BELL LABORATORIES RECORD

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BELL LABORATORIES **RECORD**

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To the members of the Laboratories:

As 1948 draws to a close, we look back on it as a banner year of accomplishment, and we look forward to 1949 with confidence that we will achieve great things and that all that we do will contribute to the national welfare. My New Year's wish is that joy in our work and pleasure in our association as a happy family may ever increase as we continue on our way to serve the people of the fortunate country in which we live.

Oliver E. Buckley

DECEMBER 21, 1948

A M A

an epoch in telephone accounting

An automatic accounting system which can keep track of thousands of dial telephone calls—remember who made them, what numbers were called, how long the conversations lasted, and then add up and print detailed charge information—is the Laboratories' latest contribution to improved telephone service.

The result of years of intensive development work, the new service is believed to be one of the most significant advances in telephone engineering since the introduction of the dial system.

The first installation was recently made in the Philadelphia area, with part of the intricate equipment in the city itself and other necessary apparatus in nearby Media, Pennsylvania, a residential suburb, where the new service is being introduced.

It is known as AMA, an abbreviation for automatic message accounting. It works like this: Information needed for accounting is automatically stored up, as calls are made, on reels of paper tape with equipment located in the Media telephone exchange. Holes are automatically punched in this tape in a coded pattern which can later be read and interpreted by accounting office machines. These reels are taken daily to an accounting center in downtown Philadelphia, where a battery of machines assembles, translates, sorts, summarizes and prints the information, thus making it ready for use in the preparation of subscribers' telephone bills.

Several other exchanges will soon be

Lillian Chadwick splices two paper tapes on which billing records have been automatically stored. The records are punched in a coded pattern on the tape as telephone calls are made. The tape is then run through machines which "read" and interpret the information at the rate of 80 coded digits per second

←The machine being observed by A. E. Hague is a part of the automatic message accounting equipment and is able to "read" perfectly 80 coded digits per second. Paper tape, on which records of thousands of telephone calls are stored, contains information on the calling and called numbers, the month, day and exact time to tenths of minutes at which the conversation begins and ends. The tapes are run through "reader" machines and the information is assembled, translated, sorted, summarized and printed so that telephone bills may be made from it

equipped to feed into the Philadelphia accounting center, and similar systems are planned for use in other parts of the Bell Telephone System.

The equipment, housed in neat metal cabinets with plastic windows, would appear to the layman to be a baffling maze of springs, magnets, switches, wires and motors. There are, indeed, a multitude of precision-made component parts.

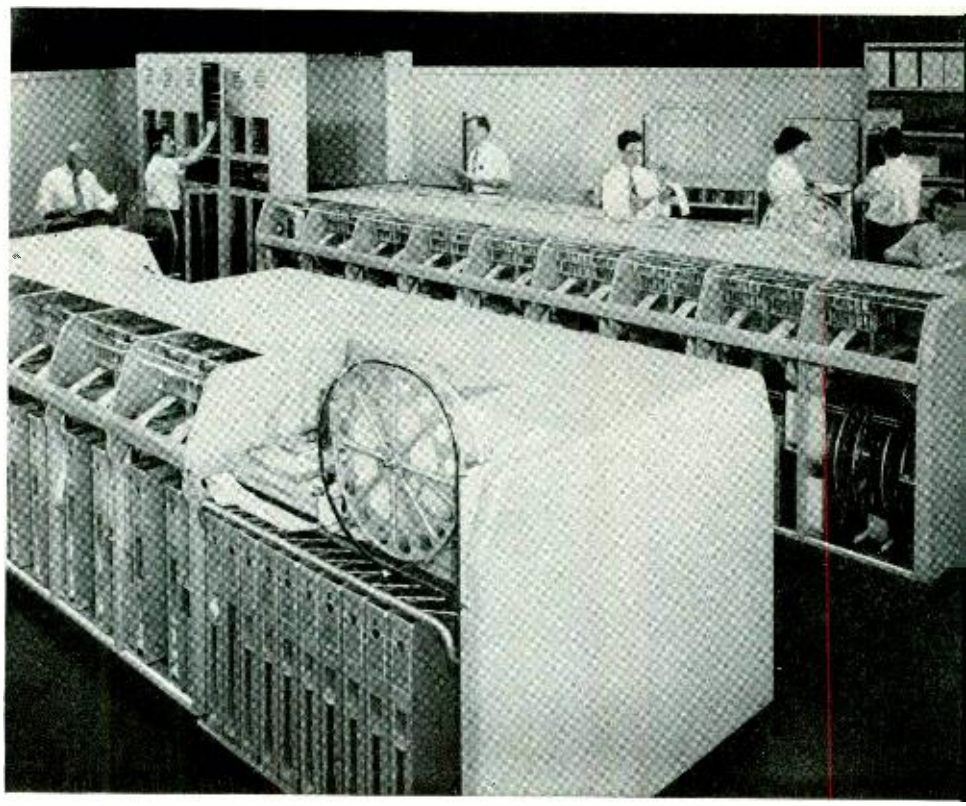
In brief, the system operates in this way:

The "electrical brain" of the central office switching system recognizes, on each local call, whether the subscriber making it has flat-rate or message-rate service, or, if the call is for a more distant point in the metropolitan area, which he can dial under the new system, whether the call is to be billed as a toll call. Thus it knows whether any record need be made of the call and, if so, in what detail.

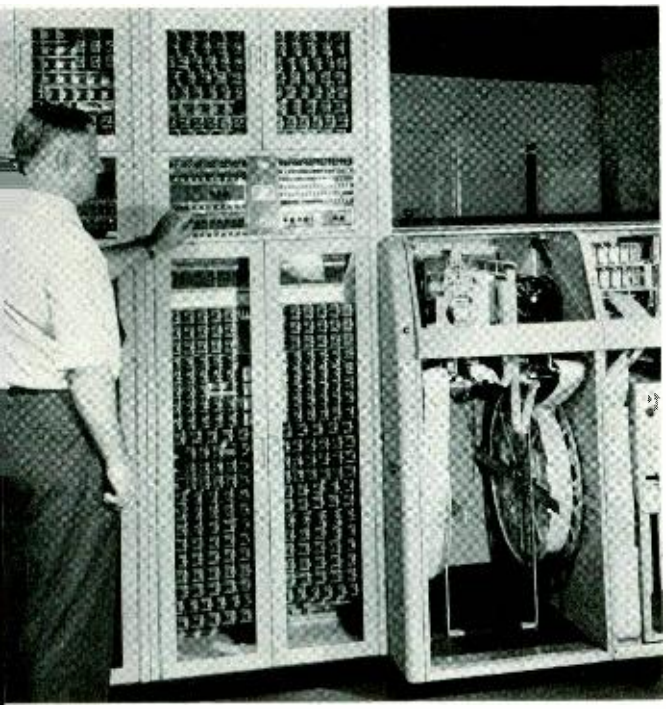
All of the information to be recorded is first translated into numerals, which are in turn represented by tiny holes punched in varying patterns on a 3-inch-wide paper tape. In this way a record is kept, where required, of the calling and called numbers, and the month, day, and exact time to tenths of minutes at which the conversation begins and ends. Each of these entries is made on the tape in a fraction of a second.

Thus, immediately after dialing, both the calling and the called numbers are punched into the tape. These entries are controlled by the "electrical brain" of the switching system, which has momentarily "memorized" these numbers to set up the necessary connection.

Later, after the called subscriber has an-



One of the tape reels like that shown in the foreground can hold all the required billing information on as many as 25,000 individual calls



E. W. Flint at one of the control panels of the automatic message accounting equipment. Billing information is stored up as telephone calls are made. Recorded in a coded pattern punched in paper tape, as shown at the right, this information is then assembled, sorted, summarized and printed by five successive machines in the accounting center

swered, the starting time of the conversation is recorded, and finally, as soon as the parties have finished talking, the time of disconnect is entered.

The tapes are cut daily and taken to the accounting office, where clerks feed them into the first of five successive machines. The first machine locates and groups together the various items of information on any single call—an ingenious operation required because the entry denoting the end of a conversation may appear on the tape at a point several yards distant from the starting entry. Between the two, there may be many other items—records of hundreds of other calls.

Other machines in the series rapidly go through the basic mathematical processes of addition, subtraction, multiplication and division. Certain relatively complex calculations are also made in converting the elapsed time of a call into chargeable units. A single machine can be set to deal with as many as eight formulae and will select the proper one automatically in order to solve the problem.

The equipment also performs a variety of other office tasks. For example, it sorts out all the thousands of calls according to the directory number of the subscriber who made them, and finally prints the details of the calls for use in making out bills.

One of the tape reels, filled to capacity, would contain code records on approximately 25,000 local and toll calls. The first processing machine in the accounting office is able to "read" all this information in about two hours. It scans, perfectly, over 80 coded digits per second.

The entire system is as thoroughly reliable as modern engineering and human ingenuity can make it. As one safeguard against possible breakdown, special tapes, containing the records of test calls, are run periodically to give advance warning of any mechanical difficulty.

The automatic message accounting system has been one of the major projects of the Laboratories. Its successful development from a basic concept to commercially operating machinery is the result of integrated group effort, with many individual members contributing their specialized skills and knowledge. There were engineers who studied the economics of various plans and formulated requirements. There were switching circuit designers who created the intricate maze of electrical control paths which automatically records, computes, sorts, summarizes, etc. There were equipment designers who visualized the circuit blueprints as a system of complex assemblage in three dimensions. Apparatus designers fashioned for the project such things as tape perforators and tape readers and relays that go through cyclic operations a thousand times a minute. Technical assistants, draftsmen, and shop personnel contributed their essential share. Finally, there were the supervisors who coördinated and guided the efforts of these various groups into an over-all pattern of progress toward the final goal. Such was the team that brought into working reality what was but an idea not so long ago.

Fifty years of telephone repeaters

C. A. SMITH
Transmission Development

Bell's first telephone transmitter was of the electro-magnetic type, and had no inherent amplification. There was thus only the power of the voice to overcome the losses of the line and give an audible sound at the distant end. With such a device, the distance over which communication could be carried on was short, and the immediate prospect for long-distance communication did not seem too bright. Within less than three years, however, Blake had invented his carbon transmitter that by the microphonic action of carbon contacts provided an amplification of the power obtained from the voice.

Almost at once it was seen that the carbon transmitter might have still greater usefulness. By placing such a transmitter directly facing a receiver, with a common diaphragm for the two instruments, an amplifying device might be available that could be placed in the line between terminals to overcome the attenuation losses in long circuits. It was not quite as simple

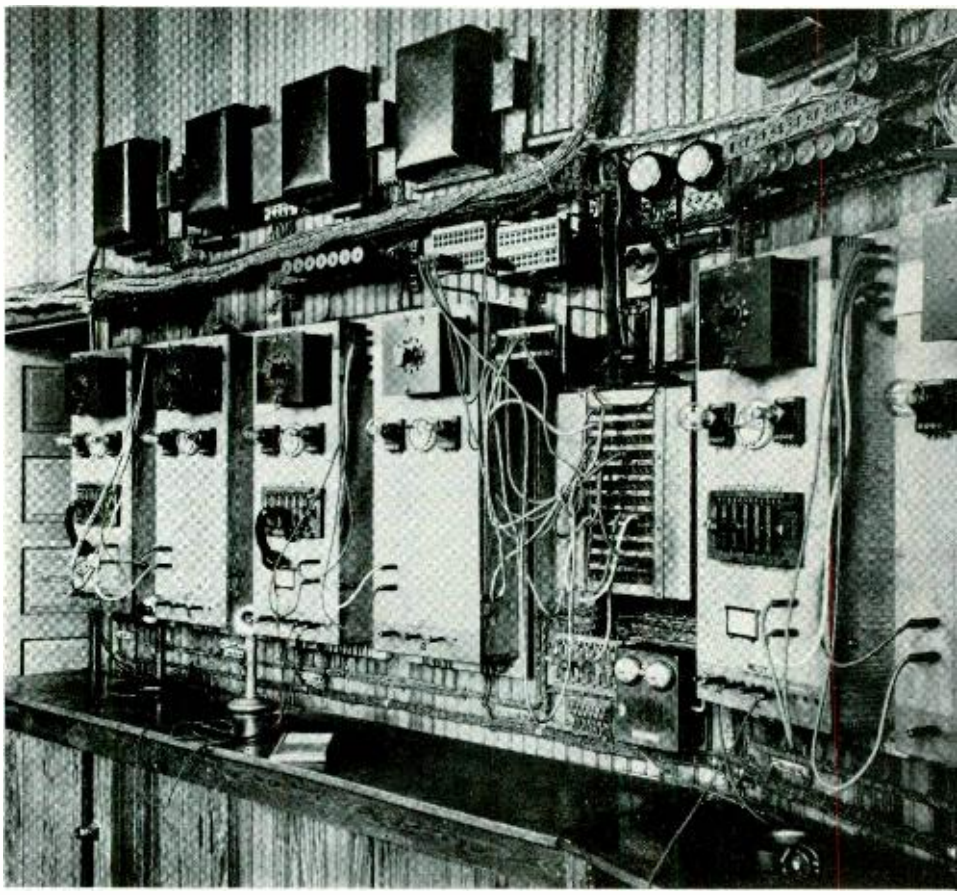


Fig. 1—A group of the first vacuum-tube repeaters installed at Brushton, Pa., on the transcontinental line. A view of one of these repeater cabinets with the door open is shown in Figure 3

as it sounded, however, and for twenty-five years inventors all over the world struggled to make such a device serve as a satisfactory telephone repeater. It was not until 1903 that H. E. Shreeve produced an amplifier of this type that was commercially usable. It went into service in 1904, and by 1907 there were sixty-one of them in use in the Bell System. A 1912 model is shown in Figure 2. Although never considered entirely satisfactory, it was used for lack of something better until it was replaced by the vacuum tube in 1915.

The Shreeve amplifying unit was associated with the line through hybrid coils. Prior to 1912, none of the filters, equalizers,

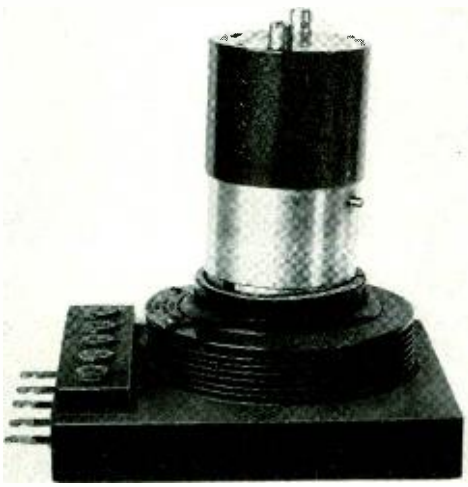


Fig. 2—The Shreeve repeater of 1912

and networks were available to make repeaters work in tandem. Repeaters in the modern sense of the word, therefore, really began with the first vacuum-tube repeater of 1915.

An installation of these first vacuum-tube repeaters in Brushton, Pa., is shown in Figure 1. It occupied two cabinets—each serving for one direction of speech flow, with additional apparatus mounted on the wall above the cabinets. A view of one of the cabinets with the door open is shown in Figure 3. A two-stage amplifier was used for each direction of transmission, and the two tubes, the gain adjusting potentiometer, and testing jacks are evident on the front of each cabinet. Within the cabinet is the rest of the equipment such as hybrid and retardation coils, plate and filament chokes, grid batteries, monitoring coil, and other accessories. These repeaters were used only for the transcontinental line at Brushton, Chicago, Omaha, Denver, Salt Lake City, and Winnemucca, Calif. Those west of the Mississippi remained in service in some instances for many years, but those east of the Mississippi were replaced in 1917 by the floor-type repeater.

This latter repeater is shown in Figure 4. Only one stage of amplification is used in each direction, but the major change is a more compact mounting arrangement that reduced the space required from about 12 cubic feet for the transcontinental repeater to 5.5 cubic feet. Manufacture of this repeater continued until 1923, when some two thousand had been produced.

Although the first designs of the above repeaters were for open-wire circuits, a similar design was used on the Boston-Washington cable. In 1920, however, the Reading-type repeater—shown in Figures 5 and 6—was developed. It was used only on the cable circuits between New York and Pittsburgh, but remained in service for many years. Besides having the advantage of being suitable for cable, it reduced the space required to 1.85 cubic feet.

In 1923, the 22A1 repeater, shown in Figure 7, became available for new installations in place of floor-type and Reading-type repeaters. It could be used with either open wire or cable. For nearly fifteen years, this repeater remained standard for the Bell System, and to date more of them have been installed than of any other type. One of the features of this repeater was its design for appearance. This is even more evident in the 22A2, shown in Figure 8. This latter repeater was brought out in 1931 to incorporate an accumulation of improvements since the original design of the 22A1. In size and general features, it is essentially the same as the A1, and a repeater with the same general equipment features became available for four-wire circuits called the 44A1. In briefly following repeater history, the 22A1, 22A2, and the 44A1 may be considered as a single development, and over 125,000 of them have been produced in one

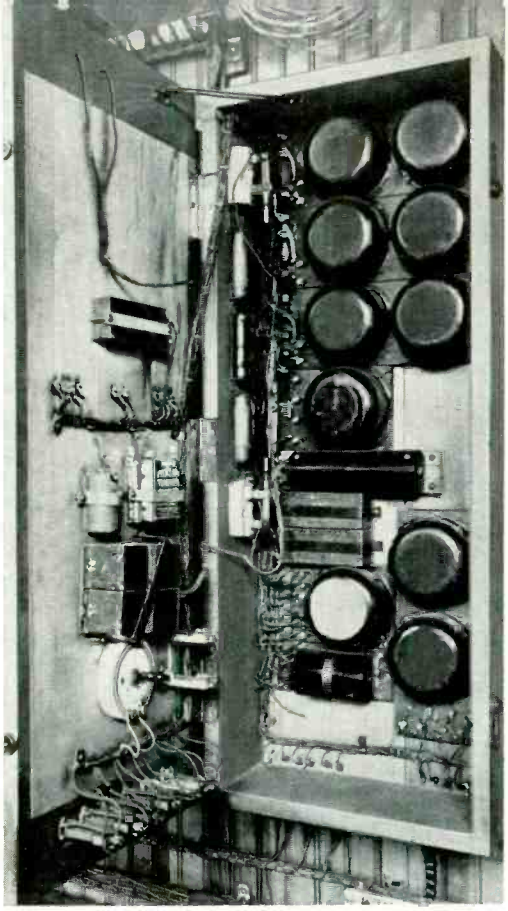
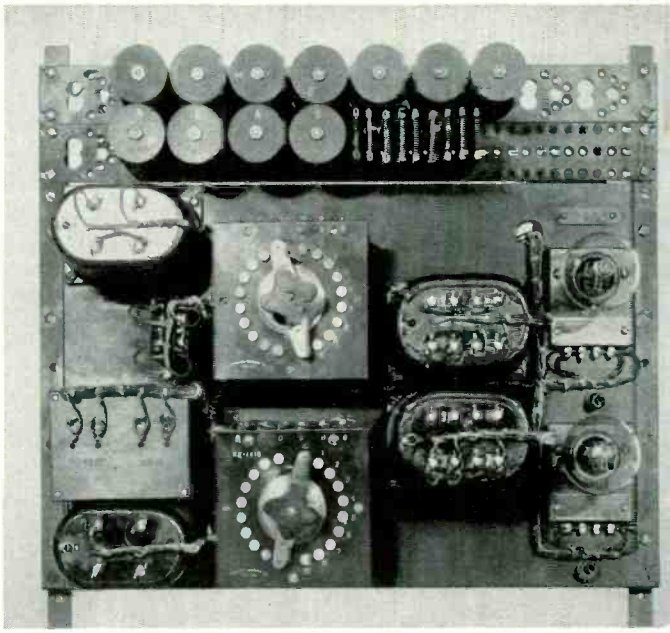
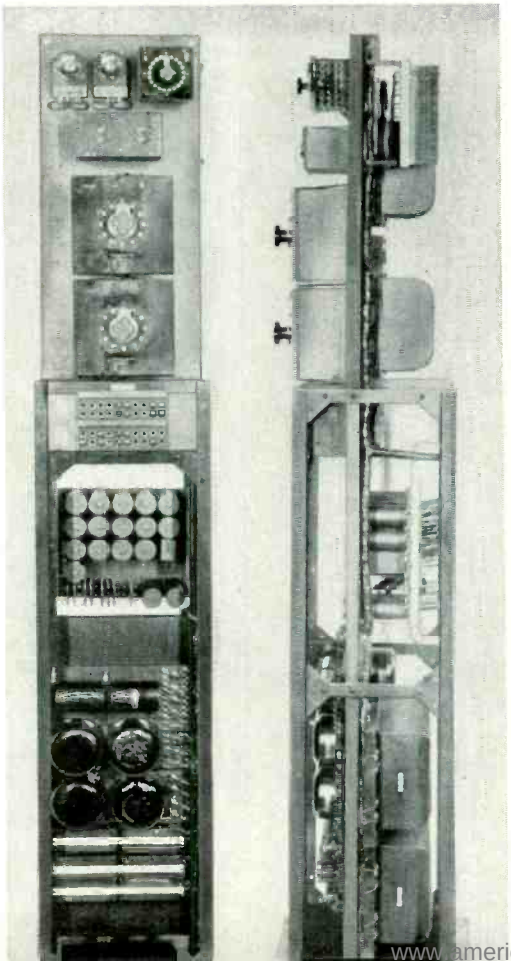


Fig. 3—One of the amplifiers of the Brushton repeater

Fig. 5—Front view of the Reading-type repeater





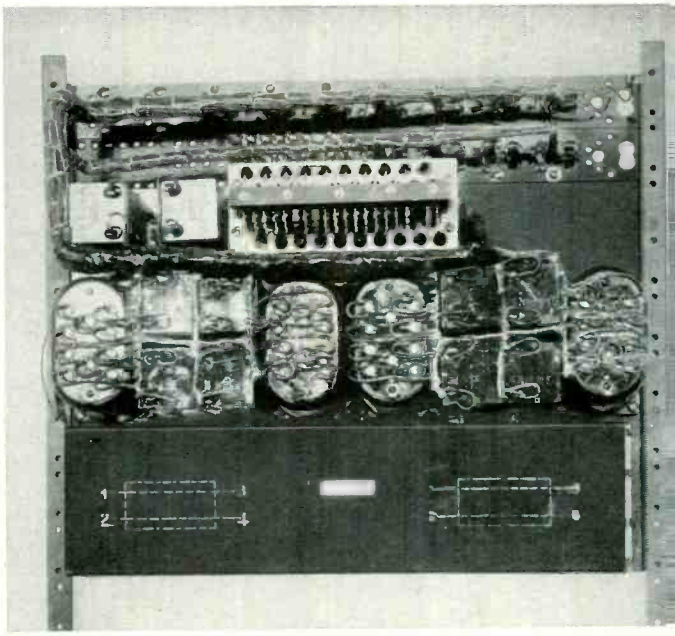


Fig. 6—Rear view of the Reading-type repeater

Fig. 4—Front and side views of the floor-type repeater

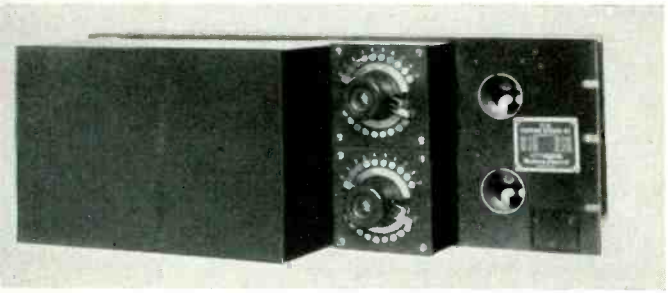


Fig. 7—The 22A1 repeater, which began its extensive life in 1923, could be used with either open wire or cable. Standard for over fifteen years, more of them have been installed than any other type

form or another. The 22A1 had a filament power of 4.5 watts as did the earlier repeaters, but in the late 20's this was reduced to 2.1 watts by the substitution of an improved design of tubes. This repeater occupies a volume of only 0.92 cubic foot and thus from the standpoint of size also makes a decided advance over its predecessor.

The next major advance was the V1 repeater, brought out in 1939. Shown in Figure 9, it marked a radical departure from previous designs in combining the hybrid with the line repeating coil, and in relegating the filters and equalizers to the line equipment, thus permitting the repeater

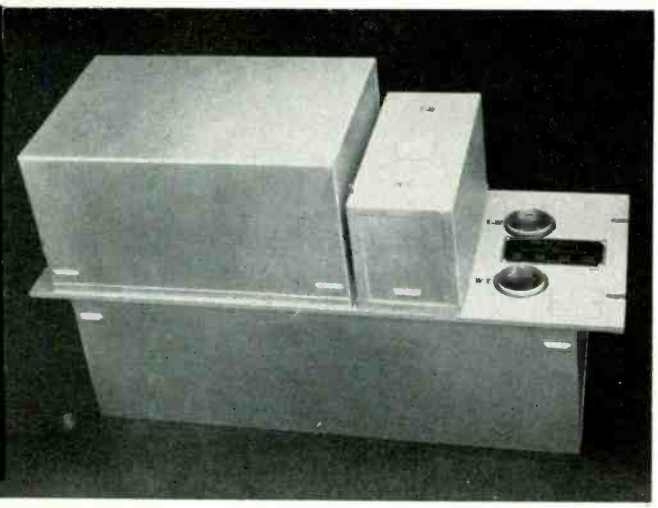


Fig. 8—The 22A2 repeater, which in 1931 incorporated a number of improvements of the 22A1. A repeater with the same general features, called the 44A1, also became available for four-wire circuits

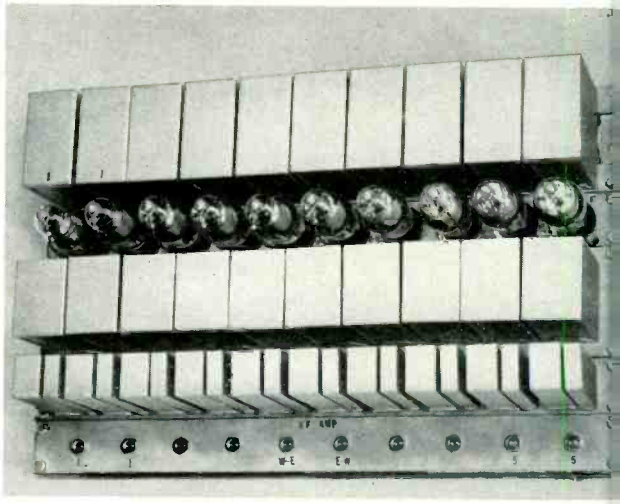


Fig. 9—Five of the V1 repeaters which marked a radical departure from previous designs. Applicable to either two-wire or four-wire circuits, one of these repeaters occupied a space of 0.28 cubic foot

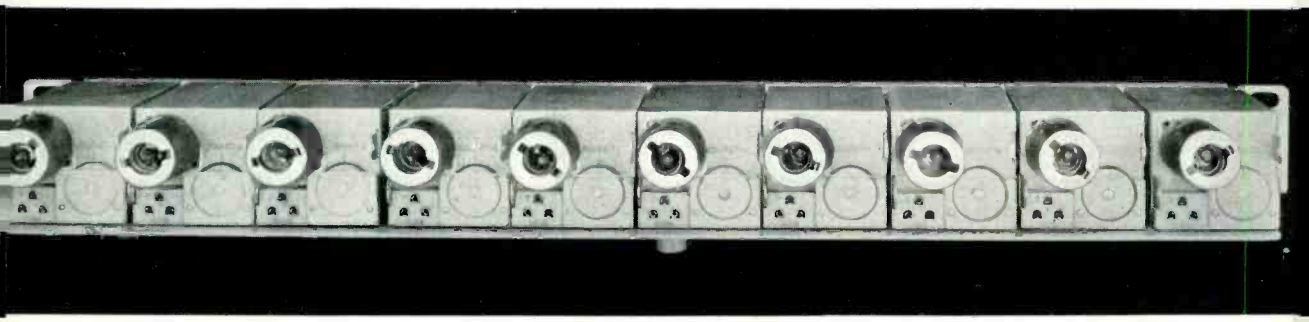


Fig. 10—Five of the V3 repeaters which were placed in operation during 1948. A pair of amplifiers, constituting one of these repeaters, has a cathode power drain of only 2 watts and occupies only 0.04 cubic foot

bays to carry only the amplifying circuits. The space required for the two amplifiers, however, was reduced to 0.28 cubic foot. This reduction in size was offset, somewhat, by an increase in cathode power to 3.2 watts which was later reduced to 2.7 watts. It was applicable to either two-wire or four-wire circuits.

Even this large reduction in size made by the V1 is small compared to that achieved by the V3, shown in Figure 10, which went into the telephone plant in 1948. The pair of amplifiers which constitute the V3 repeater occupies only 0.04 cubic foot and has a cathode power drain of only 2 watts. When mounted on a rack, the space required is about one-sixth that of the V1 repeater. The V3 repeater, which will be described in greater detail in a forthcoming issue of the RECORD, leaves little room for further reduction in size in the near future.

THE AUTHOR: C. A. SMITH graduated from Alabama Polytechnic Institute with a B.S. in E.E. degree in 1921, and then joined the Engineering Staff of the Southern Bell Telephone Company. In 1923, he transferred to Hawthorne Standards Engineering, and thence, in 1926, to the Systems Development Department of these Laboratories. As a member of the Technical Staff, he has worked on the equipment aspects of various toll transmission and measuring systems. During the war, he was in charge of equipment development groups on sonar, radar test equipment, harbor protection devices, airborne communication jammers, and secrecy devices. At present he heads the development group handling the equipment phases of wire carrier, broadband terminals, and transmission measuring circuits.

Timing control for PCM

A. E. JOHANSON
Transmission Research

In any PCM system, precise timing of a number of operations is required at both the transmitting and receiving ends of the circuit. Eight or more thousand instantaneous samples of the voice wave of each channel are taken every second, and each is coded into a group of on-or-off pulses for transmission. Not only must each step in the sampling and coding procedure be accurately timed but the codes for successive channels must be supplied to the transmitting circuit in a definite predetermined sequence. At the receiving end there must be a similar timing system to control the decoding and distributing of channels. Moreover, the receiving end must be synchronized with the sending end so that each pulse of a code will be assigned its correct rôle in the decoding process, and so that the decoded samples for the various channels that are involved will always be distributed to the proper receiving channels.

In the experimental 96-channel PCM system,* the channels are divided into eight groups of twelve channels each. Each of the eight groups is modulated by a group carrier to a different frequency band for transmission, but the twelve channels within each group are all transmitted within the same frequency band by the PCM method of time division multiplex. Since the precise timing is required only for the PCM part of the system, a single timing system is employed for all the twelve-channel groups.

Each code pulse is about 1.5 microseconds long; eighty-four of them, seven for each channel, exactly fill an interval 125 microseconds long—one-eighth of a thousandth of a second. There is no space between successive code groups or between

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

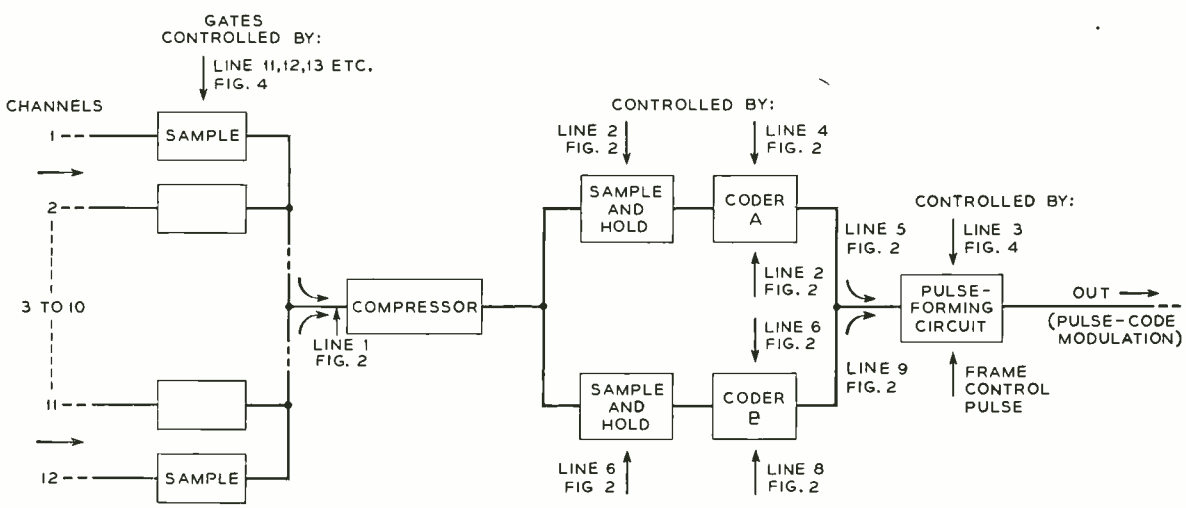


Fig. 1—Block schematic of the transmitter of the 96-channel experimental PCM system

successive pulses within the code group. Since there are eighty-four pulse positions in 125 microseconds, the pulse frequency is 84 divided by $125\times10^{-6}=672$ kc. As a basic source of timing, therefore, a 672-kc stable crystal-controlled oscillator is used at the transmitter. If a similar oscillator were used at the receiver, two difficulties would arise. In the first place the two oscillators would inevitably drift apart to cause incorrect synchronization, and in addition there would be the difficulty of phasing which would be complicated by the time required for the transmitted signals to reach the receiver. Instead, therefore, both the correct timing frequency and the correct phasing are derived from the transmitted pulses, and thus the basic timing wave of the receiver is identical to that at the transmitter and the phasing is automatically held correct. With this arrangement any slow drift in the frequency of the oscillator has no effect since the receiving end varies with it.

A simple block diagram of the transmitter is shown in Figure 1. The boxes marked "sample," at the left, are electronic gate tubes activated by pulses from a ring circuit so that one and only one will be conducting at a time, and when the conducting tube is blocked, the adjacent one will start to conduct. These gates are used to connect the twelve channels to the compressor successively for equal periods of time in each 125-microsecond interval. Since each gate must be opened every eight-thousandth of a second, and since there are twelve gates in the group to be opened successively, a timing pulse recurring at a 96-kc rate (12×8 kc) is required to trip the tubes of the ring circuit, so that each channel is connected to the coding circuit for just one-twelfth of the eight-thousandth of a second period between successive samples of a channel. The current to the compressors, therefore, the next box to the right in Figure 1, consists of a continuous succession of 10.4-microsecond specimens of the twelve channels. This is illustrated on line 1 of Figure 2.

A block diagram of the timing system at the transmitter is shown in Figure 3, and some of the pulses generated are shown in Figure 4, where the numbered lines show the wave-forms at the correspondingly numbered points of Figure 3. Line 1 of Figure 4 represents the output of the basic 672-kc oscillator. This is passed through a limiter to give the square-top pulses of the same frequency shown in line 2. These pulses are in turn passed through a differentiating and rectifying circuit—one of several such circuits in the timing system. The differentiator forms narrow pips of voltage alternately positive and negative

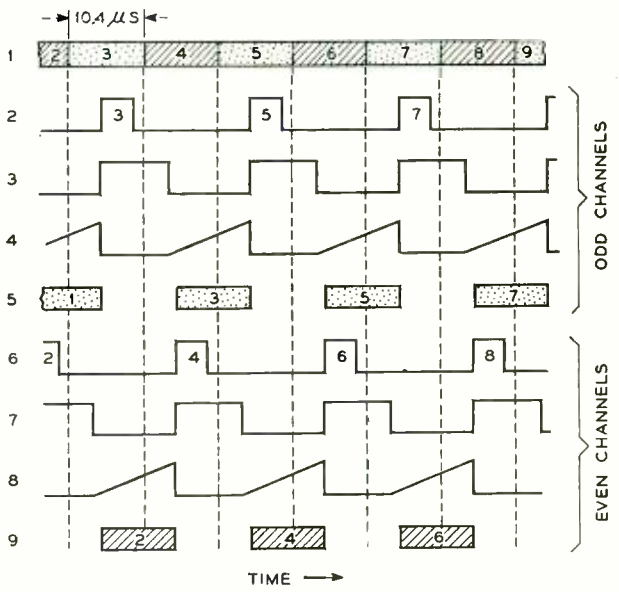


Fig. 2—Pulse forms at numbered points of Figure 1

at the steep sides of the square pulses, and the rectifier eliminates all the positive pips so that the output from the circuit appears as on line 4.

This is passed to a 7 to 1 multivibrator frequency reducer which gives a square-top output wave of 672 divided by 7, or 96 kc. This is an unsymmetrical wave—one "half cycle" being three periods long of the basic timing wave, and the other four. Two outputs are taken from this frequency reducer, which are identical but of opposite phase. One output, shown in line 5 of Figure 4, is passed through a differentiator and rectifier which gives the 96-kc sequence of positive pips shown on line 6 of Figure 4—the rectifier eliminating the negative pips instead of the positive pips as the similar

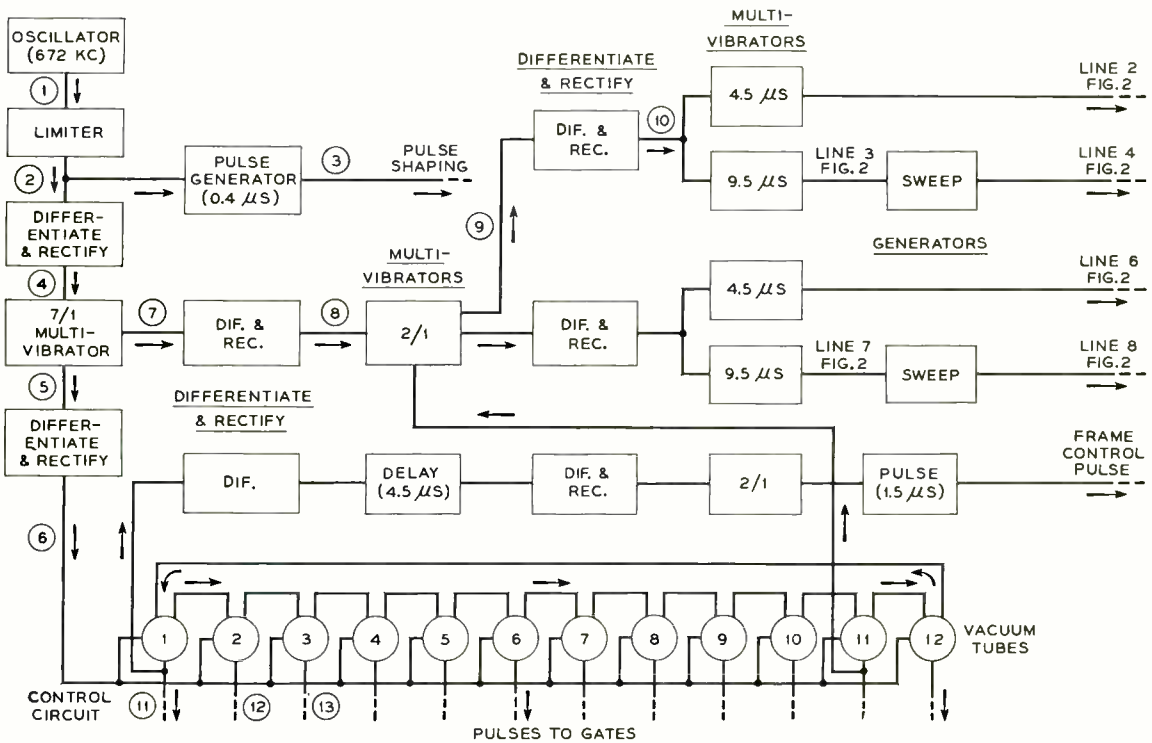


Fig. 3—Block diagram of timing system at the transmitter

circuit did in producing line 4. This sequence of pips is applied to the common control bus of a 12-stage ring circuit shown in the lower part of Figure 3. With each occurrence of a 96-kc pip, conduction is stepped along from one stage to the next until number 12 is reached. The next pip shifts conduction from stage 12 to stage 1, and the cycle repeats. In this way, the 10.4-microsecond activating pulses for the gates of Figure 1 are generated.

Coding, which has already been described in the RECORD,* is done by two circuits, one coding the samples of all even channels, and the other of all odd channels. The complete coding period is therefore about 20.8 microseconds long, or twice the length of a single code group. During this period, an instantaneous sample must be taken of the 10.4-microsecond specimen of the speech wave, the value of the sample must be applied to the vertical deflecting plates of the coding tube, the tube must be enabled, the sample must be quantized, the beam must then be swept across the code mask to produce a code group, and then the tube must be disabled while the sweep returns to the starting point. Since the period of each coder is 20.8 microseconds, corresponding to a frequency of 48 kc, a set of pulses occurring at a 48-kc rate is used as the basic timing for this circuit. These are derived by passing the second output of the 7 to 1 multivibrator shown on line 7 of Figure 4, through another differentiator-rectifier that gives the sequence of negative pips shown in line 8. These are used to control a 2 to 1 multivibrator that gives a square-top output at 48 kc shown on line 9 of Figure 4.

Two outputs are taken from this multivibrator which are identical but of opposite phase. Each controls one of the two coders, since the actions with each coder are the same except for the displacement in time. Only the pulse sequences for controlling coder A are shown in Figure 4. The se-

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

quence for the other coder is exactly the same but shifted in time 10.4 microseconds. Besides occurring at the proper frequency, the pulses controlling the coding must be phased relative to the entrance of the specimens from the channels they are to code. That is: the phasing of the 2 to 1 multivibrator must be controlled so that coder A always codes the odd-numbered channels and coder B the even. This is accomplished by a second control circuit taken to the 2 to 1 multivibrator from the No. 11 stage of the ring circuit, as indicated in Figure 3.

Output 9 from the multivibrator is passed through another differentiator-rectifier to obtain the 48-kc sequence of negative pips shown in line 10. These pips trigger two single-trip multivibrators whose time constants are arranged to give output pulses of 4.5 and 9.5 microseconds duration respectively. These are shown on lines 2 and 3 of Figure 2. The 9.5-microsecond pulse, line 3, Figure 2, controls the charging time of a capacitor in a constant current circuit, allowing the capacitor to charge linearly while the pulse is off and maintaining the voltage across the capacitor at zero when the pulse is present. This gives the linear sweep voltage of line 4, Figure 2.

The "sample and hold" circuit at the entrance to the coder is an electronic gate with a capacitor in its output circuit. While the gate is held open by the 4.5-microsecond pulse of line 2, Figure 2, the voltage across this capacitor follows the voltage of the admitted specimen. When the gate closes, therefore, the voltage on the capaci-

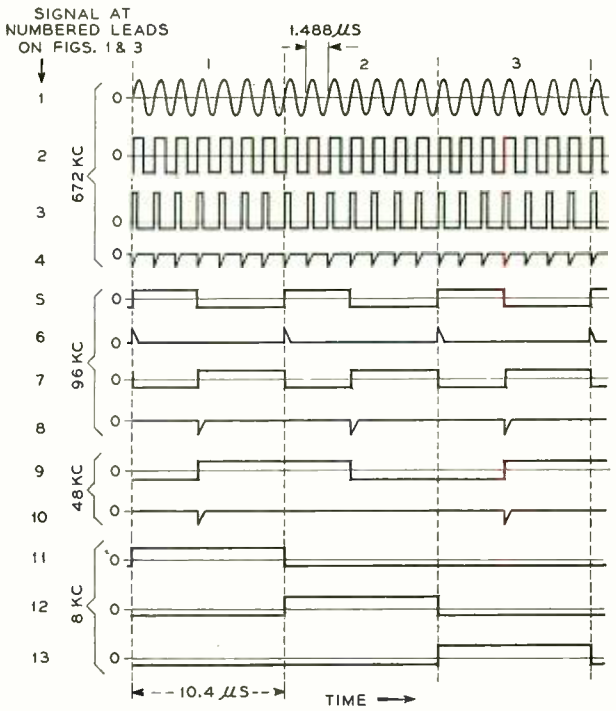


Fig. 4—Pulse forms at the numbered points of Figure 3

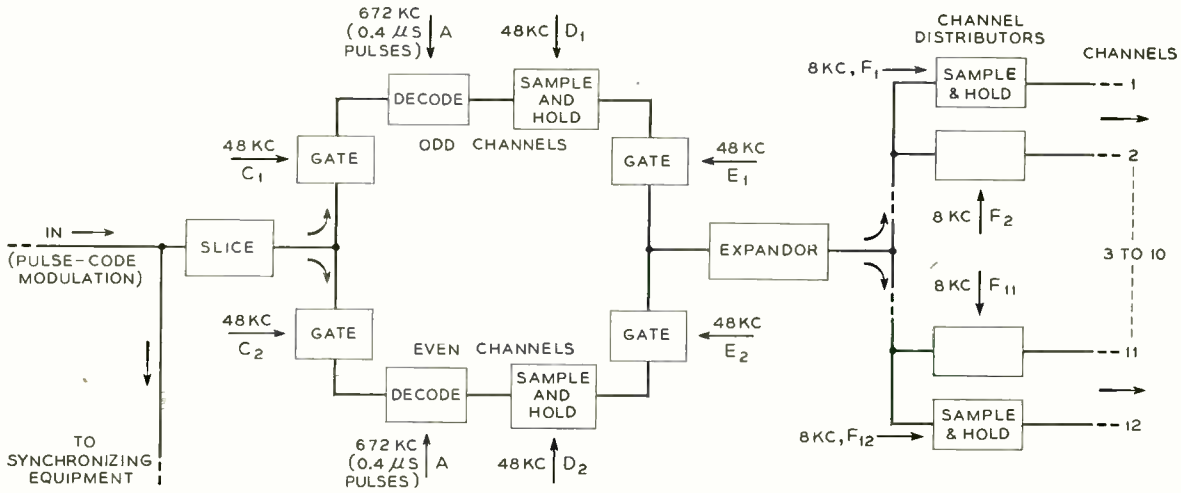


Fig. 5—Simplified block diagram of the receiving circuit

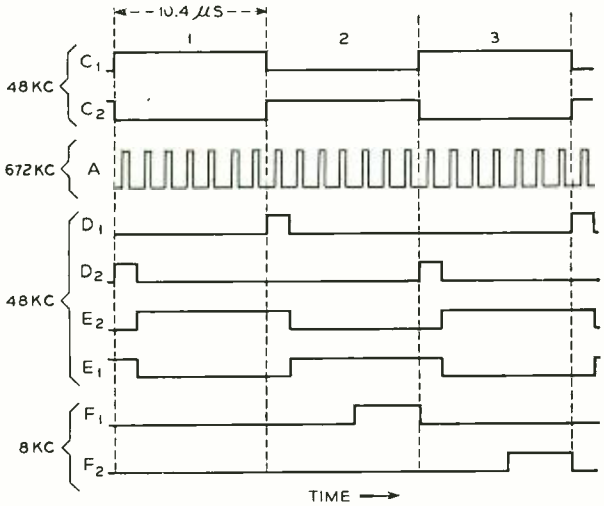


Fig. 6—Timing pulses used in the receiving circuit

tor will be equal to that of the signal at that instant and will remain at that voltage until the gate opens again. This held voltage thus represents an instantaneous sample of the signal and is at once applied to the vertical deflecting plates of the coding tube. At the closing of the gate, the electron beam of the coder tube is turned on. A brief interval is then allowed to permit the feedback of the coding tube to adjust the height of the beam to the proper quantized position, and then the coding sweep, line 4, Figure 2, sweeps the beam across the code plate, giving the code groups indicated on line 5 of Figure 2. The same pulse that opens the gate, line 2, Figure 2, then turns off the beam, the sweep returns to zero, and the instantaneous sample from the next odd channel is taken and applied to the coder tube. Lines 6, 7, 8, and 9 of Figure 2 show the same sequence for coder B.

The outputs of both coders connect directly to the common pulse-forming circuit shown at the right of Figure 1, and it will be noticed from Figure 2 that the code trains are supplied to it continuously. An even code will begin exactly at the point where the previous odd one ended, and the next odd one will begin where the preceding even ended. As they are formed in the coding tube, however, the code pulses are irregular in shape, and the next step is to square up the pulses and make them of uniform duration. To accomplish this, a small section is taken out of the middle of each code pulse, squared up and increased to the proper 1.5-microsecond duration for transmission. Since the pulse rate is 672 kc, a 672-kc sequence of pulses 0.4 microsecond long is used for this purpose. These pulses are derived from the pulses of line 2 of Figure 4, and are shown on line 3.

At the receiving end, a similar timing sequence is carried out but with the intervals suited to the operation of the decoding as already described.* A simplified block diagram of the receiving circuit is shown in Figure 5, and the timing pulses used are shown in Figure 6, where lettered lines indicate the controlling wave-form at the correspondingly lettered points that are shown in Figure 5.

As already mentioned, the basic timing frequency is derived from the incoming code pulses, as will be described in a forthcoming article. Having this wave correct

*Record, *November,* 1948, *page* 451.

THE AUTHOR: A. E. Johanson joined the Laboratories after graduating from high school in 1929. Beginning as a messenger, he progressed to Technical Assistant and finally to Member of the Technical Staff. He received the degree of B.E.E. from New York University in 1944. He is a member of Tau Beta Pi and Eta Kappa Nu. As a member of the Transmission Research Department, his work is primarily on pulse modulation. During the war he was concerned with the development of non-linear coils for radar applications.

in frequency and phase is not sufficient to properly synchronize the receiving end to the transmitting terminal. The code pulses of each group of twelve channels are received in a continuous string, and it is necessary to insure that the receiving circuits start decoding at the right points and that a sample of a particular channel be distributed to that channel at the receiving end. With the present synchronizing system (to be described in a forthcoming article) to time all ninety-six receiving channels properly, it is necessary to recognize only one code pulse out of all the code pulses for ninety-six channels. For this purpose, the least valued code pulse of one channel is taken over and given a distinctive repetition rate. This is accomplished by applying a "frame control" pulse to the pulse-forming circuit of Figure 1. This pulse is 1.5 microseconds long and occurs once in each 125-microsecond interval, but has opposite polarity in successive intervals. It is timed to coincide with the first code pulse of channel No. 1 and is large enough in amplitude to override the pulse or space put out by the coder tube in that pulse position. Hence in the final PCM output, code pulse 1 of channel No. 1 recurs at a 4-kc rate. The steps used in deriving this "frame control" pulse are shown in Figure 3, but the sequence is not carried out in Figure 4.

Now the Telephone

The New York Telephone Company's application for an increase in rates is less than surprising. In these ascending days, the telephone business feels it also has a case. With no change in charges since 1930, the argument goes that while the revenue is far up, the expenses have risen even more. As a result, earnings are steadily sliding downward, and it is contended that rates must be bolstered to provide the added income that swings the earnings upward and attracts capital required for improved and expanded operation. No going business is able to stand still, and so the telephone company has presented its case to the Public Service Commission. An approximate increase of 15 per cent is sought, with the additional request that an immediate charge of 10 per cent be imposed on subscribers' bills until the details of a new schedule are worked out.

The details are for experts to judge; the ordinary individual, represented by a number in the telephone book, simply does not know the merits of the company's case. Upon reading that home telephones, on the average, would cost 75 cents a month more, and business telephones an extra $1.50, the amount of grumbling is likely to be rather modest. Most people, after all, take the telephone almost for granted as one of life's enforced necessities. The P. S. C. should take care to look upon the telephone company's plea with a critical eye, conducting thorough public hearings, weighing and analyzing the evidence. But it should report out a fair decision, meeting the needs of the company, with reasonable dispatch.

While few of us enjoy the thought of paying out more money, some of the sting is relieved by the so-called "metropolitan plan." In line with the New York Telephone Company's gift for making and handling news, it points ahead to the day when New York City and suburbs will be on a universal dial basis. As one step toward that goal, toll-free calling areas are to be greatly expanded in Nassau and Westchester, and calls to and from the city may be reckoned as multiple units against the monthly bill's allowance of messages. In effect these two great counties will become even more a part of the city as telephone engineering keeps step with metropolitan facts. The proposed plan is a forward step that should be welcomed.

—*New York Herald-Tribune, November* 18, 1948.

Meter scales for transmission measurements

J. L. MERRILL, JR.
Exchange Engineering

In maintaining satisfactory transmission over telephone circuits, and in many studies carried on by the Bell System, a number of quantities and units are employed that differ from those encountered in most other engineering work. Noise, for example, and speech volume, although familiar to everyone, require precise measurement chiefly in electrical communication and the allied arts. Moreover, the instruments and scales used for measuring them differ from those more ordinarily employed; and even for measuring some of the more common quantities, such as power, the instruments and scales are not like those of other industries. The most widely used of these scales are shown in Figure 1. They are all alike among themselves but differ from the more usual form of scale in being logarithmic; and the instruments using them, except the sound meter, are also alike in all, being calibrated on 1,000-cycle sine-wave power in a 600-ohm circuit. In spite of these similarities, the readings of the various instruments are not directly comparable because of differences in the reference units and in the dynamic characteristics of the instruments themselves.

To measure a thing is to determine its magnitude relative to some standard magnitude; the measure itself is merely the numerical value of this ratio with the name of the reference unit added. The law of measuring could thus be expressed as $y=kx$, where y is the magnitude of the thing measured, x is the magnitude of the unit in which y is to be measured, and k, the measure proper, is the constant of proportionality relating x and y. For simple, direct measurements of this type, the principal criterion in selecting a unit is the magnitude of the thing being measured, since it is inconvenient to have the measure either too large or too small. Thus for a measure of the distance between New York and Chicago, the mile would be a convenient unit. Had the distance to be measured been that between the sun and Arcturus, a light-year would probably have been a more convenient unit, while had the length involved been that of a wave of yellow light, an angstrom unit would have been more convenient to use.

In this simple, direct form of measurement, both the thing measured and the unit employed are of the same type of quantity: all are lengths in the above examples. Many measurements in science and engineering are of an indirect type, in that to determine the magnitude of a quantity of one type, the magnitude of a quantity of another type is measured. Thus to determine the voltage across a known resistance in a d-c circuit, we might measure the current flowing in the resistance. The voltage would thus be determined by a measurement of current. In this case, the process also is simple because the voltage across a resistance is directly proportional to the current flowing through it: $v=ri$, and the measure of the current is merely multiplied by the value of the resistance in order to obtain the voltage.

It happens, however, that in many of the indirect measurements made in scientific and engineering work, the two quantities involved are not directly proportional to each other. Under such conditions, a more or less complicated computation may be required to determine the value of one

quantity from the measurement of another. Considering, for example, the relationship between distance and time for a freely falling body, which may be expressed as $d=16t^2$. To determine the distance from this expression, the time of fall must be found, then squared, and then multiplied by 16. If for some reason or other it were necessary to make a very large number of such calculations, it would be simpler to employ for the time measurements a different type of unit that would include the squaring and the difficult part of the multiplying, and to design a meter, if possible, that would measure time in this new unit, which might be called a distance unit and designated DU. If the DU were taken as equal to $1.6t^2$, distance and DU would be related by the simple expression $d=10DU$. The clock used to indicate values of time in DU would have to be designed so that it read 1 when the time was 0.79 second, 4 when the time was 1.58 seconds, 10 when the time was 2.5 seconds, and so on, but once the meter was available, the determination of distance from its readings would be a simple matter.

In telephone and acoustical work, it is found that a number of quantities commonly used vary with power, but that as with distance and time of the above example, the relationship is not one of direct proportionality. With the direct current flowing through a resistance, the variation of v with i is constant; in terms of the calculus, it would be expressed as

(1) $dy/dx=k$,

where y represents voltage, and x current. With the falling body, the equivalent relationship would be

(2) $dy/dx=kx$,

where y is distance and x, time. The relationship commonly found in telephone work, on the other hand, is of the form:

(3) $dy/dx=ky$,

where y may be voltage, current or power, and the x may be any of several things. In equation (1) above, the change of y with respect to x is constant; in equation (2), it is proportional to x; and in equation (3), to y. This latter type of relationship is very common in nature and is sometimes called the compound interest law, since the change with time in a sum of money, or principal, drawing compound interest is proportional to the principal. If the differential expression $dy/dx=ky$ is integrated to obtain an equation giving the relationship over a finite period of time, it becomes:

(4) $\log y_1/y_0=kx_1$,

where y_0 is the amount of principal at the beginning of the period considered, and y_1 the amount at the end of the period, while x_1 is the length of the period, and k depends on the rate of growth of principal, and on the units in which x_1 is measured. This is the mathematical compound interest law in which the growth of principal is continuous, that is, the compounding is carried on over infinitesimal periods. In commercial practice, the compounding is carried out over finite periods, usually of one year, and in this case k is the logarithm of 1 plus the interest rate. To find y_1 from a measurement of x_1 with such a relationship is not simple. Those dealing with compound interest, such as banks, have tables giving the values of y_1, y_0, interest rate, and x_1 over a wide range of values.

In telephone work, where solutions of exactly similar equations are more frequently required than readings of voltage, even tables would be too awkward. Instead, the difficulty is overcome by a method similar to that suggested as possible in connection with the falling body. A new unit of power measurement is employed, and meters* have been developed to indicate power in terms of this artificial unit, which is called the decibel—abbreviated db. Equation (4) above may be rewritten as

(4A) $1/k \log y_1/y_0=x_1$.

For the db unit of power measurement, k is taken as 0.1, and since y_1 and y_0 are both powers, the db is $10 \log p_1/p_0$. When power is measured in db, therefore, the value of the quantity x_1, whatever it happens to be, is exactly the same as the number of db shown by the meter when the relationship between x_1 and power is as given in equation (4).

This type of unit and the particular value chosen for it arose because of the relationship between power and distance in a telephone line.† Between the power at two points of a telephone line and the distance

*RECORD, *January*, 1937, *page* 167.

†RECORD, *December*, 1928, *page* 137.

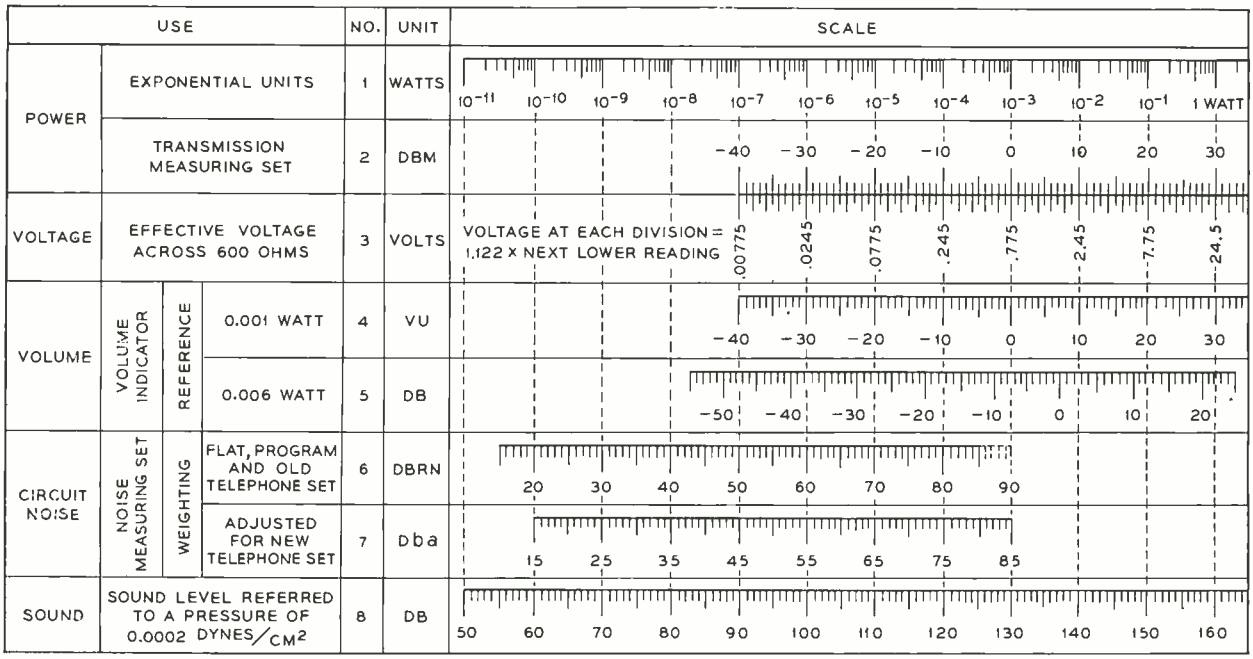


Fig. 1—Db scales widely used in the Bell System

between them, the relationship is as expressed in equation (4), and for the particular type of cable standard at that time, the constant k was approximately 0.1. A similar relationship holds between power and volume, and between power and noise. There are a number of factors that complicate these latter relationships, however, and it is because of them that the various instruments, whose scales are shown in Figure 1, are not directly comparable except on the basis of 1,000-cycle sine-wave power.

Because a reading in db always expresses the logarithm of a ratio, the zero of the db scale does not have the significance it has on a linear scale. When a milliammeter reads zero, for example, it means no current is flowing. When a db meter reads zero, on the other hand, it means that the ratio between the two powers involved is 1, since the log of 1 is zero. Plus readings mean that the power is greater than the reference power and negative readings that it is less. The ratio involved is between two powers—that in the numerator being the power existing at the time the reading is made and that in the denominator being the reference power. With any reading in db, therefore, a reference power is associated. For the various db scales plotted in Figure 1, the reference power at 1,000 cycles may be determined from the upper scale, which is in watts plotted exponentially. Except at 1,000 cycles, however, the relationship between meter reading and reference power may be complicated. Speech waves, for example, vary in a complex way with time, and the instruments used for measuring them have specified time-response characteristics. Sound level, on the other hand, requires translation from one medium to another, and the primary reference is pressure instead of power, since it is the pressure of an acoustic wave that is measured directly. Only for steady-state quantities measured in dbm is the relationship direct and precise.

It is common practice in the Bell System to express the electric power used for testing telephone lines and equipment in decibels with reference to one milliwatt. This unit of measurement is abbreviated dbm and means: db with respect to one milliwatt. Scale 2 is of this type, and is used

with transmission measuring instruments.

Instruments with db scales used for measuring across a transmission line are essentially voltmeters. When bridged across a line, they draw a very small current that is proportional to the voltage of the circuit. Their scale readings are interpreted as power, however, and they truly represent power if the impedance of the circuit is 600 ohms, which is the input impedance of the transmission measuring sets used today. For a 600-ohm circuit, the voltages corresponding to the various indications are shown in scale 3. If the impedance across which the instrument is connected is not 600 ohms, a correction must be made; the reading must be decreased if the impedance is above 600 ohms and increased if it is below. This correction is shown in Figure 2.

The volume indicator now standard in the Bell System measures speech voltages in terms of volume units. The zero of its scale is set at 0.775 volt rms of a 1,000-cycle sine wave. This is equivalent to a power of one milliwatt of 1,000-cycle tone dissipated in a 600-ohm resistance. One volume unit, VU, compares to 1 db in that both units stand for the same ratio. The scale of the volume indicator* is No. 4 of Figure 1. When the volume indicator is used to measure the volume of speech on a 600-ohm telephone line, however, a reading in VU made in the manner specified for this type of device does not indicate the average power in the speech. The meter is too slow to follow speech peaks, yet too fast to indicate long-time average power.*

Prior to the adoption of the VU as a measure of speech volume, 6 milliwatts at 1,000 cycles was used as the reference power, and volumes were given in db above or below this reference volume. Scale 5 is used for this purpose. Its zero corresponds to 6×10^{-3} of scale 1, and from this point the scale has positive values of db to the right and negative values to the left.

Scales 6 and 7 are used with instruments measuring noise in electrical circuits. The 2A† and 2B noise meters are standard measuring sets. Since the minimum value of 1,000-cycle power that can be heard on a circuit with the older types of telephone sets in a quiet room is about 10^{-12} watts, this value of power is taken as the reference for the noise meter. The scale is in db, and a reading is referred to as so many db above reference noise, or dBRN. On this scale, 90 db corresponds to a power of one milliwatt at 1,000 cycles.

Since the purpose of a noise measurement is to determine the interfering effect of noise, a simple measure in terms of power is not sufficient. Telephones and other terminal equipment, like the human ear, do not have the same efficiencies at all frequencies, and thus the interfering effect of the noise will depend on its frequency composition, the characteristics of the telephone system, and the noise conditions in the room in which the person is listening. To take care of some of the factors that affect the interfering effect of noise, weighting networks have been developed to be used with the noise meters.

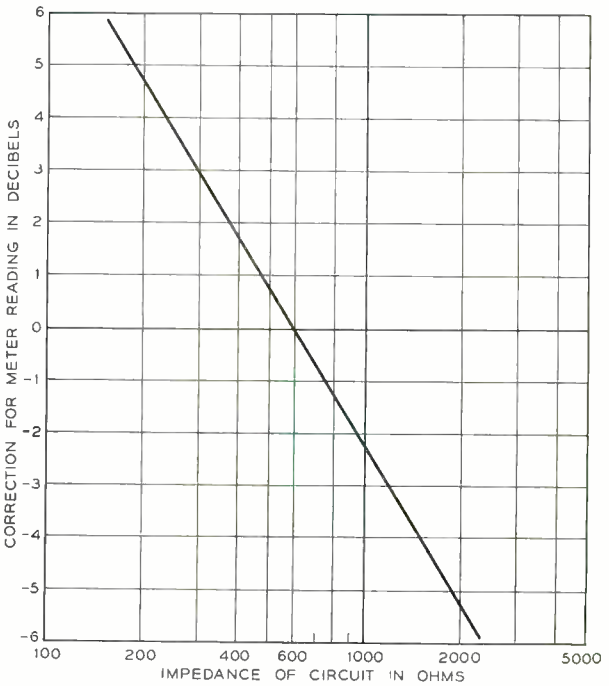


Fig. 2—Db meters used for measuring across a transmission line must be corrected according to this curve when the impedance of a line differs from 600 ohms

*RECORD, *December*, 1934, *page* 122, and *June*, 1940, *page* 310.

†RECORD, *April*, 1937, *page* 252.

Those most commonly employed until recently have been called flat weighting, program weighting and 144-line weighting —the latter being designed to take account of the characteristics of the 144-type telephone receiver, which is one of the older types. When the F1A subset came into the telephone plant, a new weighting network was necessary because the frequency characteristic of the receiver used with the F1A subset was better than that of the 144 type over most of the frequency range. At 1,000 cycles, however, it was about 5 db less efficient. When the F1A weighting is used, therefore, an adjustment of 5 db is made in calibrating; a milliwatt of 1,000-cycle calibrating power reads 85 rather than 90 db. Such an adjusted reading is distinguished by giving it the name of dba, standing for db adjusted. This adjusted scale is marked 7 in Figure 1.

Scale 8 is that of the sound level meter.*

*RECORD, *May*, 1932, *page* 334.

The reference point equals a sound pressure of 0.0002 dyne per square centimeter at 1,000 cycles. This corresponds approximately to 10^{-16} watts per square centimeter, a power generally accepted as being approximately the average threshold of hearing at 1,000 cycles for young observers. The range of usable sound extends from zero, or the threshold of hearing, up to about 120 db; beyond this point, the sound becomes painful.

Whatever his objective in making a measurement, the transmission engineer almost invariably states his results in terms of the db, or the closely allied unit, the VU. The db, however, is a protean unit; its significance is not always the same. It is necessary, therefore, to interpret the results in the light of the descriptive definitions given above, and to know not only the reference quantity for the measurement being made, but the other particular conditions that qualify its proper interpretation.

THE AUTHOR: J. L. MERRILL, JR., joined the D & R of the American Telephone and Telegraph Company in 1930, just after receiving the degree of M.S. from the Pennsylvania State College. There he worked on transmission problems relating to the exchange area plant. Since coming to the Laboratories with the 1934 consolidation, he has been with the group engaged in local transmission development and engineering, and has worked on systems such as time and weather announcement and service observing. During the war, he worked on the integration of tactical wire and radio systems. Since the war, he has been engaged in transmission studies on the application of voice-frequency repeaters to the exchange area plant.

News and Pictures of the Month

Dr. Buckley Attends Military Conference

During the early part of November, Dr. Buckley was one of a group of industrial executives who were invited by Secretary Forrestal to participate in a Joint Orientation Conference on current activities and problems of the National Military Establishment. Assembling in Washington on November 8, the group was welcomed by the Secretary, and on the three days following were addressed by specialists on the world situation, its impact on our national security, and the planning for military and industrial coördination. On November 12, the group left by air for Bolling Field at Pensacola. While at the naval station there, Dr. Buckley and the group spent a night and day aboard the light carrier *Wright*, during which they were shown the entire operation of the ship, including the takeoff and landing of planes. On the second day he had a short cruise and made several dives in the submarine *Sea Robin*, veteran of the Pacific war.

Proceeding to the Infantry School at Fort Benning, Georgia, the party was shown the modern weapons of land warfare, and saw a simulated attack by infantry following air and artillery preparation with live ammunition. They also saw paratrooper training, and mass jumps from airplanes. A feature was an outdoor luncheon on field rations with fifty enlisted men as hosts.

While at Fort Benning, Dr. Buckley was one of a group of seven industrial executives who spoke on a program broadcast by Station WRBL of Columbus, Georgia. The speakers compared what they had seen of Army education, transportation, and technology with that of industry in general.

Eglin Field in Western Florida, the seat of the Air Proving Ground, was the next point visited. Facilities and personnel to make tests of matériel under simulated combat conditions through a wide range of climates are located at this point. Rooms are provided in which conditions of desert, jungle and tropic-marine environments are permanently maintained. An all-weather room is available for personnel testing and, in the Climatic Hangar, temperatures ranging from −70 degrees F. to +165 degrees F. can be provided while airplane engines are on test. The party saw demonstrations of guided missiles, of air bombing on targets, and of the highest-speed jet plane of the Air Forces.

Commenting on his observations, Dr. Buckley stressed the sincerity of military authority in its effort to maintain peace and the absence of any "planning to make war." He was favorably impressed with the interest in improved devices and in taking advantage of scientific research, and in the increased dignity and importance of the individual enlisted man. He was also favorably impressed with the progress being made in the direction of unification of the three military services.

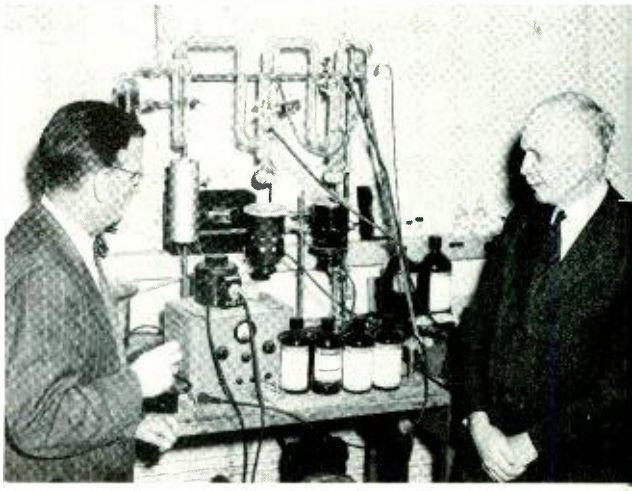
Broadcasting from WRBL

Noted British Physicist Visits Murray Hill

A description of the work and organization of the Cavendish Laboratory of Physics at Cambridge, England, was presented in the Arnold Auditorium on November 15 by Sir Lawrence Bragg, Director of the Laboratory and Nobel Prize winner. As Cavendish Professor, Sir Lawrence succeeds such notable physicists as Maxwell, J. J. Thompson and Rutherford. His talk covered studies of fission of the lighter elements, of X-ray diffraction of protein crystals, of creep and flow of metals, and of the ionosphere by means of an unusual wave interferometer.

Sir Lawrence described model two-dimensional and three-dimensional lattices which he himself had been able to create from tiny soap bubbles. These bubbles act in many ways as the atoms in metallic lattices are supposed to behave. Accordingly, actual measurements of the stress-strain properties of such bubble arrays have revealed several surprising and most significant aspects of the slip as well as elastic reaction assumed to occur along atomic planes in metal deformation.

Sir Lawrence and Lady Bragg visited various laboratories at Murray Hill during the day and were guests of honor at a luncheon.



Dr. Kelly and Sir Lawrence Bragg paused briefly for this picture in the preparation room associated with electron diffraction and electron microscopy

Transistor Audiences

Widespread interest in the Transistor, which can perform many of the functions of the vacuum tube, continues unabated. Speakers from the Laboratories who were invited to appear before large audiences to expound the subject again testify to the fact.

On November 4, W. H. Brattain gave a talk on *The Transistor—Its Properties and Characteristics* at the National Electronics Conference in Chicago. Dr. Shockley presented a paper which he coauthored with Drs. Brattain and Bardeen on *Electronic Theory of the Transistor* before an audience of 800 during meetings of the National Academy of Sciences at Berkeley, California, November 17; then a Transistor talk and demonstration was repeated to Pacific Telephone and Telegraph employees in San Francisco the same afternoon. On the following day, Drs. Shockley and Bardeen were in Pasadena for an appearance before 200 students and faculty members at the Cal Tech Physics Colloquium and the same evening their material was again presented to 400 members of the I.R.E. and A.I.E.E. in Los Angeles. They also spoke before 520 Los Angeles employees of the Pacific Company.

Dr. Brattain gave a number of Transistor talks and demonstrations before audiences as

D. I. Cone (left), transmission engineer, and J. W. Powell (extreme right), chief engineer of the Pacific Company's Northern California Area, welcome Drs. Shockley, Brattain and Bardeen to California

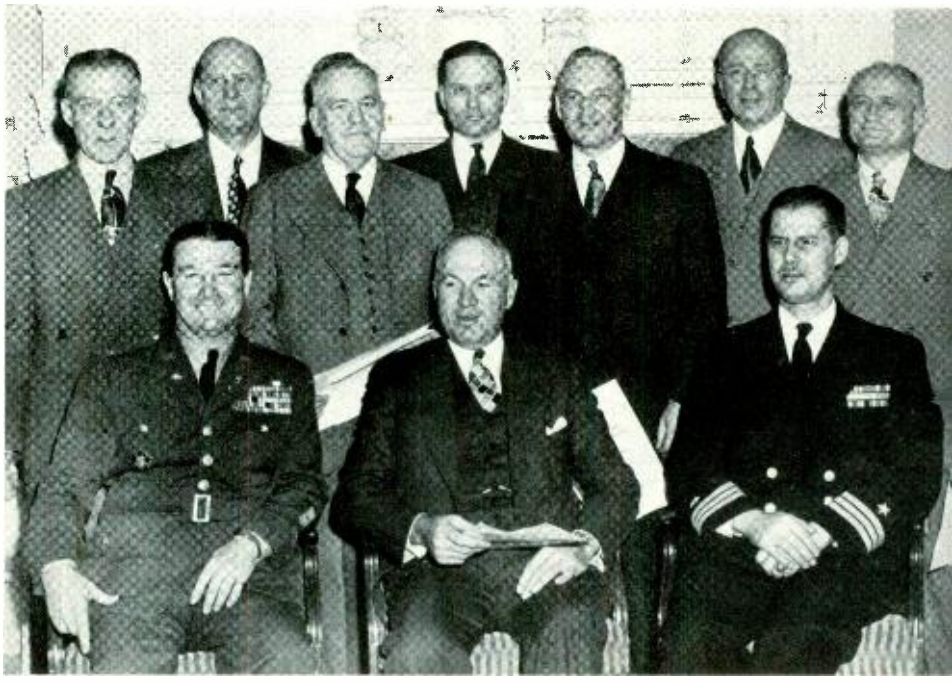
follows: I.R.E. in Seattle, Washington, November 14; I.R.E. and A.I.E.E. in Portland, Oregon, November 18; the Pacific Company in Seattle, November 19; University of Washington, November 22; I.R.E. in Minneapolis, November 29; University of Minnesota, November 30; and University of Iowa, December 1.

In addition, Dr. Bardeen presented *Physical Properties Involved in the Transistor, a Semi-Conductor Triode* at the Chicago meeting of the American Physical Society on November 27, on which occasion Dr. Shockley was presiding; again at Purdue University before the Engineering and Physics group on the 29th; and before 200 in attendance at the Oak Ridge Laboratory of Physics on December 1. Dr. Shockley talked before University of Illinois students and faculty on November 29 with 75 in attendance. Drs. J. A. Becker and W. Shockley appeared before a group of 400 A.I.E.E. members in Philadelphia, November 8, and an I.R.E. gathering in New York City on November 10. Other similar talks given by Dr. Becker were those of December 2 before 150 Southwestern Bell employees in St. Louis in the daytime and to 300 members of the St. Louis Engineers' Club, together with members of the I.R.E. and those of the Instrument Society of America. On December 3 he spoke to 650 I.R.E. and A.I.E.E. members in Kansas City; on the 4th, to about 100 faculty and students of the University of Missouri; and on the 5th, to the I.R.E. and Carnegie Tech in Pittsburgh.

In the same time interval, J. W. McRae talked on Transistors to the Armed Forces Communication Association in Washington, D. C., and to a joint meeting of the Monmouth, New Jersey, sections of I.R.E. and the Monmouth Chapter of A.F.C.A.

Laboratories Men Honored

At a public ceremony in New York City, eight 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 Colonel Frank J. Allen, Jr., for the Army and Commander John M. Steinbeck for the Navy. The recipients, and their contributions, were:



Recipients of the Certificate of Appreciation: J. F. Wentz, M. L. Almquist, J. J. Gilbert, R. L. Robbins, C. H. G. Gray, W. C. Babcock and Pierre Mertz. Seated, Col. Frank J. Allen, Jr., H. O. Siegmund and Commander John M. Steinbeck—Official U. S. Navy Photograph

H. O. Siegmund—Rocket launching mechanisms and controls.

John J. Gilbert—Work on airplane-laid wire.

Pierre Mertz—Guided missiles.

M. L. Almquist—Direction of a group on radio counter-measures.

W. C. Babcock—Radio counter-measures; technical observer, Australia and New Guinea.

R. L. Robbins—Radio counter-measures; technical observer in North Africa and Italy.

J. F. Wentz—Optical proximity fuses.

C. H. G. Gray—Speech privacy systems.

Walter Koenig, Jr., was unable to attend the ceremony and his certificate was mailed to him. He received it for his work in data transmission systems for seacoast artillery.

Registration for chest X-rays at West Street Medical Department was carried on by four Laboratories' girls, working in alternate pairs, mornings and afternoons, in conjunction with a clerk from the Department of Health of New York City

Survey of Chest X-Rays

Individual results of chest X-rays have been mailed to 5,610 members of the Laboratories at all locations who availed themselves of the opportunity of free examination, sponsored cooperatively by the Laboratories' Medical Department and by the New York City and New Jersey State Departments of Health. Results were interpreted by the Health Departments.

Mobile Radio Channels

Mobile radio telephone service now uses six channels in Chicago and three channels in Boston, Detroit, New York, Philadelphia, Pittsburgh, St. Louis and Washington. Two channels are in use in nine other cities. Service is now rendered in a total of 45 cities. Highway mobile service is furnished to 107 cities; five of these are operated by connecting companies.

The Bell System is now furnishing private radio telephone systems to 254 customers, of which 148 are taxicab companies.

View of the X-ray apparatus operated by a member of the New York City Health Department

H. J. Van der Bijl Dies

A press dispatch from Johannesburg records the death there, December 3, 1948, of one who had become South Africa's leading industrialist and who will be recognized by many in the Laboratories to have been a prominent former member of our own staff.

Dr. Henrick Johannes Van der Bijl was born in South Africa, November 23, 1887. He took his B.A. at the University of Cape of Good Hope, 1908. Pursuing graduate studies in mathematics and physics in the Universities of Halle and Leipzig, he obtained his doctorate in 1912. For a year thereafter, he was instructor in physics at the Royal School of Technology in Dresden under Professor Hallwachs.

In 1913 Van der Bijl joined the then embryo Research Department of the Western Electric Company. He shared with Dr. H. D. Arnold credit for putting the high-vacuum amplifier tube upon a quantitative design basis, and in evaluating the amplification factor and naming it μ. They originated the "master oscillator" type of vacuum tube high-frequency transmitter, wherein the carrier is generated and modulated at low power and then power-amplified, used in the first radio transmissions of the voice overseas in 1915, and in carrier multiplex telephony.

The first high-vacuum tubes to go into commercial service in telephone repeaters were designed by Van der Bijl, as were the first developed during World War I for radio pur-

poses. His book on *The Thermionic Vacuum Tube*, published in 1920, was a classic, and for years the authority in its field.

In 1920, Premier Smuts persuaded Van der Bijl to return to South Africa as Government Technical Advisor. There he founded the Electricity Supply Commission in 1923 and had headed it ever since. He founded the South African Iron and Steel Industrial Corp., Ltd. in 1928, and headed it until his death. During the war, he was Director General of Supplies, responsible for South Africa's war output.

We of the American telephone fraternity sympathize with Van der Bijl's native State in the loss of a truly great builder, one of remarkable versatility, a scientist-technician graduated to an industrial statesman.

—LLOYD ESPENSCHIED.

NEW JERSEY BELL'S STATEMENT ON RATE HEARINGS

Hearings are continuing before the New Jersey Board of Public Utility Commissioners on New Jersey Bell Telephone Company's application, filed in September, to increase intrastate telephone rates. The company seeks $16,036,000 in additional annual gross revenue, approximately $4,620,000 of which is to meet the cost of "third round" wage increases in 1948 and the balance to restore earnings.

The company presented its direct case November 8 and 9. The Telephone Workers' Union of New Jersey, representing plant employees of the company, and the New Jersey State CIO Council were heard November 30.

In November, 1947, the New Jersey Company was granted higher rates, effective January 1, 1948, designed to produce $10,515,000 more a year in gross revenues. In its decision, the Commission termed a rate of return of 5.6 per cent on intra-state business "just and reasonable" under the circumstances then existing. The award was made after protracted hearings on all phases of the business, including the relationship of the Laboratories and Western Electric to the American Company and New Jersey Bell.

Principally due to the general wage increases last summer and additional expenses associated with an increase of about $31,000,000 in plant investment during the year, the actual intrastate rate of return for the first nine months of 1948 was approximately 3.23 per cent instead of 5.6 per cent, Thomas G. Walker, the company's general counsel, stated at the November 8 hearing, and if the wage increases and other changes had been in effect the full year, the intra-state rate of return would have been only 1.88 per cent.

The CIO Council representative opposed any rate increase. The Telephone Workers' Union supported the company's application so far as it may be necessary to take care of increases in cost of labor and material. Opposition to the 7 per cent rate of return sought by the company, as compared with the 5.6 per cent rate of return, has been voiced at the hearings by the state, through the Attorney General, the City of Newark, and the two labor organizations which appeared.

Of interest in this connection is rate of return testimony presented for the company by Caleb Stone, vice-president of Prudential Insurance Company in charge of that company's investment portfolio, and Edward Schickhaus, vice-president, Fidelity Union Trust Company.

Stating that the telephone industry has not earned an adequate rate of return for a number of years, Mr. Stone said: "However many factors there may be which bear upon the appraisal of any corporate credit or security, there is one basic question which must be answered favorably before any other factor can even be considered. That is, can the overall earning power of the whole enterprise support, under any reasonably foreseeable circumstances, the necessary capital structure, not only now but as it must be expanded in the future to finance in this instance the expanding services of the company?

"For the Bell System, of which I consider the New Jersey Company an indivisible part, that question cannot be answered favorably, in my opinion, unless the over-all rate of earnings of the Bell System is approximately seven and one-half per cent of the total money invested in the business."

Mr. Schickhaus indicated that the telephone company is in continual competition with industrial companies and other utilities for the available supply of expansion capital, and the growing demand for such capital is rapidly making the capital markets more competitive.

"If the telephone companies with their enormous requirements for new money," Mr. Schickhaus said, "are to compete successfully in the face of the tremendous demand for new debt and stock capital, they must hold out to the investor an adequate level of earnings as potential protection for their interest, dividends and principal. This level I consider to be in the range of 7½ to 8 per cent on the total invested capital."

Thirty-nine institutions, hospitals, and orphanages benefited by the dolls and toys displayed above. Through efforts of the Doll and Toy Committee in New York, under the chairmanship of Mary Upton, extreme left, the toys were procured for three thousand children by contributions of men and women of the Laboratories. Three hundred baby dolls were dressed by Laboratories' girls and wives of engineers

Left—Murray Hill display, under the chairmanship of Betty Anderson, extreme right

Left, below—Graybar-Varick display, under the leadership of Molly Radtke, seated

Below—Chairman Marion Merck, seated, left, was responsible for the Whippany Doll and Toy display shown in part below

To P. A. Stevens of Graybar, these dolls meant packages to be carried every night for weeks. He carried twenty-four dolls home for his wife to dress as is her custom each year and then carried the twenty-four back for the display at that location

Doll and Toy Committee Again Plays Traditional Santa Rôle

Over 3,500 youngsters who were sick, orphaned or needy had a happier Christmas in 1948 because of the efforts of Laboratories men and women through the Doll and Toy Committee of Bell Laboratories Club. Under the chairmanship of Mary Upton in New York, Marion Merck in Whippany and Betty Anderson in Murray Hill, money was collected, 3,000 toys bought and 500 dolls distributed to be daintily dressed by girls at various locations for these children. Early in December, the gifts were displayed, as is the tradition of the Doll and Toy Committee, so that men and women who contributed their time, money and effort would have the opportunity of admiring all the gifts before their distribution to the institutions, hospitals and social services which had submitted requests for toys and dolls. The display, with music, in the West Street Auditorium centered around a miniature winter scene designed by A. V. Loog of Systems Development Department; the Murray Hill display that was placed in the Lounge featured a maypole so that all the dolls, most of them straight-legged ones, could stand and be seen; the Whippany display was built around their Santa Claus, made by Mrs. H. A. Helm, wife of a Whippany engineer.

Moves to Murray Hill

The power transformer group, reporting to A. B. Haines, moved to Murray Hill on December 10. They will be quartered in Rooms 2D-115, 116, 117, 121 and 243, and in 2C-172 and 174.

The transmission transformer group, headed by N. Botsford, moved to Murray Hill on December 29. Their locations are 2C-141, 146, 147, 256, 260, 261, 262, 265, 269, and 2D-104.

The following members of Apparatus Drafting and Specifications were transferred to Murray Hill during December: H. C. Baarens, P. S. Kubik, E. T. Lundgren, A. Pellegrinelli, Miss E. C. Canansen, Miss A. V. Adorno, Mrs. F. L. Coran, Miss F. A. Scherer. The Misses T. Gradwell and A. Fandetta have been transferred to Murray Hill Service, and will be located in 1D-301 and 1C-352, respectively.

D. K. Batchelor of Purchasing will now be found in 2C-227 at Murray Hill; A. E. Anderson of Electronic Apparatus in 1E-419; and the magnetic studies group, headed by V. E. Legg, will be found in Rooms 2C-116, 118, 139, 140 and 144 at Murray Hill.

Heart of the Doll and Toy display at West Street was the miniature winter scene, designed and executed by A. V. Loog of Systems Development, which shows a minister on the vestibule of his church awaiting Christmas worshippers. To the rear of the little church are children coasting and grown-ups skiing, while on a miniature pond children are skating

Dr. I. I. Rabi at Murray Hill

Dr. I. I. Rabi spoke in the Arnold Auditorium at Murray Hill recently on *The Intrinsic Magnetic Moment of the Electron*, and the *Hyperfine Structure of the Hydrogens*. Professor and head of the Department of Physics at Columbia University, Dr. Rabi received the degree of Bachelor of Chemistry at Cornell in 1919 and his doctorate at Columbia in 1927. The Nobel Prize in physics was awarded to him for his work on molecular and sub-molecular magnetic moments.

Instruction Course for 4A Toll Switching System

The Systems Engineering Department has completed a school for twenty-three key instructors of Associated Companies who are to conduct the training of the switchmen required to operate the advance 4A toll switching system. Early installations of this system are scheduled for 1949 and 1950. The staff engaged in the preparation of the descriptive material and in the conduct of the lectures and classroom courses are shown above.

Front row, left to right: L. E. McCown, Illinois Bell; H. W. Schaefer and J. J. Viggers, B.T.L.; R. V. Foxen and W. A. McKay, Pacific Tel.; J. M. Keller, Bell of Pennsylvania; and H. H. Schroeder, B.T.L.

Rear row, left to right: D. H. Mann and R. B. Bauer, B.T.L.; K. S. Southard, N. J. Bell; E. B. Chadman, Michigan Bell; J. W. Schmitt, Pacific Tel.; J. S. Murphy, Southwestern Bell; H. J. Murrell, Chesapeake and Potomac; and J. Umbdenstock of the New York Tel.

The men from the Associated Companies who took the course are shown below.

Front row, left to right: F. P. Stewart and H. J. Clark, Pacific Tel.; J. J. Lawless, N. J. Bell; R. B. Potter, N. Y. Tel.; J. E. Jacobson, Northwestern Bell; A. W. Howard, Pacific Tel.; E. W. James, Southern Bell; M. Helcher, Indiana Bell; H. A. Townsend, N. Y. Tel.; A. J. Hughes, Southern Bell; and J. R. Gaylor, Indiana Bell.

Rear row, left to right: R. J. Darby, Southwestern Bell; F. Wheeler and L. E. Travis, Southern Bell; C. M. Lavin, Illinois Bell; F. G. Gansert and F. J. Helt, Jr., N. Y. Tel.; C. L. Brown, Jr., A T & T; A. W. Tyler, Northwestern Bell; E. L. Walters, Bell of Pa.; and L. G. Carico and A. E. Mormann, C. & P.

H. C. Griffin of the Pacific Company was absent when the photograph was taken.

Nation-Wide System for Toll-Line Dialing

To three attentive audiences—in the Arnold Auditorium on November 23 and in the West Street Auditorium on November 29 and December 6—F. F. Shipley presented the plans and progress of the nation-wide system for toll-line dialing.* This involves the plan of dividing the country into zones, each of them identified by three digits, and in each of which a combination of three digits will represent only one central office. Thus New York City would be represented by 212, and the digits 243, equivalent to CH3, represent the CHelsea 3-central office. Mr. Shipley described how the problems introduced by such things as multiple switches and selection of an alternative route, if all circuits are busy, will be solved by the use of common control equipment built around the crossbar switch at the important through-switching toll offices.

Some years ago, a toll crossbar switching system was installed in Philadelphia and similar systems have recently been cut over in New York and Chicago. These systems possess none of the features essential to the nation-wide dialing system, but they can and will be modified to add these features. An advance model, which will have some of these features and to which the others can be added, will be installed in Albany early in 1950 and in several other places before 1952.

*RECORD, *October*, 1945, *page* 372.

The plan for nation-wide operator toll dialing provides for the division of the United States and Canada into 83 areas, each bearing a three-digit identifying number

Bell System Steps Up Television Network Plans

To provide the television industry with additional network channels between Philadelphia and Chicago, the American Telephone and Telegraph Company announced December 17 that it planned to increase the number of circuits available on this route by the end of the second quarter of 1949. This accelerated program results from intensive efforts on the part of the Laboratories, the Western Electric Company, and the Long Lines Department to solve the difficult technical and material problems involved.

Under the new program, a total of one eastbound and three westbound channels would be available, one westbound and the eastbound channel being available only after 6:00 p.m. When the connection between the Bell System Eastern and Mid-Western television networks for commercial operation is made on January 12, one television channel in each direction will be placed in operation.

Photographers Win Medals

In the Graphic Arts Exhibit recently held by the American Society of Mechanical Engineers, E. Alenius won honors in the Photographic Group—a gold medal for the best picture in the show, and a bronze medal for the best picture in one special class. N. C. Norman won a silver medal for the best photograph by a non-member.

Emling Talks on Broadband

How broadband carrier systems have helped the Bell System's battle with rising costs was told by J. W. Emling of Transmission Development in talks given in the West Street Auditorium on December 3 and in the Arnold Auditorium on December 16. Early in telephone history the need was felt for getting more conversations over the rather expensive long-distance circuits. Earliest attempt was the use of phantoms; in 1918 the Bell System put into service its first carrier system, that between Pittsburgh and Baltimore. This was the Type A; soon followed by the B and the famous C systems. All carrier systems divide up the frequency range by-filters, and put each talking channel into its own high-frequency path. Early systems—through the G—were for use on open wires. Eventually, carrier systems were designed for cables; the K for paper-insulated cables, the L for coaxial. At the same time (just before World War II), similar principles were applied to a new system (Type J) for open wires. All these three systems had in common the use of multiple modulation, the same carrier channel equipment, and unattended repeater stations.

Looking to the future, Mr. Emling described briefly the new L-type system which will transmit even more channels over coaxial cables, and a forthcoming system adapted to short-haul circuits.

Changes in Organization

A. J. Daly, having completed his temporary assignment as Director of the Employees' Relocation Service, has returned to the General Accounting Department to resume his duties as Chief Accountant.

A. J. Akehurst, having completed his temporary assignment as head of the Field Representatives in the Employees' Relocation Service, has assumed his regular duties as Technical Department Staff Representative, reporting to H. Schmitt, in charge of Commercial and Staff Service at Murray Hill.

K. M. Weeks, in charge of Counseling Service in the Employees' Relocation Service, has been appointed Director of the Employees' Relocation Service.

J. A. Morton Now Electronic Apparatus Development Engineer

J. A. Morton has been appointed Electronic Apparatus Development Engineer and is responsible for the development of Transistors and such other semi-conductor devices as are from time to time assigned. His group will consist of J. A. Becker, J. H. Bollman, H. Christensen, R. J. Kircher, J. J. Kleimack, F. J. Morin and J. N. Shive, and the Assistant Technical Staff formerly associated with them; and in addition, A. E. Anderson and R. M. Ryder.

M. E. Hines replaces Mr. Morton in the latter's previous assignment.

News Notes

WILLIAM FONDILLER gave an informal talk before the American Association of Scientific Workers on December 8 in New York.

A. TRADUP has received a letter from Russell J. Hopley, written at the end of his term as Director of Civil Defense Planning, thanking Mr. Tradup for his coöperation and assistance in preparing the report "Civil Defense for National Security." Mr. Hopley has returned to his post as president of Northwestern Bell. He is succeeded by Aubrey H. Mellinger, who recently retired as president of Illinois Bell.

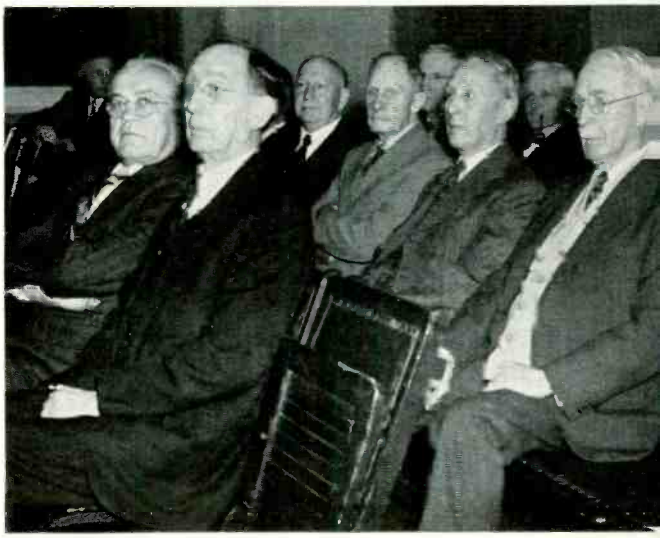
The 1948 Christmas poster for the Laboratories was designed by J. F. Neill of Systems Development at the request of the Club. Copies of the poster were displayed on bulletin boards at all locations, and in addition a copy was sent to each retired member of the Laboratories

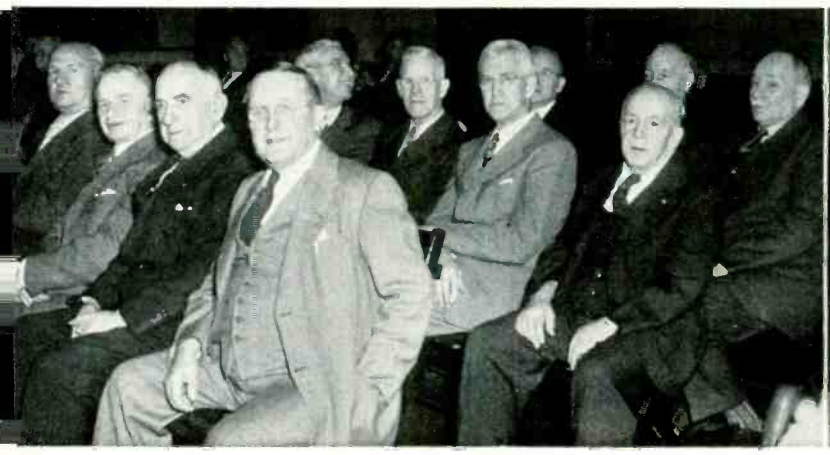
HARVEY FLETCHER inspected the new science building at Brigham Young University and addressed student health service and speech department groups on recent developments of the Laboratories.

Pioneer Life Member Club

Highlight of the Pioneer Life Member Club meeting in December was the singing of Christmas carols by the Systems Development Chorus in the West Street Auditorium. R. P. Yeaton, director of the Chorus, is in the first row on the extreme left. Groups of Pioneers are shown listening to the Chorus.

The Club's program for February will include a luncheon in the Blue Room, to be followed by a talk by M. J. Kelly on his recent trip to Europe.





LAWRENCE MESSER C. S. GORDON B. W. KENDALL

RETIREMENTS

Recent retirements from the Laboratories include Dennis F. Cronin with 42 years of service; C. W. Lowe, 39 years; C. S. Gordon, 36 years; B. W. Kendall, 35 years; and Lawrence Messer, 30 years.

BURTON W. KENDALL

In the early months of 1913, work was actively under way in the Research Department at West Street on several types of telephone repeaters. Such repeaters would be a necessity for the first transcontinental telephone line, which the Bell System planned to open in time for the San Francisco Fair. H. D. Arnold, who had devised a mercury-arc repeater, now saw the high-vacuum tube practically within his grasp. This was the climate which Burton Kendall entered in February, 1913, bringing with him a bachelor's degree from M.I.T. and graduate study and teaching experience at Columbia. A few months later, he was making field tests on mercury-arc repeaters, and after Arnold's success, the electron-tube repeater. Through 1914 he worked on the transcontinental line, then assisted in the transatlantic radiotelephone experiments. To these he contributed the so-called "homodyne" circuit, which added a locally generated carrier to reinforce that received from the distant station. His was also the idea of transferring a message from one high frequency to another, a method now universally used. Late in 1915, he began his work in carrier communication, an art which was to grow to nearly its present stature during the quarter century of his active effort in it.

Measurement being the groundwork of any development program, Mr. Kendall's first assignment was to develop instruments for measuring the impedance and attenuation of telephone lines at "high" frequencies—that is, up to about 50 kilocycles. Oscillators and modulators were taken over from the radio art. Among Mr. Kendall's contributions was the derivation of the carrier frequencies from a base frequency which could be transmitted over the line to assure synchronization of the carriers at both ends. The generation of harmonic carriers for the J, K and L systems is a later development from this fundamental idea. The Bell System's first carrier system, installed as a World War I expedient, was developed under his guidance.

After a short assignment to the engineering of the Paris-Strasbourg cable, Mr. Kendall, late in 1919, transferred to Systems Development, where he began to build up a group on toll circuits and transmission. Followed then the great period of carrier development, with such famous systems as the Type C with three channels, the Types D and H with one channel, and J and K with 12 channels for open wire and cable, respectively. There were epochal developments in other fields, such as picture transmission, the TWX system, carrier telegraphy at high frequencies and at voice frequencies, voice-frequency signaling and pilot-wire control for long voice-frequency cable circuits. To these projects Mr. Kendall contributed in ideas, as witness his 26 patents, but more importantly in the inspiration he gave his group toward sound development.

In 1940, with the general reorganization of Systems Development, Mr. Kendall transferred to Research to take charge of fundamental circuit investigations. Briefly in 1943 he substituted for Mr. Glunt, in charge of the Whippany Laboratory, and then was for a time Technical Assistant to Dr. Kelly. In 1945 he transferred to Patent, in charge of a group whose function was to make sure that all inventions developed under Government contracts were properly submitted to our attorneys and that the Western Electric Company was notified thereof for their reports to the Government.

The first few months of his retirement, Mr. and Mrs. Kendall expect to spend in the South. Beyond that he has as yet no final plans.

LAWRENCE MESSER

During his thirty years' service, Lawrence Messer has watched the movable property of the Laboratories—machinery, laboratory apparatus, furniture and office equipment—grow many fold. Entering after some 14 years in several jobs elsewhere, Mr. Messer was for eight years in charge of Plant Accounting. Then he worked on the accounting in connection with the New York Central Railroad ease-

ment covering changes made in Section G and H, to allow their tracks to pass through. From the end of that job, Mr. Messer has been compiling analyses of plant investment. It is he or his associates who come around every so often with cards and flashlights to see that all the plant items on your inventory are actually in existence. He it is who asks from time to time if you can't junk that old piece of equipment which you had stored away "just in case." About eighteen months ago he was transferred to Murray Hill to handle plant investment at that location and at Whippany.

During his earlier residence in Little Ferry, N. J., Mr. Messer was a member and for two years president of the Board of Education. He was also a director of the First National Bank.

Always interested in accounting—he took courses at New York University—Mr. Messer expects to remain in the profession after his retirement.

Chester S. Gordon

Chester S. Gordon came from a family of teachers who also had proclivities to make things grow from the soil. Today the cycle is completing itself for, having retired on November 30, his inherited yearning to work the soil is now to be satisfied.

A loyal son of Ohio, Chester Gordon matriculated at Ohio University for the school year 1906-07. This was followed by a full year's interlude as a teacher before he went through Ohio State in the period 1908-12. He was graduated as an electrical engineer, and thought of continuing there as an instructor.

At that particular time, however, the Southwestern Bell Telephone Company was launching the first of its student courses and young Gordon decided in June of 1912 to become one of the group. For four months in the St. Louis area he was indoctrinated in Plant Engineering requirements and practices. His interests and experiences in the telephone field were augmented further by assignments in Kansas, Missouri, and in Texas, first in Houston and, finally, San Antonio in the same company's territory. He spent 2½ years in San Antonio as a member of the division engineering office. In the Texas border warfare that was preliminary to World War I, his tasks, such as getting telephone facilities to officers of the National Guard who were located in the sagebrush 'way from anywhere, increased his concern with knowledge about the materials and necessities of Outside Plant. That knowledge and interest grew through his continuous Bell System service and subsequently he became an outstanding engineer in the field of communication wire development, having over a score of patents to his credit.

From San Antonio he went to the American Telephone and Telegraph Company headquarters in 1916, eventually reporting to F. L. Rhodes, then Outside Plant Engineer. Until 1927 he worked at A T & T on insulators, wire products, tools and the run of departmental materials, and on February 1 of that year, upon completion of plans to transfer part of the Outside Plant work to the Laboratories, he arrived at 463 West Street to report to R. L. Jones. His concern at the Laboratories was with a variety of Outside Plant wire products and tools, but with increasingly individual emphasis on developments in wires and wire products.

Regarded as one of the leading experts in the field of bare and covered line conductors, Mr. Gordon was called upon as a Signal Corps consultant during World War II, and a citation, received from Major General Ingles, reflects his considerable aid in production of Army field wire. Indeed, his efforts on communication wire items included as a natural corollary achievements in designs and studies of a large number of communication field materials and hence embraced much coöperative work that aided solution, with Western Electric engineers, of specific production, standardization and installation problems. As Wire Development Engineer, he has left his imprint on present usage throughout the wire field. His pro-

January Service Anniversaries of Members of the Laboratories

40 *years*

H. C. Pauly

30 *years*

LeRoy Armitage
H. A. Burgess
R. W. Burns
F. J. Canavan
W. T. Haines
Edward Jacobitti
Mary Kane
Raphael Marino
P. W. Spence
A. W. Tucker
S. B. Wright

25 *years*

Frank Hardy
B. P. Herbort
Karel Lutomirski
M. W. Redmond
R. G. Watling

20 *years*

F. W. Clayden
W. G. Dauernheim
Birney Dysart
A. E. Emerson
H. A. Hesch
F. H. King
J. P. Laico
G. H. Lovell
E. J. Mandable
C. T. McCarthy
John McEvilly
Winifred Meszaros
H. W. Nelson
Joseph Novotny
N. C. Olmstead
John Schaefer
F. W. Stubner
John Stuparich

15 *years*

Eugene Bohan
Joseph Kay
Joseph Lodato
S. E. Michaels
Anthony Sprink

10 *years*

L. M. Gambrill
H. H. Nagel
P. T. Wiiri

fessional societies have included membership in the A.I.E.E., the A.S.T.M., the Wire Association and the Rubber Division of A.C.S.

In 1924 Mr. Gordon moved from northern Manhattan to Boonton, New Jersey. Even in Manhattan he had a garden, but in New Jersey his present five acres allow freer rein to encourage more and better flowers and vegetables in the tradition of his forebears. He has a wife, a son and a daughter to make a happy family. He has his workshop as well as outside interests in the local scene, having been a member of the Board of Education of Boonton. With his intensive business period completed, he now has acquired precious time to enjoy his favorite hobbies.

Charles W. Lowe

At graduation from Wisconsin, C. W. Lowe entered the student training course at Hawthorne in the famous "Class of 1909," which contained so many others who have made their mark in the Bell System. A year later he was assigned to apparatus design at West Street, and in 1917 took charge of a group which did practically all the non-military apparatus design during World War I, plus a fair share of military work.

At that time, apparatus specifications were written by the design engineers and as a result, there was considerable variation in both style and content. In the interest of uniformity of these important documents, the late E. B. Craft created the apparatus specifications group and Mr. Lowe was placed in charge. Three years later, the apparatus drafting, files and card catalogue were added to his responsibilities. In 1915 he became Commercial Service Manager, and a year later Assistant Commercial Development Engineer.

In 1927 he became supervisor of a group, in the Apparatus Development Department, concerned with work on sound pictures, and the following year transferred to ERPI,* where he engineered studio equipment and "hill and dale" recording; and at one time had charge of general engineering service including files, drafting and library.

Returning to the Laboratories in 1937 as a member of the plant engineering group, Mr. Lowe directed the preparation of the comprehensive set of Space Occupancy Plans of all Laboratories quarters, which have been invaluable in the effective control and utilization of floor space. Early in 1941 he transferred to Purchasing, where, during the war period,

*Electrical Research Products, Inc., Western Electric subsidiary which handled sales and service of sound-picture equipment.

Charles W. Lowe

he procured all the priorities used by the Laboratories. At war's end he returned to Apparatus Staff and in July of 1948 he transferred to General Plant Engineering.

Mr. Lowe has welcomed changes in work which brought him into contact with more people in recent years because, to quote him, "I have always liked to work with people." Characteristically, in his home town of Rutherford he is a past-president of a Civic Associa-

"I have been on the job for over 42 years," says Dinny. "If I had it to do over again I'd get off the boat and two days later come right here and ask for a job"

tion and of the Board of Education. A bridge player and golfer, he is also an inveterate bowler, and expects to continue in our Bowling League, for as he says, "There is no better place than the Laboratories to enjoy life and make friends."

Dennis F. Cronin

Forty-two years ago a likely young Irish lad from County Limerick landed at pier 48 in New York and soon went to work for Western Electric. Listed by Payroll as Dennis F. Cronin, he was never known by any other name than "Dinny." He put his strong young muscles to work on any job that was to be done around the building and, without knowing it, his remarkable memory went to work storing up the names and faces of hundreds of Bell System people. There was plenty of opportunity; "West Street" was new then, and it was the headquarters of Western Electric. Soon "Dinny" was operating one of the hydraulic elevators; and with him rode such notables as Dr. Bell, Mr. Watson, Mr. Vail, Mr. Carty, Mr. Thayer, and Mr. Gifford. "Dinny" knew them all, and they had a word of greeting for the likeable young man who handled the lever. And that took skill and care, for in those days elevators were run without benefit of door-interlocks and automatic leveling.

When Section H entrance was opened in 1926, "Dinny" was put in charge there and a good choice it was. For more than twenty years he has watched the tide flow through the hall four times a day and there never has been a Laboratories' employee fail of a greeting, did he—or she—take the trouble to look in "Dinny's" direction.

Now Dennis Cronin is enjoying well-earned leisure. His summer visits to Montreal can be longer and there is the possibility of a trip back to County Limerick, where the name of Cronin is as unforgettable as is the name "Dinny" at West Street.

News Notes

M. J. Kelly addressed the junior and senior students of Missouri School of Mines and Metallurgy on *The Engineer as a Citizen—His Special Obligations* on October 28. On the following day he was elected President of the Alumni Association of the Missouri School of Mines and Metallurgy for 1949 and 1950. Dr. Kelly attended the buffet supper honoring Dr. Vannevar Bush upon his retirement from the Chairmanship of the Research and Development Board and honoring Dr. Karl T. Compton upon his appointment to the Chairmanship. He gave a talk to the Power and Propulsion Panel of the Committee on Undersea Warfare of the National Research Council in New York.

Dr. Kelly visited the Research Center of the B. F. Goodrich Company at Brecksville, Ohio, where he addressed the Directors of Industrial Research and members of the Research Center on *Observations on Items of Current Interest Made on a Recent Visit to Seven Countries in Western Europe.* He also attended the formal opening of the Abercrombie Laboratory for Instruction and Research in Science and Engineering at Rice Institute and addressed the group on *The Place of the Engineering College in Our Post-War Society.* At Indianapolis he witnessed demonstrations of electronic navigation and blind landing facilities of the Civil Aeronautics Administration; and at the Allentown plant with J. R. Wilson, he reviewed the work of the Bell Laboratories group there and saw the new Western Electric manufacturing facilities. Dr. Kelly also visited the Philco Corporation at Philadelphia on November 29.

James Campbell, Jr., addressed about 200 management employees of the Eastern Area,

"Mr. Campbell, meet Mr. Campbell!" When his audience gathered around J. Campbell, Jr., he was introduced to James Campbell, wire chief of a Philadelphia panel office. They are cousins

Bell of Pennsylvania, on November 26. His talk, given in the lecture hall of the Franklin Institute, covered such items as crystals, semiconductors, the Transistor, the beam-coding tube, and some new switching systems.

G. Q. Lumsden, J. Leutritz, Jr., and A. G. Jensen conducted a series of experimental treatments of southern pine poles with green-salt at Gainesville, Florida.

HARVEY FLETCHER, J. A. BARDEEN, W. H. BRATTAIN and W. SHOCKLEY attended the autumn meeting of the National Academy of Sciences held at Berkeley, California. Dr. Fletcher spoke on *The Perception of Speech and Its Relation to Telephony.* Dr. Shockley also spoke on *Electron Theory of the Transistor* as described on page 22.

R. O. COVELL was at the Patent Office in Washington relative to patent matters.

THE LABORATORIES were represented in interference proceedings before the Primary Examiner at the Patent Office by H. S. Wertz.

H. M. SPICER visited the Albert & J. M. Anderson Manufacturing Company's plant at Boston on new emergency cell switch designs.

S. C. DEL VECCHIO was in Richmond in connection with the trial installation of tuned reed signaling equipment for urban mobile radio.

Philatelist Walter Kuhn displays the chart of Christmas seals dating from 1900 *to* 1948 *which he arranged to boost sale of seals in his community, Staten Island*

F. W. AMBERG, with W. K. MacAdam of the O & E, made transmission measurements on the 150-mile Alliance, Nebraska-Rapid City, South Dakota, open-wire line, the first long telephone line involving a trial of tandem bracket transpositions.

H. C. RUBLY conferred at Chicago and Columbus on the performance of tools for stapling station wires. At Cleveland he also reviewed manufacturing problems on these tools.

A. L. RICHEY and V. J. ALBANO were in Pittsburgh in connection with Alpeth sheathed cable.

J. V. ELLIOTT, chairman of the Table Tennis Club, has announced that the table tennis facilities are now located in the West Street Auditorium. All new members of the Laboratories are invited to join the group at noon.

D. W. BODLE has returned from Atlanta after an extended study there of natural lightning on the Atlanta-Birmingham cable.

W. S. BISHOP, with G. H. Zieschang and J. H. Byrne of the New Jersey Bell, inspected early installations of wire guards in the Rumson area.

F. F. ROMANOW took part in the meeting in Cleveland of the Subcommittee on Fundamental Sound Measurements of the American Standards Association Committee on Acoustical Measurements and Terminology. He also attended several sessions of the Acoustical Society of America.

K. K. DARROW talked on *Magnetic Resonance* at the University of Virginia in Charlottesville, Va. Dr. Darrow went to Union College in Schenectady as a member of the Board of Visitors of the Department of Physics. He also attended the Amercian Philosophical Society meeting in Philadelphia and the American Physical Society meeting in Chicago.

W. A. SHEWHART has been appointed for a three-year period to the Commission on Statistical Standards and Organization by the Board of Directors of the American Statistical Association. Six men comprise the Commission, whose functions are to provide a tribunal to render opinions and recommendations on controversial issues relating to statistical procedure and presentation of statistical material.

B. MATTHIAS, S. O. MORGAN, E. J. MURPHY and W. A. YAGER went to the Bureau of Standards in Washington for the annual meeting of the National Research Council's *Conference on Electrical Insulation.* Mr. Matthias and ELIZABETH WOOD presented papers before the Metropolitan Section meeting at Columbia University of the American Physical Society covering *The Optical and Ferroelectric Properties of Barium Titanate.*

L. H. GERMER, F. E. HAWORTH and J. M. RICHARDSON attended the *Gas Discharge Conference* at Brookhaven National Institute. Mr. Germer spoke on *A Low Voltage Discharge Between Close Electrodes;* Mr. Richardson on *Low Pressure Arca;* and Mr. Haworth on *Electrode Separations in Discharges at Very Small Distances.*

H. T. BALCH and W. C. HUNTER spent two weeks in Chicago for the installation and test of the additional radio transmitters and new associated apparatus, which was required in order to provide six radio channels for the Chicago urban mobile service.

Heat Conduction With Engineering and Geological Applications by L. R. Ingersoll, O. J. ZOBEL and A. C. Ingersoll has been reviewed in the November issue of *Physics Today*. The textbook, recently published by McGraw-Hill, is a revised edition of L. R. Ingersoll's and O. J. Zobel's book *An Introduction to the Mathematical Theory of Heat Conduction With Engineering and Geological Applications.*

K. G. COMPTON spoke on *Corrosion Protection and Surface Finishes of Non-Ferrous Metals* before the second technical session of the New York Chapter, American Society for Metals.

W. P. MASON, H. J. MCSKIMIN and H. T. O'NEIL attended the fall meeting in Cleveland of the Acoustical Society of America at which Mr. Mason and Mr. McSkimin presented a paper entitled *Measurement of Sheer Elasticity and Viscosity of Liquids at Ultrasonic Frequencies*, and Mr. O'Neil, a paper entitled *Focusing Radiators.*

ON A RECENT three-day trip to Indianapolis and Chicago, W. H. MARTIN, A. F. BENNETT and R. J. NOSSAMAN discussed outside plant and station apparatus matters in meetings at the headquarters of the Indiana Bell and Illinois Bell Telephone Companies. Mr. Martin, in describing the new combined set, explained how a development of this type is handled in the Laboratories. Mr. Bennett discussed station apparatus, and Mr. Nossaman outside plant problems with engineering and plant groups interested in these fields. The Laboratories' people also visited the new Speedway Plant of Western Electric Company in Indianapolis and the Hawthorne, Clearing and Archer Avenue plants in Chicago.

J. R. TOWNSEND visited The Chesapeake and Potomac and the Southern Bell Companies and gave talks on *Materials Developments at Bell Laboratories* before groups of people at Washington, Richmond and Atlanta.

W. BABINGTON attended a meeting of a task group of A.S.T.M. Committee B-6 at Syracuse to discuss quality control of die castings.

J. P. GUERARD and G. R. GOHN attended meetings of A.S.T.M. Committee B-5 on Copper and Copper Alloys in Philadelphia. Mr. Guerard also visited the American Brass Company at Torrington, Conn., to discuss special copper tubing.

H. PETERS attended the rubber group meeting of the American Chemical Society in Detroit.

J. B. DECOSTE and V. T. WALLDER conferred at the Simplex Wire and Cable Company in Cambridge on the extrusion of polyethylene on special cable being made there.

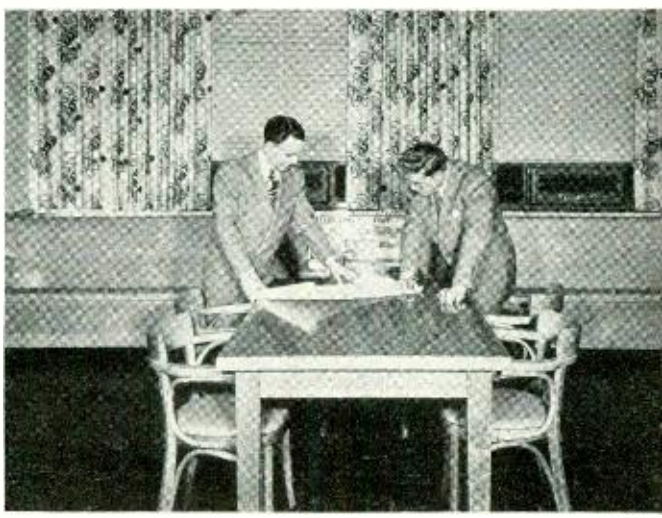
W. F. JANSSEN discussed the production of metal-to-ceramic seals and terminals at Winston-Salem and at the American Lava Corporation, Chattanooga.

H. W. HERMANCE and T. F. EGAN made a study of relay contacts in crossbar offices in Chicago and Cleveland.

J. MORRISON attended a conference on *Gas Discharges* at Brookhaven National Laboratory.

P. P. DEBYE presented a paper on *Particle Size Determination of Light Scattering* at a Symposium on Instrumental Methods of Chemical Analysis conducted by the New York Section of the American Chemical Society, at New York University.

R. D. HEIDENREICH gave a talk on *Electron Methods in the Structure of Metals* before the Oak Ridge Chapter of the American Society for Metals at Oak Ridge.



Modern facilities provided for Men's Employment at West Street. Draftsmen of Systems Development Department are checking on details of furniture for this section of the building. The bench and magazine rack in the background are the work of G. I. Wells, left, as are the cubicles and partitions (not shown) for interviews and tests. A. J. Fregosi, right, worked on the design of a reception desk having special features

R. L. HANSON, C. M. HARRIS, F. K. HARVEY, W. E. KOCK and R. L. WALLACE attended the Cleveland meeting of the Acoustical Society at which Mr. Wallace presented a paper on *Some Factors Governing Frequency Response in Magnetic Recording.* Lecture demonstrations were given at Case Institute of Technology by Mr. Hanson on *Applications of the Sing-Around Circuit* and by Mr. Kock and Mr. Harvey on *Refracting Sound Waves.*

T. R. GRIFFITH
1884-1948

A. C. GOEBEL
1889-1948

C. H. GORMAN, JR.
1905-1948

J. T. MOTTER
1904-1948

JOSEPH BORELLI
1904-1948

RECENT DEATHS

THOMAS R. GRIFFITH, December 12

Mr. Griffith's retirement in 1946 brought to a close 34 years of Bell System service. He had studied at Brooklyn Polytechnic Institute and in his early years in the Engineering Department he engaged in laboratory measurements with a group of physicists working on the newly invented vacuum tube. As the tubes were put into production, the need for a person with knowledge of them became imperative in the Western Electric Tube Department and Mr. Griffith transferred to that unit. Expert on pumping, assembly and testing operations on tubes, he spent several years there and in that capacity went to England to help Western Electric in the production of the 10-kw water-cooled anode tubes. Upon his return to the Tube Shop, he assisted in the development and production of new tubes until 1936 when he returned to the Laboratories Research Department. He then became engaged in work on copper oxide rectifiers and in the early development of silicon point contact rectifiers.

During the war, Mr. Griffith was associated with work on thermistor-bolometers and contributed to the development of infra-red detectors. From then on until his retirement, he was a member of the solid state group where his knowledge of vacuum techniques made him a valuable contributor to the basic experimental work on semiconduction. Some of the apparatus he built was used in the research work leading up to the invention of the Transistor.

ALBERT C. GOEBEL, December 14

A foreman in the Power Plant at West Street, Mr. Goebel had just completed thirty-two years of Bell System service at the time of his death. Joining the Western Electric Department in 1916, he became a wireman in the Building Shops, work in which he had had previous experience in other concerns. During World War I he served with the Research and Inspection Division of the Signal Corps for two years, and during most of that time was stationed in France. Upon his return he resumed his work in the Building Shops Department. In 1925, Mr. Goebel transferred to the Power Plant where he was later made responsible for the operation of its electrical systems and for its various power rooms at 463 West Street and in the Graybar-Varick building.

CHARLES H. GORMAN, JR., November 17

When he retired in March 1947, Mr. Gorman had completed twenty-one years of Bell System service. Joining the A T & T in 1926, he became a technical assistant and spent the first few years of his Bell System career in the field, where he engaged in general technical work on various noise and crosstalk problems. Assigned to the transmission engineering group of the Laboratories, he was particularly concerned with work on transposition systems for open wire carrier. Mr. Gorman took an active part in war projects which are still on the restricted list. After the war, he resumed work on crosstalk problems.

JAMES T. MOTTER, November 29

Joining the Equipment Development Department in 1929, Mr. Motter was assigned first to the trial installation group and then transferred to switching equipment. He was concerned with the development of step-by-step equipment for central offices and community dial offices until 1932, when he went to Washington in connection with installation and maintenance work with The Chesapeake and Potomac Telephone Company. Upon returning to the Laboratories in 1936, he continued in the step-by-step equipment field until 1941. During the war he contributed to the

development of various radar and radio equipments including the Mark XVI for the Marine Corps, the SCR-602-T3, and the AN/TRC-6 for the Army, and a number of radar test sets which were employed by the various services in all theaters of war. Shortly after V-J Day, he resumed work on switching systems equipment. Assigned to the No. 5 crossbar in its early planning stages, he made important contributions throughout its development.

A grandnephew of Theodore N. Vail, Mr. Motter loved his home and his family and the major portion of his interests were centered in them—he liked to garden and tinker; he was interested in nature and with his children spent much time observing the pets, the flora and fauna near his home in Basking Ridge, N. J. He was also active in the Somerset County Y. M. C. A. and in the local Civic Association.

JOSEPH BORELLI, November 20

Mr. Borelli had been a member of the Laboratories since 1943 when he joined the building and maintenance group at Chambers Street. Transferring to West Street in 1945, he remained with the group until 1947 when he was promoted to painter in the building.

News Notes

K. G. COUTLEE, G. DEEG, A. H. FALK, J. J. MARTIN, G. H. WILLIAMS and E. E. WRIGHT attended A.S.T.M. meetings in Atlantic City concerned with insulating materials and with plastics.

J. A. BURTON attended the American Physical Society meetings in Chicago.

R. C. PLATOW spoke before the Society of Plastics Engineers in Washington on *Practical Considerations in the Application of Adhesives.* He also spoke before a technical group at the Thiokol Corporation, Trenton, on *Some Fundamental Concepts in the Applications of Adhesives.* Mr. Platow attended an Army Ordnance Department Committee meeting to discuss a research program on adhesives under way at M.I.T. because he is chairman of a group which acts in an advisory capacity to this project.

AT THE Holmdel-Deal colloquium held at Deal, November 12, W. E. KOCK discussed the *Refraction of Sound Waves.* F. K. HARVEY assisted in a demonstration in which microwave lenses and other devices were used as acoustical refractors.

H. T. FRIIS attended a meeting in Washington of the Panel on Basic Research of the Research and Development Board.

P. H. SMITH presented a discussion, prepared by R. C. MATHES, on a paper entitled *Information Exchange as a Management Tool in a Large Research Organization* at the National Electronics Conference. A. R. D'HEEDENE and E. P. FELCH also attended this conference.

W. E. KOCK went to Chicago to present a paper on *Broadband Microwave Lens Antennas* to an A.I.E.E. section meeting held there November 18.

E. C. HAGEMANN and R. M. C. GREENIDGE discussed various resistor problems at Hawthorne and visited the plant of the Allen Bradley Company at Milwaukee where they observed and discussed the manufacture of carbon composition resistors. Mr. Greenidge and R. A. OGG conferred with the Western Electric engineers at Haverhill on various problems concerned with the manufacture of flat-type resistors.

N. INSLEY went to Allentown in connection with problems on resistance lamps.

AT THE Western Electric Company in Chicago, L. W. GILES discussed the manufacture and coding of lamp caps; G. B. BAKER, step-by-step relays; R. A. SWIFT, at Hawthorne and Duluth, No. 5 crossbar equipment; J. A. DEVOS, No. 1 crossbar equipment; R. D. WILLIAMS, the 740 PBX; H. R. CLARKE and A. HERCKMANS, station dials; C. T. WYMAN and E. V. KOSSO, general cable problems; D. R. BROBST and F. W. CLAYTON, wiring for step-by-step banks; H. M. KNAPP, new molded spring relay de-

Preliminary to the opening of a 1,500-mile television circuit from Washington to St. Louis, Laboratories engineers observed transmission and made various tests. Pictured in the St. Louis test room are: M. E. Campbell, L. G. Abraham, S. Doba, K. E. Gould and L. W. Morrison. At Washington was R. W. Marshall and at the New York test room, J. R. Brady

signs; W. G. LASKEY, message registers; W. L. TUFFNELL and W. G. TURNBULL, station handsets; D. W. MATHISON and B. O. TEMPLETON, coin collector production manufacturing problems; H. C. PAULY and F. S. MAYER, tool-made samples of colored combined sets; and W. G. BREIVOGEL, the manufacture of dials.

W. KALIN visited the Brush Development Company at Cleveland in connection with hearing aid microphones.

L. N. HAMPTON, C. B. BROWN and F. M. PEARSALL installed a second Laboratories-made perforator for the automatic trouble recorder in the Ambridge, Pa., telephone office.

J. M. MELICK, A. H. MILLER and M. SALZER assisted the Teletype Corporation in Chicago in the production of special perforators.

J. D. TEBO attended the Mid-West technical meeting of the American Institute of Electrical Engineers at Milwaukee.

W. W. WERRING and V. F. MILLER went to the General Electric Company in Pittsfield for discussions on soldering copper manufacture.

A. C. MILLARD participated in an American Standards Association meeting in Washington on the Unification of Screw Threads.

H. A. BAXTER, at General Mills, Minneapolis, discussed a new submarine project.

J. W. SMITH and F. E. NIMMCKE went to Washington and to the National Research Laboratory to discuss ordnance equipment.

W. C. HUNTER checked the operation of radio transmitters recently installed in Chicago for six-channel operation of the mobile radio service. The Chicago six-channel system was placed in commercial service on November 18.

J. A. MORTON spoke in Columbus, Ohio, before a joint meeting of the Telephone Engineer Club of Ohio Bell and the Columbus Section, Institute of Radio Engineers. Mr. Morton discussed the essential features of a new planar triode being developed for microwave radio relay use.

R. W. SEARS selected the subject *Electron Beam Coding Tubes* for his talk before the New York Section A.I.E.E. Communication Group at a specialized electronics meeting.

A. A. HANSEN conducted tests at the Toledo toll office of the performance of the new single frequency signaling equipment. He was also at the new Chicago No. 4 toll office at the time of cutover, in connection with observations of single frequency signaling performance and maintenance.

James Barton, usher at the 463 West Street door, accepting a visitor's identification slip from his daughter, Mary, a junior clerk in the General Service Department, whose duty it is to escort visitors

N. A. NEWELL and MR. HANSEN were at the Madison and Milwaukee toll offices in connection with the field trial of the N1 carrier telephone system.

AT POINT BREEZE, G. M. BOUTON and E. E. SCHUMACHER discussed cable sheath problems; D. R. BROBST, twisting and stranding of switchboard cable; W. H. MARTIN, R. J. NOSSAMAN, S. C. MILLER, C. S. GORDON and C. C. LAWSON, manufacturing developments relating to wires, cable terminals and associated equipment proposed for the coming year; H. H. STAEBNER and F. LINDBERG, cord development problems; and R. P. ASHBAUGH, cable design.

M. E. MALONEY, accompanied by P. E. Bowen of A T & T, visited Chicago and Cleveland No. 4 toll switching systems to observe the installations and to discuss them with Telephone Company engineers.

T. C. FRY and C. E. BROOKS visited Cleveland, Detroit and Cincinnati, where plant extension, maintenance and some traffic operating problems were discussed.

P. V. WELCH with F. J. Ward of A T & T visited Boston to discuss switching arrangements for a private line mobile radio system.

C. H. MCCANDLESS attended the cutover of the No. 4 toll office at 32 Avenue of the Americas. Mr. McCandless also went to Chicago for the cutover of No. 4 toll office.

W. I. MCCULLAGH, R. E. HERSEY and W. T. Milliken of Western Electric visited the Ambridge No. 5 installation at Pittsburgh and the Willoughby installation at Cleveland.

W. E. GRUTZNER was at Ambridge, Pa., in connection with the installation of trouble recorder equipment for a No. 5 crossbar office.

J. J. HARLEY is the subject of a three-page illustrated article entitled *Prize-Winning Movie Maker* in the December issue of *U. S. Camera.* The story details techniques and philosophies of the protagonists and prominent mention is made of Bell Laboratories and the recently exhibited *Crystal Clear Film.* Mr. Harley's film, *Crystals While You Wait,* was recently selected by the magazine *Movie-Maker* as one of the ten best amateur films of the year.

F. M. PEARSALL visited the Teletype Corporation in Chicago in connection with shop test procedure for the KS-13834 perforator. At the Ambridge, Pa., central office Mr. Pearsall and L. N. HAMPTON witnessed the installation and test of No. 5 crossbar equipment.

P. HUSTA, B. F. LEWIS and K. H. MULLER visited the General Electric Company at Lynn to discuss problems in connection with photoelectric cells to be used in card translators for nation-wide dialing.

F. C. GRIESE studied the AMA equipment at the Philadelphia accounting center.

AT WINSTON-SALEM, C. L. SEMMELMAN discussed a special radar project; J. P. MESSANA, ceramic terminals; J. LEIGHTON, production problems of fire-control equipment; R. O. WISE, the interchangeability of aircraft components; C. W. RAMSDEN, the manufacture of a modulation network; F. W. WEBB, a special radio project; and J. B. D'ALBORA, fire-control equipment.

"The Telephone Hour"

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

January 10	*Marian Anderson*
January 17	*Ezio Pinza*
January 24	*Jascha Heifetz*
January 31	*Bidu Sayão*
February 7	*Ferruccio Tagliavini*
February 14	*Clifford Curzon*

W. KOENIG and A. E. RUPPEL have written on *Quantitative Amplitude Representation in Sound Spectrograms* in the November, 1948, issue of *The Journal of the Acoustical Society of America,* and L. G. KERSTA on *Amplitude Cross-Section Representation With the Sound Spectrograph.*

A. F. POMEROY has been appointed chairman of the I.R.E. Technical Committee on Symbols, a member of the I.R.E. Annual Review Committee and a member of the I.R.E. Standards Committee.

T. A. DURKIN and L. R. SMITH discussed inspection results of inside wiring cable at the Tonawanda plant of Western Electric.

C. SHAFER, JR., and R. W. BURNS with J. C. Zeigler of A T & T went to Birmingham, Ala., in connection with studies of means of detecting cable sheath troubles.

THE LABORATORIES were represented in interference proceedings at the Patent Office during October by R. J. GUENTHER before the Primary Examiner, and by H. O. WRIGHT before the Interference Examiner. Mr. Wright has recently been admitted to practice before the Court of Customs and Patent Appeals in Washington.

A. MENDIZZA attended the Electrochemical Society convention in New York and also a meeting of A.S.T.M. Committee B-8, which was conducted in conjunction with the convention. He also attended a meeting of A.S.T.M. Committee B-7 in Philadelphia to discuss outdoor exposure tests that are proposed for aluminum and magnesium.

O. P. CLARK, J. G. MATTHEWS and R. C. NEWHOUSE observed tests of aircraft communication equipment at the Naval Air Test Center at Patuxent River.

E. T. STAMMER and H. A. BAXTER's visit to General Mills, Minneapolis, concerned new submarine equipment.

J. W. SMITH, H. VADERSEN and F. E. NIMMCKE went to Washington for the purpose of discussing specifications for modified fire control equipment.

W. C. TINUS accompanied an Army Ordnance Group on a tour of European laboratories.

J. F. SWEENEY conferred on airplane installation problems at the Consolidated Vultee Corporation at Fort Worth, Texas.

M. N. YARBOROUGH went to Detroit for consultations at Brooks and Perkins Company on military projects.

Prospectus for Second Employee Stock Offering

Members of the Laboratories who are eligible to participate in the second offering of A T & T stock under the Employees' Stock Plan have received copies of the prospectus setting forth the terms. They have until January 31 to elect to purchase shares.

Employees with three months' service or more on November 30, 1948, are eligible to participate. The purchase price per share will be $20 below the market price at the time payments are completed, but will in no event be more than $150 nor less than $100.

An employee may purchase one share of stock for each $500 of his annual basic rate of pay on November 30, 1948. These shares may be in addition to shares which he may be buying under the 1947 offering, except that no employee may purchase a total of more than 50 shares under both offerings.

Payments will be made at the rate of $5 per share per month by payroll allotments which will begin next March. Interest will be credited on installment payments at the rate of 2 per cent per year compounded semi-annually.

Each prospectus was accompanied by material which includes an Election to Purchase Form, a Payroll Allotment Authorization Form and a notice as to where the various forms should be sent.

Legion's Christmas Party for Hospitalized Veterans

Wounded and sick soldiers at the Manhattan Beach Veterans' Administration Hospital had a happier Christmas than usual this year, thanks to the Bell Telephone Post 497 of the American Legion. Each of the 360 men received a gaily wrapped gift package, topped with a poinsettia, in which were nail clippers, a cigarette holder, comb, key chain, tissues, and cigarettes. While some of the gifts were donated by business concerns, most of them were purchased by the Bell Post and employees of the Western at 1495 Herkimer Street, Brooklyn.

An entertainment, by the Union Men's Glee Club of the First Congregational Church of Richmond Hill and by children of the Seidler Sisters School of Modern Dancing, was followed by the presentation of a page turner to the hospital, the gift of the Page Turner Club of the Laboratories.

International Relations Group

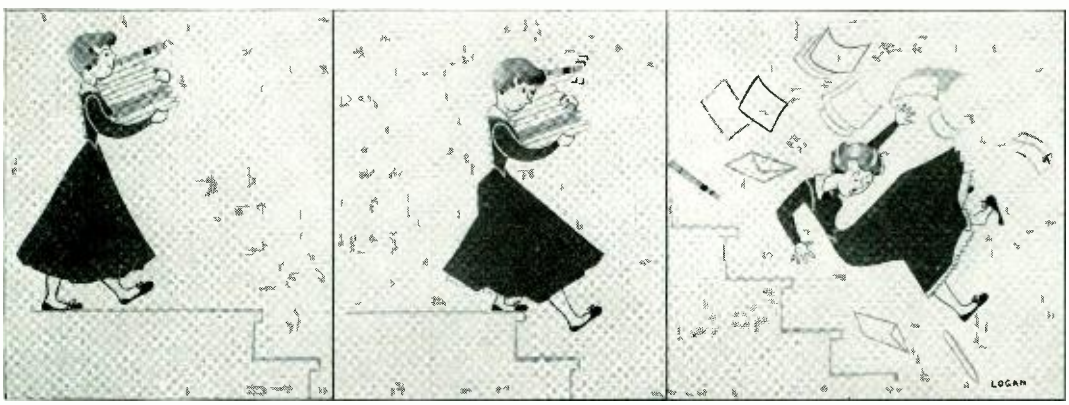
The International Relations Group of the Bell Laboratories Club at Murray Hill is adding many new members to its noon hour discussions, designed to broaden the members' outlook on world affairs. A recent guest of the group, W. Arthur McKenney, Assistant to the Chief Executive, Boy Scouts of America, described the World Jamboree held at Paris and its results in terms of lasting international friendships. On December 7, M. J. Kelly presented to the group his personal observations on Europe's Progress in Recovery.

Certificate From G N Y F

Appreciation of the Greater New York Fund has been expressed to the Laboratories by a certificate in recognition of the support given by its members to the 1948 campaign. The Fund undertakes each year to appeal to the employees of the larger corporations in behalf of hospitals, health and welfare organizations. C. H. Achenbach, Power Development Engineer, conducted the 1948 solicitation.

Cal Tech Alumni See Murray Hill

Members of the New York Chapter of the California Institute of Technology Alumni visited Murray Hill on November 29. After a snack supper had been served in the dining room, the fifty guests assembled in the Arnold



Auditorium for short talks by J. W. McRae, J. A. Becker, R. J. Kircher, H. E. Mendenhall, J. R. Pierce and H. K. Dunn. Then the group subdivided to encounter the silence of the quiet room and to visit a few other laboratories for talks about *Growing Crystals* by J. M. Richardson, *Magnetic Domains* by R. M. Bozorth, *Electron Emission* by G. E. Moore and *Television Quality* by B. M. Oliver.

In spite of two cars temporarily losing the way as a result of strange street signs, snow on the landscape and ice on the windshields, the ex-Californians all decided it had been an evening well spent.

Clifford Burton, the new president of the local Cal Tech Club, conducted the meeting. H. E. Mendenhall, the retiring president, helped with the arrangements. Other members of the Laboratories acted as guides and hosts.

Engagements

*Jean Asbury—George V. Smith
*Inga Cassano—Joseph Gaviglia
*Catherine Cheevers—William Kondrat
*Jean D'Amico—George Rocco
*Bernadette Fullhardt—Vincent J. Ferrara
*Reine Levesque—Robert D. Hudkins
*Bette MacEvoy—*Morgan Sparks
*Frances McDonnell—Thomas Egan
*Eileen P. McHenry—Edward F. Burns
Betty Roome—*Robert Erbig
Shirley Smith—*James Z. Menard
*Marie Tighe—*Ernest Guzmich
Elizabeth Uptegrove—*Warren E. Mathews

Weddings

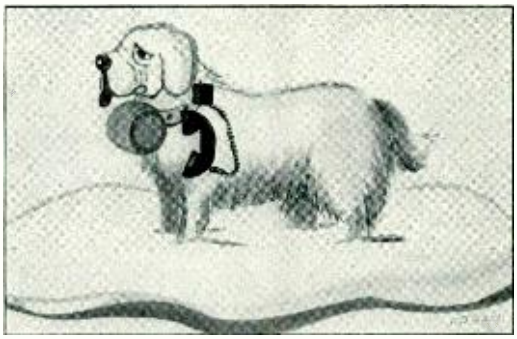
*Helen Bouselli—Edward P. Duggan
*Jean Brzezinska—Eugene Czajkowski
Anna Marie Eilbacher—*Carl W. Fink
*Doris Hogben—A. E. Kudrle
*Eleanor Hoppe—*John W. Pollio
*Florence Makoske—John P. Karbowski
Agnes Wales—*Albert L. Robinson
*Doris Wolek—William A. Vanderputten

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

Field Engineering Force Changes

Substantial shifts and increases in the workload of the Field Engineering Force during the past few years have necessitated a number of rearrangements in the assignment of territory to the various Field Offices. In connection with these rearrangements, four new Field Offices in Boston, Dallas, Denver, and Los Angeles have been opened and a number of the Field Engineers have received new office assignments. These changes have now been completed as follows:

R. E. Friedley (formerly Field Engineer—New York No. 1) becomes Field Engineer—Boston; L. E. Gaige (formerly Field Engineer—New York No. 2) becomes Field Engineer—New York No. 1; G. N. Queen (formerly Field Engineer—Atlanta) becomes Field Engineer—New York No. 2; L. F. Porter succeeds him at Atlanta. R. V. Dean becomes Field Engineer at Dallas; J. H. Miller, at Denver; and R. E. Johnson, at Los Angeles.



Colored Telephone Sets

Production has been resumed on colored telephone sets of the combined type, with the ivory color to be available first and old rose, gray-green, dark blue and Pekin red to follow shortly. These colors are mixed with powdered plastic before molding. The four metallic colors, statuary bronze, dark gold, oxidized silver, and old brass will be produced by finishes applied in Western Electric's distributing house shops. Colored sets will be available initially in the Nos. 302, 304, 305 and 306 sets, and later in the 354 set.

Emergency Telephone Service

Five small towns in Nebraska got their telephone service to the outside world over radio links following the severe snowstorm last November. Four of them were served by single-channel portable radio stations stocked by the telephone companies for emergencies; for the fifth town, two channels were made available by superposing a type-H carrier system on an AN/TRC-1 radio system borrowed from the Signal Corps. That system is designed to furnish one voice channel with frequency-space available for a carrier system.

Retired but Active

Joseph P. Maxfield, who retired on September 30, 1947, has accepted the position of Superintending Scientist at the U. S. Navy Electronics Laboratory in San Diego, California, where he will be in charge of the laboratory's scientific and technical research in the field of radio, radar, and sonar.

BELL LABORATORIES CLUB ACTIVITIES

Activity	*Chairman*	*Meeting Place*	*Time*
Archery	W. G. Laskey (West Street)	Washington Irving High School	Tuesdays and Wednesdays 7:00
	C. A. Bengtsen	Whippany	Noontime
	W. D. Goodale	Murray Hill	Noontime
Arts and Crafts	F. Frampton (New York Area)	Building T	
Bowling	Mary Upton (West Street)	Village Recreation Center, N. Y. C.	Fridays 5:45
	E. W. O'Hara (West Street)	National Bowling Recreation Arena	Wednesdays and Fridays 5:45
	H. K. Meyer (Whippany)	O'Dowd Bowling Alley, Pine Brook	Fridays 6:15
	H. Watkinson (Murray Hill)	South Orange	Thursdays 6:30
		Plainfield	Mondays 6:45
Bridge	E. G. Walsh (West Street)	1-H Game Room	Mondays 6:00
	Dorothy Thom (Murray Hill)	Murray Hill Restaurant	Mondays 5:45
Chess	H. G. W. Brown (West Street)	1-H Game Room	Noontime and Evenings
Glee Club	Phyllis Taylor (Murray Hill)	Summit Y.M.C.A.	Wednesdays 8:00
	J. Kovac (Whippany)	Whippany Lounge Room	Noontime
Golf	W. F. Malone	New Jersey	
Horseshoe Pitching		Bethune Street	Noontime
		Whippany	Noontime
International Club	H. W. Dudley	Murray Hill	Mondays Noontime
Model Railroading	P. Mallery (West Street)	West Street	Meetings as announced
	V. T. Wallder (Murray Hill)	Murray Hill	Meetings as announced
Model Railroading (*Cont'd*)	W. L. Rohr (Graybar-Varick)	West Street	Meetings as announced
	D. W. T. Cotte (Whippany)	Whippany	Meetings as announced
Motion Picture Camera Club	D. F. Hoth (West Street)	West Street Auditorium	2nd Wednesday 5:45
	J. J. Harley (Murray Hill)	Murray Hill	Noontime and Evenings as announced
Orchestra	L. E. Mellmish (West Street)	West Street Auditorium	Tuesdays 6:00
	R. R. Galbreath (Murray Hill)	Murray Hill Auditorium	Tuesdays 5:15
Photo Forum	E. Alenius	West Street Auditorium	3rd Wednesday 5:45
	W. L. Filmer	Whippany	As announced
Rifle Club	R. E. Strebel (New York Area)	W. E. Co. Range Kearny	Tuesdays 7:00
	G. Benson (New Jersey Area)	Summit	Thursdays 8:00
Stamp Club	P. W. Blye (New York Area)	West Street Conference Dining Room	Monday Luncheons
	A. N. Holden (Secretary at Murray Hill)	Murray Hill	Noontime and Evenings as announced
Swimming Classes	W. C. Buckland (Murray Hill)	Plainfield Y.W.C.A.	Wednesdays 6:00
Swimming and Gym for Men	A. J. Kuczma (New York Area)	Textile High School	Thursdays 5:30
Table Tennis	J. V. Elliott (New York Area)	West St. Auditorium and Graybar-Varick	Noontime and Evenings
	Dorothy Clothier (Whippany)	Whippany	Noontime
	F. C. Ong (Whippany)	Whippany	Noontime
Volley Ball	H. Rosier (Whippany)	Whippany	Noontime
	Betty Engstrom (Whippany)	Whippany	Noontime