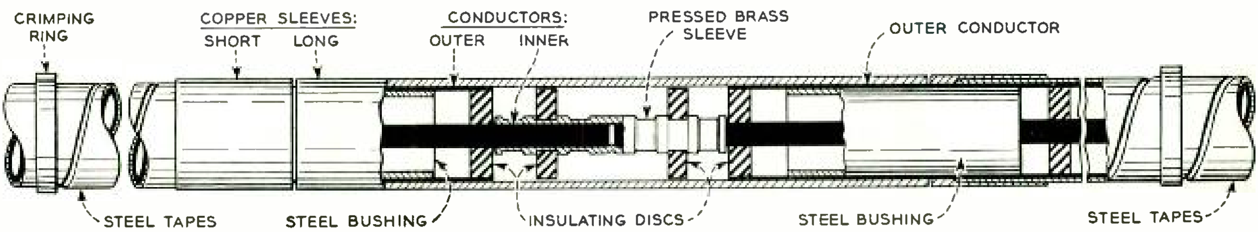


Fig. 1—Sectional view of completed splice showing all components in their final positions. The inner conductors are connected by a pressed sleeve, and the outer ones by a rolled sleeve

The dielectric strength of a coaxial splice structure is about 5,000 volts peak, the corona threshold being 500 to 800 volts lower. These voltages are well above the present maximum power transmission voltage.

In addition to the tools described above for joining two coaxials, coaxial sleeve cutters and a nip cutter are used in the process of opening a coaxial for repair or maintenance operations.

The 0.270-inch coaxial with polyethylene insulation and longitudinal seam, which was the predecessor of the 0.375-inch unit, was spliced by a rolled and pressed joint method, identical except for minor dimensional differences, and the use of tools designed for the smaller size.

The hard rubber insulating discs origi-

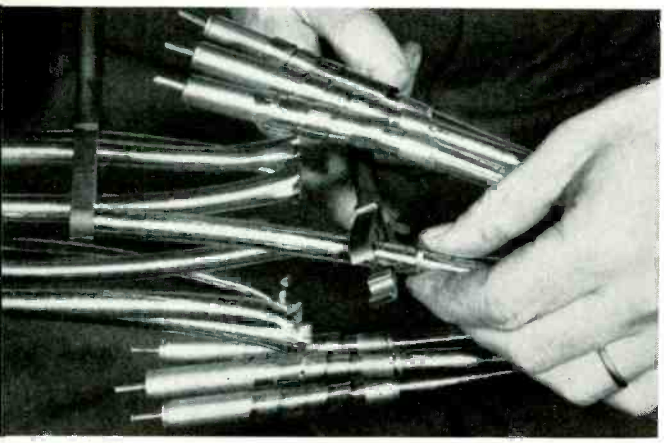


Fig. 2—A copper ring is slipped over the coaxial and crimped to keep the steel tapes from unwinding

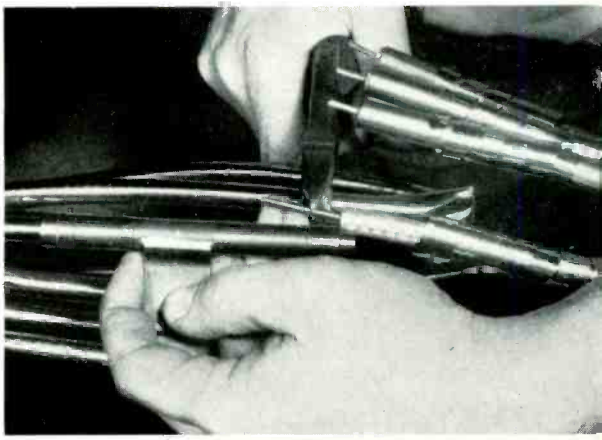


Fig. 5—The inner conductor is cut to project ½ inch from the outer one

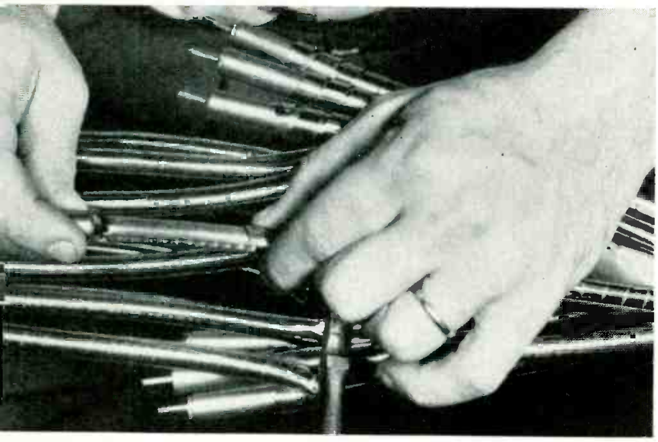


Fig. 3—A short copper sleeve is added to hold the steel tapes of the completed splice

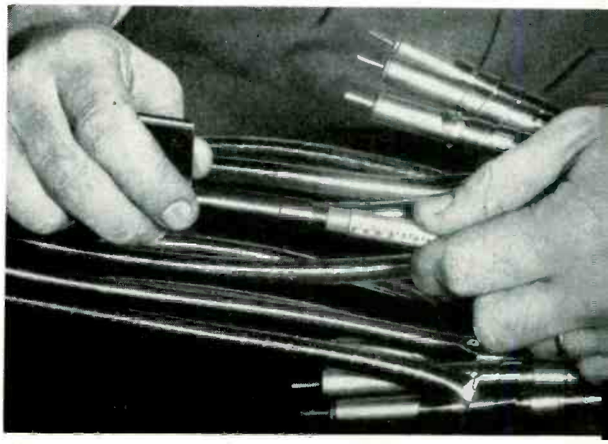


Fig. 6—A steel bushing is pushed into the coaxial with a special tool called a coaxial scale

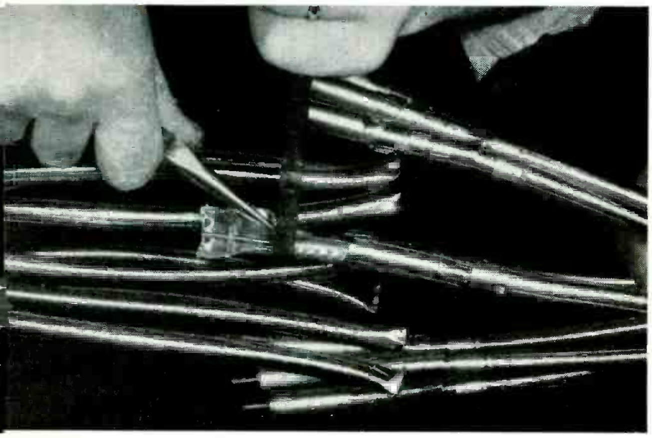


Fig. 4—The outer conductor is cut by tearing it against coaxial pliers

nally used in 0.270-inch coaxials were able to withstand the elevated temperatures of soldering. Since soldering is a familiar operation to cable splicers, a soldering procedure was the basis of the first approach to the problem of designing practicable means of joining coaxials. This method was used for the installation of all of the approximately 500 miles of cable put into the telephone plant between 1936 and 1942. A small split sleeve of standard type joined the ends of the inner conductors and a split tinned copper sleeve was folded around the ends of the outer conductors. The soldering operation, in general, made a very satisfactory joint, although there were occasional cases of electrical trouble that was

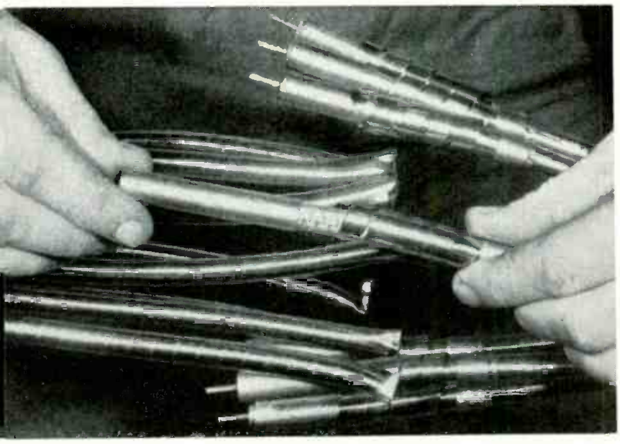


Fig. 7—Placing the long copper sleeve used to join the outer conductors

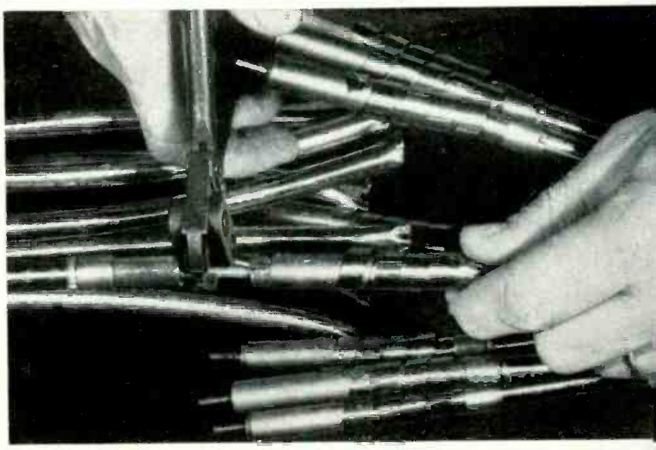


Fig. 9—Inner conductors are joined by a pressed brass sleeve by means of a sleeve presser

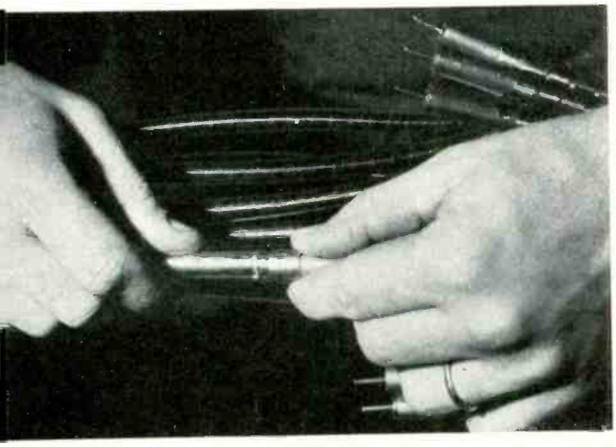


Fig. 8—A short sleeve is used on the opposite coaxial to hold the steel tapes

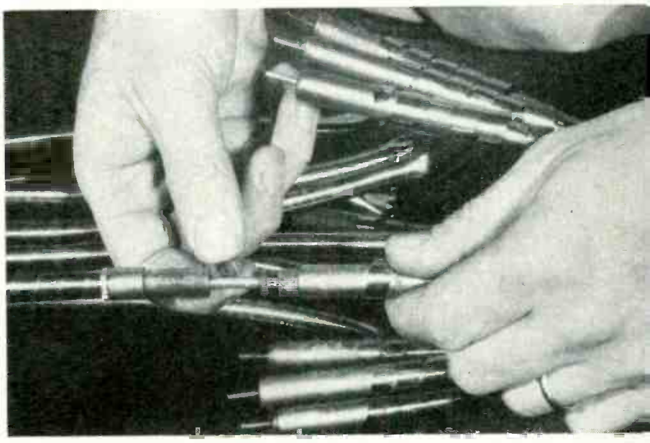


Fig. 10—Extra insulation discs are snapped over the inner sleeve to insure concentric support

caused by overheating the hard rubber discs.

In looking back at the transition from hard rubber to polyethylene insulators, it might seem that the logical way of adapting the soldering technique to polyethylene-insulated cable would be to push back the polyethylene discs for a sufficient distance to get them out of the heated zone, and then to substitute hard rubber discs capable of withstanding the heat. This easy solution was impracticable, however, because of the unacceptably high capacitance change resulting from the addition of more discs.

The L3 carrier system, with its extended frequency band, imposes much more severe requirements as to tolerable splice impedance irregularities, minimum dielectric

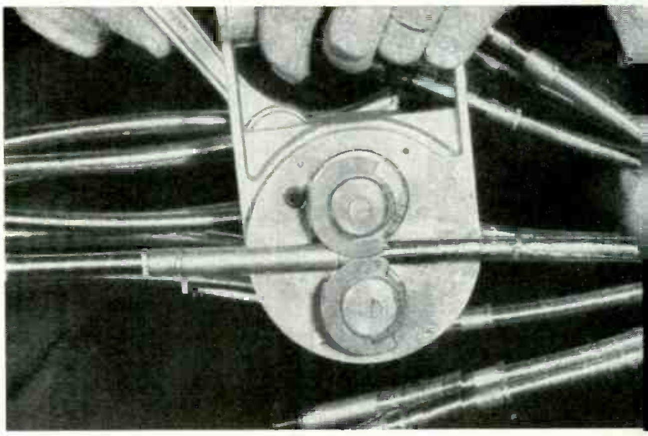


Fig. 11—The final operation is rolling the entire joint with the special tool shown

strength, and minimum corona threshold. Development is now actively under way on a splicing method that employs radically different means of joining coaxials, with the object of simplifying the manual operations performed by the splicer and achieving the necessary improvement of electrical properties that are so important.

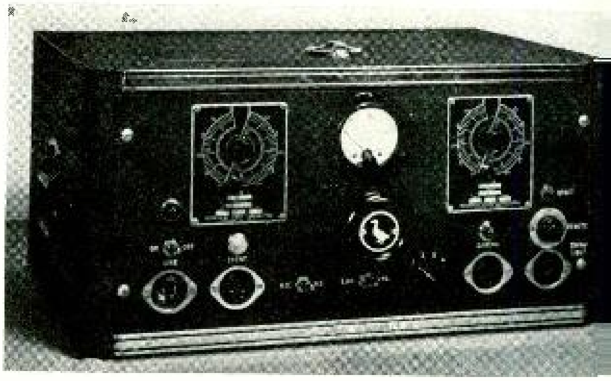
THE AUTHOR: V. H. BAILLARD received his A.B. degree from Columbia College in 1923 and the degree of Chemical Engineer from the Engineering School in 1925. He joined the Chemical Department of the Laboratories in 1926 and transferred to the Outside Plant Development Department in 1928. During the war he received leave of absence to work for the War Production Board in Washington, and later, for the Underwater Sound Laboratory at New London and in Hawaii. Currently, as Plant Materials Engineer, he has charge of a group working on cable joining, gas pressure maintenance, underground construction and miscellaneous outside plant materials.

The Goose

Called the Goose by its manufacturer, the control unit shown below was developed by Bell Telephone Laboratories to permit the Fastax camera to operate at nearly double normal speed. It is being manufactured and sold by the Industrial Timer Corporation.

The original Fastax* takes pictures at rates as high as 8,000 per second with 8-mm film or 4,000 per second with 16-mm film when 120 volts a-c is applied to the camera drive motor. By use of an adjustable transformer that will increase the applied potential to as high as 280 volts, the Goose—handled in the Laboratories as the D-177423-L2 Fastax control unit—enables these picture speeds to be raised to 14,000 and 7,000, respectively. To permit these higher voltages to be safely applied to the Fastax motor, it has been necessary to include a delay circuit that retards the application of full voltage to the motor for seventy milliseconds.

Besides the provisions for setting and applying higher voltage to the Fastax, and for inserting a starting delay, the control unit includes timers—at the upper left and right—for setting the operating times for the camera and the event being photographed, and a dial to select any of four sequences of the starting and stopping of the camera and the event. A voltmeter permits either the line voltage or the voltage applied to the Fastax motor to be read before the camera is started, and pilot lamps indicate the duration of camera and event operation.



*RECORD, *September*, 1943, *page* 1.

The 404A a broadband amplifier tube

G. T. FORD
Electronic Apparatus Development

In developing the radio relay system* now in operation between Boston and New York, intermediate frequency amplifier tubes were required that would be capable of providing essentially constant amplification over a 10-megacycle band at a mid-band frequency of 65 megacycles. At such wide bands and high frequencies, it is very difficult to design a tube with a satisfactory amount of gain. The most suitable tube available at the time was the 6AK5,† but ten stages of amplification would be required to get the needed gain with this tube. The development of a new tube was therefore undertaken, and the 404A is the result. It is shown in Figure 1 in comparison with the 6AK5 and the 6AC7, the tubes that have heretofore been most widely used for high-frequency I-F amplifiers. Sufficient gain is provided by the 404A to require only six stages in the I-F amplifier instead of the ten required for the 6AK5 tube.

In designing a tube for such an application, the primary objective is to make the product of band width and gain as large as possible. For this specific application, it was to secure the required gain, with as few stages as possible, for a band width of 10 megacycles. The gain and band width that can be actually realized depends to a large extent on the circuit used and the mid-band frequency, but the product of gain and band width mentioned above is a convenient criterion for tubes of this type.

In obtaining a high value for this product, the most important objectives are a high transconductance and low inter-electrode capacitances. In the practical design of a tube, this may be reduced to the requirement that the ratio of transconductance to grid-cathode capacitance—G_m/C—should be as large as possible, since the other capacitances are smaller and more or less fixed in size. With a tube structure consisting of infinite parallel planes, this ratio in terms of the geometry and operating characteristics of the tube is:

$$\frac{G_m}{C} = K\sqrt[3]{\frac{I_o}{a}}\left(1 - \frac{E_{c2}}{\mu^2}\frac{d\mu}{dE_g}\right)$$

Here the screen voltage, E_{c2}, and the triode-connected amplification factor, μ, are generally fixed by the available supply voltages

Fig. 1—The Western Electric 404A vacuum tube, at the left, as it appears relative to the 6AK5 and the 6AC7

*Record, *December*, 1947, *page* 437.
†Record, *November*, 1944, *page* 605.

TABLE I—SALIENT CHARACTERISTICS COMPARED FOR THE 6AC7, THE 6AK5 AND THE 404A TUBE

Type	*Heater Power* Watts	*Plate Current* Ma	*Total Power Consumption* Watts	*Gain-Band* Product* Mc	*Nominal Transconductance* μmhos
6AC7	2.84	10.0	4.7	63	9,000
6AK5	1.10	7.5	2.3	72	5,000
404A	1.89	13.0	4.5	123	12,500

*Band width for which voltage amplification is unity for one stage in a tandem string with single-tuned circuit interstage.

and by heat dissipation factors, and thus cannot be changed to secure a higher value for the G_m/C ratio. Also, the current density, I_0, cannot readily be changed since it is limited by the emission capabilities of the cathode. Efforts must be concentrated on making the grid-cathode spacing, "a," and the μ-variation factor, $d\mu/dE_g$, small.

In the 6AK5 tube, which had the best previous broadband characteristics, the grid-cathode spacing had already been reduced to 3.5 mils, and a radical further reduction seemed out of the question. Moreover, since "a" appears as a cube root, the ratio would only be doubled if "a" were reduced to one-eighth of its previous value. This spacing has actually been reduced to 2.5 mils in the 404A or to five-sevenths that of the 6AK5. The net improvement in the G_m/C ratio due to this change is thus only as the cube root of seven-fifths, or about 12 per cent. The greater part of the improvement has thus had to be secured by reducing the μ-variation factor, $d\mu/dE_g$.

This latter factor is closely related to the ratio of the grid pitch (distance between wire centers) to the grid-cathode spacing. It has been found in practice that the μ-variation becomes appreciable when this ratio exceeds 1, and that it increases very rapidly as the ratio exceeds 1.5. It is therefore desirable to make the grid pitch equal to the grid-cathode spacing. For the 404A, where the grid-cathode spacing is only 2.5 mils, this would require constructing the grid with 400 turns per inch. To do this and still leave a sufficient part of the grid area open for the transmission of space current requires that the grid wires be much smaller than 2.5 mils in diameter. It turns out that a wire only 0.3 mil in diameter would be desirable, and this is only about one-tenth the diameter of a human hair. A grid wire of this size is actually used for the 404A tube, but it has required considerable development to wind a grid with wire of this extremely small size.

As shown in Figure 2, the grid structure

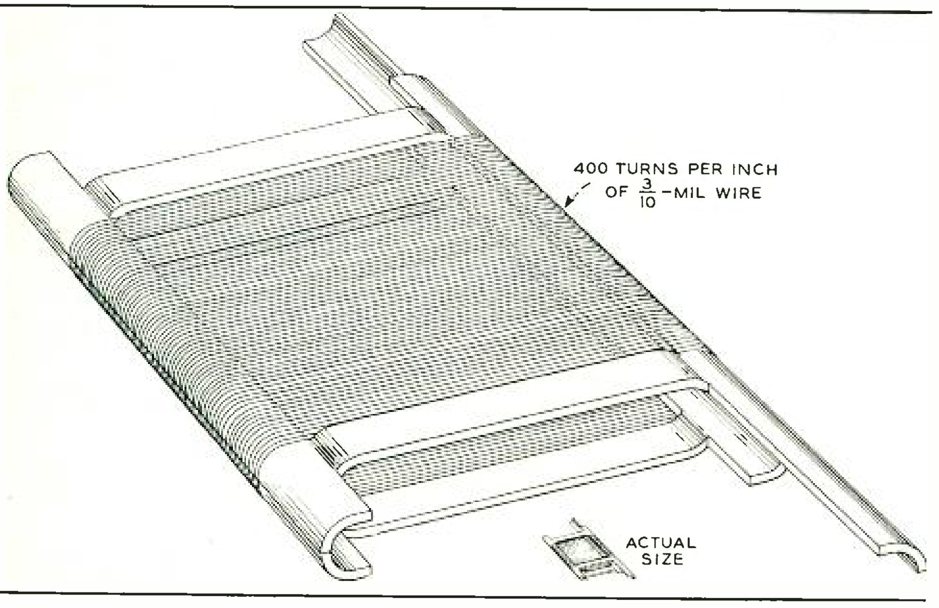


Fig. 2—Much enlarged grid structure of the 404A tube with an actual size grid in the foreground

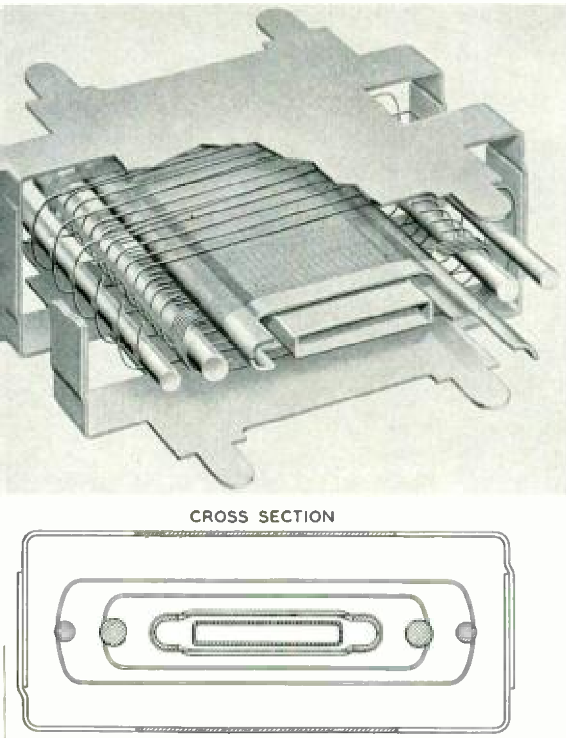


Fig. 3—Internal structure of the 404A tube; in perspective above and in cross-section below. From inside to outside the structure are: cathode, control grid, screen grid, suppressor grid, and plate

consists of two molybdenum frames bent in along the two sides so that when they are butted together they enclose a space of oval cross-section wide enough to accommodate the cathode structure. Two of these half frames are placed in a holder that retains them in their proper positions, and the fine wire is wound on under tension at the proper pitch. This unit is then brazed to provide a comparatively rugged grid which can be easily assembled in the tube. The stiffness of the grid lateral wire is so small that it must be kept at a tension equal to half its breaking strength to keep it straight. An automatic tensioning device is employed, and it is very important to maintain the maximum safe tension. If the tension is too great, the wire will break, either during the winding or during the later brazing. If the tension is too low, on the other hand, the wires will be loose in the completed grid. This is undesirable for several reasons, the most important of which are that the transconductance is reduced and that the microphonic noise produced by movement of the grid wires under mechanical vibration is greater.

By using this new grid design in the 404A tube, and by reducing the grid-cathode spacing, it has been possible to increase the product of gain and band width by about 70 per cent compared to that of the 6AK5. Figure 3 shows the structural details of the 404A tube and Table I shows a comparison of its salient characteristics with those of two other types often used in I-F amplifiers. The improved performance of the 404A may be taken either as wider band width with a given gain, more gain at a given band width, or a combination of these. For the radio relay system between Boston and New York, it has permitted the reduction in the number of I-F stages already referred to.

THE AUTHOR: G. T. Ford received the B.S. degree from Michigan State College in 1929, and at once joined the Technical Staff of the Laboratories. He first spent two years with the Personnel Department as an instructor in courses for student assistants, and then joined the Physical Research Department, where he worked on gas tubes and thermistors. Transferring to the Electronics Research Department in 1934, he has since been engaged in vacuum tube development. In 1936, he received the M.A. degree from Columbia University.

Synchronization for the PCM receiver

J. M. MANLEY
Transmission Research

In the experimental PCM system, the messages of twelve telephone channels are transmitted, by methods and circuits already described,[1] as a continuous sequence of pulse code groups. Each code group represents the magnitude of the signal in one channel at a particular instant, and samples of each channel are taken every 125 microseconds. Each group of code pulses occupies a time of about 10.5 microseconds, and a set of code groups for the twelve channels, which is referred to as a "frame," occupies 125 microseconds, and has 84 code-pulse positions since there are seven for each sample. Since the time between successive samples of one channel is also 125 microseconds, the frames travel along the transmission path as a continuous chain—the code group for channel 1 of one frame beginning immediately at the end of the code group for channel 12 of the preceding frame. The sequence of code groups arriving at the receiving terminal could thus be represented as in the upper part of Figure

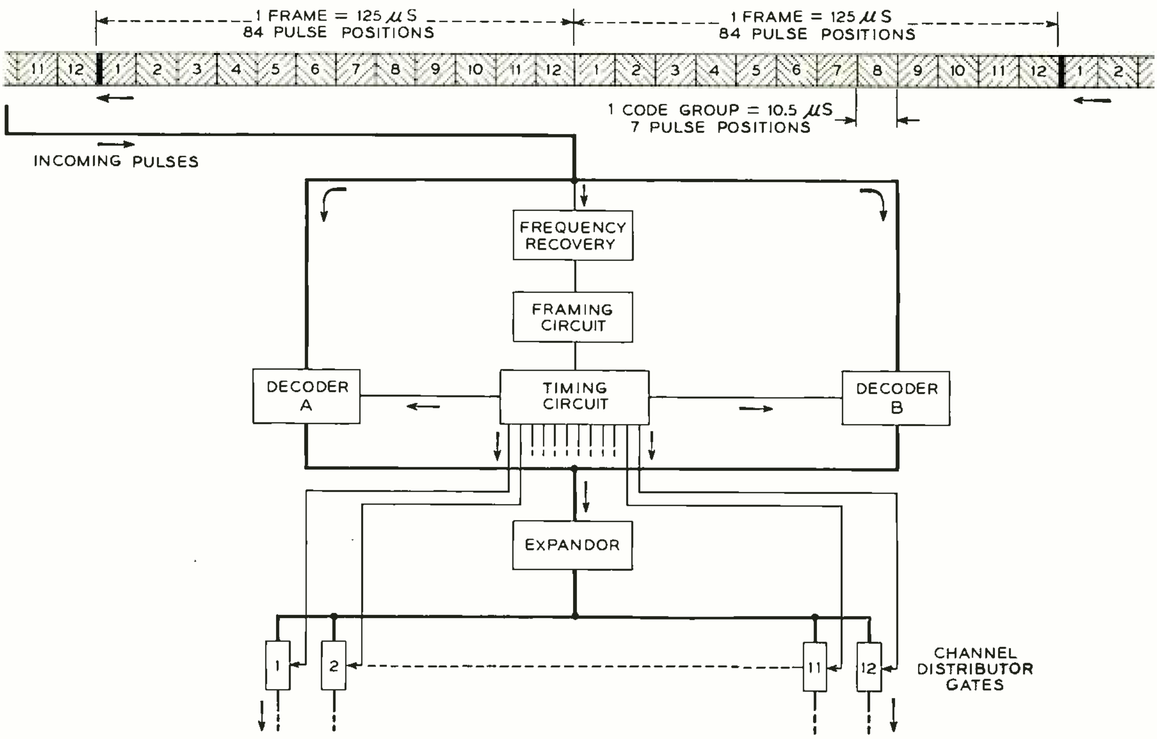


Fig. 1—Block schematic of the synchronizing circuit at the receiver of the experimental PCM system with the sequence of code groups and the synchronizing pulses indicated above

1, where each code group is marked to indicate the channel to which it belongs. The synchronizing equipment described here is sufficient to maintain seven additional groups of twelve channels each so that a 96-channel system may be handled.

At the receiving terminal, the sequence of code groups is passed to the decoder,[2] which then distributes the decoded samples to the twelve channel circuits. A timing circuit similar in its general features to that of the transmitting terminal[3] provides pulses which open the gate to the A decoder for just the 10.5-microsecond duration of one code group, and as they close this gate, they immediately open the gate to the B decoder for a similar period. As the decoded sample leaves the A decoder, the gate to one of the channel circuits opens to receive it, and as the decoded sample leaves the B decoder 10.5 microseconds later, the channel gate that was opened will be closed and the gate to the next higher numbered channel will be opened. If the timing circuit at the receiving terminal were in perfect synchronism with that at the transmitting terminal, the gate to a decoder would always open exactly at the beginning of a code group, and when a pulse of the amplitude represented by this code group left the decoder, the gate of the channel to which that sample belonged would open. In this way, each code group would be correctly decoded and distributed to its proper channel. In this condition, the receiver is said to be in frame.

Obviously, the basic timing pulses which drive the timing circuit at the receiving terminal must be recurring at exactly the same rate as those at the transmitter. An independent oscillator, therefore, could not be used to drive the receiver timing, since no matter how close together in frequency any practical transmitting and receiving oscillators might be, the time difference for a given number of cycles from each would eventually become too great. The receiving timing network must, therefore, be driven from the incoming pulse train.

To conserve band width in the transmission medium, each code pulse is made as wide as the time interval assigned to a code pulse position. As a result, the spectrum of any sequence of these code pulses does not contain their recurrence rate of 672 kc, which therefore cannot be obtained by direct filtering. This situation may be made clearer by Figure 2. There the spectrum of a single pulse of duration δ seconds is shown, and it will be observed that there is a null in this spectrum at frequency $1/\delta$. Thus any sequence of such pulses has a spectrum with a null at $f = 1/\delta = 672$ kc.

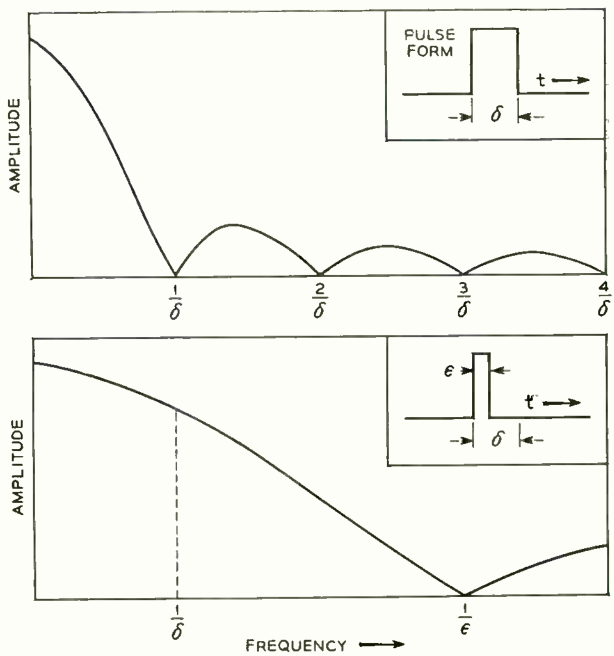


Fig. 2—Frequency spectrum of a single pulse of duration δ seconds

One way in which the fundamental recurrence rate can be recovered is to pass the incoming pulse train through a differentiator and rectifier before filtering. In this way, a pulse appreciably narrower than a code pulse is obtained whenever a code pulse is followed by a blank space. From the lower diagram of Figure 2, it will be seen that the spectrum of this derived pulse has a large component at the recurrence frequency $1/\delta$. These derived pulses occur at intervals which are integral multiples of the code-pulse duration δ. Thus the component at the recurrence frequency $1/\delta$ of

[1]Record, *September*, 1948, e 364 and *October*, 1948, *page* 411.

[2]Record, *November*, 1948, *page* 451.

[3]Record, *January*, 1949, *page* 10.

each derived pulse has the same phase and so all the contributions add up. By applying the derived train of pulses to a very narrow band filter centered at 672 kc, the recurrence frequency is easily recovered. For the system described in these articles, a quartz crystal filter with a 60-cycle band width and 70 db loss outside the band was found to be more than adequate. The output of the filter, after passing through a shaping circuit, is a sequence of square-top pulses at the pulsing rate of the transmitter, and is thus suitable for driving the timing circuit at the receiver just as does the similar sequence of pulses derived from a 672 oscillator at the transmitter terminal. In this way, the timing operations at the receiving terminal are made to take place at exactly the same rate as those at the transmitting terminal.

Even though the timing pulses at the receiving terminal operate in proper sequence and at exactly the same rate as those at the transmitting terminal, proper operation may not be obtained because of incorrect "framing." This term derives from the motion picture industry, where the picture frames on the film must be aligned with respect to the frame gate of the projector. Since there are four sprocket holes per frame on 35-mm film, there are only three possible incorrect alignments. Because of the method of deriving the timing pulses at the PCM receiver, however, the receiver timing frame may begin at any one of the 84 pulse positions of the incoming frame. Of these 84 possible positions, however, only one is correct, and thus there are 83 incorrect framing positions in the PCM system. If the alignment of timing frames should be out by seven pulse intervals, for example, channel 2 message would be distributed to channel 3 or to channel 1, depending upon the direction of misalignment. If it is out by one pulse interval, decoding is incorrect and there is crosstalk.

To make it possible to frame the received code groups properly, the first pulse position of the No. 1 channel is given a distinctive marking at the transmitting terminal. This is accomplished by removing any pulse that the coder may have placed in this position, and inserting a framing pulse in every alternate frame. This is indicated in the upper part of Figure 3 by the alternate dark bands and blank spaces in the first pulse position of channel 1 of successive frames. Since these framing pulses occupy the pulse position corresponding to the lowest value of the code, there is only a slight degrading of the signal, and of only one of the channels. How these pulses are used to hold correct framing if it exists, and to attain it if it does not, may be understood with the help of Figure 3.

The box marked FREQUENCY RECOVERY indicates the circuits used for deriving the basic timing pulses at the receiving terminal as already described. These pulses are differentiated and rectified to secure short voltage pips suitable for application to a seven-to-one multivibrator step-down, which is included in the box marked TIMING CIRCUIT, as at the transmitting terminal. To reach the multivibrator and the rest of the timing circuit, however, these pips must pass through an electronic tube indicated as switch S1 in the diagram. This tube remains conducting—indicated by the solid line position of the switch—as long as negative voltage is not applied to one of its control grids—point A in the diagram.

As long as the receiving circuit is in frame, no negative voltage will be applied to point A, and the pips will pass to the seven-to-one multivibrator continuously. If the receiving system is out of frame, however, a 1.0-microsecond negative pulse will be applied to point A once every ten frames. Each time this happens, switch S1 opens, and one of the 672-kc control pips for the seven-to-one step-down multivibrator (MV) is blanked out. Ordinarily, the seven-to-one MV goes through one cycle for each seven control pips. When the last of a group of seven such pips is withheld, however, the MV will trip on the eighth pip, and this particular cycle will be 8/7 as long as normal. This lengthening amounts to one period of 672 kc. Thus all the receiver timing waves are delayed by one pulse position. If the receiver is still not in frame, this process will be repeated until it is, and from then on, as long as the receiver is in frame, no negative voltage will appear at A.

To determine whether or not the receiver is in frame, and if it is not, to bring it into frame, a square-top framing gate pulse 0.25

microsecond long and recurring at an 8-kc rate is derived from the timing circuit. This pulse is phased to occur while the receiving circuit should be receiving the first pulse of channel 1, i.e., the framing pulse, of a frame of the transmitted chain. If the receiving circuit is in frame, this pulse occurs at the midpoints of the transmitted framing pulse positions.

The framing gate pulses are applied to the grid of an electronic tube indicated as s4 in Figure 3. Each time they appear, s4 is made conducting for 0.25 microsecond—indicated by the dashed position of the switch—and if a pulse is present in the incoming train at this instant, a charge will be placed on the capacitor C.

A second pulse derived from the timing system, at the same rate as the framing gate pulse but occurring one-twelfth of a frame earlier, is applied to the grid of an electronic tube indicated as switch s3 in the diagram. This tube, under the control of this second set of pulses, discharges the capacitor just one-twelfth of a frame before the s4 path is closed. As a result of this operation, each time s4 closes the capacitor is in a discharged state.

Thus, if the system is in frame, the capacitor will alternately receive a charge and not receive a charge each time the framing gate pulses close the path s4, since it will be receiving the framing pulses transmitted. With the system in frame, therefore, the voltage at point B will be a flat-top wave recurring at a 4-kc rate, as shown in Figure 3.

This wave is passed through a narrow band 4-kc filter, and the output wave is rectified to give a negative voltage at point D, which is one control grid of another electronic tube indicated as s2 on the diagram. This negative voltage holds the tube inoperative, indicated by the solid line in Figure 3, and thus prevents the application of

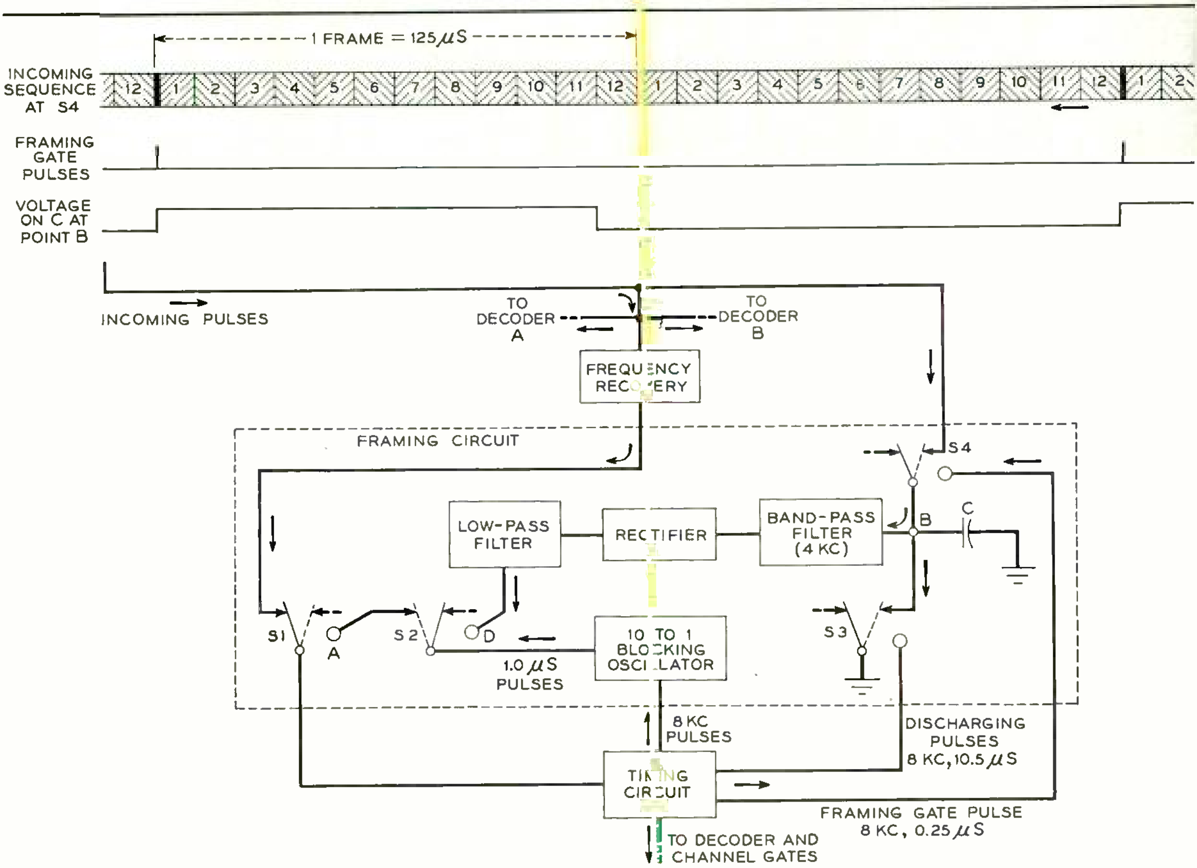


Fig. 3—Block schematic of framing circuit at the receiver

a negative voltage to point A to block tube S1. Under these conditions, the timing system operates continuously at the rate determined by the derived timing pulses.

If for any reason the system is not in frame, the charges given to the capacitor when S4 closes will be irregularly spaced since they will be caused not by the framing pulses, but by signal pulses in some other position of the frame. The charges to the capacitor, therefore, instead of occurring regularly every other frame will occur at random, and as a result, there will be little or no 4-kc component at point B. As a result, there will be little or no negative voltage at point D, and S2 will become operative, indicated by the dashed position.

As mentioned above, to attain correct framing, the receiver timing is stepped along one pulse position at a time by opening S1 for a period of one microsecond periodically, until the correct position is found. The opening of S1 is accomplished by application to point A of 1.0-microsecond negative pulses at an 800-cycle rate. These blanking pulses are not applied to point A, however, unless the tube S2 is operative, which, as just shown, will occur when the system is out of frame.

The blanking pulses are derived from the timing circuit, as are those that control S3 and S4. A blocking oscillator circuit is used to make the ten-to-one step-down from 8,000 cycles to 800 cycles, and a delay circuit to make their times of occurrence just right. Since there are eighty-three out-of-frame positions, and since the time spacing of the 800-cycle pulses is 0.00125 second, the maximum time required to bring the system into frame is 83×0.00125 second, or about 0.1 second.

The framing circuit thus automatically and continuously examines the incoming pulse frame every 125 microseconds through S4 to determine whether the framing pulses are arriving at the moment the receiving system is ready to receive the code group for channel 1. If it finds they are, the receiving circuit will continue under the control of the derived timing pulses. If it finds they are not, the receiving timing circuit will be delayed one pulse position every ten frames until framing is achieved. The greatest possible time required for reframing after an interruption is about 0.1 second. The length of this interruption is negligible in comparison with the duration of any outage that is noticeable.

THE AUTHOR: J. M. MANLEY joined the Transmission Research Department of the Laboratories in 1930 after receiving a B.S. degree in Electrical Engineering from the University of Missouri. During his first year he worked on the transatlantic telephone cable project, and then taught for a year in the Personnel Department's course for Technical Assistants. Following this, he returned to transmission research, taking up theoretical and experimental work on various non-linear electric circuits including the magnetic amplifier, the magnetic harmonic generator for coaxial cable carrier supply, and the magnetic sub-harmonic generator. During the war, he did design work on non-linear coil pulser networks for use in Naval radar systems. Since then he has been concerned with studies of synchronizing in PCM systems.

Reginald Lamont Jones, 1886-1949

Reginald Lamont Jones entered the Laboratories' predecessor organization in July, 1911, after receiving the bachelor's and master's degrees, and the doctorate of science (1911) from M.I.T. His first assignment was to work on mechanical telephone repeaters. Our era of centralized scientific research was just getting under way; one of his early contributions was the idea of making accurate quantitative measurements of amplitudes, resonances, and losses in mechanical vibrating systems.

Before long his associates were to see where Mr. Jones' greatest ability lay. It was in the field of administration—studying the broad aspects of his problems, planning methods of attack, developing men to carry out his plans and filling them with his own enthusiasm. An early opportunity came with the development of a plan to associate closely the design of transmission apparatus at West Street with an extension of the transmission engineering which had been carried on at A T & T. Mr. Jones was chosen to head the Transmission Branch, and as he built it up, he added men who later made their mark on telephony.

World War I took Mr. Jones into the Army as a Captain in the Signal Corps Reserve. His headquarters remained at West Street, and he was assigned to research and engineering on submarine detection. The war over, he again took active charge of Transmission Engineering. Later it was felt that this work would fit better in the Research Department; Mr. Jones became in 1923 the head of Inspection Engineering, where he saw great possibilities. Inspection methods might benefit, he thought, by the application of mathematical reasoning. Thus the statistical approach now known as Quality Control was born. He then drafted several engineers from his old group, gave them his vision, and set them to work. Not only did they contribute new techniques in old fields, but they made one of the Bell System's greatest contributions to industry—the science and art of quality control.

Meanwhile, another opportunity was opening up. Development of outside plant items—creosoted poles, pole line hardware, wire and the like—had been done by outside suppliers; cables had been designed by Western Electric. The decision was made to bring all this work together in a single department, which would be headed by Mr. Jones. As he added personnel, he equipped them with suitable laboratories, notably the tract at Chester, where wire and cable lines march along a wind-swept ridge, and poles fight against decay. Many notable advances have come from this group—the mortar bandage for conduit joints, the cable buried directly in the ground, new forms of cable for carrier circuits.

At the transfer of J. J. Lyng to Electrical Research Products, Inc., Mr. Jones was selected as the new head for the Apparatus Development Department. In addition to Inspection Engineering and Outside Plant, he now had several groups designing apparatus for the Bell System and—until World War II—the Specialty Products work in radio, public address and sound pictures.

When the war came, Apparatus Development contributed heavily to sonar and the gun director, as well as by applying its specialized skills to scores of other projects.

Late in 1944, as part of a general rearrangement of executives, Mr. Jones became vice-president in charge of Staff. The years which followed saw the last of our heavy war activity, and the reorientation toward peacetime aims. They were years of conferences, of reports, of studies, of heart-searching decisions involving both money and men. For "Staff" includes the great variety of services used by our technical people in their daily work. There are Patent, and Legal, and Personnel, and Accounting, and Financial, and Purchasing, and Publication, and the people who facilitate our relations with our customers, A T & T and Western Electric. There are the men and women who make models and wire up experimental equipment, and keep our buildings clean, and carry the mail and make photographs and blueprints and file our records. And there is the Murray Hill Project group, which has supervised the construction of the building and its occupancy. Modernization of present quarters, too, was his personal concern. His associates recall the broad outlook, the care for details, the sound reasoning behind his judgments, the artistic taste, the quiet kindliness which smoothed many a situation.

Mr. Jones' interest in education ran back into his college years when he taught "electricity" in an evening school for foremen. In his early years here he had many a talk with young graduates about continuing their studies; as a result he was named chairman of an educational committee, and was active in organizing our out-of-hours courses. In his home town of Summit, New Jersey, he was long a member and latterly president of the Board of Education.

For his artistic tastes, Mr. Jones found outlet not only in painting, but in stimulating the Laboratories toward better appearance of its product. He retained an independent designer as a consultant, and took a great interest in the design problems of Publication.

One of Mr. Jones' responsibilities was to represent the Laboratories in labor relations. His friendliness and his willingness to try to see others' viewpoints brought from Union leaders the statement, "He had always an open mind in this field—we have lost a friend who could always be counted upon."

In his Outside Plant work, Mr. Jones had well learned the importance of standards in the purchase of poles and hardware from outside suppliers. In Apparatus Development he learned the lesson of standardization as applied to insulation, condenser paper, wire. It was largely through his influence that the Bell System began to take its active part in the work of the American Standards Association.

Surviving are his widow, the former Marion Elizabeth Babcock; a daughter, Mrs. Donald L. Fuchs of New York City; a son, Reginald Lamont, Jr., who graduated from Princeton last year and is with the Central Hanover Bank of this city; another son, Peter Babcock, who is a senior and president of his class at Pingry School in Elizabeth; and two sisters, Mrs. Walter S. Tower of Darien, and Mrs. Arthur I. Loheed of North Middleboro, Mass. Mr. Jones was a director of the Summit Trust Company; a Fellow of the American Physical Society, the Acoustical Society of America, the A.I.E.E., and the A.A.A.S.; and a member of the Salmagundi Club, the Standards Council of the American Standards Association, the National Panel of the American Arbitration Association, the Nonferrous Metallurgical Advisory Board of the Army Ordnance Department, the American Society of Engineering Education, and the Alumni Visiting Committee, Massachusetts Institute of Technology.

On the last day of November, Mr. Jones was to be admitted to St. Luke's Hospital. Expecting to be away for a few days, he put in a busy afternoon, and was at his desk until a quarter of six. That was Mr. Jones' farewell to the Laboratories; he went home from the hospital a month later, and on January 14 he died.

A T & T pushes biggest expansion ever swung by private corporation

Excerpts of an article by John Bridge in the **Wall Street Journal,** *December 21, 1948*

Engineers of A T & T's expansion program, the biggest ever undertaken by a private corporation, are driving into 1949 under a full head of steam.

"We've spent over $3 billion for new construction since V-J Day and plan to keep right on at a high level in the months ahead in order to meet the public's needs for good telephone service," says Leroy A. Wilson, president of American Telephone & Telegraph Co. and chief executive of the huge expansion.

"In fact," he adds, "we have a lot of new ideas for improving methods and equipment and the service should get better all the time."

When World War II ended, "Old Ma Bell" had more people waiting for telephone service than ever before—about 2,200,000. After three years, and nine million net new installations, there is still a waiting list of 1,250,000.

Total subscribers have soared to 31 million, about 40 per cent more than at war's end. On September 30, Ma Bell had a record 664,686 people working for her, seven for every five employed at the end of 1945.

Meanwhile, the Bell System has installed about 5,500 miles of long-distance telephone and television-carrying coaxial cable and radio relay. It has put in service another 60,000 miles of other cable. . . . Altogether, over 23,000 new long-distance circuits have been added since the end of the war, bringing the total to 80,000.

To house their vastly increased business, Bell companies have added or rebuilt 2,800 buildings, 400 of them large enough to duplicate the downtown skyline of a good-sized modern metropolis.

This record construction has demanded a record pile of new capital—probably only a handful of national governments have ever raised as much. Since the expansion program began in 1946, the Bell System—A T & T and its affiliated companies—has raised about $2,700 million of new money. A T & T financial men think they'll be digging up another $2 billion over the next few years to complete this construction program.

A T & T figured, pre-war, that a net gain of a million phones was a good year. Net new installations since the war have been running over three million a year, and demand is better than that. Toll business has been good, too. Before the war, a 5 per cent gain in volume was considered a good year. During the war, the volume of toll business went up 50 per cent. Since then the gain has been even bigger. Today toll business is 8 per cent ahead of this time last year.

However, like many another company, A T & T has found this feast of business offset by inflated costs. Copper, for example, has gone up 108 per cent, steel 53 per cent, the payroll has tripled and wage rates have doubled, according to the company's figures.

To meet these higher costs, and help finance the construction program, Bell companies have gone hunting higher rates. Since 1946, forty-one states have authorized hikes amounting to $170,064,000 annual income. Applications now pending in 29 states would yield another $245,071,000 a year.

Rate increases already granted have raised intrastate revenues an average 14 per cent. Those pending, if granted in full, would bring total revenue increases in forty-seven states to 22 per cent.

State, local and Federal income tax collectors, of course, stand to get a sizable bite of this. Increases already granted yield $100 million after taxes. Those pending would net an estimated $143 million after taxes.

That's two sides of A T & T's "full speed ahead" doctrine—plenty of business and confidence that state regulatory commissions will on the whole allow adequate rates. Another: Belief that technological advances will help cut the costs of doing business.

Bell System officials, speaking of expansion from here on, also talk more and more in terms of service improvements and new equipment to help hold down costs. There will be increased emphasis on meeting demands for better service—a one-party line in place of a two-party line, for instance. Service will be speeded. The system will install millions of dollars of mechanical switching and accounting devices and other technical improvements.

For many years, the Bell System has maintained its own laboratories. Bell Telephone Laboratories have produced many of the telephonic advances that have given the U. S. approximately one telephone for every four people. A T & T officials think there are as many more advances to come.

The Laboratories have developed, for example, an accounting system, now being installed, which automatically does much of the clerical work connected with billing certain dial calls. Known as AMA (automatic message accounting), it's described by Bell officials as "one of the most significant advances in telephone engineering since the introduction of the dial system."

The new system "remembers" who made dial calls, what numbers were called, and how long the conversations lasted—all by means of holes automatically punched into a paper tape.

A tiny gadget called the transistor, recently announced by the Laboratories, gives an idea of some of the things afoot to save materials. This device, slightly smaller than the end of a pencil, is rugged for an electronics instrument and can be mass produced. It can do most things a vacuum tube will do and some that vacuum tubes can't. The transistor is still in the experimental stage, but Bell officials hope it will be able to do the work of the millions of relatively fragile vacuum tubes used to amplify telephone conversations.

New fields of business? A T & T's Long Lines Department, which for many years has leased lines for private telephone, teletype and radio networks, promises to be the leading intercity carrier of television.

Shortly after the new year, an Eastern Seaboard television network and a Mid-Western one will be linked by A T & T lines. Through the network, 14 major cities—Boston, New York, Philadelphia, Baltimore, Washington, Richmond, Pittsburgh, Cleveland, Buffalo, Toledo, Detroit, Chicago, Milwaukee, and St. Louis—will be linked. Coast-to-coast hook-ups are a goal for the near future, but no definite schedule of its completion has been announced.

The coaxial cables and radio relay systems which carry television broadcasts will continue to make up a segment of A T & T's expansion budget. While television will pay a share of the construction cost of coaxial and relay systems, biggest use for a number of years, at least, will be carrying telephone conversations.

A T & T President Wilson emphasizes that Bell's continuing expansion program "depends on the willingness of investors to continue putting large amounts of new money into the telephone business."

"Rates for telephone service must be increased so earnings will be sufficient to attract this new capital," he declares. "Telephone rates are still low and have increased much less than the rise in prices generally and far less than past increases in telephone wages and other higher costs of providing service."

Even the cost of borrowing money has gone up. For its first post-war debenture issue, A T & T paid interest of 2¾ per cent. An issue sold early this month carried a coupon of 3⅜ per cent.

After a sharp dip last year, due in part to a system-wide strike, Bell System earnings have perked up somewhat, aided by rate increases granted the various operating companies. But Bell officials say the average rate of return earned by the operating companies on investment devoted to intrastate business is still too low at under 4.5 per cent.

Bell System officials say they're planning to ask for more rate hikes soon. Thus far, all requests for higher rates have come from the system's 21 operating companies. A T & T, which operates long-distance business through its Long Lines Department, hasn't yet asked for any increases.

Changes in Organization

J. W. McRae has been appointed Assistant Director of Apparatus Development I.

W. H. Doherty has been appointed Director of Electronic and Television Research, succeeding Mr. McRae. E. L. Nelson will succeed Mr. Doherty; the part of Mr. Nelson's group headed by R. C. Newhouse will be consolidated with the group headed by J. F. Wentz.

G. N. Thayer, transmission development engineer, is appointed assistant director of transmission development, reporting to H. A. Affel. Mr. Thayer will retain supervision of the groups now concerned with submarine cable and microwave radio development.

H. B. Fischer has been appointed transmission development engineer, reporting to Mr. Affel. He will retain the group which formerly reported to him on the development of Bell System radio equipment, and in addition will have responsibility for overseas radio development with A. A. Oswald, overseas radio engineer, reporting to him.

Nation-Wide Toll Dialing Makes Its Bow

The Bell System, with the addition of new operator toll dialing networks centering at New York and Chicago, is now handling approximately 10 per cent of its long-distance calls by the new automatic switching method. Cutovers of the two networks marked a major stride forward in providing faster, more accurate long-distance service.

On January 6, members of the press and radio in both cities witnessed demonstrations of how the new system makes it possible for a long-distance operator to put calls straight through to distant telephones without the aid of other operators en route.

The Bell System plans ultimately to extend operator toll dialing throughout the United States and Canada. Present networks enable operators to dial calls direct to subscribers' telephones in some 300 cities. Additional automatic switching centers are scheduled to be established in Cleveland, Oakland, Cal., and Boston this year. Hundreds of smaller communities will be linked to these centers, which in turn will be connected with the new New York and Chicago systems and the earlier-established Philadelphia system.

The Bell System's program for nation-wide toll dialing is based on the development of new electronic switching equipment which can select possible routes between distant cities, direct switching operations at intermediate points along a route and complete connections automatically in a matter of seconds. The result may be that when a New Yorker calls Miami, for instance, the party on the other end may answer before the caller has even had time to draw a straight-line doodle on the pad next to his telephone.

Members of the press and radio learn about operator toll dialing at the demonstration held for them at A T & T Long Lines Department headquarters building in New York on January 6

Using toll dialing equipment, long-distance operators at the new Chicago toll center can complete calls to a great many cities without the aid of other operators. Instead of using a dial, they operate keys such as those shown here

All long-distance calls now go through in about two minutes on the average. However, when operator toll dialing has become nation-wide in scope and all the circuits now planned by the Bell System are in service, the average speed of all long-distance calls is expected to be about one minute. Operator toll dialing is expected to increase particularly the speed on calls requiring intermediate switching and make this speed almost as fast as that achieved on direct circuit calls.

The nation-wide extension of toll dialing requires a numbering plan under which the United States and Canada will be divided into about 80 numbering plan areas. Each of these will be designated by a distinctive three-digit code. Each telephone central office within an area in turn will be designated by a three-digit office code, one which does not conflict with the code of any other office within the area nor with any other code area. A map showing the numbering plan in detail was shown on page 29 of the January issue of the RECORD.

Thus, the operator will generally be able to complete any toll call by dialing a maximum of 10 digits—the six digits of the area and office and the four digits of the called number. In calling distant cities, the operator does not actually "dial" the numbers. Instead, she uses a ten-button key set which is capable of working about twice as fast as an ordinary dial. Each time she presses a key, a tone pulse is sent out over the regular voice channels to the switching center.

Each tone pulse is a combination of two different audible frequencies, which are sorted out and classified by the switching equipment, which then interprets their meaning and performs the complex switching operations.

Anna Menig, Chief Operator, West Street, decorated her desk with Christmas cards from present and former operators, other Bell System PBX's, and appreciative "subscribers"

Moves to Murray Hill

All members of Electron Dynamics Research, headed by S. Millman and J. R. Pierce, have been moved from Building T at West Street to various rooms on the first floor of Sections 2B and 2C, where H. E. Mendenhall and L. E. Cheesman of Section 1E will join them. On December 28, R. Burns of Plastics Engineering was moved to 1A-363. This reunites Mr. Burns' group at Murray Hill, save for J. J. Martin, who will remain at West Street for the present.

A. G. Ganz has moved from West Street to Room 2C-272 at Murray Hill.

R. A. Mitchell, W. J. Fullerton, and Marilyn Stevens, technical department staff representatives, were moved on December 30 from West Street to Room 2C-427. H. Berlin of the same group is now in 1B-407. All members of Crystal Engineering, headed by R. A. Sykes, moved on January 18 from Murray Hill No. 1 to various rooms on the second floor of Sections 2C and 2D, with their shop located in 2D-221.

Youngsters recuperating at St. Vincent's Hospital at Christmas derived a great deal of fun from this set of trains. Originally shown on the December cover of the Record, *the trains were donated to the Doll and Toy Committee and set up for the children by Muriel Walter, treasurer of the New York Committee*

Norman Insley and his Lamp group, with their laboratory, moved on January 21 to locations on the fourth floor of Section 2D. Personnel involved were L. L. Lockrow, T. L. Tanner, J. P. Messana, P. A. Byrnes, E. J. Zimany, Marion Cook, and Mrs. Blanche Timm. The lamp life test will be located in the penthouse, Section 2D.

Members of Apparatus Specifications who are concerned with transformers and networks moved to Rooms 2C-446 and 2D-405 and 407 on January 14. At the same time, Miss M. J. Regan moved from West Street to 2D-404A.

Television Network Extended to the Mississippi

To mark the linking of the Bell System's eastern and mid-western television networks, a joint program was presented on January 11 by A T & T and the four major television chains. More than thirty stations in fourteen cities broadcast the program from 9:30 to 11 p.m. that evening.

Following the opening announcement, there were brief flashes of familiar scenes in the principal cities, and then a shortened version of the new Long Lines movie, "Stepping Along With Television." Washington then came in with Wayne Coy, chairman of the FCC, who congratulated the participants on their achievement in bringing intercity television to an area in which a quarter of the Nation's population lives. Leroy A. Wilson, President of A T & T, then presented the facilities to the presidents of the broadcasting companies. He pointed out that this network, a by-product of activity in the telephone field, is evidence of the intention of the Bell System to bring television programs to a constantly expanding audience.

Discussing various phases of the industry, Dr. Allen B. DuMont, of the DuMont Laboratories; Niles Trammell, of the National Broadcasting Company; Frank Stanton, of the Columbia Broadcasting Company; and Mark Woods, of the American Broadcasting Company, appeared. Finally, Vincent Impellitieri, President of the City Council, in New York, and Mayor Martin Kennelly, seen in Chicago, felicitated those responsible for the occasion. Quarter-hour entertainment features sponsored by each chain followed, with popular entertainers, music, dancing, personalities in the news and a dramatic skit.

K. E. Gould, after observing at St. Louis, was stationed in the Chicago testroom; L. W. Morrison was at Washington; M. E. Campbell was at Philadelphia; J. R. Brady and L. G. Abraham were at Long Lines headquarters in New York; and A. R. Kolding was standing by a spare coaxial-to-video terminal in the laboratory at 180 Varick Street.

Certificates of Appreciation to Laboratories Men

At a public ceremony in the 102d Cavalry Armory, Newark, members of the Laboratories were honored by Army-Navy Certificates of Appreciation for work done under the auspices of O.S.R.D. Presentation was made by Commander Walter B. J. Mitchell for the Navy and Colonel Frank A. Allen, Jr., for the Army. The recipients, and their contributions, were:

Joseph A. Becker–application of thermistors to infra-red detection.

Mark E. Campbell–radio countermeasures; assigned to laboratories in England.

Eginhardt Dietze–research on underwater sound.

William S. Gorton–services in the field of acoustics.

Karl G. Jansky–radio direction finders for fixed location.

Charles Kittel–submarine operational research projects.

Julius P. Molnar–guided missiles.

Henry G. Och–research and development of electrical gun directors.

Ralph K. Potter–direction of groups on communication and radio countermeasure projects.

John C. Steinberg–research on underwater sound.

Two former members of the Laboratories were honored for contributions made while with us; they were Joseph P. Maxfield and W. B. Snow.

H. O. Siegmund has received from the Navy's Bureau of Ordnance an award "for his outstanding performance in connection with research and development of mine and depth charge firing mechanisms."

The Page-Turners' Club Plays Santa at Veterans' Hospitals

To provide reading facilities for paralyzed and armless veterans, a group of Laboratories' girls banded together last fall, each girl pledging five dollars toward the purchase of the new page-turner designed by J. T. Reck of the Laboratories. The group, formally known as The Page-Turners' Club, grew rapidly, and by Christmas was able to buy seven page-turners. Carrying their gaily wrapped gifts to Army and Navy hospitals in this vicinity, the girls presented them to the hospital libraries. A young officer at St. Albans Naval Hospital is shown learning how to use one of the two page-turners donated to that institution.

Virginia Groth adjusts the page-turner for a paralyzed patient at St. Albans Naval Hospital while Rose Chiusano looks on. Members of The Page-Turners' Club of the Laboratories, the girls were part of a group who attended a Christmas party at the hospital at which they presented two page-turners and demonstrated their use

Close-up of the desk area in Basement D Storeroom at West Street which is at present the principal supply storeroom for the entire Laboratories. Shown here are J. R. Kieran, seated, foreground; T. J. O'Neill, telephoning; William Schwarz, at the files; F. N. Maguire, seated at the desk; P. J. Keely; Harry Richards and James Sweeney, standing. Working elsewhere in the stacks was August Uhl

Conference on High-Frequency Measurements

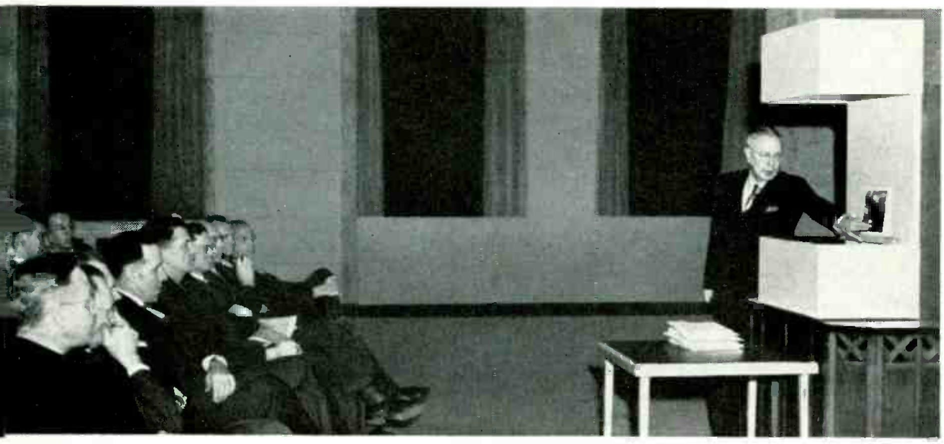
Bell Laboratories engineers played an active part in the conference on high-frequency measurements held in Washington on January 10-12 under the joint sponsorship of the American Institute of Electrical Engineers, The Institute of Radio Engineers, and the National Bureau of Standards. The conference was planned by the A.I.E.E. Subcommittee on High-Frequency Measurements, of which E. P. Felch is a member. This is one of the Subcommittees of the Instruments and Measurements Committee, of which E. I. Green is Chairman.

Papers presented included the following: *A Stabilized Variable Frequency Oscillator for Precision Frequency Measurements,* by L. F. Koerner; *A Method for Measuring the Effective Conductivity of Wires at Microwave Frequencies,* by A. C. Beck and R. W. Dawson; *A Precise Direct-Reading Phase and Transmission Measuring System for Video Frequencies,* by D. A. Alsberg and D. Leed; *Generator Mismatch Measurement in Transmission Lines,* by P. E. Gilmer; *A Method of Measuring Phase at Microwave Frequencies,* by Sloan D. Robertson; *Measurement of Artificial Dielectrics for Microwaves,* by W. E. Kock; and *Measurement of Noise Interference Caused by Radar Equipments,* by J. R. Logie, Jr.

E. I. Green presided at the opening session of the Conference. A total registration of 551 testified to the capable planning for the Conference and the large interest in the subject.

Dr. Ewing Guest Speaker

Dr. Maurice Ewing, professor of geology at Columbia University, visited the Murray Hill Laboratories on January 4, where he spoke in the Arnold Auditorium on *A New Method of Deep Sea Exploration.* The method comprises continuous automatic registration of depth, the obtaining of core samples of the ocean bottom as much as 20 feet long, analysis of the structures of the ocean bottom by explosion waves, and photography of the ocean bottom.



A photographic light box, for use at the photographic lectures, was built by E. Von Nostitz for the Laboratories Photo Forum. E. Alenius is here using it at one of his talks in the West Street Auditorium

At the winter party of the Murray Hill Chorus on January 25, the new members of the Chorus, who have been transferred from West Street to Murray Hill, were welcomed to the group. The annual spring concert is tentatively scheduled for May 1 and in the interim they plan at least one noon-hour program

Income and Expense Records

Income and Expense Records have been distributed by Personnel to members of the Laboratories requesting them. The booklet is made up of a number of work sheets to aid in preparing a budget and in classifying expenses to help one to account for receipts, balances, disbursements, savings and insurance. Copies are still available on Extension 435 at West St.

The Friendly Touch

Characteristic of the Bell System is the friendly feeling which shows up so clearly in an incident in Madison, Wisconsin. With cutover of a dial PBX in the State Capitol, the telephones were about to be changed to dial operation. But one of the telephones serves a blind attendant of the candy concession stand in the rotunda; so the local manager offered to arrange this telephone for manual operation by the "inward" operators. As a result of his thoughtfulness, the manager received this letter:

"You know, I have always maintained that if I should wake some morning and find myself with good eyesight, the first place I would seek employment would be with some big corporation. I have never believed the large business organizations to be the cold, heartless monsters they are sometimes referred to as being. Your action in considering my situation and going to the trouble of calling me about it certainly proves the contention I have always made regarding big business. Oh, sure, I know it is good business, but nevertheless it is also the kindly thoughtfulness and the human element in big business.

"I am most grateful to you and I wish to express my appreciation to you and to the Wisconsin Telephone Company."

February Service Anniversaries of Members of the Laboratories

40 years

J. F. C. Dahl
J. H. Pflanz

35 years

A. F. Price
Everett St. John
R. M. Sample

30 years

H. B. Brown
F. H. Chase
C. A. Conrad
J. C. Crowley
L. L. Eagon
A. J. Engelberg
Raymond Guenther
R. S. Newsham

25 years

K. S. Cadmus
J. J. Gillich
H. L. Holley
E. C. Laughlin
William Patterson
Hazel Reoch
Harold Schmitt
Joyce Thompson
R. E. Turner

20 years

P. V. Brunck
J. J. Darold
E. P. Dinsdorf
Eleanor Dunn
J. O. Edson
G. R. Frost
W. T. Gustafson
Lester Hochgraf
W. J. Hosford
L. W. Kirkwood
W. J. Kopp
E. V. Koski
H. K. Krantz
Sheldon Kroeter
Sylvester Longo
W. A. MacNair
John Mallett
Henry Misan
James Morrison
K. J. Ogaard
F. M. Pearsall, Jr.
J. L. Prendergast
W. R. Prinz
G. F. Richards
Pauline Skowfoe
H. A. White
J. E. Zendt

15 years

R. P. Chapman
Frances Hahn
A. F. Jacobsen
Michael J. Kelly

10 years

A. E. Bausmith
E. W. Briede
M. P. Dudeck
John Karoline

L. S. O'Roark Joseph Juley

RETIREMENTS

Recent retirements from the Laboratories include Joseph Juley with 43 years of service; A. H. Sass, 40 years; L. S. O'Roark, 37 years; and E. H. Zweygart, 6 years.

Lauren S. O'Roark

Toward the end of his undergraduate years at West Virginia Wesleyan, "Larry" O'Roark was talking with a neighbor about opportunities. "Be an electrical engineer," he was told. So he transferred to the University of Kentucky, and on graduation in 1910 he entered Western Electric's student course at Hawthorne. Later he came to New York. Enamel insulation was being introduced and his first investigation was the effect on transmission of the substitution of enamel for silk in telephone receiver coils.

After a year or so outside the Bell System, Mr. O'Roark returned to work on loading problems of a telephone cable along the Panama Canal. He then took up the testing of instruments of other manufacturers and in 1915 was project engineer on a sound-distributing system for the San Francisco Fair, a forerunner of Western Electric's system for the Futurama at the World's Fair of 1939-40.

In 1919 Mr. O'Roark joined the staff organization as Information Manager. Four years later he became General Service Manager, with supervision over photography, blueprinting, transcription, central files, mail and telegraph. In 1925 he became Employment Manager, and soon after the formation of the Publication Department in 1925, he became one of its assistant directors.

In that capacity, Mr. O'Roark had charge of a wide variety of services, such as reception of visitors, the Bell System Historical Museum, the release of technical papers, and office service. In the early years he also had preparation of Western Electric sales bulletins, and for a time, preparation of instruction books for non-associate apparatus.

On retirement, Mr. and Mrs. O'Roark headed for Florida, where "Larry" will indulge his hobby of salt water fishing. In Morristown he has a firm place in the hearts of scores of young people, to whose unfolding lives he contributed. He will long be remembered in the Laboratories for his forthrightness and for his deep loyalty to the Bell System and its people.

Adolph H. Sass

There are few men who at retirement are as familiar as A. H. Sass with the actual things produced at the Laboratories. For four of his forty years of service, he worked in the Development Shop; for the other thirty-six he was in charge of a part of it and later of the entirety. Among his early jobs were tools and dies for the flat-type relay invented by E. B. Craft; the explosion-proof telephone, and early telephone dials.

To his work in the Laboratories Mr. Sass brought, in 1908, the skill of a journeyman toolmaker. By 1912 he had demonstrated leadership, and was made a group supervisor. Nineteen twenty found him a foreman, and in 1926 he was given charge of the entire shop; with various changes of title he continued that responsibility until retirement.

In the Laboratories, there is often an informal partnership between instrument makers and engineers: the latter provides the basic idea, the shopman clothes it in the realities of

At retirement, some of his associates made up and presented to Mr. Sass this display of small parts. Enclosed behind the panel is a roster of those who gathered for a farewell party steel, brass, and insulation. Mr. Sass' ability in bringing an idea into actual working form was widely recognized and his advice was constantly sought on problems of mechanical design. He personally supervised the construction of workable models of pioneer public address systems, movie sound systems and television systems. In World War I he had charge of shop work on radio-telephones for sub-chasers and airplanes, and on submarine detectors. Came another war, and Mr. Sass was again helping to arm democracy with gun data computers, gun directors and modern submarine detectors. Since the war, his two biggest jobs have been the equipment for the Boston-New York radio relay, and much of the equipment for the No. 5 crossbar trial at Media.

Soft-spoken and a good listener, Mr. Sass was never in too much of a hurry to help out an engineer with a practical solution, or to discuss some situation that was bothering one of his shop people. Appreciating his sincerity, his people came to him with their personal problems and were never turned away. Scattered through the Laboratories and Western Electric are dozens of men who got their training in "Ed" Sass' "Model Shop."

First item on Mr. Sass' activities program is a leisurely automobile trip to the West. Meantime, he has a list of projects around his apartment in the Bronx which will be an outlet for his craftsmanship.

Joseph Juley

Before Joseph Juley reached the Western Electric Company (in 1906) he had had a year of Bell System service with a subsidiary of New York Telephone. In 1907 he came to West Street as a draftsman, and in 1911 he transferred to the then Physical Laboratory of the Engineering Department. Moving to the laboratory group of Systems Development in 1920, he had charge of a group working on call indicator and key indicator equipment. He also aided in the development of panel toll line dialing equipment and was in Seattle for a year during the installation and test of this type of equipment installed there. Early in 1926 he was placed in charge of the group that tested all panel equipment. In 1928 he took charge of a group designing routine test desks and maintenance circuits.

During World War II that phase of our work was practically discontinued, and Mr. Juley applied himself to the writing of radar instruction manuals. When the Laboratories was commissioned to develop a relay-type computer as part of a system to check gun directors, Mr. Juley's long familiarity with test circuits brought him into the project. From then until retirement he was active in all the Laboratories' relay computers.

The Juley household is indeed "of the Bell System" for Mrs. Juley, as Sophia Schumacher, was the first of our telephone dictationists, and recorded the transmissions in the Arlington-Paris tests of 1915. They will spend this winter in Florida, where Mr. Juley can indulge in his three hobbies—swimming, fishing, and making color movies.

"The Telephone Hour"

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

February 14	*Clifford Curzon*
February 21	*John Charles Thomas*
February 28	*Pia Tassinari*
March 7	*Robert Casadesus*
March 14	*Ferriccio Tagliavini*

Ernest H. Zweygart

Mr. Zweygart came to the Laboratories during the war time period with but few years to go before retirement age and became an instrument and tool maker in the Development Shop at Murray Hill. Not only had he been a machinist for the past 20 years but he had also taught embryo mechanics in the Elizabeth Vocational Schools. His outside interests have been in his church and lodge and in writing poetry. Cards bearing this poem, with a dedication to his fellow-workers, were distributed the day after he retired:

Who can measure the depth of your friendship
When the hour of parting nears
But one who has labored among you
And shared with you through the years.

The handclasp of each friend is warmer
And brighter the light in each eye
Each flaw and each fault is forgotten
When the time comes to say goodbye.

The yield of field, forest and smelter
The product of mine, loom and mill
Are cunningly blended together
By science and the craftsman's skill.

Nor do planners look down on the doers
But their efforts are all combined
Each values the other's labor
With profit to all mankind.

For the share I have had in the doing
For the chance to be one of you
Have my thanks: I am deeply grateful
And bid you a fond "Adieu."

Radio Telephone System for Southern Pacific

The Pacific Company has recently contracted to provide and maintain for the Southern Pacific Railroad a private system consisting of a 50-watt land station and ten mobile units in diesel switching locomotives at the railroad's San Francisco yards. The land station is to be installed in the customer's office building at one end of the coverage area. The radio system is to be connected on a two-wire basis to the customer's PBX in such a way as to permit communication between any mobile unit and any PBX extension.

Studies of the land station antenna and equipment arrangements for this project are being made by Newton Monk and John Mallett of Radio Systems Engineering.

News Notes

H. D. Hagstrum, J. A. Hornbeck, J. P. Molnar and A. H. White attended the *Gas Discharge Conference* held at the Brookhaven National Laboratory, at which Mr. Hagstrum spoke on *Fundamental Processes of Ionization and Dissociation in Gases by Electron Impact*, and Mr. Molnar on *Lifetime of Rare Gas Metastable Atoms*. Mr. Molnar has been appointed to the Program Committee of the Gaseous Electronic Conferences for 1949.

At their annual Christmas luncheon, the Archery Club was entertained with magicians' tricks performed by their fellow-member, C. N. Hickman. Symbolic arrows point to Helen Cruger, secretary, and W. G. Laskey, chairman of the Club

L. H. Germer gave a talk on *A Low Voltage Discharge Between Very Close Electrodes* at the Squier Laboratory, Fort Monmouth.

G. E. Moore presented a paper coauthored by H. W. Allison and James Morrison before the Chicago meeting of the American Physical Society. Its title was *The Production of Free Alkaline Earth Metal in Simple Vacuum Tube Filaments.* At the same meeting, C. Herring spoke on *Some Simple Theorems on Free Energies of Crystal Surfaces.* H. D. Hagstrum and K. G. McKay also attended the meeting.

A. H. White selected the subject *Some Problems in Physical Electronics* for his talk before the Physics Colloquium at Massachusetts Institute of Technology in Cambridge.

J. M. Hayward and J. M. Rogie attended discussions at Hawthorne concerning the development of the new telephone set.

In the December 1 issue of the *Physical Review,* K. G. McKay was the author of a paper on *Electron Bombardment Conductivity in Diamonds* and R. R. Newton and C. Kittel on *A Proposal for Determining the Thickness of the Transition Layer Between Ferromagnetic Domains by a Neutron Polarization Experiment.*

Among the recent forum discussions held under the auspices of the International Relations Group at Murray Hill was that of the Palestine problem. K. G. McKay and William Fondiller presented the discussion.

Janet Dein's career at the Laboratories has centered around the Systems Department Specifications File, where she maintains the numerical and topical index of BTL drawings and specifications as well as a cross reference file of BTL circuits and Western Electric manufacturing drawings

The Davis Building branch of West Street Transcription—a new branch of Transcription—has been established at the Davis Building under the supervision of Wilma Cadmus, shown standing in the photograph. Members of Transcription are, left to right: Loretta Schaefer, Wilma Cadmus, supervisor; Jean D'Amico, May Keiser, Shelley Russell, rear, and Lee Neergaard. Not shown is Margaret Ramagli

H. J. WILLIAMS' talk on *Ferromagnetic Domain* was given before the meeting of the Basic Science Group, New York Section of the A.I.E.E.

C. E. SHANNON addressed the Philadelphia Section of the I.R.E. on the subject *Engineering Aspects of the Statistical Theory of Communications*. Mr. Shannon has been selected by the Institute of Radio Engineers to receive the 1949 Morris Liebmann Memorial Award.

W. A. SHEWHART spoke on *Contributions of Statistics to the Science of Management* at the 1948 annual meeting of the Management Division of the American Society of Mechanical Engineers in New York. Dr. Shewhart has also been recently elected a Fellow of the Econometric Society.

B. S. BIGGS participated in a meeting of the High Polymer Group, New Jersey Section of the American Chemical Society, at which he spoke on *Polymer Degradation*.

C. S. FULLER has been appointed Chairman of the Standing Committee on Publications of the American Chemical Society.

L. A. WOOTEN has been appointed a member of the Advisory Committee of A.S.T.M. Committee E-3, on Chemical Analysis, as the Representative of Committee E-3 on Committee E-2, Spectrochemical Analysis.

C. V. LUNDBERG visited Point Breeze in connection with rubber-covered wire problems.

G. N. VACCA has been elected to the Executive Committee of the New York Rubber Group.

W. C. ELLIS attended a Symposium on *Titanium Metal* in Washington.

J. R. TOWNSEND, G. T. KOHMAN, D. A. MCLEAN, F. J. GIVEN, P. S. DARNELL, A. J. CHRISTOPHER and J. R. WEEKS conferred at Hawthorne on metallized paper capacitors. They reviewed results of Laboratories studies of the capacitor and problems relating to the operation of the equipment constructed for its production. They also discussed plans for the use of these condensers in Bell System equipment. Mr. Townsend, K. G. COUTLEE, D. B. HERRMANN, F. S. MALM, H. PETERS and G. N. THAYER attended a conference at the Western Electric Allentown Plant on December 15.

F. S. MALM and G. N. VACCA, as representatives of Laboratories membership on the U. S. Department of Commerce Wire and Cable Technical Advisory Committee, attended meetings to consider problems on the use of new synthetic rubbers for wire and cable.

Mae Copeland has been a member of the Laboratories since 1943, when she gave up her profession as a dressmaker to do war work. Elevator C at West Street, for which Mrs. Copeland is responsible, frequently has fresh flowers in a little vial on the wall. When this photograph was taken, she had a touch of the holiday season in her car

RECENT DEATHS

G. A. KELSALL
1880-1949

J. E. HARRIS
1882-1949

GEORGE A. KELSALL, retired, January 4

A graduate of Rose Polytechnic Institute '06 with a B.S. degree in Electrical Engineering, Mr. Kelsall had spent three years with General Electric and three more at Michigan State College as an instructor in Electrical Engineering before he entered Western Electric in 1912. All of his thirty-three years of service were devoted to work associated with the development of magnetic materials. During his first five years in the Physical Laboratory, he developed an a-c permeameter for measuring the permeability at elevated temperatures. He also had a number of patents issued to him relating to loading coils, magnetic testing apparatus and magnetic materials. From 1917 until his retirement, he engaged in fundamental studies of magnetic materials, investigated over twenty-five hundred alloys, and played an important part in the development of those remarkable new magnetic materials which have since become known as permalloys, perminvars and permendurs.

Following his retirement from the Laboratories in 1945, Mr. Kelsall resumed his teaching career. He lectured in mathematics at Newark College of Engineering and at Upsala College, where he was a member of the staff at the time of his death.

JAMES E. HARRIS, retired, January 5

At the time of his retirement in 1942, Dr. Harris had completed twenty-five years of Bell System service. A graduate of the University of Michigan '04, he remained in the Chemistry Department at the University, taking his master's degree in 1909 and his doctorate in 1911, until he joined the Laboratories' Research Department in 1917. In the early days of radio research, he engaged in the development of oxide coated filament for vacuum tubes. With the formation of the Chemical Laboratories, he became Research Metallurgist for the Laboratories, responsible for research into the whole metallurgical field. From that period until his retirement, Dr. Harris had eleven patents issued to him. He was the author of several articles on metallurgy and of a chapter of the book edited by Masterson on *Modern Uses of Non-Ferrous Metals.*

JOHN J. PARIS, retired, December 18

Mr. Paris joined the drafting group of the Western Electric Engineering Department in 1917. Shortly thereafter, he transferred to the Apparatus Development Department, where he engaged in the design and development of manual apparatus. During World War I he was concerned with the development of apparatus and equipment for submarine and aircraft detection. Following the war, he transferred to the specifications group, where for many years he prepared specifications on mechanical switching apparatus. Prior to his retirement in 1946, his work covered manual switchboard apparatus.

WILLIAM C. BEACH, December 30

When Mr. Beach entered the Laboratories, after receiving his B.S. from Purdue University in 1916, the country was verging toward war. Upon completing the Student Course, he began editing orders and assembling train dispatching and telephone systems for shipment to the A.E.F. in France. In 1918 he joined the Navy, where, as chief electrician, he became responsible for radio supplies for commercial vessels. Upon his return, he resumed work in the development and testing of ringing systems until 1926 when he transferred to laboratory work on circuits to connect manual and dial offices, notably key-indicator and cordless B boards. From 1933 until 1948 he had been engaged in the laboratory testing of the No. 1 and

J. J. PARIS
1881-1948

W. C. BEACH
1893-1948

No. 5 crossbar systems, giving most of his attention to marker and automatic message accounting circuits. Last September he transferred to Systems Engineering, where he had since been concerned with Bell System Practices.

WALLACE MCGREGOR, December 20

Before joining the Laboratories at Deal in 1942, Mr. McGregor had been a tool and die maker and an inspector in that field for several outside concerns. As an instrument and tool maker in the Development Shops Department, he was engaged in making development models for radar during the war years. Since 1945, he had been concerned with development work for transmitters and for television projects.

WALLACE MCGREGOR 1897-1948   F. W. DOERING 1912-1948

FREDERICK W. DOERING, December 24

Upon entering the Laboratories in 1929, Mr. Doering was enrolled in the instrument maker apprentice training course. He graduated in 1933, and progressed to instrument maker in 1934. In the latter capacity, he worked on various telephone development projects until he transferred to the Whippany Radio Laboratory in 1941. At Whippany, Mr. Doering initially worked as an analyzer of Shop orders, and since 1942 he was engaged as a Fieldman, handling Shop work which was performed in outside shops.

News Notes

K. G. COMPTON addressed the New York Chapter of the American Society for Metals on the subject *Protective Coatings for Nonferrous Metals*. Mr. Compton was elected vice-chairman of the Management Committee of the Gordon Research Conferences, which are sponsored by the American Association for the Advancement of Science, at the annual meeting on December 8. He has also been appointed chairman of a committee of the National Association of Corrosion Engineers on a study covering the cost of corrosion.

W. A. YAGER talked before the Colloquium November 12 at Massachusetts Institute of Technology in Cambridge on *Ferromagnetic Resonance*. C. KITTEL accompanied him and conferred with members of the staff.

K. M. OLSEN discussed cable sheath problems during a recent trip to Point Breeze.

L. W. GILES was at Hawthorne in connection with an economic study being made of loading coil cases and stub cables. At the Haverhill plant of Western Electric, he reviewed problems relating to repeating coils.

E. B. WOOD and D. R. BROBST conferred at Tonawanda on problems pertaining to switchboard cable and enameled wire.

C. A. WEBBER visited The Southern New England Telephone Company at New Haven for conferences on cord problems.

W. J. KING visited the Buggie Company in Toledo in connection with high-voltage cables and connectors.

E. B. WOOD, N. INSLEY and J. P. MESSANA studied problems concerning switchboard lamps and lamp caps at Hawthorne.

Patents Issued During October and November on Applications Filed at the United States Patent Office

W. M. Bacon
H. L. Barney
H. W. Bode
J. T. L. Brown
H. W. Bryant
R. B. Buchanan
O. Cesareo
J. O. Edson
P. G. Edwards
W. B. Ellwood
F. S. Farkas
H. J. Fisher
E. W. Gent
C. S. Gordon
K. E. Gould
R. H. Griest
R. K. Hansen
H. C. Harrison
H. Havstad
G. Hecht
H. W. Herrington
R. E. Hersey
F. H. Hibbard
H. A. Hilsinger
V. L. Holdaway
A. E. Joel, Jr.
F. S. Kinkead
W. Koenig, Jr.
R. F. Mallina
W. A. Marrison
W. P. Mason (3)
L. A. Meacham
L. E. Melhuish
P. Mertz
H. R. Moore
F. B. Llewellyn
A. C. Norwine
B. M. Oliver
J. R. Pierce (2)
W. A. Phelps
J. A. Potter
C. W. Ramsden
W. T. Rea
J. W. Rieke
A. L. Robinson (2)
A. L. Samuel
J. C. Schelleng (2)
R. W. Sears
O. A. Shann
F. J. Singer
E. M. Smith
L. J. Stacy
D. M. Terry
F. M. Thayer
F. M. Thomas
J. R. Wilkerson

J. P. MESSANA, L. L. LOCKROW, and E. J. ZIMANY made a study in Allentown of problems of sealed terminals and equalizers.

W. E. KAHL, in Milwaukee, studied equalization problems of the type-N carrier system.

W. R. LUNDRY modified attenuation equalizers on the L1 coaxial television circuits in Harrisburg so as to make them suitable for long-distance television transmission.

WITH J. E. Speer of Western, C. R. STEINER visited the Corning Glass Works, Corning, N. Y., regarding procurement problems and the introduction of design changes for L1 carrier capacitors.

H. A. FREDERICK, H. O. SIEGMUND, B. F. RUNYON and H. M. KNAPP visited Hawthorne to discuss manufacturing problems in connection with relay developments.

A. C. KELLER, C. N. HICKMAN and H. J. WIRTH visited the General Electric Company in Taunton, Mass., at various times recently.

B. F. LEWIS went to Lynn, Mass., for conferences with General Electric engineers.

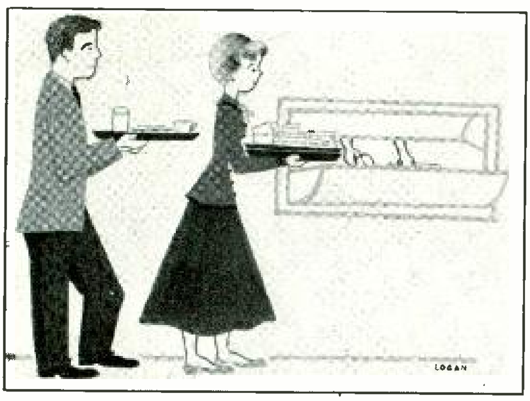
R. E. COLEMAN, JR., R. H. VAN HORN and K. H. MULLER were at General Electric Company in Lynn, Mass., for conferences on photoelectric cells.

J. T. L. BROWN, G. G. MULLER, O. M. HOVGAARD and C. F. SWASEY conferred at Allentown on mercury relays.

J. W. SMITH, C. R. TAFT, N. W. BRYANT and R. J. PHILIPPS were in Washington for discussions of submarine equipment.

J. B. D'ALBORA investigated magnetron problems at Allentown.

AT WINSTON-SALEM, W. C. HUNTER was concerned with land station equipment of the mobile telephone system; and B. O. BROWNE, with fire-control equipment.



B. H. NORDSTROM and E. F. KROMMER visited the Chesapeake Bay Annex of the Naval Research Laboratories, North Beach, Maryland, in connection with fire-control equipment.

C. BREEN and C. H. MCCANDLESS attended cutovers of No. 4 toll crossbar offices at New York and Chicago.

N. A. NEWELL and A. A. HANSEN witnessed tests being made on the N1 carrier trial installation at the Milwaukee, Watertown, and Madison, Wisconsin, toll offices. Mr. Hansen also visited the Chicago No. 2 toll office at and following the time of cutover of the No. 4 toll system, in connection with the performance and maintenance of the new single-frequency signaling equipment.

R. W. BURNS made a study in Cleveland to determine the comparative costs of maintaining No. 1 crossbar and step-by-step equipment.

J. K. MILLS observed the operation of new 805C ringing plants at the No. 5 crossbar offices at Ambridge, Pa., and Willoughby, Ohio.

R. H. ROSS visited the Ambridge, Pa., office in connection with the new emergency A-C supply for the No. 5 crossbar equipments.

H. M. SPICER conferred with engineers of the Struthers Dunn Company in Philadelphia on new designs of solenoids for use in various types of power circuits.

J. M. DUGUID, with W. W. Janes of the Western Electric, discussed new engines with the Hercules Motors Corporation at Canton, Ohio.

V. T. CALLAHAN, with O. D. Parson of the Western Electric, observed the operation of automatic alternator sets at the Fort Lauderdale, Fla., overseas radio receiving station.

They also visited several L1 carrier stations near Jackson, Miss., in connection with the Western Electric Company's modification of existing engine alternator sets along that route.

A. E. Gerbore and R. J. Miller discussed installation schedules for the reed keyset trial and post cutover changes in the Media No. 5 crossbar office with members of the Telephone Company and Western Electric Installation Department at Philadelphia.

C. H. McCandless' trip to Chicago was in connection with the No. 4 toll job.

R. E. Hersey and W. I. McCullagh visited Ambridge and Willoughby No. 5 crossbar offices in Pennsylvania.

T. C. Campbell conferred at Hawthorne with Western Electric Company engineers on rolling ladders for central offices.

W. W. Brown visited the Dunlop Rubber Company at Buffalo in connection with newly designed seat covers for operators' chairs.

W. E. Grutzner and R. A. Swift, while at Hawthorne and Duluth, discussed No. 5 crossbar problems.

J. A. Watters visited Madison and Milwaukee, Wisconsin, in connection with a trial installation of the new N1 carrier equipment and conferred with Wisconsin Telephone Company engineers on arrangements for the trial.

The Laboratories were represented in interference proceedings at the Patent Office in Washington by N. S. Ewing before the Board of Interference Examiners.

C. E. Nelson attended the Metal Joining Conference in Hawthorne.

A. H. Schirmer attended the convention of the International Association of Electrical Inspectors at Atlantic City and a meeting of the National Electrical Code Committee at Buffalo.

J. R. Logie witnessed trial tests at the Bomac Laboratories and at the Raytheon Manufacturing and the Submarine Signal Corporations.

J. G. Nordahl attended the *Symposium on Communication Research*, sponsored by the Research and Development Board of the National Military Establishment in Washington.

C. A. Webber was at Point Breeze regarding cord problems. Mr. Webber, J. H. Bower and J. H. Cook visited the Electric Storage Battery Company in Philadelphia in connection with special batteries.

W. J. King attended a meeting of the Army-Navy Cable Coördinating Committee that was held in New York.

Marion Cook, P. A. Byrnes, E. J. Zimany, N. Insley and L. L. Lockrow were at Allentown in connection with equalizer development problems.

J. B. Dalbora investigated vacuum tube production problems at Allentown.

At Burlington, C. R. Taft and G. F. Swanson discussed the production of submarine electrical equipment.

L. S. C. Neeb and H. T. Langabeer conferred on power service equipment with the Bull Dog Electric Products Company at Detroit and with engineers at Hawthorne.

G. H. Downes and R. F. Massonneau with R. V. Jones of A T & T visited Audichron Company engineers in connection with the maintenance of time announcing machines.

Whippany Highlights

On these facing pages are familiar scenes in the Whippany Radio Laboratory.

Engagements

*Gertrude Alefeld—Herbert Goddard
Barbara Atkins—*William L. Keefauver
*Louise Bonomi—*Donald H. Smith
*Doris Boyajian—John Laylagian
*Helen Budric—Harry Asklof
*Lillian Chadwick—Kenneth J. Kohlhof
*Rose Chambers—*Clifford E. Underhill
Patricia Collins—*Robert D. Williams
*Helen Fraedin—William Nagin
*Joan Heineman—Jesse S. Grace
*Helen Herrmann—Robert J. Forrester
Dorothy Knopf—*Roy W. Bruning
*Elizabeth Lockey—H. Kenneth Fish
*Marilyn Miller—*James A. Donlevy
*Margaret Ramagli—Charles Forss
*Elizabeth Sprissler—Alex L. Tullo
*Lorella Young—William S. Kanouse

Weddings

Betty Bagby—*John W. Balde
*Gladys Brocking—John J. Kwait
*Dorothy Burgess—Stanley G. Wood
*Lillian Sangberg—Howard A. Mullen
*Irene Smith—Rudolph E. Mommo

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

J. A. MILLER, C. H. TRENKLE and C. B. GREEN went to Allentown for conferences on thermistor development for a new equalizer.

C. E. BROOKS visited Minneapolis, Minnesota, to prepare comparative cost studies in connection with the replacement of manual offices.

J. K. MILLS and J. R. STONE observed the operation of the ringing plant at Media.

C. W. VAN DUYNE and E. E. HELIN discussed variable frequency power supplies and their control at Schenectady with General Electric Company engineers.

J. A. POTTER observed the operation at Fort Lauderdale of regulated rectifiers at the new overseas radio receiving station and control terminal.

L. PEDERSEN and R. E. YAEGER, with W. R. Scherb and C. J. Stolp of Western, observed and discussed die casting techniques in connection with the development of the N1 carrier telephone system at the die casting plant of the Doehler Jarvis Corporation at Pottstown, Pa.

W. L. TUFFNELL reviewed the production of station handsets at the Speedway plant in Indianapolis.

G. A. WAHL and D. W. MATHISON discussed coin collector problems at Chicago.

W. G. TURNBULL was in Chicago to discuss the new colored handset with Western Electric engineers.

F. A. POLKINGHORN has written on *Commercial Single Sideband Radio Telephone Systems* in the December issue of *Communications.*

IN *The Physical Review,* January 1 issue, R. R. NEWTON, A. J. AHEARN and K. G. MCKAY coauthored a paper on *Observation of the Ferro-Electric Barkhausen Effect in Barium Titanate;* H. J. WILLIAMS, R. M. BOZORTH and W. SHOCKLEY, a paper on *Magnetic Domain Patterns on Single Crystals of Silicon Iron;* and H. J. WILLIAMS and W. SHOCKLEY, a paper on *A Simple Domain Structure in an Iron Crystal Showing a Direct Correlation With the Magnetization.*

J. BARDEEN discussed *Physical Principles Involved in Transistor Action* at the Deal-Holmdel Colloquium held at Deal on January 7. At a special meeting of the Colloquium at Holmdel on January 21, F. A. Cowan of the Operating and Engineering Department of the A T & T spoke on *Trends in Transmission Systems.*

F. S. MAYER and H. C. PAULY visited Chicago in connection with tool-made samples of combined ivory set housings.

ON JANUARY 21, Dr. Otto Beeck, Associate Director of Research of the Shell Development Company, Emeryville, Cal., visited Murray Hill. Dr. Beeck, who is noted for his work on the physics and chemistry of surface phenomena, spoke on *Catalytic Reactions of Isotopic Hydrocarbons* in the Arnold Auditorium.

"I just wanted to find out if it really worked"